Limestone West Timber Sale
Draft Environmental Impact Statement

Montana Department of Natural Resources and Conservation
Bozeman Unit

August 31, 2018

Dear Reader:

The Montana DNRC Limestone West Timber Sale Draft Environmental Impact Statement (DEIS) is now available for your review and comment. The DEIS will be available for a 60-day public review period ending **October 30, 2018**.

You may access the Draft EIS on our project website at http://dnrc.mt.gov/divisions/trust/forest-management/limestone-west/limestone-west-environmental-documents

Starting in March 2016, the Montana Department of Natural Resources and Conservation (DNRC), Bozeman Unit began work on developing the proposed Limestone West Timber Sale Project. Through a series of public participation events, consideration of public comment, and extensive field work and analysis, DNRC has developed three Action Alternatives designed to meet the proposed project objectives and address issues and concerns raised by the public.

We invite you to:

- Review and submit comments on this Draft EIS by **October 30, 2018**. Please submit comments:
- **By E-mail**: LimestoneWest@mt.gov
- **Or by Mail**:

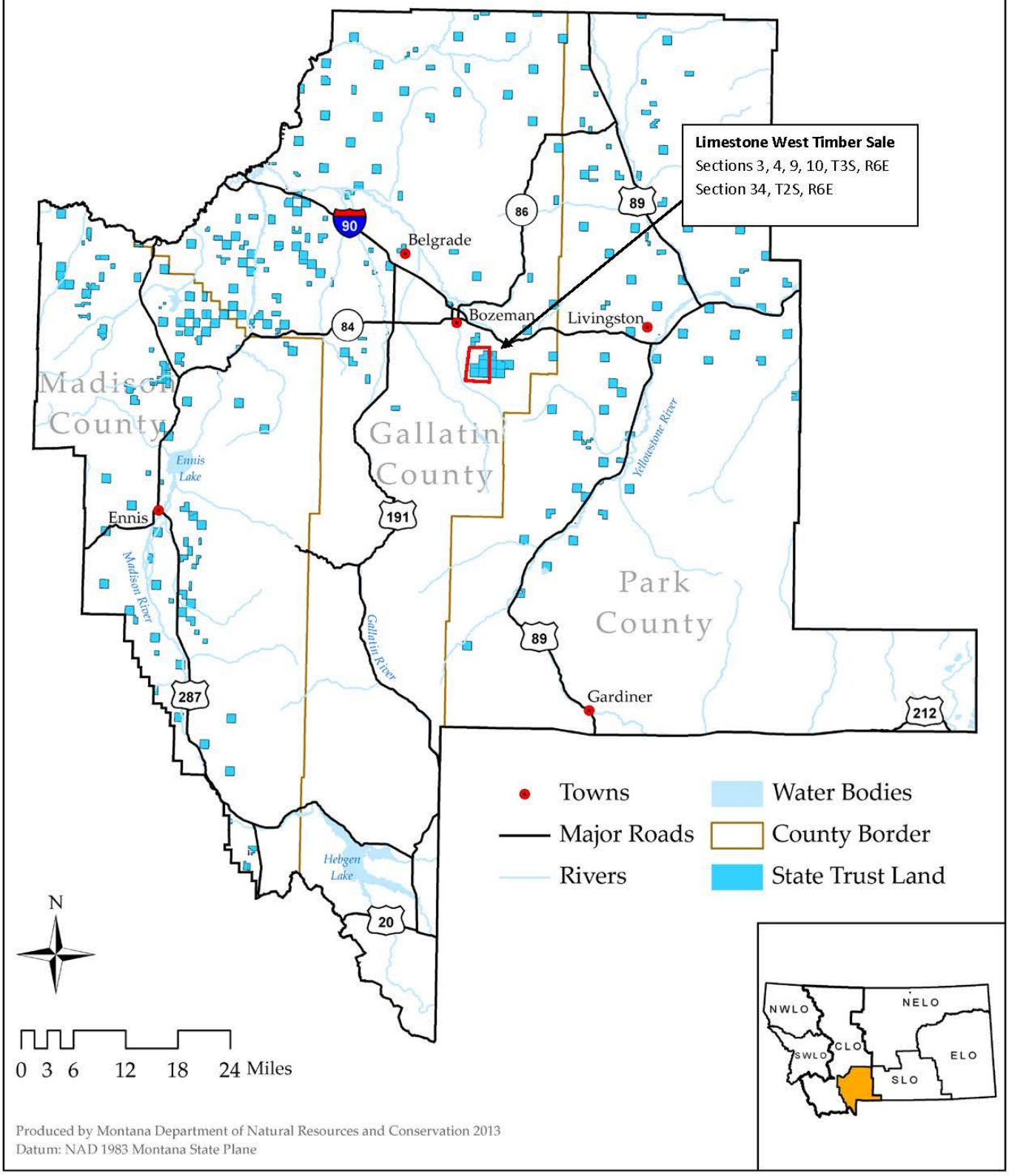
  To: Chuck Barone, Project Leader
  ATTN: Limestone West
  Timber Sale
  Montana DNRC
  2273 Boot Hill Court, Ste. 110
  Bozeman, MT 59715

Thank you for your interest in this project and the management of state trust lands.

Sincerely,

Craig Campbell
Bozeman Unit Manager

LIMESTONE WEST TIMBER SALE VICINITY MAP
BOZEMAN UNIT



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LIMESTONE WEST TIMBER SALE
DRAFT ENVIRONMENTAL IMPACT STATEMENT

PREFACE

This document has been designed and developed to provide the decisionmaker with sufficient information to make an informed, reasoned decision concerning the Limestone West Timber Sale (proposed action) and to inform the interested public about this project so they may express their concerns to the project leader and decisionmaker.

The DEIS consists of the following sections:

- Chapter I – Purpose and Need
- Chapter II – Alternatives
- Chapter III – Existing Environment and Environmental Effects
- References
- Preparers and Contributors
- Scoping List and Respondents
- Stipulations and Specifications
- Glossary
- Acronyms and Abbreviations

CHAPTERS I and *II* offer a summary overview of the proposed action. These chapters have been written so nontechnical readers can easily understand the purpose and need of the proposed action, alternatives to the proposed action, and the potential environmental, economic, and social effects associated with the no-action and action alternatives.

CHAPTER I provides a brief description of the proposed action and explains key factors about the project, such as:
1) the purpose and need of the proposed action, which includes the project objectives;

2) the *Environmental Impact Statement* (*EIS*) process, which includes how scoping is done and the decisions made by the decisionmaker concerning this project;

3) the proposed schedule of activities;

4) the scope of this *Draft Environmental Impact Statement* (*DEIS*), which includes other relevant projects, issues studied in detail, and issues eliminated from further analysis, and

5) the relevant laws, regulations, and consultations with which DNRC must comply.

CHAPTER II provides detailed descriptions of the No-Action and the Action Alternatives. Included is a summary comparison of project activities associated with each alternative and a summary comparison of the predicted environmental effects of each alternative. These

comparisons provide the decisionmaker a clear basis for choice between the No-Action and Action Alternatives.

CHAPTER III briefly describes the past and current conditions of the pertinent ecological and social resources in the project area that would be meaningfully affected, establishing a part of the baseline used for the comparison of the predicted effects of the alternatives. Chapter III also presents the detailed, analytic predictions of the potential direct, indirect, and cumulative effects associated with the No-Action and Action Alternatives.

REFERENCES list the references utilized in the DEIS.

PREPARERS AND CONTRIBUTORS lists the preparers of the DEIS.

SCOPING LIST AND RESPONDENTS lists the persons, agencies, and organizations that are listed to receive scoping documents, newsletters, and public participation activities associated with the proposed action. This list also contains those individuals who submitted issues and concerns regarding the proposed action. Some individuals submitted comments without their name and could not be listed here.

STIPULATIONS AND SPECIFICATIONS includes a list of measures designed to prevent or reduce the potential effects to the resources considered in this DEIS.

GLOSSARY defines the technical terms used throughout the document.

ACRONYMS AND ABBREVIATIONS lists the acronyms and abbreviations used throughout the document.

Table of Contents

CHAPTER 1 1

PURPOSE AND NEED 1

PROJECT LOCATION 1

PURPOSE AND NEED 1

DRAFT ENVIRONMENTAL IMPACT STATEMENT PROCESS 2

DEVELOPMENT OF ISSUES AND ALTERNATIVES 3

PROPOSED SCHEDULE OF ACTIVITIES 3

SCOPE OF THIS DEIS 4

RELEVANT PAST, PRESENT, AND REASONABLY FORESEEABLE ACTIONS 4

ISSUES STUDIED IN DETAIL AND ISSUES ELMINATED FROM FURTHER ANALYSIS 6

RELEVANT AGREEMENTS, LAWS, PLANS, PERMITS, LICENSES, AND OTHER REQUIREMENTS 11

CHAPTER II 15

ALTERNATIVES 15

COMPARISON OF ACTIVITIES (TABLE) 19

ACHIEVEMENT OF PROJECT OBJECTIVES 20

ALTERNATIVE COMPARISON OF ENVIRONMENTAL IMPACTS. 22

CHAPTER III 69

EXISTING ENVIRONMENT AND ENVIRONMENTAL EFFECTS 69

VEGETATION ANALYSIS 70

GEOLOGY AND SOILS ANALYSIS 96

WATERSHED AND FISHERIES ANALYSIS 110

WILDLIFE ANALYSIS 123

ECONOMIC ANALYSIS 229

AIR QUALITY ANALYSIS 237

TRANSPORTATION ANALYSIS 242

RECREATION ANALYSIS 258

AESTHETIC ANALYSIS 266

REFERENCES 280
PREPARERS AND CONTRIBUTORS 291
LIMESTONE WEST DEIS SCOPING LIST 292
STIPULATIONS AND SPECIFICATIONS 295
GLOSSARY 301
ACRONYMS AND ABBREVIATIONS 312
APPENDIX A 314
APPENDIX B 344

CHAPTER 1
PURPOSE AND NEED

PROJECT LOCATION

The Montana Department of Natural Resources and Conservation (DNRC), Trust Land Management Division, Bozeman Unit is proposing the Limestone West Timber Sale. The project area is located approximately 5 miles southeast of Bozeman, Montana on Public Buildings and School of Mines Trust Lands. The project area is approximately 2,725 acres within sections 3, 4, 9, and 10, Township 3 South, Range 6 East and section 34, Township 2 South, Range 6 East.

PURPOSE AND NEED

Sizeable areas of the lodgepole pine trees within the proposed harvest area have experienced serious infestations of mountain pine beetle in the past years resulting in significant rates of mortality in the mature age classes. The Douglas-fir stands within the area are confronted with health and vigor issues due to the overstocked conditions and would benefit from selective harvesting practices.

Active forest management in the project area would produce revenue for the trust beneficiaries while encouraging the development of sustainable forest conditions consistent with programmatic goals of managing for healthy and biologically diverse forests.

The lands involved in the proposed action are held by the State of Montana for the support of the Public Buildings and School of Mines (Enabling Act of February 22, 1889). The Board of Land Commissioners (Land Board) and DNRC are required by law to administer these trust lands to produce the largest measure of reasonable and legitimate return over the long run for these beneficiary institutions (1972 Montana Constitution, Article X, Section 11; Montana Code Annotated [MCA] 77-1-202).

Management of the lands in the project area is guided by DNRC's *State Forest Land Management Plan* (*SFLMP*), *Forest Management Rules* (*Administrative Rules of Montana [ARM] 36.11.401* through *470*), and the *Montana DNRC Forested State Trust Lands Habitat Conservation Plan (HCP)*. The *SFLMP* has the following philosophy:

"Our premise is that the best way to produce long-term income for the trust is to manage intensively for healthy and biologically diverse forests. Our understanding is that a diverse forest is a stable forest that will produce the most reliable and highest long-term revenue stream. Healthy and biologically diverse forests would provide for sustained income from both timber and a variety of other uses. They would also help maintain stable trust income in the face of uncertainty regarding future resource values. In the foreseeable future, timber management will continue to be our primary tool for achieving biodiversity objectives." (DNRC 1996a: Record of Decision [ROD] 1 and 2)

PROJECT OBJECTIVES

In order to fulfill its trust mandate and the management philosophy adopted through the SFLMP and Forest Management Rules, DNRC has developed the following project objectives:

- Manage the forest resource to promote improved health, productivity, and diversity.
- Capture the value of dead and dying lodgepole pine.
- Generate revenue for the trust beneficiaries.
- Minimize fire and safety risks imposed by current forest conditions.
- Enhance and expand the existing transportation system to provide improved access for long-term future management of the area and fire suppression needs.

DRAFT ENVIRONMENTAL IMPACT STATEMENT PROCESS

This section describes the process by which the Interdisciplinary Team (ID Team) developed this DEIS. The DEIS was developed in compliance with the Montana Environmental Policy Act (MEPA); MCA 75-1-101 through 75-1-324, and DNRC Procedural Rules (ARM 36.2.521 through 543).

PUBLIC INVOLVEMENT

DNRC invited interested individuals, agencies, and organizations to identify issues and concerns associated with this proposed action. Public involvement activities included public scoping, public meetings, field tours, and updates.

Public Scoping

Public scoping occurs in the initial stages of the EIS process. Interested parties are informed that DNRC is proposing an action and invited to submit their comments related to the proposed action (*ARM 36.2.526*).

In March 2016, DNRC distributed the scoping notice and invited public comments. The initial proposal was mailed to individuals, agencies, internal DNRC staff, industry representatives, and other organizations that had expressed interest in Bozeman Unit management activities (see SCOPING LIST AND RESPONDENTS). The scoping notice included the objectives of the project, proposed activities, and contact information.

On June 9, 2016, DNRC distributed a second scoping notice to provide more detailed information about the proposed sale and a map. It also invited interested parties to attend a presentation at the Bozeman Unit office.

On June 23, 2016, DNRC held a public meeting at the Bozeman Unit Office. Approximately 100 people attended the meeting. DNRC presented plans for the Limestone West Timber Sale and answered questions.

Project updates were sent out to interested parties December 22, 2016; February 9, 2018; and March 20, 2018.

DEVELOPMENT OF ISSUES AND ALTERNATIVES

ISSUES STUDIED IN DETAIL AND ISSUES ELIMINATED FROM FURTHER ANALYSIS

After reviewing the responses received during the scoping period and other public participation events, the ID Team identified 41 issues related to the project (see *ISSUES STUDIED IN DETAIL AND ISSUES ELIMINATED FROM FURTHER ANALYSIS* under *SCOPE OF THIS DEIS* later in the chapter). These issues, issues raised by the ID Team, and requirements imposed by applicable rules, laws, and regulations provided the framework by which the ID Team developed a range of alternatives. The ID Team designed the action alternatives to meet the project objectives to varying degrees and identified the direct, indirect, and cumulative impacts on relevant resources in the project area.

DRAFT ENVIRONMENTAL IMPACT STATEMENT

During summer of 2018, the ID Team prepared the *DEIS* for publication. A letter of notification was sent to individuals on the scoping list on August 31, 2018 (see *SCOPING LIST AND RESPONDENTS*), which initiated a 60-day comment period.

FINAL ENVIRONMENTAL IMPACT STATEMENT

After public comments are received, compiled, and addressed, DNRC will prepare a *Final Environmental Impact Statement* (*FEIS)* or adopt the *DEIS* as the *FEIS*. The *FEIS* would consist primarily of a revision of the *DEIS* that would incorporate additional information based on public and internal comments. The *FEIS* would also include responses to substantive comments within the scope of the project that were received during the 60-day public review period of the *DEIS*.

NOTIFICATION OF DECISION

Following publication of the FEIS, the decisionmaker will review public comments, the FEIS, and information contained in the project file. No sooner than 15 days after the publication of the FEIS, the decisionmaker will consider and determine the following:

- Do the alternatives presented in the FEIS meet the project's purpose and objectives?
- Are the proposed mitigations adequate and feasible?
- Which alternative (or combination/modification of alternatives) should be implemented and why?

These determinations will be published, and all interested parties will be notified. The decisions presented in the published document would become recommendations from DNRC to the Montana Board of Land Commissioners (Land Board). Ultimately, the Land Board will make the final decision to approve or not approve the project.

PROPOSED SCHEDULE OF ACTIVITIES

After the decision is published, and if an action alternative is selected, DNRC would prepare a timber sale contract package. The timber sale contract package would tentatively be scheduled for presentation to the Land Board December 2018. If the Land Board approves the timber sale, the sale may be advertised that winter. The sale would be advertised to potential bidders as a timber sale and as a conservation license in lieu of timber sale. If the sale is sold for timber

harvest, harvesting and roadwork activities would take place for 2 to 3 years. If the sale is sold for a conservation license in lieu of timber sale, no harvest activities would take place for the term of the license.

SCOPE OF THIS DEIS

This section describes those factors that went into determining the scope (depth and breadth) of this environmental analysis.

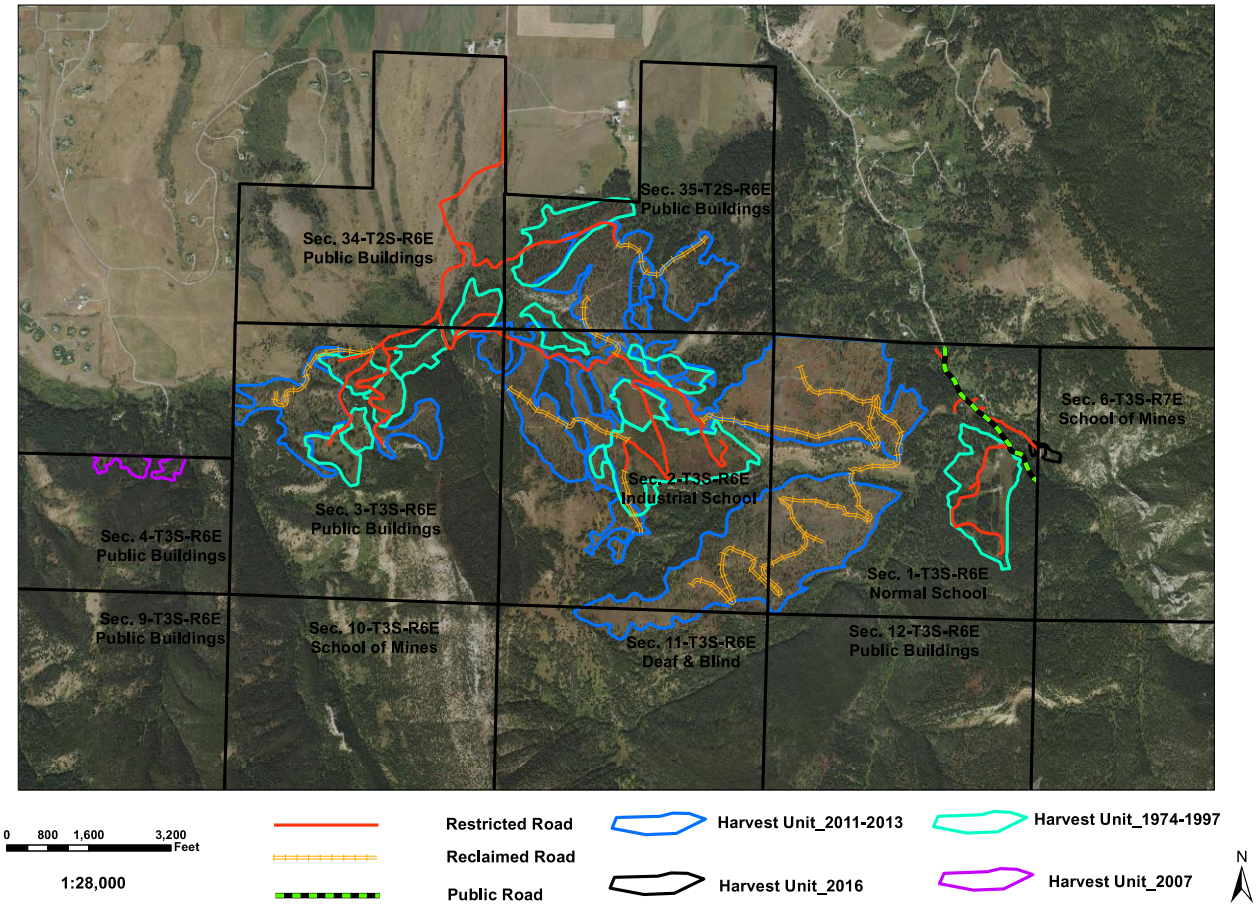
RELEVANT PAST, PRESENT, AND REASONABLY FORESEEABLE ACTIONS

In order to adequately address the cumulative impacts of the proposed action on relevant resources, each analyst must account for the impacts of past, present, and reasonably foreseeable actions within a determined analysis area. The locations and sizes of the analysis areas vary by resource (watershed, soils, etc.) and species (bull trout, grizzly bear, etc.) and are further described by resource in *CHAPTER III – EXISTING ENVIRONMENT AND ENVIRONMENTAL IMPACTS*.

Past, present, and reasonably foreseeable actions on DNRC managed lands and adjacent land ownerships were considered for each analysis conducted for this *EIS*. DNRC often lacked data regarding actions on adjacent land ownerships; therefore, resource specialists were limited to qualitatively describing and considering, rather than quantifying, such actions for cumulative impacts.

FIGURE I-1 – MAP OF ALL HARVESTS IN BEAR CANYON BLOCK

Bear Canyon Block_All Harvests_1974 - 2017



The following list encompasses other relevant actions considered in this *DEIS*:

- DNRC 1980-1981 Bear Canyon Timber Sale – Harvest on approximately 67 acres within Section 2 T3S R6E & approximately 39 acres within Section 35 T2S R6E.
- DNRC 1990-1991 Lower Bear Canyon Viewshed Harvest – Harvest on approximately 80 acres within Sections 34 T2S R6E and Section 3 T3S R6E.
- DNRC 1993-1994 Upper Bear Canyon Multi-Product Timber Permit – Harvest on approximately 12 acres within Section 2 T3S R6E.
- DNRC 2007 Eagle Rock Fuels Reduction – Harvest on approximately 11 acres within Section 4 T3S R6E.
- DNRC 2007 Pre-commercial thinning -- approximately 10 acres within Section 2 T3S R6E.
- DNRC 2010 Eight firewood permits -- 40 cords total (5 cords per permit).
- Livestock grazing Sections 34, 35 T2S, R6E.
- Permits issued across approximately 66 acres from 1974 to 2015 in Sections 1, 2, 3, T3S R6E; Section 34, T2S R6E; Section 6, T3S R7E.

- USDA Forest Service 2011, Gallatin National Forest, Bozeman Ranger District, Bozeman Municipal Watershed Project. Approximately 4,675 acres. Project duration 5 to 12 years.
- Bear Canyon Timber Sale 2011
    - Project Area: 3,500 acres
    - Harvest Area: 674 acres
    - Sections 1, 2, 3, and 11, Township 3 South (T3S), Range 6 East (R6E), and Sections 34 and 35 Township 2 South (T2S), Range 6 East (R6E)
    - 7 million board feet (7 MMbf)
    - Group selection, selection, and clearcutting harvest types
    - Approximately 7.7 miles of new roads closed with slash and debris after harvest completion
- Forest management projects on adjacent private ownerships.
- Homes and human development along the periphery of the project area and Bear Canyon vicinity.

ISSUES STUDIED IN DETAIL AND ISSUES ELMINATED FROM FURTHER ANALYSIS

Issues are statements of concern about the potential impacts the project may have on various resources. The ID Team identified 41 issues raised internally and by the public. Some issues were determined to be relevant and within the scope of the project. These were included in the impacts analyses and used to assist the ID Team in developing a reasonable range of alternatives (TABLE I - 1 – ISSUES STUDIED IN DETAIL).

Issues that were eliminated from further analysis were those that were determined to not be relevant to the development of alternatives or were beyond the scope of the project, and were, therefore, not carried through the impacts analyses (See Appendix A, ISSUES ELIMINATED FROM FURTHER ANALYSIS).

TABLE I-1 - ISSUES STUDIED IN DETAIL. Issues studied in detail by resource area and where addressed in the DEIS.

ISSUES STUDIED IN DETAIL	WHERE ADDRESSED IN DEIS
VEGETATION	
Timber harvesting activities associated with this project may alter forest cover type and age class conditions.	Chapter III, Pages 75-82
Harvesting activities and conifer encroachment into aspen galleries may reduce the amount of aspen in the project area.	Chapter III, Pages 82-86

Timber harvesting associated with this project may adversely affect old-growth forests in the project area.	Chapter III, Pages 76-81
Timber harvesting activities associated with this project may affect the ability of non-old growth stands to eventually qualify as old growth.	Chapter III, Pages 76-81
There are concerns about current levels of forest insects and diseases and the effectiveness of active forest management to address those issues.	Chapter III, Pages 82-86
Forest management activities associated with this project may not effectively reduce fire hazard or will directly or indirectly increase fire hazard in the project area.	Chapter III, Pages 91-92
There are concerns about fire hazard and potential fire behavior associated with beetle-killed lodgepole pine and associated forest management activities.	Chapter III, Pages 91-92
Forest management activities associated with this project may adversely affect native flora, threatened, endangered, or sensitive plant species, or rare and unique habitats.	Chapter III, Pages 92-93
Timber harvesting and road building may introduce or spread noxious weeds in the project area.	Chapter III, Pages 93-95
GEOLOGY AND SOILS	
Traditional ground-based harvest operations have the potential to compact and displace surface soils which can reduce hydrologic function, macro-porosity, and/or soil function.	Chapter III, Pages 103-104
Areas of impacted soil function have the potential to increase rates of offsite erosion which may affect productive surface soils.	Chapter III, Pages 104
Harvest activities associated with the proposed actions may cumulatively affect long term soil productivity.	Chapter III, Pages 104
Activities associated with the proposed actions such as timber harvest and road construction have the potential to affect slope stability through localized areas of increased saturation resulting in the exceedance of resisting forces.	Chapter III, Pages 105
The removal of large volumes of both coarse	Chapter III, Pages 104

and fine woody material through timber harvest reduces the amount of organic matter and nutrients available for nutrient cycling possible affecting the long-term productivity of the site.	
WATERSHED AND FISHERIES	
Timber harvesting and related activities, such as road construction, can lead to water-quality impacts by increasing the production and delivery of fine sediment to streams.	Chapter III, Pages 116-118
Timber harvesting and associated activities can affect the timing, magnitude, and volume of water runoff in a harvested watershed.	Chapter III, Pages 118-119
Project activities may affect fish habitat by modifying channel form and function.	Chapter III, Pages 119-120
WILDLIFE	
There is concern that the road system established for this project would appreciably increase recreational use of the project area, which could disturb and displace wildlife and increase hunting pressure.	Chapter III, Pages 154-164
There is concern that the road system established for this project would allow appreciable increases recreational use of the project area and adversely affect the ability of wildlife (particularly elk and moose) to use and move through the area.	Chapter III, Pages 154-164
There is concern that the removal of trees and the road system established for this project and cumulative effects associated with other projects in this roadless area would fragment and adversely affect wildlife habitat and movement corridors for elk, deer, bears, moose, birds and other species in one of the last pieces of habitat relatively undisturbed by people in this section of the Gallatin Valley.	Chapter III, Pages 190-203
There is concern that the proposed removal of trees and construction of roads may adversely affect listed endangered, threatened and sensitive wildlife species.	Chapter III, Pages 187-190
There is concern that increases in roads and long-term non-motorized recreational use associated with them will cause disturbance	Chapter III, Pages 154-164

and displacement of wildlife that use the area and adversely impact habitat connectivity and important linkage areas.	
There is concern that proposed logging would reduce snags and coarse woody debris, which could adversely affect species that depend on these habitat attributes.	Chapter III, Pages 138-141
There is concern that increases in roads, logging disturbance, cover loss, and long-term non-motorized recreational use associated with new restricted roads will reduce security for elk, increase vulnerability, and lower habitat effectiveness, resulting in displacement of elk to neighboring agricultural lands, which could increase game damage conflicts in the local area.	Chapter III, Pages 190-203
There is concern that increases in roads, logging disturbance, cover loss, and long-term non-motorized recreational use associated with new restricted roads will reduce habitat suitability and security for moose resulting in their displacement and/or carrying capacity.	Chapter III, Pages 190-203
There is concern that alteration of vegetation, disturbance caused by logging could reduce the abundance and diversity of birds and other wildlife species.	Chapter III, Pages 187-190
There is concern that activities proposed in this project may create disturbance, increase road amounts, and reduce forest thermal and hiding cover, which could adversely affect wintering elk, mule deer, and white-tailed deer.	Chapter III, Pages 190-203
There is concern that the presence of roads and loss of cover associated with logging could adversely affect elk calving areas on the project area.	Chapter III, Pages 190-203
There is concern that specifically, habitat within the Gallatin Bridger Big Belt Wildlife Corridor will suffer degradation and lowered effectiveness due to removal of trees and new roads as a part of proposed logging.	Chapter III, Pages 129-137

ECONOMICS	
The proposed action may directly affect private income and employment in the regional economy. Potential economic benefits from this sale may also include additional revenues for state trust beneficiaries, infrastructure development, and other forest improvements on state trust forestlands.	Chapter III, Pages 234-236
AIR QUALITY	
Dust produced from harvest activities, road building and maintenance, and hauling associated with this project may adversely affect local air quality.	Chapter III, Pages 238-241
Smoke produced from logging slash pile and broadcast burning associated with this project may adversely affect local air quality.	Chapter III, Pages 238-241
TRANSPORTATION	
Concern that harvest activities may disturb the Triple Tree Trail.	Chapter III, Pages 247-257
Increase in road densities may result in motorized use of the area which may adversely affect current recreational use of the area.	Chapter III, Pages 247-257
Increased public use would occur as a result of increased road densities associated with the project.	Chapter III, Pages 247-257
Traffic and other harvest activities may adversely affect the public along the haul route both within the project area and on the public roads leading to the harvest area.	Chapter III, Pages 247-257
RECREATION	
Harvest activities may adversely affect recreational experiences within the project area including hiking, skiing, hunting, horseback riding, birding, mountain biking, and general enjoyment of the area.	Chapter III, Pages 261-265
Harvest activities may affect the amount, location, use, and condition of many existing trails and other developed facilities within the project area.	Chapter III, Pages 261-265

Increase in road densities may result in increased recreational use and trails, changing the character of the project area.	Chapter III, Pages 261-265
AESTHETICS	
Harvest activities, such as road construction, slash/debris piles and harvest design, may adversely affect the visual quality of the landscape as seen from within the proposed project area, neighboring properties, and the City of Bozeman.	Chapter III, Pages 269-276
Activities associated with this project may increase local noise levels.	Chapter III, Pages 269-276

RELEVANT AGREEMENTS, LAWS, PLANS, PERMITS, LICENSES, AND OTHER REQUIREMENTS

Management activities on the lands within the proposed project area must comply with the following agreements, laws, plans, permits, licenses, and other authorizations. Individual resource analyses in *Chapter 3* may either expand on the following information or include other relevant agreements.

ENABLING ACT (1889) AND 1972 MONTANA CONSTITUTION

By the Enabling Act approved February 22, 1889, the United States Congress granted certain lands to the State of Montana for the support of common schools and other public institutions. These lands are held in trust for the specific trust beneficiaries to which they were assigned and ultimately for the people of the State of Montana (1972 Montana Constitution Article X, Section 11). The lands involved in the proposed project area are designated to generate revenue for the Public Buildings and School of Mines. The Land Board and DNRC are required by law to administer these lands to produce the largest measure of reasonable and legitimate return over the long run for this beneficiary institution (MCA 77-1-202).

STATE FOREST LAND MANAGEMENT PLAN

DNRC developed the SFLMP to "provide field personnel with consistent policy, direction, and guidance for the management of state forested lands" (DNRC 1996b: Executive Summary). The SFLMP provides the philosophical basis, technical rationale, and direction for DNRC's forest-management program. The SFLMP is premised on the philosophy that the best way to produce long-term income for the trust is to manage intensively for healthy and biologically diverse forests. In the foreseeable future, timber management will continue to be the primary tool for achieving biodiversity objectives on DNRC-managed forested trust lands.

DNRC FOREST MANAGEMENT RULES

DNRC's Forest Management Rules (ARM 36.11.401 through 456) are the specific legal resource management standards and measures under which DNRC implements the SFLMP and subsequently its forest-management program. The Forest Management Rules were adopted in

March 2003 and provide the legal framework for DNRC project-level decisions and provide field personnel with consistent policy and direction for managing forested state lands. Project design considerations and mitigations developed for this project comply with the Forest Management Rules.

MONTANA FORESTED STATE TRUST LANDS HABITAT CONSERVATION PLAN

In December 2011, the Land Board approved the Record of Decision for the Montana DNRC Forested State Trust Lands HCP. Approval of the Record of Decision was followed by the issuance of an Incidental Take Permit by the U.S. Department of Interior, Fish and Wildlife Service (USFWS). The HCP is a required component of an application for a Permit which may be issued by the USFWS to state agencies or private citizens in situations where otherwise lawful activities might result in the incidental take of federally-listed species. The HCP is the plan under which DNRC conducts forest-management activities on select forested state trust lands while implementing specific mitigation requirements for managing the habitats of grizzly bear, Canada lynx, and three fish species: bull trout, westslope cutthroat trout, and Columbia redband trout.

SUSTAINABLE YIELD CALCULATION

DNRC is required to recalculate the annual sustainable yield for forested trust lands at least every 10 years (MCA 77-5-221 through 223). DNRC defines the Annual Sustainable Yield as: "the quantity of timber that can be harvested from forested state lands each year in accordance with all applicable state and federal laws, including but not limited to the laws pertaining to wildlife, recreation and maintenance of watersheds and in compliance with water quality standards that protect fisheries and aquatic life and that are adopted under the provisions of Title 75, Chapter 5, taking into account the ability of state forests to generate replacement tree growth (MCA 77-5-221)."

Programmatic environmental commitments related to biodiversity, forest health, threatened and endangered species, riparian buffers, old-growth, and desired species mix and cover types are incorporated into the calculation of the annual sustainable yield. The current annual sustainable yield is 56.9 MMbf statewide and was calculated and adopted by the Land Board in 2015.

MONTANA ENVIRONMENTAL POLICY ACT AND DNRC ADMINISTRATIVE RULES FOR MEPA

DNRC's management activities on state school trust lands are subject to the planning and environmental assessment requirements of MEPA (MCA 75-1-101 through 324). MEPA and its implementing rules (ARM 36.2.521 through 543) provide a public process that assures Montana's citizens that a deliberate effort is made to identify impacts before the state government decides to permit or implement an activity that could have significant impacts on the environment.

MEPA requires DNRC and other state agencies to inform the public and other interested parties about proposed projects, the potential environmental impacts associated with proposed projects, and alternative actions that could achieve the proposed project objectives.

MONTANA BEST MANAGEMENT PRACTICES FOR FORESTRY

Montana BMPs consist of forest stewardship practices that reduce forest management impacts to water quality and forest soils. The implementation of BMPs by DNRC is required under ARM 36.11.422. Key forestry BMP elements include: streamside management; road design and planning; timber harvesting and site preparation; stream crossing design and installation; winter logging; and hazardous substances storage, handling, and application.

MONTANA/IDAHO AIRSHED GROUP

The DNRC is a member of the Montana/Idaho Airshed Group which was formed to minimize or prevent smoke impacts while using fire to accomplish land management objectives and/or fuel hazard reduction (Montana/Idaho Airshed Group 2010). As a member, DNRC must submit a list of planned burns to the Smoke Monitoring Unit describing the type of burn to be conducted, the size of the burn in acres, the estimated fuel loading in tons/acre, and the location and elevation of each burn site. The Smoke Monitoring Unit provides timely restriction messages by airshed. DNRC is required to abide by those restrictions and burn only when conditions are conducive to good smoke dispersion.

AIR QUALITY MAJOR OPEN BURNING PERMIT

The DEQ issues permits to entities that are classified as major open burners (ARM 17.8.610). DNRC is permitted to conduct prescribed wildland open burning activities in Montana that are either deliberately or naturally ignited. Planned prescribed burn descriptions must be submitted to DEQ and the Smoke Monitoring Unit of the Montana/Idaho Airshed Group. All burns must be conducted in accordance with the major open burning permit.

GALLATIN COUNTY WEED DISTRICT BOARD

According to MCA 7-22-2151, DNRC is required to enter into written cooperative agreements with district weed boards throughout the state. These agreements must specify mutual responsibilities for noxious weed management on state-owned lands. DNRC Bozeman Unit has entered into a written cooperative agreement with the Gallatin County Weed District Board and reports to the Board on a bi-annual basis.

STREAM PRESERVATION ACT PERMIT

Montana Department of Fish, Wildlife, and Parks (FWP) has jurisdiction over the management of fisheries and wildlife in the project area. A Stream Preservation Act Permit (124 Permit) is required for activities that may affect the natural shape and form of any stream or its banks or tributaries.

SHORT-TERM EXEMPTION FROM MONTANA'S WATER QUALITY STANDARDS

Montana Department of Environmental Quality (DEQ) has jurisdiction over water quality standards within the project area. A Short-Term Exemption from Montana's Water Quality Standards (318 Authorization) may be required if temporary activities would introduce sediment above natural levels into streams or if FWP deems a permit is necessary after reviewing the mitigation measures in the 124 Permit.

TIMBER CONSERVATION LICENSE IN LIEU OF SALE

According to 77-5-208, under the direction of the board, the department may offer and provide a timber conservation license in lieu of the sale and harvesting of the timber to any person under some conditions. DNRC received an application for a conservation license in lieu of timber sale in the fall of 2016. Prospective conservation license bidders reserve the right to bid against timber sale purchasers during the bidding phase of this timber sale project. This EIS analyzes for the issuance of a conservation license in lieu of timber sale and the impacts associated with deferral of forest management for various term lengths in the project area. For ease of interpretation for the reader, the timber conservation license in lieu of sale is referred to as Alternative C throughout the document.

CHAPTER II
ALTERNATIVES

INTRODUCTION

This chapter describes in detail the no-action alternative and 3 action alternatives of the proposed action. This chapter will focus on the:

- ID Team;
- development of the action alternatives;
- description of each alternative;
- summary comparison of project activities associated with each alternative;
- summary comparison of how each alternative achieved the proposed project objectives and summary comparison of the predicted environmental impacts of each alternative; and
- stipulations and specifications common to all action alternatives.

INTERDISCIPLINARY TEAM

An ID Team was formed to work on the proposed action in the spring of 2016. The ID Team consisted of a project leader and resource specialists from various disciplines, including fisheries, wildlife biology, hydrology, geology and soils, policy, economics, and forestry. The role of the ID Team was to summarize issues and concerns, develop alternatives of the proposed action in the project area, and analyze the potential environmental impacts of the alternatives on the human and natural environments.

The ID Team began reviewing resources in the proposed project area soon after the initial scoping period began. Field reviews were conducted and data was collected in the project area to aid in the analyses for affected resources, including vegetation, watersheds and hydrology, fisheries, wildlife, geology and soils, economics, air quality, recreation, and aesthetics. The ID Team conducted in-depth quantitative and qualitative analyses of the data to assess the existing environment for each affected resource and determine the potential environmental impacts of each alternative on the affected resources

DEVELOPMENT OF ALTERNATIVES

Based on data collected from the field and issues received from the public and internally, the ID Team developed a range of alternatives designed to meet project objectives described under *PROJECT OBJECTIVES* in *CHAPTER I – PURPOSE AND NEED*. The action alternatives incorporate harvest unit design, prescriptions, mitigations, and road activities that allow DNRC to conduct forest-management activities consistent with direction contained in the *SFLMP, Forest Management Rules,* and the HCP.

The estimated timber volume produced by each alternative is based on ocular estimates obtained during stand reconnaissance, timber cruise data, professional knowledge of the area, and other available data used in the analysis. Advertised volumes may vary from the preliminary estimated volumes due to the increased statistical accuracy of measured data

obtained during sale layout. While the estimated log volume may be different, the environmental impacts are based on acres treated and postharvest stand conditions.

DESCRIPTION OF ALTERNATIVES

This section describes the No-Action Alternative and Action Alternatives A, B, and C. All alternatives are considered viable alternatives for selection (see FIGURE II-1 – ACTION ALTERNATIVE B, FIGURE II-2 – ACTION ALTERNATIVE C, and TABLE II-1 – COMPARISON OF ACTIVITIES - summarizes and compares project activities associated with each alternative.

1. **No-Action Alternative**: A no-action alternative will be considered and analyzed. Under the No-Action Alternative, no timber harvesting would occur in the project area at this time, and no conservation license would be issued.

2. **Action Alternative A**: This action alternative proposes harvest units using both conventional, ground-based equipment as well as cable harvest systems. This alternative would require the most road infrastructure, treat more acres and be the most visible alternative from recreation corridors and residential areas. This alternative would have the most impact to the character of the Limestone West project area then all other proposed alternatives.

3. **Action Alternative B**: This action alternative proposes harvest units using only conventional, ground-based equipment and defers harvest in the areas identified as highly valuable to the public, notably adjacent to the Triple Tree trail. This alternative would require less road infrastructure, treat less acres, would limit viewshed impacts to surrounding residents and recreational users, and would retain more security cover for wildlife in comparison to Alternative A. This timber sale alternative would have less impact on the character of the Limestone West project area as compared to Alternative A. See FIGURE II-2 below for a map of this alternative.

4. **Action Alternative C:** Under Montana Code Annotated 77-5-208, the Department may accept applications for conservation licenses in lieu of timber sale. DNRC received an application for a conservation license in lieu of timber sale in the fall of 2016. This license is a temporary deferral of timber harvest over a specified geographic area. During the MEPA process, the Department must set the term length of the license as well as other provisions contained within it. Through this application process, conservation license applicants have reserved the right to bid against timber sale purchasers during the bidding phase of this timber sale project. This action alternative will analyze for the issuance of a conservation license in lieu of a timber sale and the impacts associated with deferral of forest management for a term of 10 years. The potential effects of this license would be similar to the No-Action Alternative and will be analyzed accordingly.

FIGURE II-1 – ACTION ALTERNATIVE A

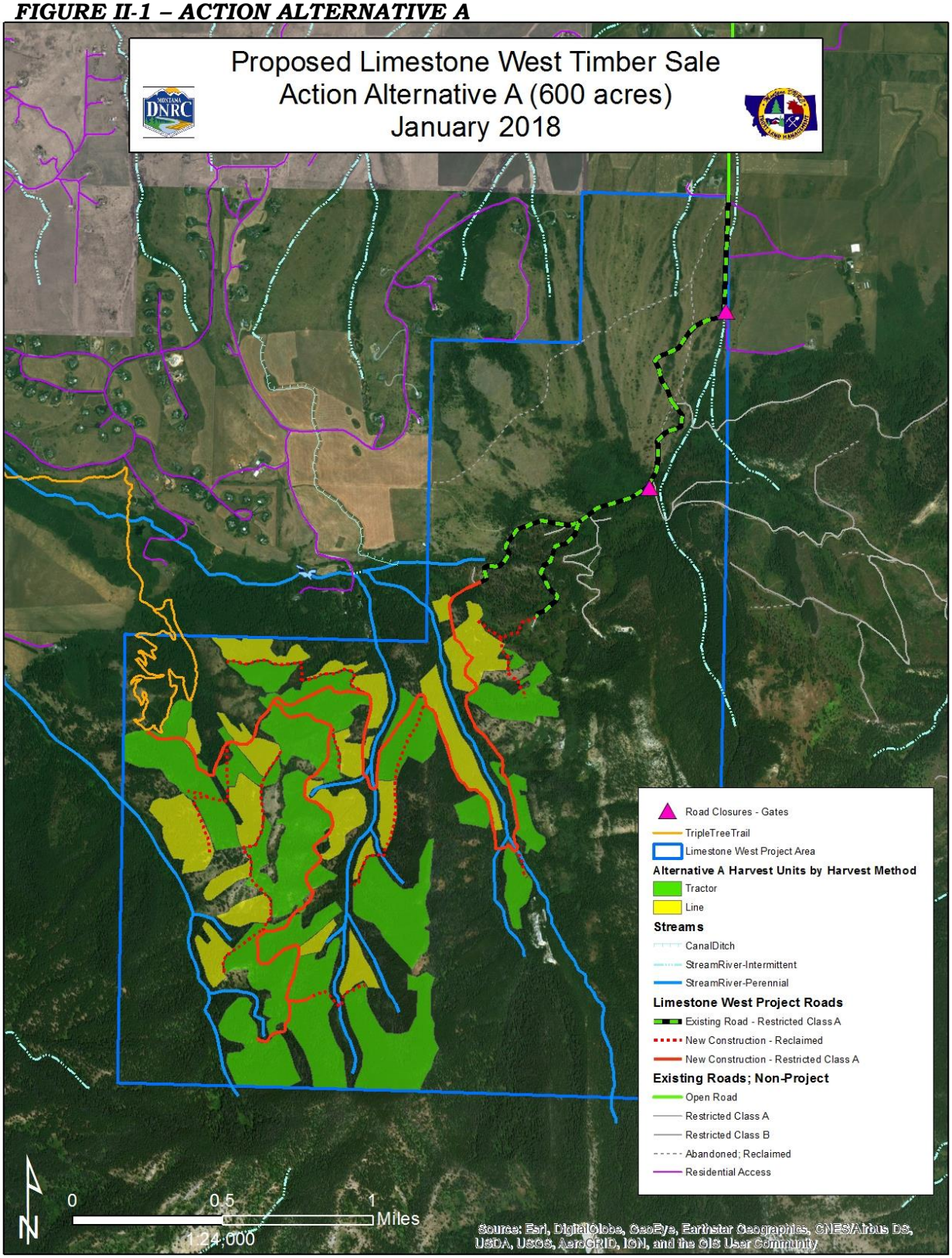
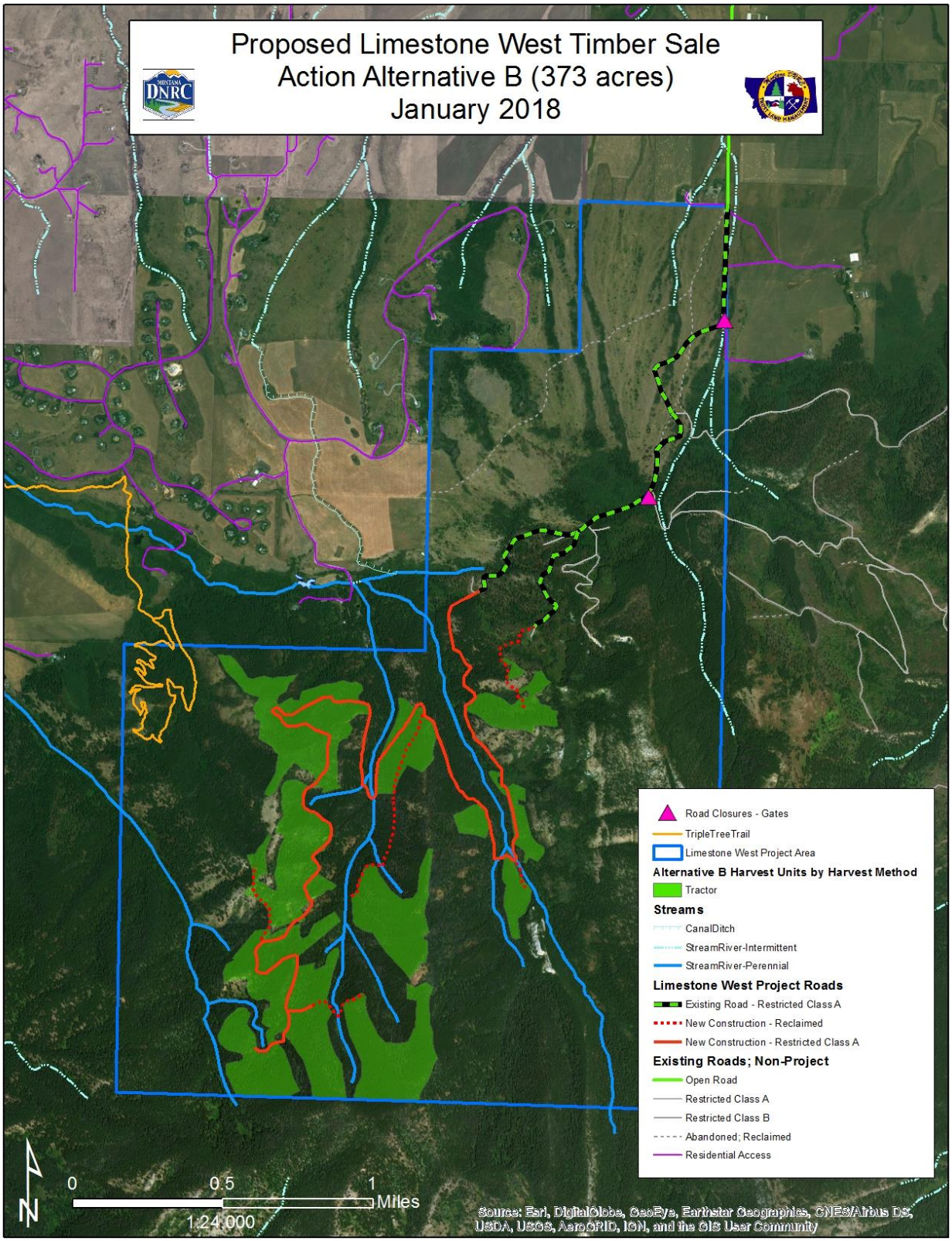


FIGURE II-2 – ACTION ALTERNATIVE B



COMPARISON OF ACTIVITIES (TABLE)

ALTERNATIVE	VOLUME (MMbf)	TOTAL ACRES	SILVICULTURAL PRESCRIPTION (ACRES)	HARVEST METHOD (ACRES)	STREAM CROSSINGS	MILES OF ROADWORK
No Action	0	0	None	None	None	None
A	4.3	600	Shelterwood (164) Clearcut with reserves (436)	Ground-based yarding (415), Cable yarding (185)	6	5.4 miles of new restricted road construction 3.8 miles of new road construction (reclaimed)
B	2.7	375	Shelterwood (110) Clearcut with reserves (265)	Ground-based yarding (375)	6	4.8 miles of new restricted road construction 1.7 miles of new road construction (reclaimed)
C	0	0	None	None	None	None

ACHIEVEMENT OF PROJECT OBJECTIVES

The following is a list of project objectives with brief identifiers that link the objectives to *TABLE II-2 – ACHIEVEMENT OF OBJECTIVES,* which summarizes how each alternative, would achieve the project objectives set forth under *PROJECT OBJECTIVES* in *CHAPTER I – PURPOSE AND NEED*. Listed after each objective is an indicator that will be used to measure how, and to what extent, each alternative meets or measures up to each project objective.

- **Biodiversity**- Manage the forest resource to promote improved health, productivity, and diversity.
  Indicator- Proportional change in cover type acres toward desired future conditions.

- **Revenue and sustained yield**- Capture the value of dead and dying lodgepole pine. Generate revenue for the trust beneficiaries and benefit local economies. Contribute sufficient volume towards DNRC's annual sustained-yield target of 56.9 MMbf.
  Indicator- Volume harvested and revenue generated.

- **Fuel loads**- Minimize fire and safety risks imposed by current forest conditions.
  Indicator- Acres treated with clearcut with reserves and shelterwood prescriptions in the project area.

- **Transportation**- Enhance and expand the existing transportation system to provide improved access for long-term future management of the area and fire suppression needs.
  Indicator- Miles of new road construction along with associated development costs.

ACHIEVEMENT OF OBJECTIVES (TABLE) *Summary comparison of predicted achievement of project objectives for the no-action and action alternatives.*

PROJECT OBJECTIVES	**ALTERNATIVES**			
	No-Action	**A**	**B**	**C**
Biodiversity (cover type) *change in acres* percentages of increase or decrease by project area	No changes in acreages from existing cover type.	164 acre (6 percent) increase in Douglas-fir; 97 acre (3.6 percent) decrease in lodgepole pine; 66 acre (2.4 percent) decrease in mixed conifer; 1 acre decrease in subalpine.	108 acre (3.9 percent) increase in Douglas-fir; 56 acre (2.1 percent) decrease in lodgepole pine; 51 acre (1.8 percent) decrease in mixed conifer; 1 acre decrease in subalpine.	No changes in acreages from existing cover type.
Yield and Trust Revenue	0 MMbf and $0	4.3 MMbf and minimum $189,600.00	2.7 MMbf and minimum $130,478.00	0 MMbf and minimum $189,600 (Alt A) or minimum $130,478 (Alt B)
Fuel Loads	0 acres	600 acres treated with clearcut with reserves or shelterwood followed by piling and burning of slash.	373 acres treated with clearcut with reserves or shelterwood followed by piling and burning of slash.	0 acres
Transportation	0 miles	5.4 miles of new restricted road construction 3.8 miles of new road construction (reclaimed)	4.8 miles of new restricted road construction 1.7 miles of new road construction (reclaimed)	0 miles

ALTERNATIVE COMPARISON OF ENVIRONMENTAL IMPACTS.

Summarizes the existing environment and the predicted environmental impacts of each alternative. The impacts are categorized by resource area and further subdivided by an abbreviated version of the issues listed in CHAPTER 1, TABLE I-1 – ISSUES STUDIED IN DETAIL.

RESOURCE ISSUE	EXISTING ENVIRONMENT	DIRECT AND INDIRECT IMPACTS	CUMULATIVE IMPACTS
VEGETATION			
Cover type representation Timber harvesting activities associated with this project may alter forest cover type conditions.	In the project area, mixed conifer, lodgepole pine, and limber pine stands are currently over-represented compared to desired amounts, while subalpine and aspen stands are under-represented.	***No-Action Alternative***	
		No effects are anticipated.	Cover types in untreated stands would not be expected to change appreciably. Stands would be expected to increase in age, and canopy structure would be expected to become more complex.
		Action Alternative A	
		97 acres of lodgepole pine, 66 acres of mixed conifer, and 1 acre of subalpine forests would be converted to the Douglas-fir cover type following harvesting. Harvesting would not change cover types on 303 acres of lodgepole pine, 126 acres of Douglas-fir, and 8 acres of mixed conifer forests.	Treatments could potentially occur on approximately 4,774 acres (14 percent) of the Southeast Bozeman Landscape. These treatments would be expected to decrease stand density and decrease the proportion of lodgepole pine occurring within stands and on the landscape in favor of other conifer species and aspen.
		Action Alternative B	

		56 acres of lodgepole pine, 51 acres of mixed conifer, and 1 acre of subalpine forests would be converted to the Douglas-fir cover type following harvesting. Harvesting would not change cover types on 224 acres of lodgepole pine, 33 acres of Douglas-fir, and 8 acres of mixed conifer forests.	Treatments could potentially occur on approximately 4,546 acres (14 percent) of the Southeast Bozeman Landscape. These treatments would be expected to decrease stand density, decrease the proportion of lodgepole pine occurring within stands and on the landscape in favor of other conifer species and aspen.
		Action Alternative C	
		No effects until future actions are initiated following expiration of the conservation license, at which time effects like those of Alternative A could be expected.	No effects until future actions are initiated following expiration of the conservation license, at which time effects like those of Alternative A could be expected.
Age class representation The proposed activities may affect forest age classes through tree removal.	Forest stands in the project area and Southeast Bozeman Landscape are primarily mature stands greater than 80 years old. Lodgepole pine stands are, on average, 100 years old, while Douglas-fir stands average 130 years old. Some areas	***No-Action Alternative***	
		Stand age would be expected to increase over time until a future disturbance, alters conditions in stands to allow regeneration of a new age class of trees.	Untreated stands would be expected to increase in age. Treatments associated with other proposed projects may change age class of treated stands depending on the type of treatment.
		Action Alternative A	

	have concentrations of older Douglas-fir trees that are over 170 years old.	Harvesting would change 303 acres of mature lodgepole pine forests to seedling/sapling forests. Treatments would not change age class on 298 acres.	Treatments could potentially occur on approximately 4,774 acres (14 percent) of the Southeast Bozeman Landscape, increasing age class diversity by reducing the amount of mature forests and increasing the amount of seedling/sapling forests by at least 303 acres.
		Action Alternative B	
		Harvesting would change 224 acres of mature lodgepole pine forests to seedling/sapling forests. Treatments would not change age class on 149 acres.	Treatments could potentially occur on approximately 4,546 acres (14 percent) of the Southeast Bozeman Landscape, increasing age class diversity by reducing the amount of mature forests and increasing the amount of seedling/sapling forests by at least 224 acres.
		Action Alternative C	
		No effects until future actions are initiated following expiration of the conservation license, at which time effects like those of Alternative A could be expected.	No effects until future actions are initiated following expiration of the conservation license, at which time effects like those of Alternative A could be expected.
Old-growth representation	119 acres of old growth in	***All Alternatives***	

The proposed activities may affect old-growth amounts and quality through tree removal.	the project area. No harvesting proposed in old growth stands. 106 acres in the Nichols Creek drainage meet criteria for number of large trees and basal area, but are not yet old enough to qualify as old growth.	No harvesting is proposed in any old growth stands under any of the Alternatives. There would be no change to current old growth amounts in the project area. Existing non-old growth stands that meet all the old growth minimum criteria except tree age would be expected to become old growth over time, potentially raising old growth amounts in the project area to 225 acres.	Treatments associated with other projects could affect amounts of old growth depending on the prescription implemented, with effects more likely in stands receiving more intensive treatment. Tree mortality in existing old growth stands could cause them to no longer meet the criteria for old growth classification. Some stands that are not currently old growth could become old growth in the future.
Insects and diseases The proposed activities may affect forest insect and disease levels through tree removal (both suppressed/ stressed and infested/ infected).	Individual and small groups of dead lodgepole pine are present in the project area because of mountain pine beetle activity. 18 percent of lodgepole pine in the project area have been killed by mountain pine beetles. Defoliated Douglas-fir, Engelmann spruce, and subalpine fir trees from Western spruce budworm activity are present.	***No-Action Alternative***	
		The average probability of mountain pine beetle outbreak in the project area is 60 percent and remains about 50 percent for the next 30 years. Defoliation and possible mortality from spruce budworm would continue.	Because of past widespread mountain pine beetle activity in the Southeast Bozeman Landscape, future widespread mortality of lodgepole pine is unlikely for several decades. In lodgepole pine stands not impacted by recent outbreaks, tree mortality could occur to varying degrees depending on the susceptibility of stands to outbreak. Other proposed actions could reduce susceptibility to mountain pine beetle attack in stands that

			receive treatment. Western spruce budworm would continue to impact forests in the project area and Southeast Bozeman Landscape to varying degrees.
		Action Alternative A and B	
		Harvesting of lodgepole pine in the project area would alter the size class, age class, and amount of available host trees, reducing stand susceptibility to attack by mountain pine beetle. Risk of mountain pine beetle outbreak would be eliminated immediately and sustained for several decades. Susceptibility of trees to spruce budworm and levels of spruce budworm activity would be reduced immediately.	Other proposed treatments could reduce susceptibility to and impacts from mountain pine beetle and spruce budworm on an additional 4,173 acres outside the project area.
		Action Alternative C	
		No decrease in risk of mountain pine beetle outbreak or in current mountain pine beetle or western spruce budworm activity. Following expiration of the conservation license, potential treatments that could occur in the project area would have effects on forest insects like those of Alternatives A and B, although	Cumulative effects like those of No Action.

		the effect would be delayed by at least 10 years.	
Fire effects The proposed activities may affect forest fire conditions, levels, and hazards through tree removal, increased public access, and/or fuel reduction.	Average of 11.4 tons/acre of coarse surface fuel. Total surface fuel load average of 27.6 tons/acre. Standing fuel load average of 73.3 tons/acre. Average torching index of 325 mph. Average crowning index of 19 mph. Predicted fire types of conditional crown fire on 53 percent and surface fire on 46% of stands proposed for treatment. Predicted surface flame length of 3.7 feet; predicted total flame length of 28.9 feet.	***No-Action Alternative***	
		Increase in coarse and total surface fuels over time. Minimal increase in standing fuels. Decrease in torching index, and minimal increase in crowning index. Increase in predicted incidence of crown fires and increase in predicted surface and total flame lengths.	Other projects could alter fuels and potential fire behavior on an additional 4,173 acres, with expected decrease in surface and standing fuels, increases in torching and crowning index, and less likelihood of crown fires in stands that receive treatment.
		Action Alternative A and B	
		Altered fuels and fire behavior on 601 acres in Alternative A and 373 acres in Alternative B. Decrease in amounts of coarse, surface, and standing fuels. Decrease in torching index and substantial increase in crowning index. Increase in predicted incidence of surface fires and decrease of predicted crown fires. Decrease in predicted total flame length.	Other projects could alter fuels and potential fire behavior on an additional 4,173 acres, with effects like those of stands treated in the project area in stands that receive treatment.
		Action Alternative C	
		Effects like those of No Action until expiration of the conservation license, after which time effects like those of Alternative A.	Effects like those of No Action until expiration of the conservation license, after which time effects like those of Alternative A.

Sensitive plants The proposed activities may affect sensitive plant populations through ground disturbance.	No Species of Concern identified within the project area. Ten plant species of concern and one potential species of concern observed within or near the Southeast Bozeman Landscape.	***All Alternatives***	
		No anticipated to these species under any of the proposed alternatives.	No anticipated impacts, as habitats where these species are found are typically not areas where forest management activities occur.
Noxious weeds The proposed activities may affect noxious weeds through ground disturbance.	The following noxious weeds, regulated plants, and exotic plants are present in the project area: Canada thistle Common tansy Houndstongue Orange hawkweed Oxeye daisy Russian knapweed Spotted knapweed Cheat grass Musk thistle Scotch thistle Bull thistle Ventenata	***No-Action Alternative***	
		No anticipated changes in existing noxious weed populations. Recreational use and grazing could introduce new species or facilitate spread of existing species. Monitoring and management of existing populations would continue.	Proposed forest management activities associated other proposed projects have the potential to facilitate the spread of and increase noxious weed populations on 4,173 acres of the Southeast Bozeman Landscape.
		Action Alternative A and B	
		Likely increase in the spread of existing species or introduction of new species due to soil disturbance and reduction of canopy cover associated with timber harvesting on 601 acres under Alternative A and 373 acres under Alternative B. Monitoring and management would be expected to minimize the increase in noxious weed populations in comparison to current levels.	Proposed forest management activities associated other proposed projects have the potential to facilitate the spread of and increase noxious weed populations on an additional 4,173 acres of the Southeast Bozeman Landscape.
		Action Alternative C	

		During the conservation license term, effects on noxious weed would be like those of no action. Potential treatments that could occur following the expiration of the conservation license would have effects like those of Alternatives A and B	Proposed forest management activities associated other proposed projects have the potential to facilitate the spread of and increase noxious weed populations on an additional 4,173 acres of the Southeast Bozeman Landscape.
GEOLOGY AND SOILS			
Physical Soil Properties	The soils within the Limestone West project area have many similarities with local variations in aspect, slope position, and depth to bedrock creating slight differences in physical properties that limit forest management activities. In general, soil depth is typically less than 60 inches before encountering impervious bedrock with loam to clay loam surface textures. Deep soils with elevated clay contents, particularly on north aspects, typically remain moist well into summer months. Due to the fine texture of these soils, pore spaces are small and matrix	***No-Action Alternative and Action Alternative C***	
		Soil physical properties would continue on a stable trend.	No cumulative effects to soil physical properties would be expected.
		Action Alternative A and B	
		High probability of low to moderate level impacts to soil physical properties.	No measurable or detectable cumulative effects are expected to soil physical properties.

	water is bound tightly by capillary forces resulting in slow infiltration capacities and moderate to poor drainage attributes.		
Erosion	No rill, gully or sheet erosion was observed on any locations outside of existing road prisms within the project area. All disturbed soils from past management activities, excluding road surfaces, have naturally revegetated and are erosively stable.	***No-Action Alternative and Action Alternative C***	
		Base erosion rates would remain constant.	Base erosion rates would remain constant. No cumulative effects would be expected.
		Action Alternative A and B	
		There is a moderate probability of low level impacts from erosion to soil productivity.	A low probability of low level cumulative effects to soil resources from erosion are expected within project area.
Site Nutrients	Amounts of coarse and fine woody debris throughout the Limestone West project area is variable and range from as little as 5 tons/acre to upwards of 20 tons/acre. This variability is dependent on habitat type and the magnitude of insect and disease mortality.	***No-Action Alternative and Action Alternative C***	
		Void of natural disturbance, nutrient pools would remain stable due to continued additions of CWD and FWD available as organic sources of carbon.	Void of natural disturbance, nutrient pools would remain stable due to continued additions of CWD and FWD available as organic sources of carbon.
		Action Alternative A and B	
		Low risk of low level impacts to site nutrient pools if either the action alternatives are selected.	No measurable or detectable cumulative effects are expected to nutrient cycling.
Long-term Productivity	Due to the moderate levels	***No-Action Alternative and Action Alternative C***	

	of precipitation and high seasonality of the project area, soils are only moderately productive when compared to other regions in Montana.	Without any site disturbance, most lodgepole pine stands would remain stagnant until historic fire regimes were restored.	Trends of long-term productivity would continue as described within Direct and Indirect Effects of No Action Alternative.
		Action Alternative A and B	
		Long-term soil productivity is expected to be maintained at levels described in the existing conditions. Alternative A would impact 140.5 more acres then Alternative B as a result of a larger harvest footprint.	No measurable or detectable cumulative effects are expected to long-term productivity.
Slope Stability	Historic scarps and rotational failures have been documented within the Limestone West project area during project review. All historic scarps show no evidence of recent motion and are likely the result of previous tectonic events as regenerated trees within the failure were aged at 70-80 years old. While mass failure hazard may be the most important limitation to road construction and harvest activities in the project area,	***No-Action Alternative and Action Alternative C***	
		Areas of potential slope instability would possibly reactivate under convergent conditions and seismic activity.	Trends of slope stability would continue as described within Direct and Indirect Effects of No Action Alternative.
		Action Alternative A and B	
		A moderate probability of low to moderate impacts to soil productivity, and potentially water quality, from small, localized slope failure is possible for both timber sale Action Alternatives A and B.	There is a low probability of low level cumulative effects to slope stability within the project area.

	simple mitigations such as avoidance and adequate drainage can significantly reduce the likelihood of failure.		
WATERSHED AND FISHERIES			
Timber harvesting and road construction may increase sediment delivery into streams/lakes and affect water quality.	**Limestone Creek**: Approximately four hundred feet of road exists within 100′ of Limestone Creek at two privately owned crossing structures. Road densities within this analysis area are low at 0.6 mi/mi^2. The estimated rate of sediment delivery to this watershed from roads is low and was calculated at 0.3 tons per year. **Nichols Creek:** Approximately four hundred feet of road exists within 100′ of Nichols Creek at two crossing structures. Road densities within this analysis area are low at 0.8 mi/mi^2. Neither of these crossing sites are	***No-Action Alternative and Action Alternative C***	
		Sediment delivery rates from existing road stream crossings and other sources would continue to supply very low levels of introduced sediment to stream channels as described in the Affect Environment section. Either of these alternatives would result in no direct and indirect effects related to sediment delivery.	Either of these alternatives would result in a low probability of low level cumulative effects related to sediment delivery.
		Action Alternative A and B	
		The moderate probability of low level effects of upland erosion from timber harvesting coupled with the increased sediment delivery from new road construction and crossing structure installation results in a high probability of moderate direct and indirect effects to sediment delivery in Limestone Creek resulting from the	Due to very low levels of existing sources of sediment delivery and the forecasted direct and indirect effects of implementing either action alternative, a high probability of low level cumulative effects from sediment delivery exists in Limestone Creek while a low probability of low level cumulative effects from

	within the forested portion of the analysis area thus have negligible effects on riparian function.	implementation of Action Alternative A or B. There is a low probability of low level effects from sediment delivery in Nichols Creek.	sediment delivery exists in Nichols Creek.
Timber harvesting and road construction has the potential to increase water yield, which, in turn, may affect erosive power, sediment production, and stream-channel stability.	Existing water yield increases: Limestone Creek: 0.9% over fully forested conditions. Nichols Creek: 1.3% over fully forested conditions.	***No-Action Alternative and Action Alternative C***	
		Water yield would continue to increase in the project area as disease/insect infected stands of lodgepole pine continue to lose canopy and stand structure is lost.	Water yield would continue to increase in the project area as disease/insect infected stands of lodgepole pine continue to lose canopy and stand structure is lost.
		Action Alternative A and B	
		Direct and Indirect water yield increase to Limestone Creek would be 8.2% and 4.5% for Alternative A and B, respectively. Direct and Indirect water yield increase to Nichols Creek would be 5.3% and 2.2% for Alternative A and B, respectively. As a result of this, a moderate probability of low level direct and indirect effects would be expected in both watershed analysis areas if a timber sale alternative is implemented	Cumulative Water yield increases to Limestone Creek would be 9.1% and 5.4% for Alternative A and B, respectively. Cumulative Water yield increases to Nichols Creek would be 6.6% and 3.5% for Alternative A and B, respectively. Due to this, implementing either action alternative would result in a

			moderate probability of low level cumulative effects to water yield increases.
Channel forms	Both Montana FWP and DNRC surveyed Limestone Creek and its tributaries in 2016 and found no fish on State owned lands despite stable channels and highly functional riparian conditions. Montana DNRC surveyed Nichols Creek in the fall of 2016 and found no fish on State owned lands. Two natural fish barriers were identified which likely limit any potential fish movement in Nichols Creek.	***No-Action Alternative and Action Alternative C***	
		No measurable or detectable direct or indirect effects to channel form and function would occur.	No measurable or detectable direct or indirect effects to channel form and function would occur.
		Action Alternative A and B	
		Both sediment and water yields would continue to be within the natural range of variability that these channels evolved with thus presenting a low level of risk to channel stability and downstream fish habitats.	Low probability of low level cumulative effects to channel form and function in both Limestone and Nichols creek.
WILDLIFE			
Fragmentation/Corridors Concern that removal of trees and roads in this roadless area would fragment and adversely affect wildlife habitat and	Approximately 77% of the project area and 83% of the cumulative effects analysis area contain connected mature cover with >40% canopy cover.	***No-Action Alternative***	
		No direct or indirect project-related effects to wildlife associated with habitat connectivity, movement corridors or linkage areas would be anticipated under this alternative.	No cumulative project-related effects to wildlife associated with habitat connectivity, movement corridors or linkage areas would be anticipated under this alternative.

movement corridors for many species. Particular concern that habitat within the Gallatin Bridger Big Belt Wildlife Corridor will suffer degradation.	5.4 miles of restricted roads in the project area and no open roads. Approximately 48.7 miles of open roads in the cumulative effects analysis area and 26.9 additional miles of restricted roads.	***Action Alternative A***	
		Cover of >40% canopy would remain on 63% of the project area and 5.3 miles of permanent restricted road would be constructed. Low risk of appreciable adverse effects to wildlife linkage, connectivity, or the Gallatin Bridger Big Belt Corridor.	Cover of >40% canopy would remain on 82% of the cumulative effects analysis area and total road density would increase from 1.45 miles per square mile to 1.55 miles per square mile. Low risk of adverse effects to wildlife linkage, connectivity, or the Gallatin Bridger Big Belt Corridor.
		Action Alternative B	
		Cover of >40% canopy would remain on 6% of the project area and 4.6 miles of permanent restricted road would be constructed. Low risk of appreciable adverse effects to wildlife linkage, connectivity, or the Gallatin Bridger Big Belt Corridor.	Cover of >40% canopy would remain on 82% of the cumulative effects analysis area and total road density would increase from 1.45 miles per square mile to 1.54 miles per square mile. Low risk of adverse effects to wildlife linkage, connectivity, or the Gallatin Bridger Big Belt Corridor.
		Action Alternative C	
		No trees would be removed, and no roads would be built. Changes in habitat conditions related to the proposed timber sale alternatives that could fragment habitat and	No trees would be removed, and no roads would be built. Changes in habitat conditions related to the proposed timber sale alternatives that could

		adversely affect movement corridors and linkage for wildlife in the project area would not occur.	fragment habitat and adversely affect movement corridors and linkage for wildlife in the cumulative effects analysis area would not occur.
Snags and Down Logs There is concern that proposed logging would reduce snags and coarse woody debris, which could adversely affect species that depend on these habitat attributes.	Snags and coarse woody debris vary considerably across the project area.Few large old trees and snags greater than 20 inches dbh present (<1 per acre). Many smaller 8-12 inch dbh lodgepole pine snags present in some stands. Coarse woody debris highly variable and ranges from about 3 to 40 tons per acre and averages approximately 10 tons per acre.	***No-Action Alternative***	
		No logging or road construction would occur, and no short-term changes would occur in the abundance or distribution of snags or coarse woody debris in the project area.	No effects would be anticipated that could contribute to cumulative reductions of snags and coarse woody debris that could adversely affect wildlife within the cumulative effects analysis area.
		Action Alternative A	
		Snags would be reduced on 601 acres, but a minimum of 4 snags/trees per acre of the largest trees/snags would be retained to maintain some habitat attributes. Snags and down logs would not be altered on approximately 71% of the project area. Coarse woody debris would be expected to remain at similar or greater levels and requirements would be in place to retain 5 to 15 tons per acre. Native species likely to continue using habitats in the project area, but in fewer numbers because less snag habitat may	Snags would be reduced on 601 acres, but a minimum of 4 snags/trees per acre of the largest trees/snags would be retained to maintain some habitat attributes. Snags and down logs would not be altered on approximately 98% of the cumulative effects analysis area. Coarse woody debris would be expected to remain at similar or greater levels and requirements would be in place to retain 5 to 15 tons per acre.

		support fewer individuals.	
		Action Alternative B	
		Snags would be reduced on 373 acres, but a minimum of 4 snags/trees per acre of the largest trees/snags would be retained to maintain some habitat attributes. Snags and down logs would not be altered on approximately 82% of the project area. Coarse woody debris would be expected to remain at similar or greater levels and requirements would be in place to retain 5 to 15 tons per acre. Native species likely to continue using habitats in the project area, but in fewer numbers because less snag habitat may support fewer individuals.	Snags would be reduced on 373 acres, but a minimum of 4 snags/trees per acre of the largest trees/snags would be retained to maintain some habitat attributes. Snags and down logs would not be altered on approximately 99% of the cumulative effects analysis area. Coarse woody debris would be expected to remain at similar or greater levels and requirements would be in place to retain 5 to 15 tons per acre.
		Action Alternative C	
		No logging or road construction would occur, and no short-term changes would occur in the abundance or distribution of snags or coarse woody debris in the project area.	No effects would be anticipated that could contribute to cumulative reductions of snags and coarse woody debris that could adversely affect wildlife within the cumulative effects analysis

			area.
Wildlife Diversity There is concern that alteration of vegetation, disturbance caused by logging could reduce the abundance and diversity of birds and other wildlife species.	Project area habitats are primarily comprised of 54% Douglas-fir forest, 12% aspen forest, 10% lodgepole pine forest, 5% sagebrush steppe, 4% subalpine mesic meadow, 4% deciduous shrubland, (MNHP 2018) Similarly, types in the cumulative effects analysis area consist primarily of 43% Douglas-fir forest, 11% aspen forest, 8% lodgepole pine forest, 7% agricultural pasture, 5% lower foothill riparian hardwood/shrub, (MNHP 2018).	***No-Action Alternative***	
		Direct and indirect effects to birds and other wildlife species attributable to vegetation alteration and logging disturbance associated with this project would not be anticipated.	Cumulative effects to birds and other wildlife species attributable to vegetation alteration and logging disturbance associated with this project would not be anticipated.
		Action Alternative A	
		Mature forest cover ≥40% canopy would remain on 1,724 acres (63%) of the 2,725-acre project area of which 53% in dense forest cover. Forest openings created on 371 acres clearcut and stand age class diversity would be increased over several decades. 5.3 miles of new restricted permanent road would be constructed. The abundance of species sensitive to humans and forest cover reduction would likely decrease, while species less sensitive to human activity and those that prefer forest openings and more park-like stand conditions to	Mature forest cover >40% would remain across 82% of the 33,422-acre cumulative effects analysis area. Cover density would be affected on approximately 1.8% of the cumulative effects analysis area. Total road density increase at this scale would be 0.1 mile per square mile. Minimal change in the observed abundance or diversity of wildlife would be expected in the cumulative effects analysis area.

		increase.	
		Action Alternative B	
		Mature forest cover ≥40% canopy would remain on 1,811 acres (66%) of the 2,725-acre project area of which 62% in dense forest cover. Forest openings created on 371 acres clearcut and stand age class diversity would be increased over several decades. 4.6 miles of new restricted permanent road would be constructed. The abundance of species sensitive to humans and forest cover reduction would likely decrease, while species less sensitive to human activity and those that prefer forest openings and more park-like stand conditions to increase.	Mature forest cover >40% would remain across 82% of the 33,422-acre cumulative effects analysis area. Cover density would be affected on approximately 1.1% of the cumulative effects analysis area. Total road density increase at this scale would be 0.09 mile per square mile. Minimal change in the observed abundance or diversity of wildlife would be expected in the cumulative effects analysis area.
		Action Alternative C	
		Under Alternative C, no trees would be removed, and no roads would be built in the project area. Mechanical disturbance and changes in structural habitat conditions related to the proposed	Under Alternative C, no trees would be removed, and no roads would be built in the cumulative effects analysis area. Mechanical disturbance and changes in structural

		timber sale alternatives that could adversely affect the abundance or diversity of birds and other wildlife species would not occur.	habitat conditions related to the proposed timber sale alternatives that could adversely affect the abundance or diversity of birds and other wildlife species would not occur.
Recreational Use There is concern that the road system established for this project would appreciably increase recreational use of the project area, which could disturb and displace wildlife and affect their ability to move through the area.	Project area receives frequent access by recreational users during all seasons. Currently 4.3 miles of restricted roads in the project area. Habitat security is currently affected on approximately 880 acres in the north portion of the project area. Currently 13,425 acres 40.2% of secure habitat areas are affected by open and restricted existing roads.	***No-Action Alternative***	
		Direct and indirect project-related effects to wildlife species that would be attributable to increases in new roads and subsequent increases in project-related recreational use would not be anticipated.	Cumulative project-related effects to wildlife species that would be attributable to increases in new roads and subsequent increases in project-related recreational use would not be anticipated.
		Action Alternative A	
		Cover would be altered on 601 acres. Total road amounts would increase from 4.3 miles to 9.6 miles in the project area and a proportional increase in disturbance and displacement of wildlife would be expected. Considering the 9.6-mile road amount, security could be adversely affected on up to 72.7% of the project area. Public use of new roads would likely increase, but the actual amounts and types are uncertain. Moderate to high	Cover would be altered on 601 acres. Total road amounts would increase from 4.3 miles to 9.6 miles in the cumulative effects analysis area and a proportional increase in disturbance and displacement of wildlife would be expected from recreational use. The percentage of secure area affected by roads of the 33,422-acre cumulative effects analysis area area would increase by 3.3%. Actual amounts and

		level of localized wildlife displacement potential into the future due the increase in new permanent, restricted roads and cover removal.	types of recreational use are uncertain. A low level of displacement potential and associated adverse effects to wildlife would be expected at the scale of the 33,422-acre cumulative effects analysis area.
		Action Alternative B	
		Cover would be altered on 373 acres. Total road amounts would increase from 4.3 miles to 8.9 miles in the project area and a proportional increase in disturbance and displacement of wildlife would be expected. Considering the 8.9-mile road amount, security could be adversely affected on up to 66.2% of the project area. Public use of new roads would likely increase, but actual amounts and types are uncertain. Moderate to high level of localized wildlife displacement potential into the future due the increase in new permanent, restricted roads and cover removal.	Cover would be altered on 373 acres. Total road amounts would increase from 4.3 miles to 8.9 miles in the cumulative effects analysis area and a proportional increase in disturbance and displacement of wildlife would be expected from recreational use. The percentage of secure area affected by roads of the 33,422-acre cumulative effects analysis area area would increase by 2.7%. Actual amounts and types of recreational use are uncertain. A low level of displacement potential and associated adverse effects to wildlife would be expected at the scale of the 33,422-acre cumulative effects analysis area.

		Action Alternative C	
		No trees would be removed, and no roads would be built in the project area. Mechanical disturbance, additional roads and increased potential recreational use related to the proposed timber sale alternatives that could disturb and displace wildlife, or affect their ability to move across the landscape would not occur.	No trees would be removed, and no roads would be built in the cumulative effects analysis area. Mechanical disturbance, additional roads and increased potential recreational use related to the proposed timber sale alternatives that could disturb and displace wildlife, or affect their ability to move across the landscape would not occur.
Canada Lynx Timber harvesting and associated activities could remove canopy closure, alter stand conditions, and/or cause motorized disturbance, which could alter habitat, rendering it unsuitable for supporting Canada lynx.	Currently the project area is comprised of 63.8% suitable habitat, 8.3% temporary non-suitable habitat, and 27.9% non-habitat. Approximately 27,618 acres of suitable lynx habitat occur in the 33,422-acre cumulative effects analysis area.	***No-Action Alternative***	
		No habitat altering activities would occur, thus, no direct or indirect effects to lynx would be anticipated.	No habitat altering activities would occur, thus, no cumulative effects to lynx would be anticipated.
		Action Alternative A	
		Approximately 371 acres (21.3%) of the 1,738 acres of existing suitable lynx habitat would be removed. Post project, 50.2% of the project area would remain in lynx suitable habitat. Ample habitat connectivity would remain. Low adverse direct and indirect effects to lynx would be expected.	Suitable habitat would be removed on 1.3% of the cumulative effects analysis area. Post project, 27,247 acres (98.7%) of the existing lynx suitable habitat would be retained. Habitat connectivity would remain high. Minimal adverse cumulative effects to lynx would be expected at the scale of the cumulative effects

			analysis area.
		Action Alternative B	
		Approximately 284 acres (16.3%) of the 1,738 acres of existing suitable lynx habitat would be removed. Post project, 53.4% of the project area would remain in lynx suitable habitat. Ample habitat connectivity would remain. Low adverse direct and indirect effects to lynx would be expected.	Suitable habitat would be removed on 1.0% of the cumulative effects analysis area. Post project, 27,334 acres (98.9%) of the existing lynx suitable habitat would be retained. Habitat connectivity would remain high. Minimal adverse cumulative effects to lynx would be expected at the scale of the cumulative effects analysis area.
		Action Alternative C	
		No trees would be removed, and no roads would be built in the project area. Mechanical disturbance and changes in structural habitat conditions related to the proposed timber sale alternatives, which could alter lynx habitat, rendering it unsuitable for supporting lynx would not occur.	No trees would be removed, and no roads would be built in the cumulative effects analysis area. Mechanical disturbance and changes in structural habitat conditions related to the proposed timber sale alternatives, which could alter lynx habitat rendering it unsuitable for supporting lynx, would not occur.
Grizzly Bear	Currently 2,095 acres of	***No-Action Alternative***	

There is concern that timber harvesting activities could remove security cover, cause displacement, increase roads, and increase presence of unnatural attractants and bear foods, which could adversely affect grizzly bears.	hiding cover and 4.3 miles of restricted roads occur on the project area. Currently 1.0 mile per square mile road density in the project area. Approximately 27,618 acres of hiding cover, 48.7 miles of open roads, and 26.9 miles of restricted roads occur within the 33,422-acre cumulative effects analysis area.	No habitat altering activities would occur, thus, no direct or indirect effects to grizzly bears would be anticipated.	No habitat altering activities would occur, thus, no cumulative effects to grizzly bears would be anticipated.
		Action Alternative A	
		Approximately 1,724 acres (82.3%) of hiding cover would remain of which 84.1% would be in dense forest cover. 371 acres of openings of limited size would be created. 13.4 miles of roads would be subject to motorized and/or non-motorized uses during project activities for a duration of 2 to 3 years. 5.3 miles of permanent restricted road would be constructed. Total road density post project would increase by 1.3 miles per square mile to a total of 2.3. Moderate long-term adverse effects to grizzly bears associated with disturbance and displacement would be expected.	Approximately 27,247 acres (98.7%) of hiding cover would remain of which 81.5% would be in dense forest cover. 371 acres of openings of limited size would be created. 5.3 miles of permanent restricted road would be constructed. Total road density post project would increase by 0.1 miles per square mile to a total of 1.55 in the cumulative effects analysis area. Minor adverse effects to grizzly bears would be anticipated.
		Action Alternative B	
		Approximately 1,811 acres (86.4%) of hiding cover would remain of which 92.3% would be in dense forest cover. 284 acres of openings of limited size would be	Approximately 27,334 acres (98.9%) of hiding cover would remain of which 82.1% would be in dense forest cover. 284 acres of openings of limited

		created. 10.5 miles of roads would be subject to motorized and/or non-motorized uses during project activities for a duration of 2 to 3 years. 4.6 miles of permanent restricted road would be constructed. Total road density post project would increase by 1.1 miles per square mile to a total of 2.1. Moderate long-term adverse effects to grizzly bears associated with disturbance and displacement would be expected.	size would be created. 4.6 miles of permanent restricted road would be constructed. Total road density post project would increase by 0.09 miles per square mile to a total of 1.54 in the cumulative effects analysis area. Minor adverse effects to grizzly bears would be anticipated.
		Action Alternative C	
		No trees or security cover would be removed, and no roads would be built in the project area. Mechanical disturbance, potential for increases in attractants, potential increases in public recreation, and reductions in security cover related to the proposed timber sale alternatives, which could adversely affect grizzly bears would not occur.	No trees or security cover would be removed, and no roads would be built in the cumulative effects analysis area. Mechanical disturbance, potential for increases in attractants, potential increases in public recreation, and reductions in security cover related to the proposed timber sale alternatives, which could adversely affect grizzly bears would not occur.
Wolverine	Approximately 407 acres of	***No-Action Alternative***	

There is concern that activities associated with timber harvesting could disturb and displace denning female wolverines and adversely affect their habitat.	high elevation habitat capable of supporting persistent snow in spring is present on the project area. Approximately 4,116 acres occur in the 33,422-acre cumulative effects analysis area.	No habitat altering activities or motorized activities would occur, thus, no direct or indirect effects to wolverines would be anticipated.	No habitat altering activities or motorized activities would occur, thus, no cumulative effects to wolverines would be anticipated.
		Action Alternative A	
		Approximately 8 acres of habitat would be affected by logging treatments. 5.3 miles of permanent restricted road would be constructed supporting uncertain levels of future recreational use. Moderate adverse direct and indirect effects to wolverines would be expected.	Approximately 8 acres of habitat would be affected by logging treatments. 5.3 miles of permanent restricted road would be constructed supporting uncertain levels of future recreational use. At the scale of the 33,422-acre cumulative effects analysis area, minor adverse cumulative effects to wolverines would be expected.
		Action Alternative B	
		Approximately 8 acres of habitat would be affected by logging treatments. 4.6 miles of permanent restricted road would be constructed supporting uncertain levels of future recreational use. Moderate adverse direct and indirect effects to wolverines would be expected.	Approximately 8 acres of habitat would be affected by logging treatments. 4.6 miles of permanent restricted road would be constructed supporting uncertain levels of future recreational use. At the scale of the 33,422-acre cumulative effects analysis area, minor adverse cumulative effects to wolverines would be expected.

		Action Alternative C	
		No trees or cover would be removed, and no roads would be built in the project area. Mechanical disturbance in winter months that might adversely affect denning female wolverines would not occur. No direct or indirect effects to wolverines or their habitat in the project area would occur.	No trees or cover would be removed, and no roads would be built in the cumulative effects analysis area. Mechanical disturbance in winter months that might adversely affect denning female wolverines would not occur. No cumulative effects to wolverines or their habitat would occur.
Sensitive Species There is concern that the proposed removal of trees and construction of roads may adversely affect sensitive species.	Habitat conditions were evaluated and project-related effects were considered for 13 species that can be adversely affected by timber sale activities in central Montana.	***No-Action Alternative***	
		No habitat altering activities would occur, thus, no direct or indirect effects to sensitive species would be anticipated.	No habitat altering activities would occur, thus, no cumulative effects to sensitive species would be anticipated.
		Action Alternative A	
		Habitats were either not present or would be affected in a manner that would pose very minimal risk to the species considered.	Habitats were either not present or would be affected in a manner that would pose very minimal cumulative risk to the species considered.
		Action Alternative B	
		Habitats were either not present or would be affected in a manner that would pose very minimal risk to the species considered.	Habitats were either not present or would be affected in a manner that would pose very minimal cumulative risk to the species considered.
		Action Alternative C	

		No habitat altering activities would occur, thus, no direct or indirect effects to sensitive species would be anticipated.	No habitat altering activities would occur, thus, no cumulative effects to sensitive species would be anticipated.
Moose There is concern that increases in roads, logging disturbance, cover loss, and long-term non-motorized recreational use associated with new restricted roads will adversely affect moose calving areas, habitat suitability and security, resulting in their displacement and/or reduced carrying capacity.	2,095 acres of the 2,725-acre project area (77%) possess greater than 40% overstory canopy cover in mature forest patches. 27,618 acres (83%) of the 33,422-acre cumulative effects analysis area currently possess greater than 40% overstory canopy cover in mature forest patches (Table W-2).	***No-Action Alternative***	
		No habitat altering activities or motorized activities would occur, thus, no direct or indirect effects to moose would be anticipated.	No habitat altering activities or motorized activities would occur, thus, no cumulative effects to moose would be anticipated.
		Action Alternative A	
		1,724 acres (63% of project area) would remain in mature forest cover with >40% overstory canopy closure that would facilitate continued use of the project area by moose. 1,450 (84%) would possess dense, >60% overstory cover (53% of project area). Moderate to high level of direct and indirect displacement potential that could cause adverse effects to individual moose due the increase in 5.3 miles new permanent, restricted roads and associated indirect increases in recreational uses during all seasons. Minor adverse effects expected to calving female moose.	27,247 acres (82%) would remain in mature forest cover with >40% overstory canopy closure that would facilitate continued use of the area. Of the acres 27,247 acres, approximately 22,221 (82%) would possess >60% overstory cover (66% of cumulative effects analysis area), which would provide quality cover during all seasons. Total roads would increase from 75.6 miles to 80.9 miles, which could cause a minor increase in disturbance and displacement of moose that use the 33,422-acre cumulative effects analysis area. Minor cumulative effects

			associated with disturbance and displacement potential that could cause adverse effects to moose.
		Action Alternative B	
		1,811 acres (66% of project area) would remain in mature forest cover with >40% overstory canopy closure that would facilitate continued use of the project area by moose. 1,678 (93%) would possess dense, >60% overstory cover (62% of project area). Moderate to high level of direct and indirect displacement potential that could cause adverse effects to individual moose due the increase in new permanent, restricted roads and associated indirect increases in recreational uses during all seasons. Minor adverse effects expected to calving female moose.	27,334 acres (82%) would remain in mature forest cover with >40% overstory canopy closure that would facilitate continued use of the area. Of the acres 27,247 acres, approximately 22,449 (82%) would possess >60% overstory cover (67% of cumulative effects analysis area), which would provide quality cover in all seasons. Total roads would increase from 75.6 miles to 80.2 miles, which could cause a minor increase in disturbance and displacement of moose that use the 33,422-acre cumulative effects analysis area. Minor cumulative effects associated with disturbance and displacement potential that could cause adverse effects to moose.
		Action Alternative C	

		No trees or cover would be removed, and no roads would be built in the project area at this time. No habitat alterations or disturbance would occur that would adversely affect moose in the project area.	No trees or cover would be removed, and no roads would be built in the cumulative effects analysis area at this time. No habitat alterations or disturbance would occur that would adversely affect moose in the cumulative effects analysis area.
Elk Habitat Effectiveness and Security There is concern that increases in roads, logging disturbance, cover loss, and long-term non-motorized recreational use associated with new restricted roads will lower habitat effectiveness for elk and reduce security resulting in bull elk vulnerability and displacement of herds to neighboring agricultural lands.	1,845 acres of security habitat patches occur on the project area. 4.6 miles of restricted roads occur in the project area. 47,227 acres of security habitat patches occur in the 93,552-acre elk security analysis area. Approximately 93.3 miles of restricted roads and 107.1 miles of open roads are present in the elk security analysis area. DNRC manages 7% of the 93,552-acre elk security analysis area.	***No-Action Alternative***	
		No habitat altering activities or motorized activities would occur, thus, no direct or indirect effects to elk would be anticipated.	No habitat altering activities or motorized activities would occur, thus, no cumulative effects to elk would be anticipated.
		Action Alternative A	
		Following project activities only 10% of security patches not affected by new road locations would remain. However, 1,724 acres (63% of project area) would remain in mature forest cover. 5.3 miles of new restricted road would be constructed, and road density would increase from 1.0 miles per square mile to 2.3. Moderate and uncertain long-term added risk of disturbance and displacement of elk is expected.	45,661 acres of security habitat (48.8% of the elk security analysis area) would remain after logging exceeding the 30% Hillis et al. (1991) threshold. 70,118 total acres would remain in mature forest cover within the 93,552-acre analysis area (74.9%). Total road density would increase by 0.04%. Open road density would not increase. Motorized disturbance would be localized and short term. Both short and long-term added risk of

			disturbance and displacement of elk would be possible that could result in minor and uncertain direct and indirect adverse effects. Minor increases in elk vulnerability would be possible.
		Action Alternative B	
		Following project activities only 10% of security patches not affected by new road locations would remain. However, 1,724 acres (63% of project area) would remain in mature forest cover. 5.3 miles of new restricted road would be constructed, and road density would increase from 1.0 miles per square mile to 2.3. Moderate and uncertain long-term added risk of disturbance and displacement of elk is expected.	45,661 acres of security habitat (48.8% of the elk security analysis area) would remain after logging exceeding the 30% Hillis et al. (1991) threshold. 70,205 total acres would remain in mature forest cover within the 93,552-acre analysis area (75.0%). Total road density would increase by 0.03%. Open road density would not increase. Motorized disturbance would be localized and short term. Both short and long-term added risk of disturbance and displacement of elk would be possible that could result in minor and uncertain direct and indirect adverse effects. Minor increases in elk vulnerability would be possible.

		Action Alternative C	
		No trees or cover would be removed, and no roads would be built in the project area. No habitat alterations or disturbance would occur that would adversely affect elk in the project area or neighboring agricultural lands.	No trees or cover would be removed, and no roads would be built in the cumulative effects analysis area. No habitat alterations or disturbance would occur that would adversely affect elk in the project area or neighboring agricultural lands.
Winter Range There is concern that activities proposed in this project may adversely affect wintering elk, mule deer, and white-tailed deer.	2,095 acres of mature forest cover with ≥40% canopy cover in the project area. 2,051 acres (98%) possess dense canopy conditions with ≥60 cover, capable of ameliorating severe winter conditions for elk and deer. There are currently 4.6 miles of restricted roads on the project area and no open roads.	***No-Action Alternative***	
		No habitat altering activities or motorized activities would occur, thus, no direct or indirect effects to wintering cervids would be anticipated.	No habitat altering activities or motorized activities would occur, thus, no cumulative effects to wintering cervids would be anticipated.
		Action Alternative A	
		Cover reduced on 601 acres of mature forest in the project area. 1,724 acres (63% of project area) would remain in mature forest cover with >40% overstory canopy closure. 1,450 acres would possess dense >60% overstory cover (53% of project area). Thermal cover would be removed on 371 acres. Total road density would increase from an existing level of 1.0 miles per square mile, to 2.3. Short and	27,247 acres (82% of cumulative effects analysis area) would remain in mature forest cover with >40% overstory canopy closure. 22,221 acres would possess >60% overstory cover (67% of cumulative effects analysis area), which would provide quality thermal cover and snow intercept cover for wintering elk, and deer. Total road density would increase

		long-term moderate adverse effects would be anticipated to wintering elk and deer.	from an existing level of 1.45 miles per square mile, to 1.55 miles per square mile. Short term and long term minor adverse cumulative effects to winter habitat and wintering elk, mule deer and white-tailed deer would be anticipated.
		Action Alternative B	
		Cover reduced on 373 acres of mature forest in the project area. 1,811 acres (67% of project area) would remain in mature forest cover with >40% overstory canopy closure. 1,450 acres would possess dense >60% overstory cover (62% of project area). Thermal cover would be removed on 284 acres. Total road density would increase from an existing level of 1.0 miles per square mile, to 2.1. Short and long-term moderate adverse effects would be anticipated to wintering elk and deer.	27,334 acres (82% of cumulative effects analysis area) would remain in mature forest cover with >40% overstory canopy closure. 22,449 acres would possess >60% overstory cover (67% of cumulative effects analysis area), which would provide quality thermal cover and snow intercept cover for wintering elk, and deer. Total road density would increase from an existing level of 1.45 miles per square mile, to 1.54 miles per square mile. Short term and long term minor adverse cumulative effects to winter habitat and wintering elk, mule deer and white-tailed deer would be anticipated.

		Action Alternative C	
		No trees or cover would be removed, and no roads would be built in the project area. No habitat alterations or disturbance would occur that would adversely affect wintering moose, elk, mule deer or white-tailed deer in the project area.	No trees or cover would be removed, and no roads would be built in the cumulative effects analysis area. No habitat alterations or disturbance would occur that would adversely affect wintering moose, elk, mule deer or white-tailed deer in the cumulative effects analysis area.
Elk Calving Habitat There is concern that the presence of roads and loss of cover associated with logging could adversely affect elk calving areas on the project area.	2,095 acres of mature forest cover with ≥40% canopy cover in the project area. 2,051 acres (98%) possess dense canopy conditions with ≥60 cover. There are currently 4.6 miles of restricted roads on the project area and no open roads.	***No-Action Alternative***	
		No habitat altering activities or motorized activities would occur, thus, no direct or indirect effects to pregnant female elk or calving areas would be anticipated.	No habitat altering activities or motorized activities would occur, thus, no cumulative effects to pregnant female elk or calving areas would be anticipated.
		Action Alternative A	
		1,724 acres (63% of project area) would remain in mature forest cover with >40% overstory canopy closure. 1,450 would possess >60% overstory cover (53% of project area), which would provide quality cover for elk. New permanent roads would result in an increase in road density from an existing level of	27,247 total acres (82%) would remain in mature forest cover with >40% overstory canopy closure. 22,221 (67% of the 33,422-acre area) would possess >60% overstory cover, which would provide quality hiding cover in spring for female elk. Total road density would increase from an existing level of 1.45 miles per

		1.0 miles per square mile, to 2.3 miles per square mile. Minor short-term effects from project disturbance, and minor long-term effects from increased recreational use would be expected to calving elk.	square mile, to 1.55 miles per square mile. Minor adverse cumulative impacts involving spring habitat used during parturition for elk would be expected.
		Action Alternative B	
		1,811 acres (67% of project area) would remain in mature forest cover with >40% overstory canopy closure. 1,678 would possess >60% overstory cover (62% of project area), which would provide quality cover for elk. New permanent roads would result in an increase in road density from an existing level of 1.0 miles per square mile, to 2.1 miles per square mile. Minor short-term effects from project disturbance, and minor long-term effects from increased recreational use would be expected to calving elk.	27,334 total acres (82%) would remain in mature forest cover with >40% overstory canopy closure. 22,449 (67% of the 33,422-acre area) would possess >60% overstory cover, which would provide quality hiding cover in spring for female elk. Total road density would increase from an existing level of 1.45 miles per square mile, to 1.54 miles per square mile. Minor adverse cumulative impacts involving spring habitat used during parturition for elk would be expected.
		Action Alternative C	

		No trees or cover would be removed, and no roads would be built in the project area. No habitat alterations or disturbance would occur that would adversely affect elk or calving habitat in the project area.	No trees or cover would be removed, and no roads would be built in the cumulative effects analysis area. No habitat alterations or disturbance would occur that would adversely affect calving elk in the cumulative effects analysis area.
Economics			
Income	Gallatin and Park Counties contain parts of the statewide forest products economy.	***No-Action Alternative***	
		$0 total income earned.	Cumulative income effects are limited by the scale of the initial project. Measuring cumulative income effects with any certainty is difficult.
		Action Alternative A	
		Total delivered value of $1,741,600 would be created in the harvest and delivery of logs.	Cumulative effects have been considered and though they cannot be quantified in respect to action alternatives A and B, collectively include the minor role the proposed action has in supporting and making whole, long term capital investments made by forest product manufacturers and other timber companies in the analysis area. The infrastructure in these industries guarantees not only

			jobs and income in the analysis area, but also helps guarantee resource and land value for owners, public and private, of forested lands in Western Montana.
		Action Alternative B	
		Total delivered value of $1,090,600 would be created in the harvest and delivery of logs.	Cumulative effects have been considered and though they cannot be quantified in respect to action alternatives A and B, collectively include the minor role the proposed action has in supporting and making whole, long term capital investments made by forest product manufacturers and other timber companies in the analysis area. The infrastructure in these industries guarantees not only jobs and income in the analysis area, but also helps guarantee resource and land value for owners, public and private, of forested lands in Western Montana.
		Action Alternative C	

		Direct trust revenues would be identical to Action Alternative A or B, dependent on what timber harvest alternative is selected.	This action alternative would defer potential cumulative effects for a period of 10-years.
Employment	The two counties share an equivalent number of industry jobs, although Park County has proportionally higher employment in timber industries overall. Park County hosts significantly more sawmill jobs, while Gallatin County has larger job numbers in wood products manufacturing. Employment opportunities supported directly, or indirectly to timber sales in the project area may occur in both of these counties.	***No-Action Alternative***	
		0 annual jobs supported by the proposed alternative.	Cumulative employment effects are limited as more timber sales in the region are required to maintain employment in the forestry, logging, and wood-products-manufacturing sectors.
		Action Alternative A	
		24 annual jobs supported by the proposed alternative.	This action alternative has a minor role in supporting and making whole, long term capital investments made by forest product manufacturers and other timber companies in the analysis area. The infrastructure in these industries guarantees jobs.
		Action Alternative B	
		15 annual jobs supported by the proposed alternative.	This action alternative has a minor role in supporting and making whole, long term capital investments made by forest product manufacturers and other timber companies in

			the analysis area. The infrastructure in these industries guarantees jobs.
		Action Alternative C	
		This alternative produces no estimated direct or indirect employment effects in the timber sale area.	This action alternative would defer potential cumulative effects for a period of 10-years.
Air Quality			
The proposed activities may adversely affect local air quality through dust produced from harvest activities, road building and maintenance, and hauling, and through smoke produced from logging slash pile and prescribed burning.	Excellent air quality with very limited local emission sources and consistent wind dispersion. Existing sources of emissions include occasional construction equipment, vehicles, road dust, residential wood burning, wood fires, and smoke from logging slash disposal.	***No-Action Alternative and Action Alternative C***	
		No effects.	No effects.
		Action Alternative A and B	
		Activities associated with Action Alternatives A and B would produce dust and smoke with minor and temporary effects on air quality in localized areas when road construction and maintenance, hauling, and slash burning occur.	Activities associated with proposed actions would produce dust and smoke with minor and temporary effects on air quality in localized areas when road construction and maintenance, hauling, and slash burning occur.
Transportation			
Road Density	The existing road system in the Limestone West project area consists of approximately 1 mile of gravel road and 4.3 miles of	***No-Action Alternative and Action Alternative C***	
		The amount and distribution of roads within the project area would not change.	The transportation system roads managed as Motorized Use Restricted year-round would continue to be used for

	vegetated native surface roads.		administrative purposes including; weed management, grazing management, firewood permits, and future forest management activities.
		Action Alternative A	
		Up to 9.2 miles of new road would be constructed in accordance with the SFLMP to facilitate the timber harvest. At the completion of harvest 3.8 miles of the new road constructed would be abandoned, all culverts removed, seeded to grass and closed with debris leaving the road prism in place. 5.3 miles of the new road would remain usable for administrative purposes and future harvest as Restricted road.	At project completion, the transportation system roads managed as Motorized Use Restricted year-round would continue to be used for administrative purposes including; weed management, grazing management, firewood permits, and future forest management activities including timber permits and sales. The improved access through Sections 3 and 4 may provide for more opportunities to use permits to facilitate small forest management projects in the future.
		Action Alternative B	
		Up to 6.5 miles of new road would be constructed in accordance with the SFLMP to facilitate the timber harvest. At the completion of harvest 1.7 miles of the new road constructed	At project completion the transportation system roads managed as Motorized Use Restricted year-round would continue to be used for administrative purposes

		would be abandoned, all culverts removed, seeded to grass and closed with debris leaving the road prism in place. 4.8 miles of the new road would remain usable for administrative purposes and future harvest as Restricted road.	including; weed management, grazing management, firewood permits, and future forest management activities including timber permits and sales. The improved access through Sections 3 and 4 may provide for more opportunities to use permits to facilitate small forest management projects in the future.
Traffic and Harvest Activities	With the exception of the Bear Canyon Timber Sale (November 2011 – July 2014), the motorized traffic the past 15 years on the road system has consisted of occasional administrative visits by state personnel (about once or twice a month during summer and fall), use by our grazing lessee, weed abatement contractor, and the occasional firewood permit holder. The majority of the traffic has been non-motorized recreational traffic.	***No-Action Alternative and Action Alternative C***	
		Motorized traffic by state personnel and associated Trust land management activities would remain occasional.	The transportation system roads managed as Motorized Use Restricted year-round would continue to be used for administrative purposes including; weed management, grazing management, firewood permits, and future forest management activities including timber permits and sales. Traffic and maintenance would continue in roughly the same pattern that they have been on for the last few years. An increase in recreational traffic could be expected since

			recreational traffic has increased regularly in the Gallatin valley at most of the access points to public lands.
		Action Alternative A	
		The Limestone West Timber Sale would result in increased traffic for both administrative purposes and the commercial harvesting activities. In general, administrative trips could be expected to be around 2-3 a week with the exception that there could be multiple trips in one day depending on the issues being addressed.	Log hauling and support traffic on Mt. Ellis lane could result in up to 16% increase traffic on days that experience peak use.
		Action Alternative B	
		The Limestone West Timber Sale would result in increased traffic for both administrative purposes and the commercial harvesting activities. In general, administrative trips could be expected to be around 2-3 a week with the exception that there could be multiple trips in	Log hauling and support traffic on Mt. Ellis lane could result in up to 16% increase traffic on days that experience peak use.

		one day depending on the issues being addressed.	
Triple Tree Trail Concern that harvest activities may disturb the Triple Tree Trail.	The Triple Tree Trail is located in the project area.	***No-Action Alternative and Action Alternative C***	
		There would be no changes to the Triple Tree Trail.	There would be no changes to the Triple Tree Trail.
		Action Alternative A	
		Selective harvest would occur along approximately 1,000 feet of trail located in the south and southeast portion of the trail. The trail would be closed in this area for 2-3 days as a safety precaution until harvest activities are completed.	There would be no changes to the Triple Tree Trail.
		Action Alternative B	
		There would be no changes to the Triple Tree Trail.	There would be no changes to the Triple Tree Trail.
Recreation			
Harvest activities may adversely affect recreational experiences within the project area including hiking, skiing, hunting, horseback riding, birding, mountain biking, and general	During late spring and summer, the area sees the heaviest and most diverse recreational use which includes; hiking, mountain biking, birding, running, horseback riding, dog	***No-Action Alternative and Action Alternative C***	
		No appreciable changes to access for the developed areas or existing infrastructure would occur.	No appreciable changes to access for the developed areas or existing infrastructure would occur.
		Action Alternative A	

enjoyment of the area.	walking, and wildflower viewing. In the fall the primary use transitions to hunting activities, though most of the summer uses are still present to a lesser degree.	Those who choose to recreate in the area during the workweek daytime hours would likely meet harvest-related traffic on designated haul routes and operators in harvest units. Direct and indirect effects on these recreationists are expected to be moderate to high.	Adverse cumulative effects are expected to be minor within the cumulative effects analysis area since recreationists would continue to have similar recreational opportunities on trails nearby.
		Action Alternative B	
		Those who choose to recreate in the area during the workweek daytime hours would likely meet harvest-related traffic on designated haul routes and operators in harvest units. Direct and indirect effects on these recreationists are expected to be moderate to high.	Adverse cumulative effects are expected to be minor within the cumulative effects analysis area since recreationists would continue to have similar recreational opportunities on trails nearby.
Harvest activities may affect the amount, location, use, and condition of many existing trails and other developed facilities within the project area.	The general recreational use within the area depends on the use of one hiking trail and existing infrastructure not specifically developed by the DNRC for recreation. There is a parking area for the Triple Tree Trail on Sourdough Road.	***No-Action Alternative and Action Alternative C***	
		No appreciable changes to access for the developed areas or existing infrastructure would occur.	No appreciable changes to access for the developed areas or existing infrastructure would occur.
		Action Alternative A	
		Selective harvest would occur along approximately 1,000 feet of trail located in the south and southeast portion of the trail. The	Cumulative effects would result in increases in roads available for nonmotorized public access and further

		trail would be closed in this area for 2-3 days as a safety precaution until harvest activities are completed.	displacement of recreationists from active harvest areas during typical business hours.
		Action Alternative B	
		Since there will be no harvest located in the Triple Tree Trail area, these recreationists would not be displaced during harvest activities.	Cumulative effects would result in increases in roads available for nonmotorized public access and further displacement of recreationists from active harvest areas during typical business hours.
Increase in road densities may result in increased recreational use and trails, changing the character of the project area.	Currently there are approximately 5.3 miles of road within the project area designated as "Motorized Use Restricted Year-Round".	***No-Action Alternative and Action Alternative C***	
		No appreciable changes to access for the developed areas or existing infrastructure would occur.	No appreciable changes to access for the developed areas or existing infrastructure would occur.
		Action Alternative A	
		Approximately 9.2 miles of new road would be constructed. The Limestone West Timber Sale transportation system would result in increased non-motorized access to the project area.	New, permanent road construction would lead to increases in public nonmotorized access.
		Action Alternative B	

		Approximately 6.5 miles of new road would be constructed. The Limestone West Timber Sale transportation system would result in increased non-motorized access to the project area.	New, permanent road construction would lead to increases in public nonmotorized access.
Aesthetics			
Views The proposed activities may adversely affect local viewsheds and scenic vistas.	The view consists of foothills rising from the alluvial plain bisected by drainages at each end, predominantly timbered north slopes transitioning to generally open west slopes and meadows with brushy draws in the alluvial plain.	***No-Action Alternative and Action Alternative C***	
		The viewshed would continue to noticeably change due to the effect of the mountain pine beetle.	The viewshed would continue to noticeably change due to the effect of the mountain pine beetle.
		Action Alternative A	
		The visual impact of implementing this alternative would be the more visible of the two timber sale alternatives from all observer points.	Following harvest, the increase in the amount of managed acres visible from each observation points is expected to be very noticeable within the range of the cumulative effects analysis area especially from Fort Ellis, South Third Street and Star Ridge Road observation points. Over time, the harvest units are expected to blend in with the surrounding landscape, appearing more consistent with other managed areas throughout the area.

		Action Alternative B	
		The visual impact of implementing this alternative would be the less visible than Action Alternative A from all observer points.	Following harvest, the increase in the amount of managed acres visible from each observation points is expected to be very noticeable within the range of the cumulative effects analysis area especially from Fort Ellis, South Third Street and Star Ridge Road observation points. Over time, the harvest units are expected to blend in with the surrounding landscape, appearing more consistent with other managed areas throughout the area.
Noise levels The proposed activities may increase local noise levels.	Traffic associated with administrative use, firewood harvesting, and recreational use produce noise throughout the area.	***No-Action Alternative and Action Alternative C***	
		No change in noise levels would be expected.	No change in noise levels would be expected.
		Action Alternative A and B	
		Noise would be generated by harvest operations, harvest related traffic, road construction and administrative oversight Road construction, harvesting operations and timber hauling are expected to be louder than other	Cumulative effects to noise during the daytime and on weekends would be expected to increase beyond current levels found within the cumulative-effects analysis area. Cumulative effects to noise

		harvest related traffic.	during the evenings would not be expected to increase beyond current levels found within the area.

CHAPTER III
EXISTING ENVIRONMENT AND ENVIRONMENTAL EFFECTS

INTRODUCTION

This chapter is a summary of resource conditions as they relate to the proposed Limestone West Timber Sale Project. The current, or existing, condition can be viewed as a baseline to compare changes resulting from the selection of any alternative. How each alternative may affect the environment is also described. For more complete assessments and analyses related to the resources for both scientific and judicial review, refer to the appropriate section of this DEIS.

VEGETATION ANALYSIS

INTRODUCTION

The vegetation assessment describes the present conditions and components of the vegetation communities in the area, as well as the anticipated environmental effects associated with each alternative.

Issues and Measurement Criteria

During the scoping period, 110 individual comments related to vegetation were received from DNRC staff and the public. Those comments were reviewed and summarized into 27 separate issues related to vegetation, of which 18 were eliminated from further analysis as shown in Appendix A, and 9 were carried forward for analysis. Those 9 issues are summarized by the following statements:

1. Timber harvesting activities associated with this project may alter forest cover type and age class conditions.

   Measurement criteria: forest cover type distribution, desired future conditions, age class distribution, stand structure

2. Harvesting activities and conifer encroachment into aspen galleries may reduce the amount of aspen in the project area.

   Measurement criteria: cover type distribution, desired future conditions

3. Timber harvesting associated with this project may adversely affect old-growth forests in the project area.

   Measurement criteria: age class distribution, amount of old growth forests

4. Timber harvesting activities associated with this project may affect the ability of non-old growth stands to eventually qualify as old growth.

   Measurement criteria: age class distribution

5. There are concerns about current levels of forest insects and diseases and the effectiveness of active forest management to address those issues.

   Measurement criteria: insect presence and distribution, probability of mountain pine beetle outbreak

6. Forest management activities associated with this project may not effectively reduce fire hazard or will directly or indirectly increase fire hazard in the project area.

   Measurement criteria: fuel loading, potential flame length, torching index, crowning index, expected fire types

7. There are concerns about fire hazard and potential fire behavior associated with beetle-killed lodgepole pine and associated forest management activities.

   Measurement criteria: fuel loading, potential flame length, torching index, crowning index, expected fire types

8. Forest management activities associated with this project may adversely affect native flora, threatened, endangered, or sensitive plant species, or rare and unique habitats.

   Measurement criteria: species presence and distribution

9. Timber harvesting and road building may introduce or spread noxious weeds in the project area.

   Measurement criteria: species presence and distribution

Analysis Areas

This analysis includes two geographic scales for assessing potential direct, indirect, and cumulative effects of the No-Action and Action Alternatives.

Direct and Indirect Effects Analysis Area

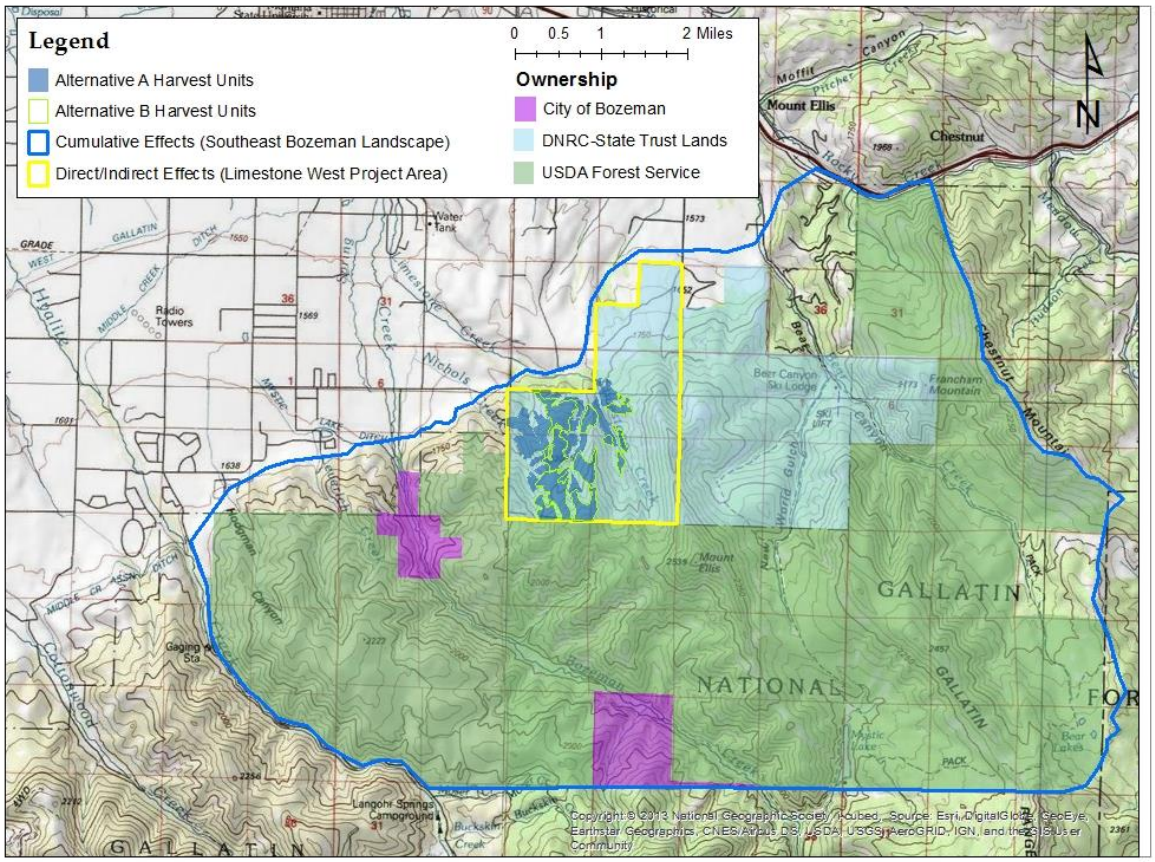
The analysis area for direct and indirect effects includes the State-owned parcels in Section 34 of T.2S, R.6E and Sections 3, 4, 9, and 10 of T.3S, R.6E (*FIGURE V-1*). This 2,713-acre area is referred to as the project area (*see Chapter I — Purpose and Need*).

Cumulative Effects Analysis Area

An analysis area, hereafter referred to as the Southeast Bozeman Landscape, was identified to analyze cumulative effects to forest vegetation associated with this project. This area of 33,422 acres is southeast of Bozeman and surrounds the project area (*FIGURE V-1*). It is defined by northern edge of the Gallatin Range where it meets the valley and rangeland southeast of Bozeman, the east ridge of the Bear Creek drainage on the east, the southern boundaries of sections 28, 29, and 30 of T.3S, R.7E and sections 25, 26, 27, 28, and 29 of T.3S, R.6E on the south, and Hyalite Creek on the west. The Southeast Bozeman Landscape generally includes portions of the following drainages southeast of Bozeman: Hyalite Creek, Bozeman Creek, Nichols Creek, Limestone Creek, New World Gulch, and Bear Creek.

The prominent land feature within the Southeast Bozeman Landscape is Mount Ellis. Steep and rugged mountainous terrain is found throughout the area. Property ownership within the Southeast Bozeman Landscape is generally divided among four categories: National Forest lands managed by the USFS Custer Gallatin National Forest (66 percent), State Trust Lands (19 percent), private ownership (12 percent), and lands owned by the City of Bozeman (3 percent). Private land and State Trust Lands are primarily located in the northern portion of the Southeast Bozeman Landscape, while National Forest and City of Bozeman Lands are in the central and southern portions. Forest cover predominates throughout the Southeast Bozeman Landscape.

FIGURE V-1. VEGETATION ANALYSIS AREAS FOR DIRECT, INDIRECT, AND CUMULATIVE EFFECTS.



Stand History and Past Management

Natural and human-caused events have shaped forest development in the Limestone West project area and Southeast Bozeman Landscape. The primary natural event affecting stand development in the Southeast Bozeman Landscape is fire. The current stands in the project area likely originated following fires that occurred over 100 years ago, including a 1909 fire on Mount Ellis (*GNF 2010*). Since that time, fire has been largely absent from the project area and Southeast Bozeman Landscape, due primarily to effective suppression of fire starts that have occurred (*GNF 2010*).

Within the project area, past timber harvesting has occurred on 166 acres, with most of the activity concentrated in the north half of section 3 and additional small areas in sections 34 and 4. Most recently, 74 acres in Section 3 were harvested in the Bear Canyon Timber Sale that was completed in 2013. 11 acres in Section 4 were harvested in the mid-2000s. 67 acres in Section 3 and 14 acres in Section 34 were harvested in the early 1990s. Sections 9 and 10 have never been

harvested. Harvesting activities have employed the following treatment types: thinning[1] to address overstocking, promote growth, or reduce fire hazard near private property; sanitation[2] and salvage[3] of insect-killed trees; and treatments that aim to establish a new stand of trees including seed tree with reserves[4], and shelterwood with reserves[5]. These harvests created gaps or openings in the forest canopy, as well as reduced tree density and increased tree spacing where harvesting occurred (*see Chapter 2 — Relevant Past, Present, and Related Future Actions*).

In the Southeast Bozeman Landscape, the majority of forests have no history of past management. Most recent harvesting activities in the Southeast Bozeman Landscape have occurred on private and State Trust Lands adjacent to but not included in the project area. In addition to the harvesting within the project area, 626 acres in sections 34 and 35 of T.2S, R.6E and sections 1, 2, 3, and 11 of T.3S, R.6E were harvested in the Bear Canyon Timber Sale. An additional 258 acres in sections 1, 2, and 3 of T.3S, R.6E were harvested from 1974 through 1997. Harvest treatments included those listed above, as well as clearcutting[6]. Past harvesting, most of which occurred between the 1950s and 1980s, has also occurred on National Forest land within the Southeast Bozeman Landscape, primarily in the Hyalite and Bozeman Creek drainages.

Forest Cover Types, Age Classes, and Stand Structure

ISSUES ADDRESSED

1. Timber harvesting activities associated with this project may alter forest cover type and age class conditions.
2. Harvesting activities and conifer encroachment into aspen galleries may reduce the amount of aspen in the project area.
3. Timber harvesting associated with this project may adversely affect old-growth forests in the project area.

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[1] Thinning is a silvicultural treatment made to reduce stand density of trees primarily to improve growth, enhance forest health, or recover potential mortality (*Helms 1998*).

[2] Sanitation cutting is the removal of trees to improve stand health by stopping or reducing the actual or anticipated spread of insects and disease (*Helms 1998*)

[3] Salvage cutting is the removal of dead trees or trees damaged and dying because of injurious agents other than competition, to recover economic value that would otherwise be lost (*Helms 1998*).

[4] Seed tree with reserves is a silvicultural treatment that involves the cutting of all trees except for a small number of widely dispersed trees retained for seed production and to produce a new age class in a fully exposed microenvironment (*Helms 1998*). Additional trees are retained to attain goals other than regeneration of new trees.

[5] Shelterwood with reserves is a silvicultural treatment involving the cutting of most trees, leaving those needed to produce sufficient shade to produce a new age class in a moderated microenvironment (*Helms 1998*). Additional trees are retained to attain goals other than regeneration of new trees.

[6] Clearcutting is the cutting of essentially all trees, producing a fully exposed microclimate for the development of a new age class (*Helms 1998*).

4. Timber harvesting activities associated with this project may affect the ability of non-old growth stands to eventually qualify as old growth

ANALYSIS METHODS

Stand level inventory (SLI) data collected by DNRC foresters in the summer of 2016 were used to assess potential effects on forest cover types, age classes, and old growth in the project area. Desired future condition (DFC) cover types for stands in the project area were determined using SLI data and DNRC's model described in *ARM 36.11.405*. The U.S. Forest Service's Forest Vegetation Simulator (FVS) growth and yield model was used to evaluate the effects of the No-Action and Action alternatives on forest cover types within the project area.

The U.S. Geological Survey GAP/LANDFIRE National Terrestrial Ecosystems data (*USGS 2018*) for 2011 were used to identify and summarize land cover types in the Southeast Bozeman Landscape. Aerial photography was used to estimate age classes in the Southeast Bozeman Landscape.

AFFECTED ENVIRONMENT

Project Area Cover Types and DFCs

Within the project area, there are 2,105 acres of forested land and 608 acres of non-forest land (*TABLE V-1*). Of the forested acres, Douglas-fir (*Pseudotsuga menziesii*) is the most commonly occurring cover type; it is found on 30 percent (802 acres) of the project area (*TABLE V-1*). In the project area, Douglas-fir stands contain at least 60 percent Douglas-fir (commonly greater than 80 percent) and minor amounts of co-occurring species including lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*), limber pine (*Pinus flexilis*), or quaking aspen (*Populus tremuloides*). Lodgepole pine is the second-most common forest type in the project area (740 acres). Lodgepole pine stands contain at least 50 percent lodgepole pine and more often greater than 70 percent. Co-occurring species in lesser amounts within lodgepole pine stand include those listed above. Mixed conifer stands in the project area (256 acres) are typically composed of lodgepole pine and Douglas-fir where each species represents less than 50 percent of the stand's composition. Subalpine stands (193 acres) have greater representation of subalpine fir and Engelmann spruce, with combined amounts of those species typically greater than 50 percent of the stand's composition. Hardwood cover types (58 acres) are dominated by aspen and often include minor presence of coniferous species that are encroaching on the edges of aspen stands. Non-forested cover types in the project area include grass and shrub lands, meadows, and riparian areas.

TABLE V-1 also shows DNRC's DFC for the stands in the project area. The DFC represents the cover type that DNRC aims to manage toward in each stand in order to implement its coarse-filter approach to managing for biodiversity (*ARM 36.11.404*). In the project area, mixed conifer, lodgepole pine, and limber pine stands are currently over-represented compared to desired amounts, while subalpine and aspen stands are under-represented.

TABLE V-1. CURRENT COVER TYPES AND DESIRED FUTURE CONDITIONS FOR THE PROJECT AREA.

COVER TYPE	PRE-TREATMENT (CURRENT COVER)		DFC		ALTERNATIVE A POST-TREATMENT		ALTERNATIVE B POST-TREATMENT	
	Acres*	Percent	Acres	Percent	Acres*	Percent	Acres*	Percent
Douglas-fir	802	29.6	800	29.5	966	35.6	910	33.5
Hardwoods	58	2.1	72	2.7	58	2.1	58	2.1
Limber pine	57	2.1	0	0	57	2.1	57	2.1
Lodgepole pine	740	27.3	666	24.5	643	23.7	684	25.2
Mixed conifer	256	9.4	0	0	190	7.0	205	7.6
Subalpine	193	7.1	567	20.9	192	7.1	192	7.1
Non-forest	608	22.4	608	22.4	608	22.4	608	22.4
Totals	*2,713*	*100.0*	*2,713*	*100.0*	*2,713*	*100.0*	*2,713*	*100.0*

*numbers may not sum to total due to rounding.

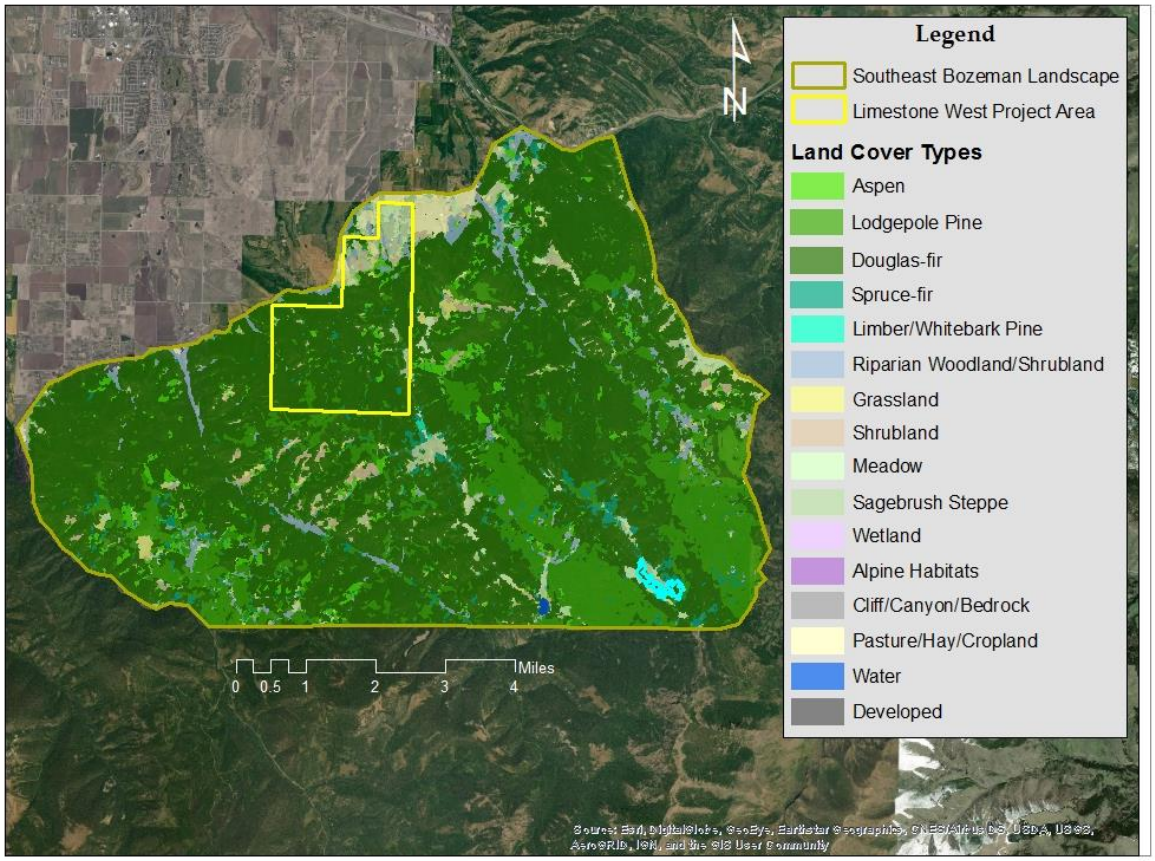
Southeast Bozeman Landscape Cover Types

Within the Southeast Bozeman Landscape, there are 29,182 acres of forest land and 4,240 acres of non-forest land (*TABLE V-2; FIGURE V-3*). Of the forested acres, Douglas-fir is the most commonly occurring cover type; it is found on 59 percent (19,602 acres) of the Southeast Bozeman Landscape (*TABLE V-2*). Lodgepole pine forests occupy 19 percent of the Southeast Bozeman Landscape. Aspen forests and subalpine forests dominated by Engelmann spruce and subalpine fir are each found of 5 percent of the Southeast Bozeman landscape. Non-forested cover types in the Southeast Bozeman Landscape are predominately riparian areas, sage and other shrub lands, and meadows.

TABLE V-2. CURRENT COVER TYPES FOR THE SOUTHEAST BOZEMAN LANDSCAPE.

COVER TYPE	ACRES	PERCENT
Douglas-fir	19,602	58.7
Hardwoods	1,702	5.1
Lodgepole pine	6,326	18.9
Subalpine	1,552	4.6
Non-forest	4,240	12.7
Totals	*33,422*	*100.0*

FIGURE V-2. GAP LAND COVER DATA IN THE PROJECT AREA AND SOUTHEAST BOZEMAN LANDSCAPE.



Age Classes

Forest stands in the project area and Southeast Bozeman Landscape are primarily mature stands greater than 80 years old. Lodgepole pine stands are, on average, 100 years old, while Douglas-fir stands average 130 years old. Some areas have concentrations of older Douglas-fir trees that are over 170 years old.

Old Growth

DNRC has adopted the *Green et al*. (*1992*) criteria for determining old growth stands on state lands (*ARM 36.11.403*). *Green et al*. (*1992*) established minimum criteria including minimum diameter of large trees, number of large trees per acre, average age of large trees, and stand basal area to identify potential old growth stands. Stands that meet each of those criteria are considered old growth.

Within the project area, there are 119 acres that meet the minimum criteria to be classified as old growth. These stands are in the southeast quarter of section 10 and are not included in any of the proposed harvest units. Three other stands in sections 3 and 9 were identified as potential old growth but field verification efforts determined that they did not meet all the minimum criteria for old growth classification. Several stands encompassing 106 acres in the Nichols

Creek area, primarily west of the creek, meet the minimum criteria for number of large trees and basal area but are not yet old enough to meet the age criteria to be classified as old growth.

Stand Structure

Stands in the project area and Southeast Bozeman Landscape are predominantly single-storied stands (60 percent of forested stands in the project area). These stands have one well-defined canopy layer composed of mature trees, and there may be scattered individuals, usually seedlings or saplings of shade-tolerant species, present below the mature canopy. This stand structure is prevalent in the lodgepole pine and much of the Douglas-fir forests in the project area. In two-storied stands (20 percent of forested stands in the project area), there is an overstory canopy with well-established seedling or sapling regeneration, usually Douglas-fir, beneath the mature overstory. This condition is found in approximately 23 percent of the Douglas-fir cover types and 15 percent of the lodgepole pine stands. Multi-storied stands (20 percent of the project area), those with three or more well-defined canopy layers, are most commonly found in subalpine stands and also occur in about 15 percent of the Douglas-fir stands in the project area.

ENVIRONMENTAL EFFECTS

Direct and Indirect Effects

- ***Direct and Indirect Effects of the No-Action Alternative***

With no action, the acreage of existing cover types in the project area would not be expected to change. However, in forested stands, subtle shifts in species composition would be expected to occur over time. In current lodgepole pine cover types, natural mortality of lodgepole pine would be expected to decrease the current proportion of lodgepole pine while the proportion of comparatively more shade-tolerant species such as Douglas-fir, Engelmann spruce, and subalpine fir would be expected to increase as those species grow and advance into the dominant canopy layer. Potential increases in mountain pine beetle activity would accelerate the rate of this shift in species composition; however, over time a new age class of regenerating lodgepole pine would be expected to develop, especially if larger canopy openings were created by beetle-caused mortality.

In hardwood (aspen) cover types, conifer encroachment into aspen galleries would be expected to continue over time, reducing the proportion of aspen in those stands.

Stand age would be expected to increase over time until a future disturbance, whether naturally caused such as wildfire or insect outbreaks or human-caused such as timber harvesting, alters conditions in stands that would effectively reduce the overstory canopy to a sufficient degree to allow regeneration of a new age class of trees.

There would be no change to current old growth amounts in the project area. Natural events, such as wildfire or insect outbreaks, could cause mortality in current old growth stands that could cause those stands to no longer meet the minimum criteria for old growth classification. Stands in the Nichols Creek area that meet all the old growth minimum criteria except tree age would be expected to become old growth over time, potentially raising old growth amounts in the project area to 225 acres.

Stand structure could change over time depending on the amount of regeneration that is currently present under the dominant canopy layer or the success of new regeneration in establishing beneath the dominant canopy layer(s). Stands that are currently single-storied but with little development of regeneration in the understory would be expected to remain single-storied stands. If shade-tolerant regeneration successfully establishes in single-storied stands, two-storied stands would develop. In stands that are currently two-storied, two-storied conditions would be expected to persist, or if shade-tolerant regeneration were able to successfully establish, multi-storied structures could develop. Stands that are currently multi-storied would be expected to maintain that structure.

- ***Direct and Indirect Effects of Alternative A***

Within the project area, the proposed harvesting activities would be expected to immediately alter coniferous cover types on approximately 164 acres using clearcut with reserves and shelterwood prescriptions. 97 acres of lodgepole pine, 66 acres of mixed conifer, and 1 acre of subalpine forests would be converted to the Douglas-fir cover type following harvesting. Harvesting would not change cover types on 303 acres of lodgepole pine, 126 acres of Douglas-fir, and 8 acres of mixed conifer forests.

Most merchantable lodgepole pine, except those left for snag and snag recruit retention requirements or those within small patches of sub-merchantable trees, would be removed in all harvest units; in forests dominated by lodgepole pine this treatment would mimic a stand-replacing fire that removes most of the overstory canopy. Well-formed Douglas-fir that occur in lodgepole pine forests would be left as reserve trees. In lodgepole pine stands that currently have more than 20 percent Douglas-fir (97 acres), Douglas-fir would be retained in sufficient levels to temporarily shift the cover type of those stands from lodgepole pine to Douglas-fir following harvesting. As lodgepole pine regenerates in those stands, they would be expected to revert to lodgepole-pine dominated forests in approximately 20 years. The age class on those acres would not change due to the retention of Douglas-fir. In 303 acres of lodgepole pine forest, harvesting treatments would effectively remove most of the overstory trees, and regenerating lodgepole pine would effectively maintain that cover type. The age class on those 303 acres would shift from mature forests to seedling/sapling forests.

In Douglas-fir, mixed conifer, and subalpine stands, implementation of a shelterwood prescription would reduce tree density in those stands by approximately 50%, effectively emulating a low- to mixed-severity fire. Tree retention would focus on well-formed, healthy, and vigorous trees, with poorly-formed and trees affected by insects and/or disease targeted for removal. Douglas-fir would be primary species retained, as a result, this would shift species composition on 66 acres of mixed conifer and 1 acre of subalpine forest to Douglas-fir. This treatment would not change cover types on 126 acres of Douglas-fir and 8 acres of mixed conifer forests where Engelmann spruce is the primary species. The age class of forests treated with this prescription would not change due to the level of overstory retention in the stands. Shade-tolerant regeneration may establish in some openings created with this prescription; however, experience in similar forests in this area has shown a lengthy regeneration period that may exceed 30 years due to infrequent and poor seed crops as well as heavy competition from brush, particularly ninebark (*Physocarpus malvaceus*), and grass that establishes following

harvesting. Planting and brush control may be necessary and used in some areas to establish Douglas-fir regeneration at sufficient stocking levels in these stands.

In areas adjacent to aspen cover types, removal of all merchantable conifers within 75 feet of aspen colonies would reduce conifer encroachment and promote aspen suckering and regeneration. Aspen may be knocked down during harvesting to stimulate suckering. Successful regeneration of aspen may slightly reduce coniferous acreage within the project area.

Compared to desired future conditions, the anticipated changes in cover type would temporarily increase Douglas-fir above its target percentage and decrease lodgepole pine below its desired percentage. In lodgepole pine stands converted to Douglas-fir because of harvesting (97 acres), those acres would be expected to revert to lodgepole pine forests after regeneration establishes in the stands, bringing cover types closer toward their target amounts.

No old growth stands are proposed for harvesting under Alternative A. There would be no change to old growth amounts because of harvesting. Most of the non-old growth stands that have potential to become old growth in the future are located west of Nichols Creek where no harvesting is proposed. In older stands where harvesting is proposed, harvesting would leave sufficient numbers of large trees to facilitate their development into old growth upon meeting the minimum age requirement.

Stand structure would not be appreciably altered because of harvesting, although tree density will be reduced. Single-storied stands dominated by lodgepole pine would remain single-storied following harvesting, although tree size would change from mature overstory trees to seedling/sapling regeneration. Single-storied lodgepole pine stands that convert to Douglas-fir stands following harvesting would remain single-storied until lodgepole pine regeneration establishes, at which point they would be two-storied stands. Stands that are currently two-storied or multi-storied would not change from harvesting.

Alternative A would not be expected to alter cover types, age classes, or stand structure in untreated areas within the project area. The development of such stands would be as described under no or delayed action.

- ***Direct and Indirect Effects of Alternative B***

Within the project area, the proposed harvesting activities would be expected to immediately alter coniferous cover types on approximately 108 acres using clearcut with reserves and shelterwood prescriptions. 56 acres of lodgepole pine, 51 acres of mixed conifer, and 1 acre of subalpine forests would be converted to the Douglas-fir cover type following harvesting. Harvesting would not change cover types on 224 acres of lodgepole pine, 33 acres of Douglas-fir, and 8 acres of mixed conifer forests.

Most merchantable lodgepole pine, except those left for snag and snag recruit retention requirements or those within small patches of sub-merchantable trees, would be removed in all harvest units; in forests dominated by lodgepole pine this treatment would mimic a stand-replacing fire that removes most of the overstory canopy. Well-formed Douglas-fir that occur in lodgepole pine forests would be left as reserve trees. In lodgepole pine stands that currently have more than 20 percent Douglas-fir (56 acres), Douglas-fir would be retained in sufficient

levels to temporarily shift the cover type of those stands from lodgepole pine to Douglas-fir following harvesting. As lodgepole pine regenerates in those stands, they would be expected to revert to lodgepole-pine dominated forests in approximately 20 years. The age class on those acres would not change due to the retention of Douglas-fir. In 224 acres of lodgepole pine forest, harvesting treatments would effectively remove most of the overstory trees, and regenerating lodgepole pine would effectively maintain that cover type. The age class on those 224 acres would shift from mature forests to seedling/sapling forests.

In Douglas-fir, mixed conifer, and subalpine stands, implementation of a shelterwood prescription would reduce tree density in those stands by approximately 50%, effectively emulating a low- to mixed-severity fire. Tree retention would focus on well-formed, healthy, and vigorous trees, with poorly-formed and trees affected by insects and/or disease targeted for removal. Douglas-fir would be primary species retained, as a result, this would shift species composition on 51 acres of mixed conifer and 1 acre of subalpine forest to Douglas-fir. This treatment would not change cover types on 33 acres of Douglas-fir and 8 acres of mixed conifer forests where Engelmann spruce is the primary species. The age class of forests treated with this prescription would not change due to the level of overstory retention in the stands. Shade-tolerant regeneration may establish in some openings created with this prescription; however, experience in similar forests in this area has shown a lengthy regeneration period that may exceed 30 years due to infrequent and poor seed crops as well as heavy competition from brush, particularly ninebark, and grass that establishes following harvesting. Planting and brush control may be necessary and used in some areas to establish Douglas-fir regeneration at sufficient stocking levels in these stands.

In areas adjacent to aspen cover types, removal of all merchantable conifers within 75 feet of aspen colonies would reduce conifer encroachment and promote aspen suckering and regeneration. Aspen may be knocked down during harvesting to stimulate suckering. Successful regeneration of aspen may slightly reduce coniferous acreage within the project area.

Compared to desired future conditions, the anticipated changes in cover type would temporarily increase Douglas-fir above its target percentage and decrease lodgepole pine below its desired percentage. In lodgepole pine stands converted to Douglas-fir because of harvesting (56 acres), those acres would be expected to revert to lodgepole pine forests after regeneration establishes in the stands, bringing cover types closer toward their target amounts.

No old growth stands are proposed for harvesting under Alternative B. Effects on old growth associated with this alternative are the same as Alternative A.

Effects on stand structure associated with Alternative B are the same as Alternative A.

Alternative B would not be expected to alter cover types, age classes, or stand structure in untreated areas within the project area. The development of such stands would be as described under no or delayed action.

- ***Direct and Indirect Effects of Alternative C***

Under Alternative C, delaying action for at least 10 years would result in effects like those of no action until any future actions are initiated following expiration of the conservation license. At

that time, potential treatments that could occur would have effects on cover type, age class, old growth, and stand structure like those of Alternative A.

Cumulative Effects

- ***Cumulative Effects of the No-Action Alternative***

Cumulative effects of no action in untreated stands within the Southeast Bozeman Landscape would be like those described for no action in the project area. In the absence of disturbance, cover types in untreated stands would not be expected to change appreciably; however, subtle shifts in species composition within stands, increasing the amount of shade-tolerant species, would be expected to occur. Stands would be expected to increase in age, and canopy structure would be expected to become more complex.

Treatments associated with other projects proposed within the Southeast Bozeman Landscape could alter cover types and age classes. The USDA Forest Service, Custer Gallatin National Forest, has proposed the Bozeman Municipal Watershed (BMW) Project, under which treatments could be implemented on approximately 4,173 acres (12 percent) of the Southeast Bozeman Landscape (*GNF 2011*). Noncommercial treatments, including small tree thinning and prescribed burning, associated with the BMW project are proposed on approximately 2,547 acres. Commercial treatments, including skyline, helicopter, and tractor thinning, proposed in the BMW project could be implemented on approximately 1,626 acres within the Southeast Bozeman Landscape. These treatments would focus on reducing stand density to reduce fuels and fire hazard. The treatments proposed in the BMW project would be expected to alter species composition, density, and structure, and age class to varying degrees within individual stands depending on the prescription implemented, with more substantial effects in stands receiving more intensive treatments. The age class of treated stands may change depending on the type of treatment.

- ***Cumulative Effects of Alternative A***

Treatments to forest stands included with the DNRC Limestone West Timber Sale project and Custer Gallatin National Forest BMW project could potentially occur on approximately 4,774 acres (14 percent) of the Southeast Bozeman Landscape. These treatments would be expected to decrease stand density, decrease the proportion of lodgepole pine occurring within stands and on the landscape in favor of other conifer species and aspen, alter stand structure, and increase age class diversity by reducing the amount of mature forests and increasing the amount of seedling/sapling forests by at least 303 acres.

Cumulative effects to untreated stands within the Southeast Bozeman Landscape would be like those described for no action.

- ***Cumulative Effects of Alternative B***

Treatments to forest stands included with the DNRC Limestone West Timber Sale project and Custer Gallatin National Forest BMW project could potentially occur on approximately 4,546 acres (14 percent) of the Southeast Bozeman Landscape. These treatments would be expected to decrease stand density, decrease the proportion of lodgepole pine occurring within stands and

on the landscape in favor of other conifer species and aspen, alter stand structure, and increase age class diversity by reducing the amount of mature forests and increasing the amount of seedling/sapling forests by at least 224 acres.

Cumulative effects to untreated stands within the Southeast Bozeman Landscape would be like those described for no action.

- ***Cumulative Effects of Alternative C***

Cumulative effects of delaying action for at least 10 years would result in effects like those of no action until any future actions are initiated following expiration of the conservation license. At that time, potential treatments that could occur following would have effects on cover type, age class, old growth, and stand structure like those of Alternative A.

FOREST INSECTS

ISSUES ADDRESSED

5. There are concerns about current levels of forest insects and diseases and the effectiveness of active forest management to address those issues.

ANALYSIS METHODS

USFS Aerial Detection Survey (ADS) data from 2010-2017 was used to estimate the distribution and type of insect activity in the Southeast Bozeman Landscape. Stand exam data collected by DNRC foresters during the fall of 2016 was used to estimate the amount of mortality due to insects in the project area. The Lodgepole Pine Mountain Pine Beetle Extension for the Forest Vegetation Simulator (FVS) was used to estimate the probability of mountain pine beetle outbreak.

AFFECTED ENVIRONMENT

Over the past decade, two insects, mountain pine beetle (*Dendroctonus ponderosae*) and western spruce budworm (*Choristoneura occidentalis*), have had widespread impact on forests in the Limestone West project area and Southeast Bozeman Landscape. Mountain pine beetle was most active from 2008 through 2011 and caused extensive damage to lodgepole pine forest throughout the project area and Southeast Bozeman Landscape (*FIGURE V-3*). Since 2011, mountain pine beetle has mostly returned to endemic levels in the project area and landscape; however, mortality in lodgepole pine caused by mountain pine beetle is still evident.

DNRC stand exams conducted in the summer of 2016 found mountain pine beetle activity and associated mortality throughout the project area. The average mortality of lodgepole pine within stands sampled in the project area was 18 percent, with values for individual stands ranging from 0 to 100 percent. Mortality in lodgepole pine within the project area is most prevalent in Sections 3, 4, 9, and 10, and is generally seen in small groups or individual trees.

Western spruce budworm has also impacted a large portion of the project area and Southeast Bozeman landscape over the past decade (*FIGURE V-4*). 2009, 2013, 2015, and 2016 were years with the largest amounts of spruce budworm activity in both the project area and Southeast Bozeman landscape. Spruce budworm affects Douglas-fir, Engelmann spruce, and subalpine fir, but does not typically cause mortality unless repeated defoliation occurs. However,

defoliation weakens and stresses affected trees, making them susceptible to other damaging agents such as Douglas-fir beetle (*Dendroctonus psuedotsugae*), spruce beetle (*Dendroctonus rufipennis*), and various diseases. There are areas in sections 3 and 9 where mortality in Douglas-fir has occurred, but it is not widespread in the project area.

FIGURE V- 3. AREAS AFFECTED BY MOUNTAIN PINE BEETLE IN THE PROJECT AREA AND SOUTHEAST BOZEMAN LANDSCAPE, 2008-2017.

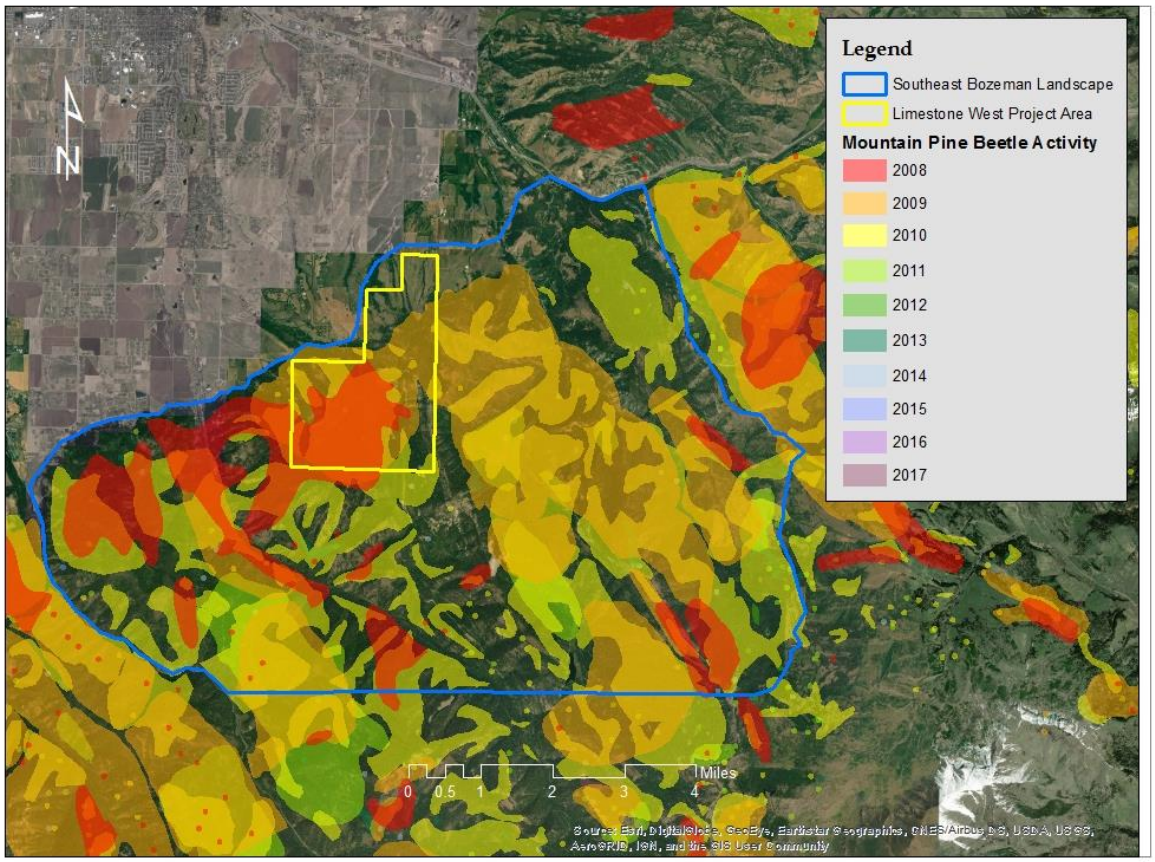
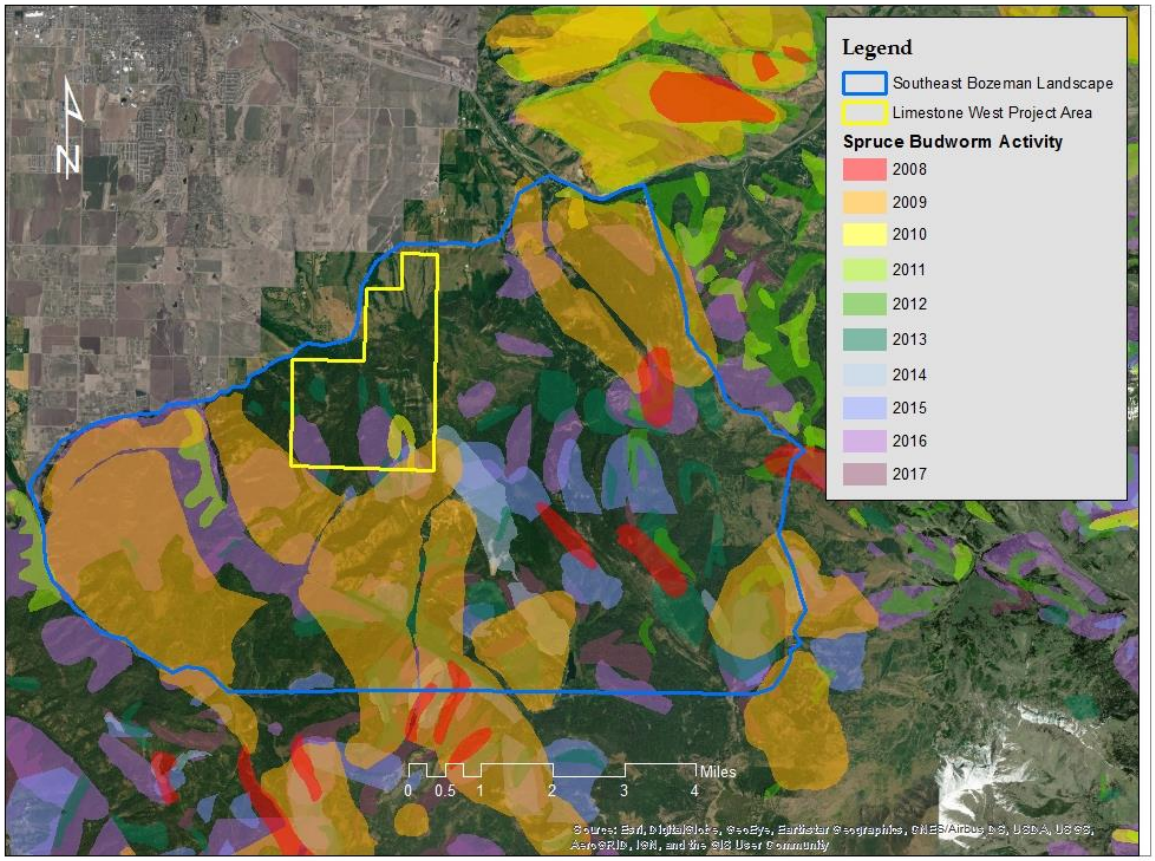


FIGURE V- 4. AREAS AFFECTED BY SPRUCE BUDWORM IN THE PROJECT AREA AND SOUTHEAST BOZEMAN LANDSCAPE, 2008-2017.



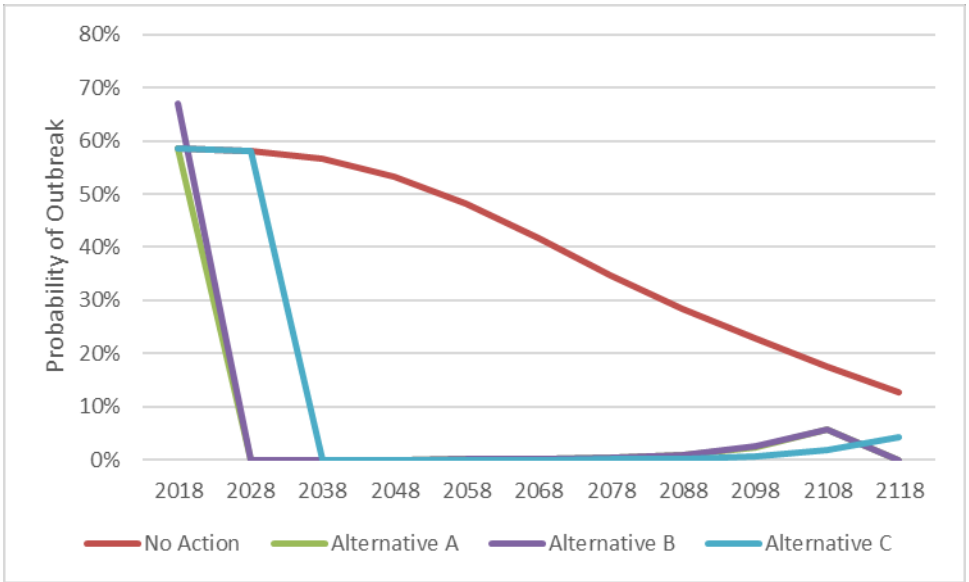
Other insects observed by ADS surveys in the project area and Southeast Bozeman Landscape include Douglas-fir beetle and spruce beetle. These insects currently exist at endemic levels, and neither has caused widespread damage in the past decade.

ENVIRONMENTAL EFFECTS

Direct, Indirect, and Cumulative Effects of the No-Action Alternative

The Lodgepole Pine Mountain Pine Beetle Extension for FVS was used to estimate the probability of a mountain pine beetle outbreak in lodgepole pine in the project area over successive 10-year periods for 100 years. This simulation does not mean that an outbreak would occur during any 10-year period, but instead serves as an indicator of stand conditions and their relative susceptibility to an outbreak. Under current conditions, the average probability of a mountain pine beetle outbreak in lodgepole pine stands where treatment is proposed is nearly 60 percent (*FIGURE V-5*). Probability of outbreak under no action declines over time as the stand ages, natural mortality removes trees, and species composition shifts toward Douglas-fir. Simulation of no action indicates that probability of outbreak would remain above 50 percent for the next 30 years.

FIGURE V-5. AVERAGE PROBABILITY OF MOUNTAIN PINE BEETLE OUTBREAKS OVER A 100-YEAR PERIOD.



Because of past widespread mountain pine beetle activity in the Southeast Bozeman Landscape, future widespread mortality of lodgepole pine is unlikely for several decades. Where lodgepole pine stands exist that were not impacted by recent outbreaks, mortality of lodgepole pine could occur to varying degrees depending on the susceptibility of stands to outbreak. Susceptibility of lodgepole pine is dependent on stand conditions, with intermediate to mature (6+ inches d.b.h), densely stocked stands more susceptible than stands with smaller average diameter, such as seedling/sapling stands that have regenerated from past harvesting, or less-densely stocked stands. Actions proposed in the BMW project could reduce susceptibility to mountain pine beetle attack in lodgepole pine stands that receive treatment under that project.

Western spruce budworm would continue to impact forests in the project area and Southeast Bozeman Landscape to varying degrees. Areas where overstocked conditions and/or multi-storied tree canopies exist in stands of the preferred tree host species are more susceptible to damage from spruce budworm than stands that lack those characteristics.

Direct, Indirect, and Cumulative Effects of Alternatives A and B

Harvesting of lodgepole pine in the project area would alter the size class, age class, and amount of available host trees, reducing stand susceptibility to attack by mountain pine beetle in treated stands. Stands proposed for treatment under Alternative B have a higher current average probability of outbreak than stands proposed for treatment under Alternative A (*FIGURE V-5*). Modeling the proposed treatments under Alternatives A and B with FVS and simulating subsequent forest growth over a 100-year period indicates that treatment would effectively eliminate the risk of outbreak in treated stands and that the effect of treatment on reducing stand susceptibility in the project area would last for several decades (*FIGURE V-5*). Under Alternatives A and B, the effect of treatment to reduce risk of outbreak occurs

immediately. As with no action, actions proposed under the BMW project could reduce susceptibility to mountain pine beetle outbreak of stands receiving treatment.

Effects of Alternatives A and B on western spruce budworm would be expected to reduce both susceptibility of trees to spruce budworm attack and levels of spruce budworm activity in the project area through the reduction of stocking levels in Douglas-fir and mixed conifer stands. Under Alternatives A and B, reduced susceptibility and activity would occur immediately. Actions proposed under the BMW project could reduce susceptibility to and activity of spruce budworm in stands receiving treatment.

Effects in untreated stands with the project area and Southeast Bozeman Landscape would be expected to be like no action.

Direct, Indirect, and Cumulative Effects of Alternative C

Under Alternative C, delaying action for at least 10 years would result in effects like those of no action in the project area and Southeast Bozeman Landscape until any future actions are initiated following expiration of the conservation license. During that time, endemic mountain pine beetle activity could result in further damage and potential mortality in lodgepole pine stands in the project area. Western spruce budworm would continue to affect Douglas-fir, spruce, and subalpine fir in the project area, with potential repeated defoliation resulting in mortality among those species. Following expiration of the conservation license, potential treatments that could occur in the project area would have effects on forest insects like those of Alternatives A and B, although the effect would be delayed by at least 10 years (*FIGURE V-5*). Actions proposed under the BMW project could reduce susceptibility to and activity of mountain pine beetle and spruce budworm in stands receiving treatment.

FIRE ECOLOGY AND BEHAVIOR

ISSUES ADDRESSED

6. Forest management activities associated with this project may not effectively reduce fire hazard or will directly or indirectly increase fire hazard in the project area.
7. There are concerns about fire hazard and potential fire behavior associated with beetle-killed lodgepole pine and associated forest management activities.

ANALYSIS METHODS

Potential fire behavior was determined using the Fire and Fuels Extension of FVS (FFE-FVS). FFE-FVS can be used to evaluate stand characteristics and estimate the behavior of a potential fire given those characteristics, as well as estimate the necessary conditions for certain types of fire behavior to occur. Potential fire behavior was evaluated under the following weather and fuel moisture conditions: 20 mile per hour wind speed with an ambient air temperature of 70 degrees Fahrenheit, and surface fuel moisture of 4 percent for dead material less than 1 inch diameter, 5 percent for dead material 1 to 3 inches diameter, 10 percent for dead material greater than 3 inches in diameter, 15 percent for duff, and 70 percent for live material. Surface and standing fuel loads were evaluated, as well as potential flame lengths, torching index, and crowning index.

AFFECTED ENVIRONMENT

Fire Ecology

The fire ecology of forests in the project area Southeast Bozeman Landscape is mainly characterized by three fire groups— Six, Seven, and Eight—described by *Fischer and Clayton* (*1983*) and summarized in *TABLE V-3*. These three groups account for nearly 90 percent of the project area.

Fire Group Six occurs on over half the project area and includes cool, dry Douglas-fir habitat types. Douglas-fir and lodgepole pine tend to be the dominant species on these habitat types, and fires vary from low-to-moderate severity fires that thinned stands to stand-replacing fires. The average return interval for fires on these habitat types is 42 years.

Fire Group Eight is the second-most common group in the project area and includes dry lower subalpine habitat types. These stands are typified by a mixture of Douglas-fir, lodgepole pine, Engelmann spruce, and subalpine fir. Fires on these types are mixed in severity, with low- to moderate-intensity fires thinning spruce and subalpine fir from stands and promoting Douglas-fir and lodgepole pine, while stand-replacing events favor the development of lodgepole pine. Return intervals typically range from 50-90 years on these sites.

Fire Group Seven includes cool habitat types dominated by lodgepole pine. Lodgepole pine is the dominant species in these stands. In this fire regime, periodic wildfires typically perpetuate lodgepole pine cover types, with stands rarely reaching climax conditions dominated by shade-tolerant species. Fires in Group Seven are typically stand-replacing, occurring at intervals of less than 100 years to 500 years, with longer return intervals occurring at higher elevations. The average frequency for lodgepole pine stands in Group Seven is 50 years. Such fires remove the overstory canopy, opening cones of lodgepole pine and releasing seeds that fall on an exposed seedbed to germinate.

TABLE V-3. CHARACTERISTICS OF FIRE GROUPS OCCURRING IN THE PROJECT AREA (SUMMARIZED FROM FISCHER AND CLAYTON 1983).

	FIRE GROUP		
	6	**7**	**8**
Habitat type group	Moist Douglas-fir habitat types	Cool types dominated by lodgepole pine	Dry lower subalpine habitat types
Mean Fire return interval/severity	42 years/Mixed	50 years/High	50-90 years/ Mixed
Average fuel loading (tons/ac.)	13	15	20

Small amounts of fire groups One, Five, and Nine are also present in the project area and Southeast Bozeman Landscape. Fire Group One occurs on dry limber pine habitat types. Fire Group Five affects cool, dry Douglas-fir habitat types, with fire regimes similar to Fire Group Six. Fire Group Nine affects moist lower subalpine habitat types that typically border streams

and meadows. Stands on these sites are typically dominated by Engelmann spruce, Douglas-fir, and lodgepole pine. Fires on these habitat types typically occur on long intervals and burn with moderate intensity.

Fuel Loads and Potential Fire Behavior

Estimated fuel loading is summarized in *TABLE V-4*. The estimated average surface fuel load consisting of dead coarse material (greater than 3 inches diameter) for stands proposed for treatment in the project area is 11.4 tons per acre, with values for individual stands ranging from 3.9 to 15.7 tons per acre. Local areas within stands may have higher or lower coarse surface fuel loads. The estimated average total surface fuel loading, including litter, duff, dead fine (less than 3" diameter) material, dead coarse material, and live herbaceous and shrub material is 27.6 tons per acre, with values for individual stands ranging from 14.8 to 34.5 tons per acre. Standing fuels (dead and live) average 73.3 tons/acre, with values for individual stands ranging from 30 to 178 tons per acre.

TABLE V-4. COMPARISON OF ESTIMATED FUEL LOADING OVER AN 80-YEAR PERIOD.

	COARSE FUELS >3" DIAMETER (TONS/ACRE)				TOTAL SURFACE FUELS (TONS/ACRE)				TOTAL STANDING FUELS (TONS/ACRE)			
YEAR	No Action	A	B	C	No Action	A	B	C	No Action	A	B	C
2018[a]	11.4	5.7	4.0	11.4	27.6	25.4	16.6	27.6	73.3	22.3	8.3	73.3
2028[b]	14.5	9.2	6.0	7.2	30.1	23.4	15.1	26.7	75.2	19.6	6.2	24.2
2038	18.0	11.0	6.9	11.7	33.8	24.4	15.5	26.1	75.5	18.7	5.6	19.1
2048	19.7	9.8	6.0	12.2	35.7	22.9	14.3	25.7	76.1	22.5	8.1	19.1
2058	21.3	8.7	5.2	10.9	37.3	21.6	13.4	24.1	76.7	27.6	11.4	22.5
2068	22.7	7.9	4.6	9.7	38.7	20.8	12.8	22.6	76.6	33.6	15.6	27.2
2078	23.9	7.4	4.2	8.8	39.9	20.4	12.5	21.6	76.2	40.4	20.3	32.7
2088	25.0	7.2	4.0	8.1	41.0	20.5	12.4	21.1	75.3	47.4	25.5	39.1
2098	25.9	7.5	4.1	7.9	41.9	21.0	12.7	21.1	74.2	54.3	30.7	45.5

[a] 2018 values for Alternatives A and B are post-harvest.
[b] 2028 values for Alternative C are post-harvest.

TABLE V-5 shows the average torching index and crowning index for stands proposed for treatment in the project area. Torching index is the wind speed at which a surface fire would be expected to ignite the crown layer, and crowning index is the wind speed necessary to support an active or running crown fire. The average torching index is 325 mph, with values for individual stands ranging from 15 to 999 miles per hour. This indicates that for most stands in the project area, given current fuel conditions and stand structures that are predominantly single- or two-storied, there is virtually no likelihood of a surface fire moving into the crown layer under the specified weather and fuel moisture conditions. The average crowing index is 19 miles per hour, with values for individual stands ranging from 6 to 32 miles per hour.

TABLE V-5: COMPARISON OF TORCHING INDEX AND CROWNING INDEX OVER AN 80-YEAR PERIOD.

YEAR	TORCHING INDEX (MPH)				CROWNING INDEX (MPH)			
	No Action	A	B	C	No Action	A	B	C
2018[a]	325	155	51	325	19	67	55	19
2028[b]	308	286	112	160	19	76	52	75
2038	180	242	125	212	19	68	48	104
2048	154	247	171	206	20	59	42	70
2058	150	165	115	173	20	51	36	61
2068	176	182	126	187	21	45	30	54
2078	164	198	119	159	22	40	26	47
2088	165	230	116	178	23	36	23	42
2098	157	185	122	198	24	35	22	39

[a] 2018 values for Alternatives A and B are post-harvest.
[b] 2028 values for Alternative C are post harvest.

TABLE V-6 shows the expected fire type for stands proposed for treatment in the project area in terms of percent of acres by fire type. Fire types are described among the following four categories:

- Active crown fire: where the fire moves through tree crowns, burning all crowns in the stand
- Conditional crown fire: a fire that begins as an active crown fire, where the wind speed is greater than the crowning index but less than the torching index
- Passive crown fire: some crowns burn as individual trees or groups of trees torch, where the wind speed is greater than the torching index but insufficient to sustain an active crown fire
- Surface fire: tree crowns do not burn, fire remains on the ground surface

Currently, conditional crown fires are predicted for 53% of the stands proposed for treatment in the project area, and surface fires are predicted on 46% of the project area. Because the torching index is not sufficient in most stands proposed for treatment to allow passage from the surface into the crown layer, any stands where conditional crown fires are predicted would burn as surface fires unless ignited from a crown fire burning in an adjacent stand.

TABLE V-6: EXPECTED FIRE TYPES (PERCENT OF ACRES) OVER AN 80-YEAR PERIOD.

FIRE TYPE	ALT.	YEAR								
		2018[a]	2028[b]	2038	2048	2058	2068	2078	2088	2098
Active Crown	No Action	0%	8%	20%	24%	12%	10%	10%	11%	1%
	A	0%	0%	0%	0%	0%	0%	0%	0%	0%

	B	0%	0%	0%	0%	0%	0%	0%	0%	0%
	C	0%	0%	0%	0%	0%	2%	3%	0%	0%
Conditional Crown	No Action	53%	50%	41%	31%	27%	20%	19%	16%	11%
	A	4%	8%	8%	9%	9%	9%	5%	2%	2%
	B	0%	0%	0%	1%	1%	1%	1%	1%	1%
	C	53%	4%	4%	4%	4%	2%	2%	2%	2%
Passive Crown	No Action	1%	0%	15%	16%	19%	4%	1%	0%	9%
	A	1%	5%	8%	10%	4%	4%	1%	1%	1%
	B	0%	1%	1%	0%	1%	1%	1%	0%	0%
	C	1%	1%	11%	7%	4%	4%	1%	3%	1%
Surface	No Action	46%	41%	24%	28%	42%	67%	70%	73%	78%
	A	95%	86%	84%	81%	87%	87%	94%	97%	97%
	B	100%	99%	99%	99%	98%	98%	98%	99%	99%
	C	46%	95%	84%	89%	92%	92%	95%	95%	97%

[a] 2018 values for Alternatives A and B are post-harvest.
[b] 2028 values for Alternative C are post-harvest.

TABLE V-7 shows potential flame lengths for stands proposed for treatment the project area under the weather and fuel moisture conditions previously mentioned. The expected surface flame length of a potential fire in the project area averages 3.7 feet, with values for individual stands ranging from 1.0 to 4.8 feet. The expected total flame length averages 28.9 feet, with values for individual stands ranging from 1.0 feet to 96 feet.

TABLE V-7. COMPARISON OF POTENTIAL FLAME LENGTHS OVER AN 80-YEAR PERIOD.

	SURFACE FLAME LENGTH (FEET)				TOTAL FLAME LENGTH (FEET)			
YEAR	**No Action**	**A**	**B**	**C**	**No Action**	**A**	**B**	**C**
2018[a]	3.7	5.6	3.8	3.7	28.9	7.8	3.8	28.9
2028[b]	4.0	2.5	1.5	5.9	31.2	6.1	1.5	8.0
2038	4.8	2.5	1.4	3.5	38.2	6.4	1.5	5.6
2048	5.2	1.9	1.0	2.7	36.9	6.5	1.2	4.9
2058	5.5	1.7	0.9	2.1	32.5	6.1	1.1	4.3
2068	5.8	1.6	0.8	1.8	22.9	5.9	1.0	4.3
2078	6.0	1.6	0.8	1.6	22.4	4.1	1.1	4.0
2088	6.3	1.6	0.8	1.6	21.2	3.0	1.1	2.9
2098	6.5	1.7	0.9	1.6	17.3	3.1	1.2	2.9

[a] 2018 values for Alternatives A and B are post-harvest.
[b] 2028 values for Alternative C are post-harvest.

Fuel loads and potential fire behavior were not evaluated for the areas of the Southeast Bozeman Landscape outside of the project area. However, aerial photographs show similarity between forests existing in the project area and those in the broader landscape, and for that

reason some similarity in fuel loads and potential fire behavior to those found in the project area could be expected.

ENVIRONMENTAL EFFECTS

Direct, Indirect, and Cumulative Effects of the No-Action Alternative

With no action, surface fuels in the project area would be expected to increase over time as mortality and subsequent downfall in stands adds coarse woody fuel to the forest floor (*TABLE V-4*). Total standing fuels would remain relatively static over time. The torching index of stands in the project area would generally decrease over time as understory canopy layers in single-, two-, and multi-storied stands continue to develop, indicating that slower wind speeds compared to current conditions could lift surface fires into the crown layer (*TABLE V-5*). In turn, the predicted incidence of crown fires, particularly active crown fires, would increase over time, while the predicted incidence of surface fires would decrease (*TABLE V-6*). The crowning index would remain at or slightly above current levels (*TABLE V-5*). Expected surface flame lengths of potential fires in the project area would increase above current predicted levels, as would total flame lengths (*TABLE V-7*).

Treatments associated with the BMW project could alter fuels and potential fire behavior on an additional 4,173 acres (12 percent) of the Southeast Bozeman Landscape. Amounts of surface and standing fuels would be expected to decrease in treated areas. Surface and total flame lengths would be expected to decrease as a result of treatment, and torching and crowing indexes would be expected to increase, meaning that higher wind speeds would be required to lift a surface fire to the crown layer and sustain a running crown fire. Impacts in untreated stands within the Southeast Landscape would be expected to be similar to the effects of no action on stands within the project area.

Direct, Indirect, and Cumulative Effects of Alternatives A and B

Harvesting treatments would alter fuels and fire behavior on 601 acres of the project area under Alternatives A and 373 acres under Alternative B. Current fuel amounts in stands proposed for treatment under Alternative B are slightly less than for those proposed for treatment under Alternative A, but the effects of treatment are similar. Amounts of coarse, surface and standing fuels left after treatment would be less than pre-treatment levels for both alternatives (*TABLE V-4*). Over time, the amounts of coarse fuels would be expected to increase as snags left after harvesting fall, while the total amount of surface fuels would decrease as fine material decomposes.

For the first 40 years following treatment, torching index would decrease compared to no action due to the growth form of regenerating trees where branches are present on the lower stem and near the ground surface (*TABLE V-5*). In that stand condition, the lower portion of the crown layer essentially extends to the ground surface; therefore, relatively low wind speeds would be expected to readily facilitate spread from the surface to the crown layer. After 40 years, the torching index in treated stands is higher when compared to no action; at that point of stand development, the distance from the ground surface to the lower crown has increased to the point that higher wind speeds are needed to lift a surface fire into the crown layer.

Harvesting treatments would substantially increase crowning index compared to no action, meaning that higher wind speeds would be necessary to support a running crown fire (*TABLE V-5*). As regenerating stands grow over time, the crowning index of treated stands would decrease, but is still higher than levels predicted for no action.

Because of harvesting treatments under both Alternatives A and B, surface fires are the predicted fire type in most of the treated stands. Crown fires are predicted for less than 20 percent of treated stands in the project area under Alternative A, while surface fires are predicted for virtually all stands treated under Alternative B.

Compared to no action and current conditions, surface flame lengths would be expected to initially increase following treatment due to increased amounts of fine fuels and improved air flow at the surface; however, total flame lengths would be expected to decrease due to reduction in standing fuels (*TABLE V-7*). Over time, as stands regenerate, both the surface and total flame length in treated stands would be expected to decrease from initial post-treatment levels.

Effects on untreated stands in the project area would be like those predicted for no action.

Forest management activities associated with this project and the BMW project could cumulatively alter fuel loads and potential fire behavior on 4,774 acres of the Southeast Bozeman Landscape under Alternative A, and 4,546 acres under Alternative B. Treatments associated with the BMW project would be expected to have effects similar to treated stands within the project area, although to varying degrees depending on the intensity of the treatment (lower levels of effect would be expected for less intensive treatments). In untreated stands within the Southeast Bozeman Landscape, effects on fuel loading and potential fire behavior would be expected to be like the effects of no action.

Direct, Indirect, and Cumulative Effects of Alternative C

Under Alternative C, delaying action for at least 10 years would result in effects like those of no action in the project area and Southeast Bozeman Landscape until any future actions are initiated following expiration of the conservation license. During that time, fuel conditions and associated predicted fire behavior would be like that predicted for no action. Following expiration of the conservation license, potential treatments that could occur in the project area would have effects on fuels and fire behavior like those of Alternative A, although the effect would be delayed by at least 10 years (*FIGURE V-5*).

THREATENED, ENDANGERED, AND SENSITIVE PLANTS

ISSUES ADDRESSED

8. Forest management activities associated with this project may adversely affect native flora, threatened, endangered, or sensitive plant species, or rare and unique habitats.

ANALYSIS METHODS

The Montana Natural Heritage Program (MTNHP) was used to identify the presence of Species of Concern, including threatened, endangered, or sensitive plant species, in the project area and Southeast Bozeman Landscape. Species of Concern are native species that are considered at risk of extirpation in Montana due to declining populations, threats to their habitats, restricted

distribution, or other factors. Designation as a Montana Species of Concern is not a statutory or regulatory classification (*MTNHP 2018*). MTNHP reports for sensitive plants were queried for each township that intersects or is contained within the Southeast Bozeman Landscape.

AFFECTED ENVIRONMENT

No Species of Concern have been identified in the project area. MTNHP identified ten plant species of concern and one potential species of concern that have been observed near or within the Southeast Bozeman Landscape. These species are listed in *TABLE V-8*.

TABLE V-8. PLANT SPECIES OF CONCERN POTENTIALLY FOUND WITHIN THE SOUTHEAST BOZEMAN LANDSCAPE.

SCIENTIFIC NAME	COMMON NAME	STATUS*	LOCATION(S) (TOWNSHIP, RANGE)
Carex occidentalis	Western Sedge	SOC	3S,6E
Carex rostrata	Glaucus Beaked Sedge	SOC	2S,6E
Cryptantha fendleri	Fendler Cat's-eye	SOC	2S,6E
Cypripedium parviflorum	Small Yellow Lady's-slipper	PSOC	2S,7E
Erigeron formosissimus	Beautiful Fleabane	SOC	2S,6E
Eriogonum crosbyae	Crosby's Buckwheat	SOC	2S,6E
Mimulus nanus	Dwarf Purple Monkeyflower	SOC	3S,5E; 3S,6E; 2S,7E; 2S,6E
Penstemon whippleanus	Whipple's Beardtongue	SOC	3S,5E; 3S,6E; 2S,6E
Physaria saximontana var. dentata	Rocky Mountain Twinpod	SOC	2S,7E; 2S,6E
Pinus albicaulis	Whitebark Pine	SOC	3S,7E
Veratrum californicum	California False-hellebore	SOC	3S,5E

*SOC = Species of Concern, PSOC=Potential Species of Concern

ENVIRONMENTAL EFFECTS

Direct, Indirect, and Cumulative Effects of All Alternatives

Because no plant Species of Concern were identified in the project area, there are no anticipated impacts to these species under any of the proposed alternatives. Within the Southeast Bozeman Landscape, no impacts to these species is expected, as the habitats where these species are found are typically not areas where forest management activities occur.

NOXIOUS WEEDS

ISSUES ADDRESSED

9. Timber harvesting and road building may introduce or spread noxious weeds in the project area.

ANALYSIS METHODS

The presence of noxious weeds in the project area was determined through field observation and evaluation of current grazing activities.

AFFECTED ENVIRONMENT

The following species are included on the Montana Noxious Weed List (*MDA 2017*) and have been observed in the project area and Southeast Bozeman Landscape: Canada thistle (*Cirsium arvense*), common tansy (*Tanacetum vulgare*), houndstongue (*Cynoglossum officinale*), orange hawkweed (*Hieracium aurantiacum/Pilosella aurantiaca*), oxeye daisy (*Leucanthemum vulgare*), Russian knapweed (*Acroptilon repens/Rhaptonicum repens*), and spotted knapweed (*Centaurea stoebe* or *maculosa*). Each of these species, with the exception of orange hawkweed, are classified as priority 2B, meaning that they are abundant in Montana and widespread in many counties. Their distribution in the project area is primarily in small patches and along, existing roads and popular trails, or non-forest areas where grazing occurs. Orange hawkweed is classified as a priority 2A species, meaning that it is a common weed in isolated areas of Montana.

In addition to the listed noxious weeds, the following regulated plants have been observed in the project area and Southeast Bozeman Landscape: cheat grass (*Bromus tectorum*). Regulated plants have the potential for significant negative impacts to native flora and may not be intentionally spread or sold other than as a contaminant in agricultural products (MDA 2017). Cheat grass is typically found at scattered locations along roads in the project area.

Gallatin County has also identified the following species present in the project area and Southeast Bozeman Landscape that are not listed on the Montana Noxious Weed List as County Noxious Weeds (*GCWD 2017*): musk thistle (*Carduus nutans*) and scotch thistle (*Onopordum acanthium*).

Two exotic plants not listed as noxious weeds by the Montana Department of Agriculture or Gallatin County Weed District are present in the project area and Southeast Bozeman Landscape: bull thistle (*Cirsium vulgare*) and ventenata (*Ventenata dubia*).

ENVIRONMENTAL EFFECTS

Direct, Indirect, and Cumulative Effects of the No-Action Alternative

In the project area, existing noxious weed populations would be expected to remain at or near current levels. Recreational use and grazing activity that currently occurs in the project area has the potential to introduce new species or aid in the spread of existing species in the project area. Lessees of State land for grazing activity are required to monitor and manage noxious weed populations on their leased parcels. Monitoring and management of existing populations would continue.

Proposed forest management activities associated with the BMW project have the potential to facilitate the spread of and increase noxious weed populations on 4,173 acres of the Southeast Bozeman Landscape.

Direct, Indirect, and Cumulative Effects of Alternatives A and B

Forest management activities associated with this project and BMW project are likely to facilitate the spread of existing species or introduce new species to the project area and Southeast Bozeman Landscape due to soil disturbance and reduction of canopy cover associated with timber harvesting. Harvesting operations in the project area would affect approximately 601 acres under Alternative A and 373 acres under Alternative B, and proposed forest management activities in the Southeast Bozeman Landscape could potentially affect an additional 4,173 acres. Recreational use and grazing activity could also introduce new species or aid in the spread of existing noxious weeds in both the project area and Southeast Bozeman Landscape.

In the project area, the following measures would be taken to minimize the potential spread and introduction of noxious weeds:

1. Monitoring of noxious weed populations prior to and following proposed treatments
2. Required washing of equipment before entering the site
3. Limiting the extent and magnitude of soil disturbance within harvested areas
4. Sowing grass seed on roads after harvesting has been completed
5. Development of a comprehensive weed management plan that could include the following activities:
    a. Spot or broadcast application of herbicide (using all-terrain vehicles with boom applicators or aerial spraying) along roadsides and other identified areas with noxious weeds prior to and after harvesting operations.
    b. Release of biological control agents (insects)

The combination of project-level measures to prevent noxious weed spread or introduction and ongoing monitoring and management by grazing lessees would be expected to minimize the potential increase in noxious weed populations compared to current levels.

Direct, Indirect, and Cumulative Effects of Alternative C

During the conservation license term, effects on noxious weed would be like those of no action. Potential treatments that could occur following the expiration of the conservation license would have effects like those of Alternatives A and B.

GEOLOGY AND SOILS ANALYSIS

INTRODUCTION

The following effects analysis will place the Limestone West project area and proposed actions in context with the geologic setting and dominate processes controlling the landscape evolution, geomorphology, and soil properties of the area. These physical landscape attributes ultimately control the many ecological processes we readily observe as well as the productive capacity of the forest stands. By better understanding these processes and connections, a more accurate forecast of potential effects from a proposed action can be described and effective mitigation strategies can be designed to minimize potential effects.

Four alternatives will be analyzed for potential effects as outline in *CHAPTER 2 – ALTERNATIVES*. Action Alternatives A and B proposes activities such as road construction and maintenance, timber harvesting, log skidding and processing, burning slash, site preparation activities and weed management. All of the actions mentioned above have been shown to result in a range of impacts to soil resources in both magnitude and spatial extent (*DNRC 2009, DNRC 2011*). The following document will analyze each alternative with respect to issues and concerns that were raised internally at DNRC and through public comment and public meetings as described in *CHAPTER 1 – PURPOSE AND NEED, SCOPE OF THIS ENVIRONMENTAL IMPACT STATEMENT, ISSUES STUDIED IN DETAIL.*

ANALYSIS AREA

The gross Limestone West project area consists approximately 2,725 acres of State owned lands (*Appendix I; MAP LW-1 LIMESTONE WEST PROJECT AREA AND SOIL MAP UNITS*). The analysis area for direct, and indirect effects to soil physical properties, nutrient cycling, and site productivity will be a subset of the gross project area and will include all harvest units, landings, the clearing limits of new and temporary road construction.

The proposed timber sale action alternatives have the potential to affect slope stability and erosion on different spatial scales than the analysis area described above. Recognizing this, the analysis areas for issues concerning slope stability and erosion will include the gross project area.

Cumulative effects are the collective impacts on the human environment of the proposed action(s) when considered in conjunction with other past, present and future actions related to the proposed action by location or association. For an impact to soil resources to be cumulative they must overlap a least twice in both time and space. Considering this constraint, the cumulative effects analysis area for all proposed alternatives will be the same as that described for direct and indirect impacts above except for issues relating to slope stability and erosion, in which case the project area will be the unit of analysis.

ANALYSIS METHODS

Methods for disclosing impacts to geologic and soil resources relied on information from multiple data sources. These data sources ranged from field evaluation, verification and measurement, to professional published surveys including the soil survey of the Gallatin County, Montana (USDA, 2006) and the Geologic map of the Livingston 30′ x 60′ quadrangle (Berg et. al, 2000). Professional training and judgment was intricate in synthesizing the

information from these various sources to describe the geologic structure and physical soil properties within the project area to forecast potential forest management limitations. Soil variables gained from field interpretations and professional surveys used to forecast risk include soil texture, soil depth, percent coarse fragments, plasticity index, liquid limit, permeability, infiltration capacity and Unified classification.

It has been shown through DNRC soil monitoring *(DNRC 2009, DNRC 2011*) that past performance in timber sale contract administration, BMP design and implementation, and harvest design are good indicators of expected future results regarding impacts to soil resources from timber harvest. The following soil analysis was designed around this assumption which has been validated through 22 years of quantitative soil monitoring conducted by DNRC. The risk of adverse effects to soils resources resulting from the proposed actions was assessed by merging physical soil attributes from the above listed data sources and DNRC soil monitoring data which provides context for these soils with regard to applied DNRC timber harvest soil mitigations and site-specific BMPs.

The evaluation of slope stability in the project area used the SINMAP model to forecast areas with elevated risk for shallow slope failures. SINMAP has its theoretical basis in the infinite plane slope stability model (Montgomery and Dietrich, 1994) with wetness (pore pressures) obtained from a topographically based steady state model of hydrology. It allows the calculation of a stability index for discrete points over large areas so that terrain features with low potential stability can be further evaluated during field reconnaissance. Results from this model and field observations will be used to describe the potential risk of slope instability as a result of implementing a timber sale alternative.

Effective risk management requires assessment of inherently uncertain events and circumstances, typically addressing two dimensions: how likely the uncertainty is to occur (probability or risk), and the magnitude the effect would be if it happened (impact) (Hillson and Hulett, 2004). In terms of the risk that an impact may occur, a low risk of an impact means that the impact is unlikely to occur. A moderate risk of an impact means that the impact may or may not (50/50) occur. A high risk of an impact means that the impact is likely to occur.

In terms of impacts, very low impact means that the impact is unlikely to be detectable or measurable, and the impact is not likely to be detrimental to the resource. A low impact means that the impact is likely to be detectable or measurable, but the impact is not likely to be detrimental to the resource. A moderate impact means that the impact is likely to be detectable or measurable, and the impact is likely to be moderately detrimental to the resource. A high impact means that the impact is likely to be detectable or measurable, and the impact is likely to be highly detrimental to the resource.

ISSUES AND MEASUREMENT CRITERIA

The following bulleted issue statements listed below summarize both internal and public concerns that will be analyzed in this effects analysis.

- Traditional ground-based harvest operations have the potential to compact and displace surface soils which can reduce hydrologic function, macro-porosity, and/or soil function.
- Areas of impacted soil function have the potential to increase rates of offsite erosion which may affect productive surface soils.
- Harvest activities associated with the proposed actions may cumulatively affect long term soil productivity
- Activities associated with the proposed actions such as timber harvest and road construction have the potential to affect slope stability through localized areas of increased saturation resulting in the exceedance of resisting forces.
- The removal of large volumes of both coarse and fine woody material through timber harvest reduces the amount of organic matter and nutrients available for nutrient cycling possible affecting the long-term productivity of the site.

The measurement criteria that will be used to assess the direct, indirect and cumulative effects regarding the issues listed above are listed below in *TABLE S1 -MEASUREMENT CRITERIA*.

TABLE S1 - MEASUREMENT CRITERIA

Generalized Issue	Measurement Criteria	Units
Slope stability	Acres of proposed new road construction on potentially unstable land types.	Acres, % of new road construction
Soil Physical Properties	Bulk density, infiltration capacity, displacement, and compaction (*Howes et al. 1983*)	g/cm^3, $cm\ s^{-1}$, % of area
Erosion	Magnitude of current chronic upland erosional and mass wasting sites	# of sites
Site Nutrients	Volume of coarse and fine woody debris	Tons/Acre
Long Term Productivity	Acres proposed for re-entry, detrimental soil disturbance, coarse and fine woody debris	Acres, % of area, Tons/Acre

AFFECTED ENVIRONMENT

Climate

The climate of the Limestone West project area is highly seasonal. The average annual precipitation of 21-37 inches in the project area is directly correlated to elevation which ranges from 5,600 to 7,500 feet. Approximately 53% of this precipitation is received as snow in winter months from late November to early April although spring rains during May and June also comprise a substantial portion of annual precipitation. *TABLE S2 – PRECIPITATION INTENSITY AND RECURRENCE* below provides storm recurrence intervals for the project area along with the associated 24-hour precipitation totals and the probability of such a storm happening in any given calendar year. Intense precipitation in short durations can be an analog to erosion events and can help highlight the probability of such events in the project area during and immediately after the implementation of a proposed action. It is assumed here that BMP

effectiveness would be compromised to varying degrees during a storm with a 5-10% event probability.

TABLE S2 – PRECIPITATION INTENSITY AND RECURRENCE

Recurrence Interval (years)	24hr Precipitation (inches)	Event Probability of Occurrence per Year (%)
1	1.1	100%
2	1.3	50%
4	1.5	25%
5	1.6	20%
10	1.9	10%
20	2.2	5%
25	2.2	4%
50	2.3	2%

Geology

The Limestone West project area is an interesting area geologically because it presents a wide range of rock types and ages in a small area. This is due to the complex geologic structure of the area. Folding, faulting, tilting and subsequent stream dissection and erosion have shaped the landscape in the project area that we observe today. Structurally, there are numerous anticlines, synclines and thrust faults within the project area. During field review it was noted that all faults showed very little motion during the Holocene.

Limestones, sandstones and shales of various thickness and mixed orders are present to the east of Limestone Creek and comprise a small portion of the project area. All the project area, west of Limestone Creek, is underlain by Quartzofeldspathic gneiss of Archean age. This is a very old formation comprised mainly of feldspars and quartz and provides a very stable geologic structure with very little evidence of faulting.

Landscape Morphology

Tectonically controlled mass failure has shaped the hillslope geomorphology of only a small portion of the project area and is confined to the hillslope east of Limestone Creek. Most hillslopes could be characterized as planer to slightly concave with moderate to steep slopes. *TABLE S3 – SLOPE CLASS DISTRIBUTION* below shows both the acreage and percent of the area within various slope categories. Tables such as this further help to describe hillslopes as well as many other physical attributes such as erosion potential, runoff response, terrain complexity and slope stability hazard within the project area. Drainage density is low to moderate due to the modest precipitation levels with stream channels showing only slight incision.

TABLE S3 – SLOPE CLASS DISTRIBUTION

Slope Class	Project Area			Harvest Units - Alternative A			Harvest Units - Alternative B		
	Acres	% of Project Area	Cumulative Total	Acres	% of Area	Cumulative Total	Acres	% of Area	Cumulative Total
0-10%	243	9.0%	9.0%	7	1%	1.1%	6	2%	1.6%
11-20%	428	15.8%	24.7%	29	5%	6.0%	24	6%	8.0%
21-30%	342	12.6%	37.4%	74	12%	18.4%	61	16%	24.5%
31-40%	471	17.4%	54.7%	180	30%	48.3%	139	37%	61.7%
41-50%	506	18.7%	73.4%	194	32%	80.8%	113	30%	92.1%
51-60%	445	16.4%	89.8%	90	15%	95.9%	28	8%	99.6%
>60%	277	10.2%	100.0%	25	4%	100.0%	1	0%	100.0%

Slope Stability

Slope stability is the ability of material on a slope to remain in equilibrium (stable) and therefore represents some balance between driving forces (shear stress) and resisting forces (shear strength). Many variables, both natural and/or anthropogenic, may affect either driving or resisting forces. For a slope to be considered unstable, driving forces and resisting forces must equal or less than 1.0. This value is typically referred to as the factor of safety. The SINMAP model can be used to calculate a stability index for large landscapes using the factor of safety concept while also including a conservative approach to the inherent uncertainty associated with such a predictive value.

SINMAP stability classes for the watershed analysis areas are presented in TABLE S3 – WATERSHED ANALYSIS AREA STABILITY CLASSES. Stability classes greater than 2 are considered stable as the factor of safety for these stability indexes is conservatively calculated at over 1.0.

Structural weaknesses and poor permeability will limit many forest management activities on clay rich materials, particularly road construction activities. More specifically, mass failure has been associated with several site factors in this area of Gallatin Range (Montagne, 1975). These factors typically include: 1.) Excessive saturation, 2.) Steep slopes, 3.) Certain bedrock formations (shales, mudstones and sandstones) 4.) Dip slopes in harmony with hillslopes, 5.) History of mass failure.

TABLE S3 – WATERSHED ANALYSIS AREA SINMAP STABILITY CLASSES

Stability Class	Stability Description	Watershed Analysis Area		
		Total Acres	% of Analysis Area	Cumulative %
Stable (Class 6)	Significant destabilizing factors are required for instability	970.1	31.0%	31.0%
Moderately Stable (Class 5)	Moderate destabilizing factors are required for instability	388.5	12.4%	43.4%
Quasi-Stable (Class 4)	Minor destabilizing factors are required for instability	640.1	20.4%	63.8%
Lower Threshold (Class 3)	Destabilizing factors are not required for instability	1,087.7	34.7%	98.6%
Upper Threshold (Class 2)	Stabilizing factors may be responsible for stability	44.0	1.4%	100.0%
Defended (Class 1)	Stabilizing factors are required for stability	1.1	0.0%	100.0%
Totals		3,131.5	100%	100.0%

Historic small-scale scarps, slumps and rotational failures have been documented within the Limestone West project area during project review and were exclusively isolated to the landscape variables listed above. All historic rotational failures show no evidence of recent motion and are likely the result of previous tectonic events as regenerated trees within the failure were aged at 70-80 years old. While mass failure hazard may be the most important

limitation to road construction and harvest activities in the project area, simple mitigations such as avoidance and adequate drainage can significantly reduce the likelihood of failure.

Soils

Soil development within the Limestone West Project area can be directly correlated to bedrock geology, slope position and aspect. The Gallatin Valley, Montana soil survey (USDA, 2006) has identified nine individual soil map units where actions have been proposed (road construction and timber harvest). A description of these map units along with the risk of impacts associated with forest management activities is listed in *TABLE S4- SOIL MAP UNIT DESCRIPTIONS* at the end of this analysis.

The soils within the Limestone West project area have many similarities with local variations in aspect, slope position, and depth to bedrock creating slight differences in physical properties that limit forest management activities. In general, soil depth is typically less than 60 inches before encountering impervious bedrock with loam to clay loam surface textures. Deep soils with elevated clay contents, particularly on north aspects, typically remain moist well into summer months. Due to the fine texture of these soils, pore spaces are small and matrix water is bound tightly by capillary forces resulting in slow infiltration capacities and moderate to poor drainage attributes. The amount of coarse rock fragments within the soil profile varies throughout the project area but typically is within the range of 5-30% by volume. With increasing coarse rock fragments, the bearing strength of the material increases thus decreasing the limitation of road construction and risk of compaction. The risk of compaction from forest management activities for each soil map unit can be found in *TABLE S4- SOIL MAP UNIT DESCRIPTIONS.*

Surface layers of organic matter form from needles and leaves from forest canopies, decomposition of plant material and roots as well as coarse and fine woody material. This organic layer is critical in providing habitat for microbial activity, regulating soil respiration, aeration and soil temperature. Throughout the project area surface organic layers or duff depths range from a few centimeters to several inches dependent upon habitat type, aspect and fire history.

In some portions of the project area surface ash deposits from the Holocene eruption of Mt. Mazama can be found under this duff layer, particularly on sheltered, high elevation, north to northeast facing terrain. Local ash depths range from 2-6 inches and provide significant water holding capacity to surface vegetation, particularly in late summer months and are typically associated with highly productive sites.

While both organic duff layers and ash caps, where present, are critical to soil function, they are also the most susceptible to surface displacement from equipment operations and log skidding. Factors affecting the risk of displacement from forest management activities include slope, amount of downed coarse woody material, equipment type, and operator skill. The risk of surface soil displacement for each soil map unit in the analysis area can be found in *TABLE S4- SOIL MAP UNIT DESCRIPTIONS.*

When surface soils become displaced and protective organic layers removed, bare mineral soil is exposed to surface processes, most notably erosion. Erosion of productive surface soils can

entrain and transport nutrients offsite and expose more infertile subsoils. Factors effecting offsite erosion include the amount and magnitude of exposed surface soils, vegetative cover, intensity of precipitation (*TABLE S2 – PRECIPITATION INTENSITY AND RECURRENCE*), and local slope. Elevated clay contents within a majority of the Limestone West soils provide significant bonds between clay particles due to Van der Waal forces. These attractive forces limit particle detachment and transport resulting in moderately erosive soil properties in most of the project area. Erosion on these materials can commonly be overcome with standard drainage practices, providing temporary vegetative cover with slash mats and limiting the areal extent of soil disturbance. The risk of soil erosion for specific soil map units can be found in *TABLE S4- SOIL MAP UNIT DESCRIPTIONS.*

No rill, gully or sheet erosion was observed on any locations outside of existing road prisms within the project area. All disturbed soils from past management activities, excluding road surfaces, have naturally revegetated and are erosively stable.

Nutrient Cycling and Soil Productivity

Coarse (CWD) and fine (FWD) woody debris provides many necessary functions to sustain soil productivity and includes site moisture retention, soil temperature modification, soil protection, nutrient cycling as well as providing a long-term supply of soil wood which is paramount to soil microbial activity (Harmon et al. 1986). Amounts of coarse and fine woody debris throughout the Limestone West project area is variable and range from as little as 5 tons/acre to upwards of 20 tons/acre. This variability is dependent on habitat type and the magnitude of insect and disease mortality. Due to the increased level of mortality through most stands proposed for treatment, CWD and FWD is accumulating in trend as needles fall and Lodgepole pine stands collapse. Due to the moderate levels of precipitation and high seasonality of the project area, soils are only moderately productive when compared to other regions in Montana. Forest management activities have the potential to modify both amounts and trends of recruitable material and in turn the long-term productivity of the soil.

Past Management Activities

Three forest management projects have been implemented in the past within the Limestone West Project area. The first was in 1990 and included approximately 81 acres of regeneration harvest of Douglas fir. The second project was completed in approximately 2006 that treated approximately 11 acres using a group selection prescription adjacent to Triple Tree home owners to mitigate hazardous fuels. Lastly, the Bear Canyon Timber sale, completed in 2013, treated approximately 74 acres in the project area with both regeneration and select harvest prescriptions. These projects provide valuable insight into the magnitude of potential soil impacts that can be expected from forest management activities on these soil types as well as how impacts will ameliorate over time if the proposed timber sale actions are implemented.

Physical soil properties were measured within skid trail areas within a 1981 regeneration harvest unit and compared to control locations sampled on similar soils, though unaffected, adjacent to impacted areas. TABLE S5- SOIL PROPERTIES FROM HISTORIC HARVEST below displays the data from physical measurements that were made with a minidisk infiltrometer as well as lab analysis of bulk soil samples collected from five individual locations.

TABLE S5- SOIL PROPERTIES FROM HISTORIC HARVEST

Stratum	Infiltration (cm s^{-1})	Hydrologic Conductivity (cm s^{-1})	Bulk Denisty (g/cm^3)	Porosity (%)
Control (n=5)	0.00220	0.00027	0.87	58.8
Skid Trail (n=5)	0.00231	0.00029	1.09	48.0

Results from this sampling effort show that skid trail locations still show detectable levels of increased soil bulk density from actions implemented over 30 years prior, but these increases are well below root limiting values. Hydrologic function, as measured by infiltration, has completely recovered. This data is critical when forecasting the temporal scale of potential impacts for the proposed actions.

Soil monitoring of the more recent Bear Canyon timber sale shows comparable results as those published by DNRC (DNRC 2011). Post-harvest soil disturbance data collected at approximately 1,600 monitoring points within two harvest units (Seedtree and commercial thin prescriptions) showed rates of detrimental soil disturbance of 11.4% and 6.4%, respectively.

ENVIRONMENTAL EFFECTS

- ***Direct and Indirect Effects of the No-Action and Alternative C***

Under the no action alternative, none of the proposed actions outlined in *CHAPTER 2 – ALTERNATIVES* would be implemented. Soil physical properties would continue on a stable trend though the productivity, or ability of the land to produce biomass, would potentially decrease in the short-term as insect and disease mortality continued to increase and forest stand further collapsed. Without any site disturbance, most lodgepole pine stands would remain stagnant until historic fire regimes were restored.

Areas of potential slope instability would possibly reactivate under convergent conditions and seismic activity. Base erosion rates would remain constant.

Amounts of CWD and FWD would continue to increase as stands collapse and fall to the forest floor. Void of natural disturbance, nutrient pools would remain stable due to continued additions of CWD and FWD available as organic sources of carbon.

- *Direct and Indirect Effects of Action Alternative A and B*

Soil Physical Properties and Long-term Productivity

DNRC has been conducting quantitative soil monitoring studies on timber harvest projects since 1988 that cover a wide range of soil and equipment types, climates, geologies, and silvicultural prescriptions throughout the State. This data, in concert with data presented in TABLE S5 – SOIL PROPERTIES FROM HISTORIC HARVEST, allows the forecast of potential impacts to soil resources to be more informed and thus more accurate. Only a portion of the 90 plus soil monitoring sites DNRC has observed are applicable to the Limestone West Project in terms of equipment type, soil texture, and slope class. When this dataset is filtered by these attributes for similarities with the proposed actions, a more representative dataset for the project area is defined. TABLE S6 below represents data from DNRC soil monitoring database

for projects employing ground-based equipment on clay loam soils with slopes similar to those within the project area (TABLE S3).

TABLE S6- SOIL DISTURBANCE RATES FROM PREVIOUS DNRC FOREST MANAGEMENT PROJECTS

Stratum	Sites (n)	Sample Area (acres)	Displacement (%)	Slight Compaction (%)	Severe Compaction (%)	Erosion (%)	Total Detrimental Disturbance (%)
Ground Based Equipment	72	3,911	8.5	5.4	4.5	0.1	13.1
Clay Loam Soil Textures	17	572	5.4	3.9	3.5	0.0	8.9
Slope Class (20-40%)	41	1,625	9.8	5.0	3.7	0.1	13.6

The equipment used to harvest timber and the slopes that the equipment operates on typically are the best indicators for potential soil impacts with increased levels of impacts as slopes increase with traditional ground-based equipment. Understanding these controls on soil disturbance, a weighted average can be calculated to estimate a potential rate of soil disturbance within the Limestone West analysis area. This weighted rate, expressed as a percentage of area disturbed, was calculated at 12.9% for ground-based equipment (Equipment: 0.5, Slope: 0.4 and Soil Texture: 0.1). A rate of 6.8% was applied for cable harvest systems which reflects the average of all DNRC monitoring sites using cable harvest systems. Applying this soil disturbance rate to the acres proposed for timber harvest and road construction shows that approximately 210.5 and 70.0 acres of land will have varying ranges of detrimental soil disturbance for Action Alternatives A and B, respectively.

When this data is paired with measurements collected on historic skid trails within the project area, it can confidently be forecasted that primary skid trails and other areas of severe soil impacts will remain for approximately 10-30 years. The land use within the road prism of new road construction (31.2 and 21.6 acres for Alternative A and B, respectively) will permanently be converted from forest products to transportation and will facilitate administrative access to these lands in the future. The level of soil disturbance forecasted from harvest activities are below the 20% recommendation within the SFLMP (DNRC, 1996) and presents a **high probability of low to moderate level impacts to soil physical properties** within the analysis area and the long-term soil productivity is expected to be maintained at levels described in the existing conditions. Alternative A would impact 140.5 more acres than Alternative B as a result of a larger harvest footprint.

TABLE S7- ESTIMATED SOIL DISTURBANCE FOR ACTION ALTERNATIVES A AND B

Area of Analysis	Disturbance Rate (%)	Total Area of Activity Alternative A (Acres)	Area of Potenital Impacts Alternative A (Acres)	Total Area of Activity Alternative B (Acres)	Area of Potenital Impacts Alternative B (Acres)
Tractor Harvest Units	12.9%	417	53.8	375	48.4
Cable Harvest Units	6.8%	185	125.8	0	0
New Roads Construction *	100.0%	31.2	31.2	21.6	21.6
Summary Totals	-	633.2	210.8	396.6	70.0
% of Project Area (2,713 acres)	-	23.3%	7.8%	14.6%	2.6%

Nutrient Cycling

The amount of coarse and fine woody material retention within the Limestone West analysis area is recommended at 5-10 tons/acre dependent upon habitat type and aspect (Graham et al., 1994). This can be achieved by cut-to-length harvest systems or return skidding slash to harvest units. Due to the high level of dead and dying trees that will be harvested and the brittle nature

of dead trees, breakage during felling and skidding operations will be high and retention is easily achievable. Coupling this retention with the natural rate of organic accumulation, given the high levels of mortality in pine stands, will result **in a low risk of low level impacts to site nutrient pools** if either the action alternatives are selected.

Erosion

In addition to distributing slash within all harvest units for nutrient cycling and soil resource protection, slash will also be heavily scattered on primary skid trails and log landing sites to provide temporary vegetative cover. This cover will help to limit soil particle detachment and transport during intense rain events and minimize the erosion potential of disturbed areas (Wynn et al., 2000). This mitigation measure is designed to be temporary until grass seed takes and provides more permanent cover. Due to this mitigation, the moderate erosion risk of project area soils, and BMPs/mitigations that will be implemented to limit the extent and magnitude of soil disturbance, there is **a moderate probability of low level impacts from erosion to soil productivity**.

Slope Stability

Stability index values for shallow instabilities, derived from the SINMAP model, were summarized within harvest units and clearing limits of new road construction for both timber harvest alternatives. These values can be found in *TABLE S8- STABILITY INDEX FOR ACTION ALTERNATIVES A AND B* at the end of this analysis. A very small percentage of the analysis area has stability index values of 2 or less. Areas of low stability indexes (≤ 2) are confined to areas of topographic convergences where saturation would likely occur during rapid spring snowmelt and/or intense rain events. These areas were evaluated in the field and were found in location that will have SMZ protections adjacent to them which limit equipment operations and require tree retention. A watershed scale map of stability indexes can be found in *Appendix II; MAP LW-2 LIMESTONE WEST PROJECT SLOPE STABILITY INDEX.*

The application of BMPs during road design and construction would engineer road surface drainage away from these areas of potential rapid saturation to limit the potential increase of destabilizing forces at the site. Reestablishment of vegetation by means of quick cover grass seed as well as managing roads for administrative use only will also limit the runoff potential from roads in these areas. Lower impact cable harvesting systems on steeper slopes and the application of SMZ and RMZ buffer will also limit the potential of disturbance in these small zones of marginal instability. Due to all the above listed considerations, onsite field evaluations and information provided from the SINMAP model, a **moderate probability of low to moderate impacts to soil productivity, and potentially water quality,** from small, localized slope failure is possible for both timber sale action alternatives A and B.

Historic, large scale rotational failures like those observed on the eastside of limestone creek and the east end of the Bear Canyon project area are controlled and activated by forces larger than can be manipulated by modern forest management activities. Rather, motion on these historic scarps typically result when stochastic events synchronize such as abnormal and prolonged wet periods and/or natural disturbance events (wildfire) and tectonic activity. The timber sale action alternatives proposed in Limestone West timber sale have a **very low**

probability of high impacts to soil productivity, and potentially water quality, resulting from reactivating instabilities on these rotational failures.

Cumulative Effects

- ***Cumulative Effects of the No-Action and Alternative C***

Under the no action alternative and alternative C, none of the proposed actions outlined in *CHAPTER 2 – ALTERNATIVES* would be implemented. A **low risk of low level cumulative effects** to soil resources resulting from continued fire wood permits and grazing leases and licenses would be expected. Trends of soil physical properties, nutrient cycling, long-term productivity, erosion, and slope stability would continue as described within *Direct and Indirect Effects of No Action Alternative*.

- *Cumulative Effects of Action Alternative A and B*

Cumulative effects as defined in the analysis area section require multiple entries into a harvest unit for an impact to be cumulative. Under the action alternatives, no previously harvest area is proposed for reentry. Because of this **constraint, no measurable or detectable cumulative effects are expected to soil physical properties, nutrient cycling or long-term soil productivity.**

No chronic upland erosion was noted during field review of the project area. Due to these observations, lack of current erosion and a moderate probability of low level impacts from erosion resulting from direct and indirect effects of the proposed action, **a low probability of low level cumulative effects** to soil resources from erosion are expected within the project area.

There is no sign of mass failure within the project area directly attributed to past management actions such as road construction, timber harvest, and/or grazing practices. The observed rotational failure in the project area is at least 70-80 years old and most likely triggered by seismic activity common to the Greater Yellowstone ecosystem. All existing roads are currently constructed on stable landtypes with high stability indexes and show no signs of instabilities. Due to these factors in conjunction with the potential direct and indirect effects, there is a **low probability of low level cumulative effects** to slope stability within the project area.

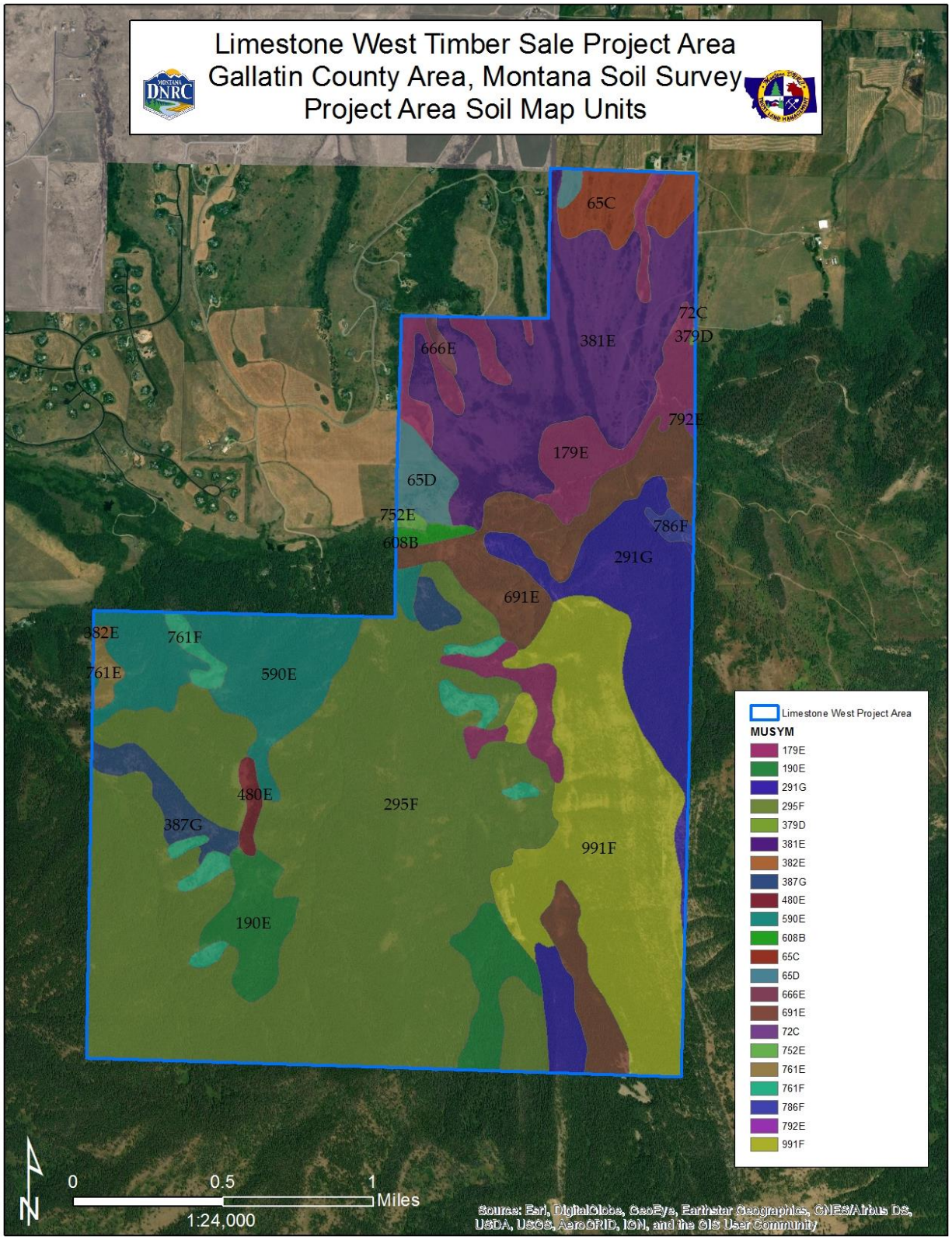
TABLE S4- SOIL MAP UNIT DESCRIPTIONS

Map Unit	Description	Alt A Acres	Alt B Acres	% Alt A Analysis Area	% Alt B Analysis Area	Landtype Description	Compaction Hazard	Erosion Hazard	Displacement Hazard
179E	Bridger loam, cool, 4 to 25 percent slopes	9.0	8.6	1.5%	2.3%	Pluvial Dissection - pluvial, mixed sedimentary	Moderate	Low/Moderate	Moderate
190E	Jaegie gravelly coarse sandy loam, 8 to 35 percent slopes	52.7	49.5	8.8%	13.2%	Pluvial Dissection - churned, granitic	Low/Moderate	Moderate	Moderate
295F	Shadow very cobbly coarse sandy loam, moist, 35 to 60 percent slopes, stony	410.8	242.2	68.5%	64.6%	Structural Control - colluvial-alluvial, mixed sedimentary	Moderate	Moderate/High	Moderate
387G	Rochester, very stony-Rock outcrop complex, 35 to 70 percent slopes	28.1	2.2	4.7%	0.6%	Pluvial Dissection - pluvial, grantic	Moderate	Moderate/High	Moderate
480E	Libeg, stony-Copenhaver complex, 15 to 45 percent slopes	5.7	6.1	1.0%	1.6%	Pluvial Dissection - pluvial, grantic	Low/Moderate	Moderate	Moderate
590E	Jaegie-Shadow, stony complex, 15 to 45 percent slopes	86.9	61.6	14.5%	16.4%	Pluvial Dissection - pluvial, mixed sedimentary	Moderate	Low/Moderate	Moderate
691E	Whitore-Sicklesteets complex, 15 to 40 percent slopes, stony	0.3	0.3	0.1%	0.1%	Structural Control - colluvial-alluvial, mixed sedimentary	High	Moderate	Moderate
761F	Sawicki-Catgulch complex, 35 to 60 percent slopes, very stony	5.7	3.7	1.0%	1.0%	Dip Slopes - pluvial, mixed sedimentary	Moderate/High	Moderate	Moderate
991F	Whitore-Rock outcrop complex, 35 to 70 percent slopes	0.8	0.8	0.1%	0.2%	Structural Control - colluvial-alluvial, mixed sedimentary	Low	Moderate	Moderate

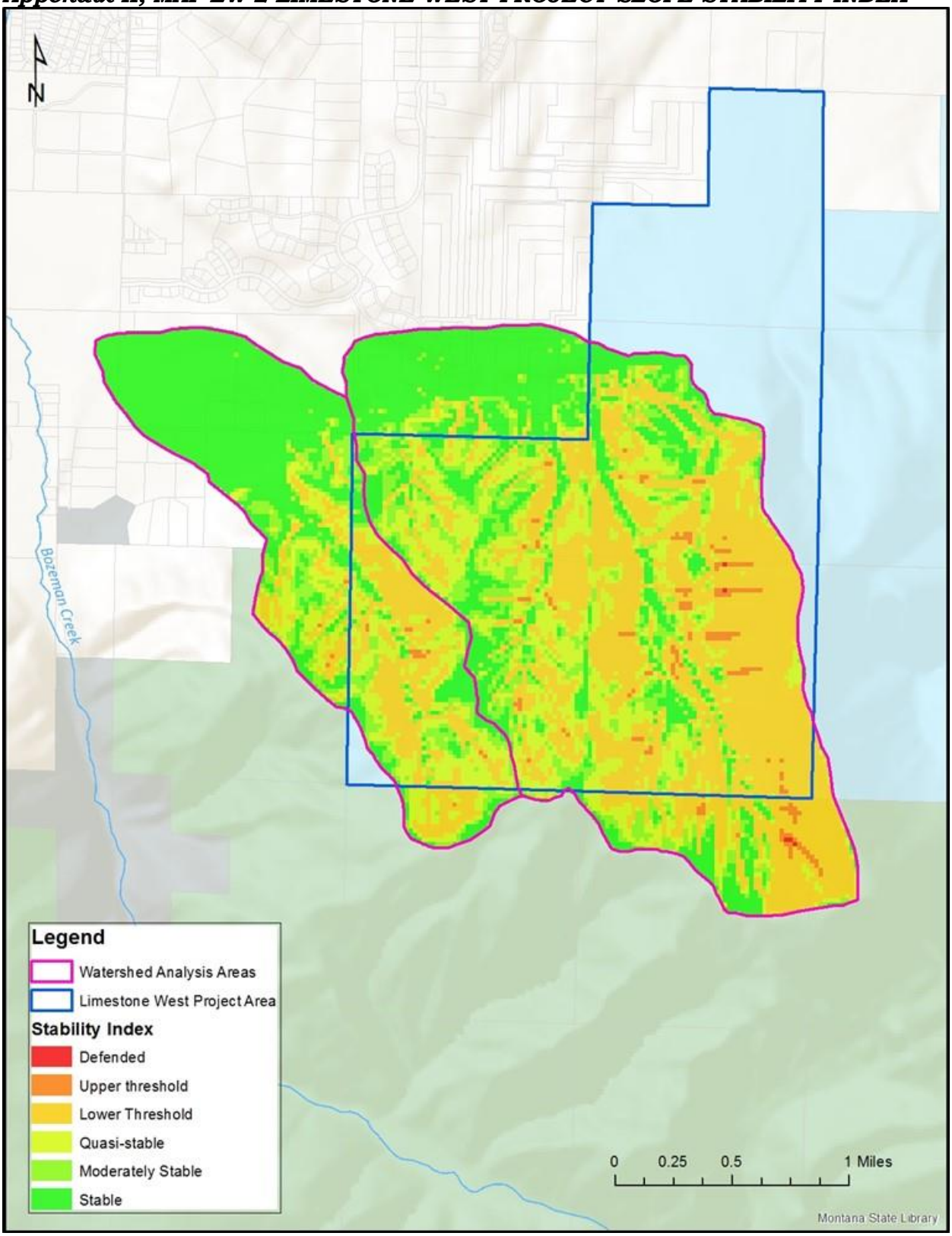
TABLE S8- STABILITY INDEX FOR ACTION ALTERNATIVES A AND B

Stability Class	Stability Description	Alternative A					Alternative B				
		Harvest Units (acres)	Roads (acres)	Total Acres	% of Analysis Area	Cumulative %	Harvest Units (acres)	Roads (acres)	Total Acres	% of Analysis Area	Cumulative %
Stable (Class 6)	Significant destabilizing factors are required for instability	98.5	6.2	104.7	16.6%	16.6%	85.0	5.16	90.2	22.7%	22.7%
Moderately Stable (Class 5)	Moderate destabilizing factors are required for instability	116.0	5.5	121.5	19.2%	35.8%	89.9	3.70	93.6	23.6%	46.3%
Quasi-Stable (Class 4)	Minor destabilizing factors are required for instability	221.6	9.6	231.1	36.6%	72.5%	140.3	5.46	145.8	36.8%	83.1%
Lower Threshold (Class 3)	Destabilizing factors are not required for instability	161.0	9.7	170.7	27.1%	99.5%	58.8	7.06	65.9	16.6%	99.7%
Upper Threshold (Class 2)	Stabilizing factors may be responsible for stability	2.9	0.2	3.1	0.5%	100.0%	0.9	0.22	1.2	0.3%	100.0%
Defended (Class 1)	Stabilizing factors are required for stability	0.0	0.0	0.0	0.0%	100.0%	0.0	0.00	0.0	0.0%	100.0%
Totals		600.0	31.2	631.2	100%	100.0%	375.0	21.6	396.6	100%	100%

Appendix I; MAP LW-1 LIMESTONE WEST PROJECT AREA AND SOIL MAP UNITS



Appendix II; MAP LW-2 LIMESTONE WEST PROJECT SLOPE STABILITY INDEX



WATERSHED AND FISHERIES ANALYSIS

INTRODUCTION

The following effects analysis will describe the dominant controls on runoff generation, the patterns and processes observed during runoff and how these physical watershed characteristics help to support downstream aquatic ecosystems. By further understanding these watershed attributes and associated connections, potential effects of specific forest management activities can be forecasted with higher degree of certainty and communicated more effectively. Two timber harvest alternatives will be analyzed for potential effects as outline in *CHAPTER 2 – ALTERNATIVES*. The Action Alternatives propose activities such as road construction and maintenance, road-stream crossing construction, timber harvesting, log skidding and processing, and log hauling. All the actions mentioned above have been shown to result in a range of impacts to watershed resources in magnitude, duration, and spatial extent. The following document will analyze each alternative with respect to issues and concerns that were raised internally at DNRC and through public comment and public meetings as described in *CHAPTER 1 – PURPOSE AND NEED, SCOPE OF THIS ENVIRONMENTAL ANALYSIS, ISSUES STUDIED IN DETAIL.*

ISSUES AND MEASUREMENT CRITERIA

The following bulleted issue statements listed below summarize both internal and public concerns that will be analyzed in this effects analysis.

- Timber harvesting and related activities, such as road construction, can lead to water-quality impacts by increasing the production and delivery of fine sediment to streams.
- Timber harvesting and associated activities can affect the timing, magnitude, and volume of water runoff in a harvested watershed.
- Project activities may affect fish habitat by modifying channel form and function.

The measurement criteria that will be used to assess the direct, indirect and cumulative effects regarding the remaining issues are listed below.

TABLE WS1 - MEASUREMENT CRITERIA

Generialized Issue	Measurement Criteria	Units
Water Quanity	Equivilant Clearcut Area (ECA), Water Yield Increase	Acres, % increase
Water Quality	Length of road construction within 100' of a stream, upland soil distrubance, new stream crossing sites, Sediment Delivery	Feet, % of area, # of sites, Tons/year
Channel Form and Function	Channel stability, water yield increase	Stability rating, % increase

ANALYSIS AREAS

The gross Limestone West project area consists of 2,713 acres of State owned lands where actions have been proposed (*Appendix I; MAP WS1 –LIMESTONE WEST PROJECT AREA AND WATERSHED ANALYSIS AREAS*). Two watersheds containing these proposed actions have been identified and potential direct, indirect and cumulative effects to watershed and fish habitat as a result of implementing either the no action or action alternatives will be described at this scale.

The scale chosen for watershed analysis areas was determined by considering the proposed actions in each watershed, existing watershed conditions and the beneficial uses the watershed supports. The choice of scale balances the need to be small enough to accurately communicate watershed condition and potential measurable effects with the inherent problems of large scale analysis. In large scale analysis, potential effects may not be measurable or potentially masked by impacts such as urban development or agricultural practices that are scale dependent and outside the scope of analysis.

Each watershed analysis area varies in size but generally are forested, 2nd order watersheds similar to the location where actions are proposed. Physical attributes of individual watersheds can be found below in *TABLE WS02 – PHYSICAL ATTRIBUTES OF WATERSHED ANALYSIS AREAS.*

TABLE WS02 – PHYSICAL ATTRIBUTES OF WATERSHED ANALYSIS AREAS.

Physical Atrribute	Watershed Analysis Area	
	Limestone Creek	Nichols Creek
Area (Acres)	2187	944
Proposed Harvest (Acres)	Alt A 470 / Alt B 299	Alt A 130 / Alt B 76
Proposed New, Permanent Road (miles)	Alt A 4.9 / Alt B 4.3	Alt A 0.5 / Alt B 0.5
Mean Precipitation (inches)	28.1	25.3
Mean Watershed Slope (%)	40	29
Mean Watershed Aspect (degrees)	130	215
Relief (feet)	2,831	2,089
Geology	Limestones, Shales and Gneiss	Gneiss
Average Forest Canopy Cover (%)	56%	59%
Non-Forested (acres)	104	286
General Soil Erosion Hazard	Moderate	Moderate
Channel Stability	Good	Good
Stream Order	2nd	1st
Fisheries	None	None
Mean Basin Runoff (inches)	15.1	17.2
Existing Road Density (mi/mi^2)	0.6	0.8
Proposed Road Density (mi/mi^2)	Alt A 2.0 / Alt B 1.86	Alt A 1.2 / Alt B 1.2
Existing Harvest (acres)	88	64
Proposed + Existing Harvested Area (acres)	Alt A 558 / Alt B 387	Alt A 194 / Alt B 140
Post-Project Percent Harvested (%)	Alt A 27% / Alt B 19%	Alt A 29% / Alt B 21%
Water-yield Increase Threshold (%)	15%	15%

ANALYSIS METHODS

Methods for disclosing impacts to watershed and fisheries resources relied on information from numerous data sources. These sources included internal DNRC data and reports,

professionally published surveys on soil and water resources, and fisheries data from Montana Fish, Wildlife & Parks. These data sources assisted in field evaluation and verification of the project area during the summer of 2016. Professional training and judgment was intricate in synthesizing the information from these various sources to describe watershed processes and connections within the project area and to ultimately forecast potential impacts from forest management activities.

Effective risk management requires assessment of inherently uncertain events and circumstances, typically addressing two dimensions: how likely the uncertainty is to occur (probability or risk), and the magnitude the effect would be if it happened (impact) (Hillson and Hulett, 2004). In terms of the risk that an impact may occur, a low risk of an impact means that the impact is unlikely to occur. A moderate risk of an impact means that the impact may or may not (50/50) occur. A high risk of an impact means that the impact is likely to occur.
In terms of impacts, very low impact means that the impact is unlikely to be detectable or measurable, and the impact is not likely to be detrimental to the resource. A low impact means that the impact is likely to be detectable or measurable, but the impact is not likely to be detrimental to the resource. A moderate impact means that the impact is likely to be detectable or measurable, and the impact is likely to be moderately detrimental to the resource. A high impact means that the impact is likely to be detectable or measurable, and the impact is likely to be highly detrimental to the resource.

Sediment Delivery

Sediment delivery to streams consisted of a sediment-source inventory. Stream crossings and roads within 100 feet of a stream, both existing and proposed, were evaluated to determine existing and potential sources of introduced sediment (Callahan, 2000). Potential sediment delivery from harvest units was evaluated from a risk assessment of potential upland sediment sources, considering stream buffer mitigations. This risk assessment used the soil information provided in the *GEOLOGY AND SOILS ANALYSIS* and the results from soil monitoring on past DNRC timber sales (DNRC 2009, DNRC 2011).

Instream turbidity measurements from the spring of 2018 will be used to describe existing water quality conditions as it relates to fine sediment transport. These measurements were taken in-situ at a location close to the watershed outlet of Limestone Creek. A turbidity sonde measured stream turbidity every minute throughout the runoff period. These data provide an excellent baseline condition as well as a background in which to compare concurrent and post-implementation conditions to.

Water Yield

Annual water yield will be described as a cumulative effect in the *AFFECTED ENVIRONMENT* portion of this report because it represents the existing condition of the watersheds, representing past harvesting and associated activities that effect water yield. Annual water yield refers to the gross volume of water in a watershed that is contributed to a stream or other surface water features. In the *ENVIRONEMNTAL EFFECTS* section of this report, water-yield increases as a result of the action alternatives will be disclosed as a direct effect. The cumulative

water-yield increase is the additive effect of the existing condition and potential effects from a proposed action.

The annual water-yield increase for watersheds in the project area was estimated using the Equivalent Clearcut Area (ECA) method as outlined in *Forest Hydrology, Part II (Haupt et al, 1976)*. ECA is a function of the total area in a watershed comprised of roads and harvested or burned areas; percent of crown removed during harvesting or wildfire; and amount of vegetative recovery that has occurred since the harvest or natural disturbance. As live trees are removed, the water that would have evaporated and transpired either saturates the soil or is translated to runoff. This method also estimates the recovery of these increases as new trees revegetate the site and move toward preharvest water use.

To evaluate the potential effects of water-yield increases, a threshold of concern for each watershed was established per *ARM 36.11.423*. Thresholds were established based on evaluating the acceptable risk level (low), resources value (moderate), stream channel stability (excellent) and watershed sensitivity (low). Increased annual water yields above the threshold of concern can result in an increased risk of in-channel erosion and degradation of water quality. Based on these criteria, the water yield threshold of concern for both Limestone and Nichols Creek watersheds were set at 15% above fully forested conditions.

Fish Habitat – Channel Form and Function

Potential effects to processes controlling channel form and function, and ultimately fisheries habitat, compiles all the above methods and information and compares the results to the existing extent and quality of fisheries habitat in the project area. Based on the current condition and extend of habitat, potential impacts to water quality, water quantity, and riparian habitats will be used to qualitatively forecast potential modifications or impacts to fish habitat from the proposed action alternatives.

RELEVANT AGREEMENTS, LAWS, PLANS, RULES, AND REGULATIONS

Water Quality Standards and Permitting

This portion of the East Gallatin River Basin, including Limestone and Nichols Creek, are classified as B-1 by the State of Montana Department of Environmental Quality (DEQ), as stated in the *Administrative Rules of Montana (ARM 17.30.609)*. The water-quality standards for protecting beneficial uses in B-1 classified watersheds are stated in *ARM 17.30.623*. Water in B-1 classified waterways is 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. State water-quality regulations limit any increase in sediment above the naturally occurring concentration in water classified B-1. Naturally occurring means condition or materials 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 (*ARM 17.30.602 [17]*). Reasonable land, soil, and water conservation practices include "methods, measures or practices that protect present and reasonably anticipated beneficial uses…" (*ARM 17.30.602 [21]*). The State of Montana has adopted Best Management

Practices (BMPs) through its non-point source management plan as the principle means of meeting the *Water Quality Standards*.

Department of Environmental Quality (DEQ) has jurisdiction over water-quality standards in the project area. A *Short-Term Exemption from Montana Surface Water Quality and Fisheries Cooperative Program (318 Authorization)* may be required if temporary activities would introduce sediment above natural levels into streams or if *DFWP* deems a permit is necessary after reviewing the mitigation measures in the *124 Permit*.

Water Quality Limited Bodies

Limestone Creek and Nichols Creek are not listed as a water-quality limited water body in the *2016 303(d)* list (MDEQ, 2016. The *303(d)* list is compiled by DEQ as required by *Section 303(d)* of the *Federal Clean Water Act* and the *EPA Water Quality Planning and Management Regulations (40 CFR, Part 130)*. Under these laws, DEQ is required to identify waterbodies that do not fully meet water-quality standards, or where beneficial uses are threatened or impaired.

Streamside Management Zone Law (SMZ)

All rules and regulations pertaining to the SMZ Law will be followed. An SMZ width of 100 feet is required on Class I and II streams when the slope is greater than 35 percent. An SMZ width of 50 feet is required when the slope is less than 35 percent. Harvest will be allowed within Class II and III streams with retention requirements of 50% retention of trees greater than 8 inches in diameter or 10 trees per 100 feet, whichever is greater.

HCP Riparian Management Zone (RMZ)

All class I, perennial streams will have a minimum 100-foot RMZ buffer applied. Under this HCP commitment the total combined width of the SMZ and RMZ will equal one site potential tree height (SPTH) which for the Limestone West project area is 100 feet.

Water Rights and Beneficial Uses

Numerous surface water rights from Limestone Creek and Nichols Creek exist within and downstream of the project area for irrigation and stock watering. Currently the "68" irrigation ditch diverts all surface flow from Nichols Creek before the confluence with Bozeman Creek.

Streamside Protection Act

Montana *Department of Fish, Wildlife, and Parks, (DFWP)* has jurisdiction over the management of fisheries and wildlife in the project area. A *Stream Preservation Act Permit (124 Permit)* is required for activities that may affect the natural shape and form of any stream or its banks or tributaries.

AFFECTED ENVIRONMENT

Limestone Creek

Limestone Creek is a perennial, Class I stream tributary to Bozeman Creek with the confluence well downstream from the municipal inlet for the City of Bozeman. The majority of Limestone Creek is a B4 channel (Rosgen, 1996) that exhibits moderate entrenchment with channel

gradient of 2-5%. Substrates are rather coarse, composed predominately of gravels with lesser amounts of boulders, cobbles and sand. Channel stability is excellent with minimal channel disturbances noted. Numerous descriptive metrics of the Limestone Creek analysis area can be found in *TABLE WS02 – PHYSICAL ATTRIBUTES OF WATERSHED ANALYSIS AREAS* above. Runoff in Limestone Creek is typical of a snowmelt dominated system with peak flows occurring in late April to early May. Runoff response is rapid given the steep slopes and shallow soils found in the catchment. Approximately 88 acres in the watershed have been previously managed with shelterwood and group selection prescriptions. Given the hydrologic recovery and area of these previously harvest stands, the existing ECA in this analysis area is 64 acres. Existing water yield increases due to this level of ECA was calculated at 0.9% over fully forested conditions.

Both stage height and turbidity were collected in Limestone Creek in the spring of 2018 to further characterize the existing conditions of runoff and water quality. These measurements were collected immediately upstream where Limestone Creek exits State land and are presented in Appendix II at the end of this analysis. These results show discharge in Limestone Creek runs relatively low during periods of baseflow conditions yet when runoff accelerates, fine sediments stored in the channel become mobilized resulting in relatively turbid conditions given limited upstream sources of sediment delivery.

Currently, two road stream crossings exist within the analysis area providing access to private residences within the Triple Tree subdivision. These crossing structures on private land currently meets BMPs, appear adequate for fish passage and are delivering minor amounts sediment to Limestone Creek. Approximately 400 feet of road exists within 100' of Limestone Creek at these two crossing structures. Road densities within this analysis area are low at 0.6 mi/mi^2. The estimated rate of sediment delivery to this watershed from roads is low and was calculated at 0.3 tons per year.

Both Montana FWP and DNRC surveyed Limestone Creek and its tributaries in 2016 and found no fish on State owned lands despite stable channels and highly functional riparian conditions. It is assumed that Limestone Creek and its tributaries lack adequate pool depth of overwintering salmonids. On private property downstream of State lands, Limestone Creek supports a non-native population of Eastern Brook Trout (*Salvelinus fontinalis*).

Large woody debris and shade were measured along the mainstem of Limestone Creek and were found to be within an average range for the surrounding riparian habitat type. Average shade for the months of June, July, August and September was 73% with an average of 40 pieces of LWD per one thousand feet of stream.

Nichols Creek

Nichols Creek is a perennial, Class I stream with no surface water connectivity Bozeman Creek. All of the flow from Nichols Creek is captured by the "68" irrigation ditch and put to beneficial use. The majority of Nichols Creek is a B4 channel (Rosgen,1996) that exhibits moderate

entrenchment with channel gradient of 2-5%. Substrates are rather coarse, composed predominately of gravels with lesser amounts of boulders, cobbles and sand. Channel stability is excellent with minimal channel disturbances noted. Numerous descriptive metrics of the Nichols Creek analysis area can be found in *TABLE WS02 – PHYSICAL ATTRIBUTES OF WATERSHED ANALYSIS AREAS* above.

Runoff in Nichols Creek is typical of a snowmelt dominated system with peak flows occurring in late April to early May. Runoff response is rapid given the steep slopes and shallow soils found in the catchment. Approximately 64 acres in the watershed have been previously managed with shelterwood prescription on private land. Given the hydrologic recovery and area of these previously harvest stands, the existing ECA in this analysis area is 36 acres. Existing water yield increases due to this level of ECA was calculated at 1.3% over fully forested conditions.

Currently two road stream crossings exist within the analysis area. One provides access to a private residence and the other is the crossing at Sourdough Road. Both crossing structures currently meets BMPs and deliver negligible amounts sediment to Nichols Creek. Neither of these crossing sites are within the forested portion of the analysis area thus have negligible effects on riparian function. Road densities within this analysis area are low at 0.8 mi/mi^2.

Montana DNRC surveyed Nichols Creek in the fall of 2016 and found no fish on State owned lands. Two natural fish barriers were identified which likely limit any potential fish movement in Nichols Creek. Conversations with a private land owner indicated observations of non-native Eastern Brook Trout on the lowest portions of the stream, upstream from the irrigation ditch.

Large wood debris and shade were observed to be very similar to those documented in Limestone Creek with highly functional and stable channel characteristics.

ENVIRONMENTAL EFFECTS
SEDIMENT DELIVERY

- ***Direct and Indirect Effects of the No-Action and Alternative C***

Implementing either of these alternatives would result in no timber harvesting or road construction activities in any watershed analysis area for a period of at least 10 years. Sediment delivery rates from existing road stream crossings and other sources would continue to supply very low levels of introduced sediment to stream channels as described in the Affect Environment section. Either of these alternatives would result in **no direct and indirect effects** related to sediment delivery.

- ***Direct and Indirect Effects of Action Alternative A and B***

Implementing either Action Alternative A or B would result in approximately 2,830 feet of new road construction within 100 feet of a stream of which approximately 1,200 feet would be reclaimed after the completion of timber harvest activities. All new road construction would be associated with 7 new stream crossing locations, all of which would be in the Limestone Creek analysis area. This results in an average of approximately 400 feet of new road construction within 100 feet of a stream channel per crossing site.

The increase in sediment delivery in Limestone Creek associated with this road construction and crossing structure installation (culverts and bridges) would result in 2.3 tons of sediment delivery per year for approximately 2 to 3 years until vegetation is established and traffic is reduced to administrative use only. Rates of sediment delivery associated with road stream crossing construction is presented in *TABLE WS03 – EXISTING, DIRECT AND CUMULATIVE SEDIMENT DELIVERY FROM STREAM CROSSING SITES* below.

TABLE WS03 – EXISTING, DIRECT AND CUMULATIVE SEDIMENT DELIVERY FROM STREAM CROSSING SITES

Watershed Analysis Area	Existing Stream Crossings		Proposed Stream Crossings (Alternatives A and B)		Cumulative Stream Crossings (Alternatives A and B)	
	Sites	tons/year	Sites	tons/year	Sites	tons/year
Limestone Creek	2	0.3	7	2.3	9	2.6
Nichols Creek	2	0.0	0	0.0	2	0

BMPs would be applied to all new road segments and existing road drainage BMPs would be maintained on existing roads. After project completion, roads not necessary for long-term management would be debris closed with slash and grass seeded. Upland ground disturbance would be limited to 15% or less of a harvest unit and all harvest BMPs would be applied concurrently with felling and skidding operations to reduce the potential of water quality impacts (Rashin et al., 2006).

The moderate probability of low level effects of upland erosion from timber harvesting coupled with the increased sediment delivery from new road construction and crossing structure installation results in a **high probability of moderate direct and indirect effects to sediment delivery in Limestone Creek** resulting from the implementation of Action Alternative A or B. There is a **low probability of low level effects from sediment delivery in Nichols Creek** resulting from the implementation of Action Alternative A or B. Turbidity monitoring would be continued through project implementation and compared to baseline conditions to provide further information as to the concentration, duration and frequency of sediment delivery events.

Cumulative Effects

- ***Cumulative Effects of the No-Action and Alternative C***

Implementing either of these alternatives would result in no timber harvesting or road construction activities in any watershed analysis area for a period of at least 10 years. Sediment delivery rates from existing road stream crossings and other sources would continue to supply very low levels of introduced sediment to stream channels as described in the Affect Environment section. Either of these alternatives would result in a **low probability of low level cumulative effects** related to sediment delivery.

- ***Cumulative Effects of Action Alternative A and B***

Very low levels of existing sources of sediment delivery were documented in either Nichols or Limestone Creek analysis areas. The existing stream crossings in the analysis areas currently contribute very low to negligible amounts of sediment. Due to very low levels of existing sources of sediment delivery and the forecasted direct and indirect effects of implementing either action alternative, a **high probability of low level cumulative effects** from sediment delivery exists in Limestone Creek while **a low probability of low level cumulative effects** from sediment delivery exists in Nichols Creek.

WATER YIELD

- ***Direct and Indirect Effects of the No-Action Alternative and Alternative C***

Implementing either of these alternatives would result in no timber harvesting or road construction activities in any watershed analysis area for a period of at least 10 years. Water yield would continue to increase in the project area as disease/insect infected stands of lodgepole pine continue to lose canopy and stand structure is lost. The timing of peak flows would generally occur earlier in the spring period with potentially higher peak flows. Baseflows in the summer and falls months would be elevated. This natural rate of water yield increase, timing or duration is not expected to destabilize channels or effect downstream beneficial uses but would be measurable nonetheless. This would result in a **low probability of low level direct and indirect effects** to water yield.

- ***Direct and Indirect Effects of Action Alternative A and B***

Direct and indirect effects to water yield as a result of implementing Action Alternative A or B are presented below in *TABLE WS04 – EXISTING, DIRECT AND CUMULATIVE WATER YIELD INCREASES.* Water yield increases in both watershed analysis areas remain well below the 15% threshold that was set for these watersheds, regardless of the Action Alternative. The timing of peak flows would generally occur earlier in the spring period with potentially higher peak flows and more rapid runoff response. Baseflows in the summer and falls months would be elevated. As a result of this, **a moderate probability of low level direct and indirect effects** are expected in both watershed analysis areas if a timber sale alternative is implemented.

TABLE WS04 – EXISTING, DIRECT AND CUMULATIVE WATER YIELD INCREASES

Watershed Analysis Area	Existing Water Yield		Proposed Water Yield Increase (Alternative A / B)		Cumulative Water Yield (Alternative A / B)	
	ECA	% Increase	ECA	% Increase	ECA	% Increase
Limestone Creek	64	0.9%	374 / 301	8.2% / 4.5%	438 / 365	9.1% / 5.4%
Nichols Creek	36	1.3%	77 / 13	5.3% / 2.2%	113/ 49	6.6% / 3.5%

Cumulative Effects

- ***Cumulative Effects of the No-Action and Alternative C***

Implementing either of these alternatives would result in no timber harvesting or road construction activities in any watershed analysis area for a period of at least 10 years. Water yield would continue to increase in the project area as disease/insect infected stands of

lodgepole pine continue to lose canopy and stand structure is lost. Previously harvested stands would continue hydrologic recovery. This rate of both natural and anthropogenic water yield increase is not expected to destabilize channels or effect downstream beneficial uses but would be measurable nonetheless. This would result in **a low probability of low level cumulative effects** to water yield.

- ***Cumulative Effects of Action Alternative A and B***

Low levels of existing water yield increases associated with previous timber harvest were documented in both watershed analysis areas as presented above in *TABLE WS04 – EXISTING, DIRECT AND CUMULATIVE WATER YIELD INCREASES*. Considering past effects in conjunction with proposed effects still result in water yield increases below thresholds of concern set for these watersheds. Due to this, implementing either action alternative would result in a **moderate probability of low level cumulative effects** to water yield increases.

FISH HABITAT – CHANNEL FORM AND FUNCTION

- ***Direct and Indirect Effects of the No-Action and Alternative C***

Implementing either of these alternatives would result in no timber harvesting or road construction activities any watershed analysis area for a period of at least 10 years. Processes controlling channel form and function would continue in both watershed analysis areas as described in Affected Environment. As a result**, no measurable or detectable direct or indirect effects** to channel form and function would occur.

- ***Direct and Indirect Effects of Action Alternative A and B***

Considering the combined potential effects of sediment delivery and water yield increases within both watershed analysis areas, channel form and function processes would continue to be maintained with **a low probability of low level direct or indirect effects**. Both sediment and water yields would continue to be within the natural range of variability that these channels evolved with thus presenting a low level of risk to channel stability and downstream fish habitats.

Cumulative Effects

- ***Cumulative Effects of the No-Action and Alternative C***

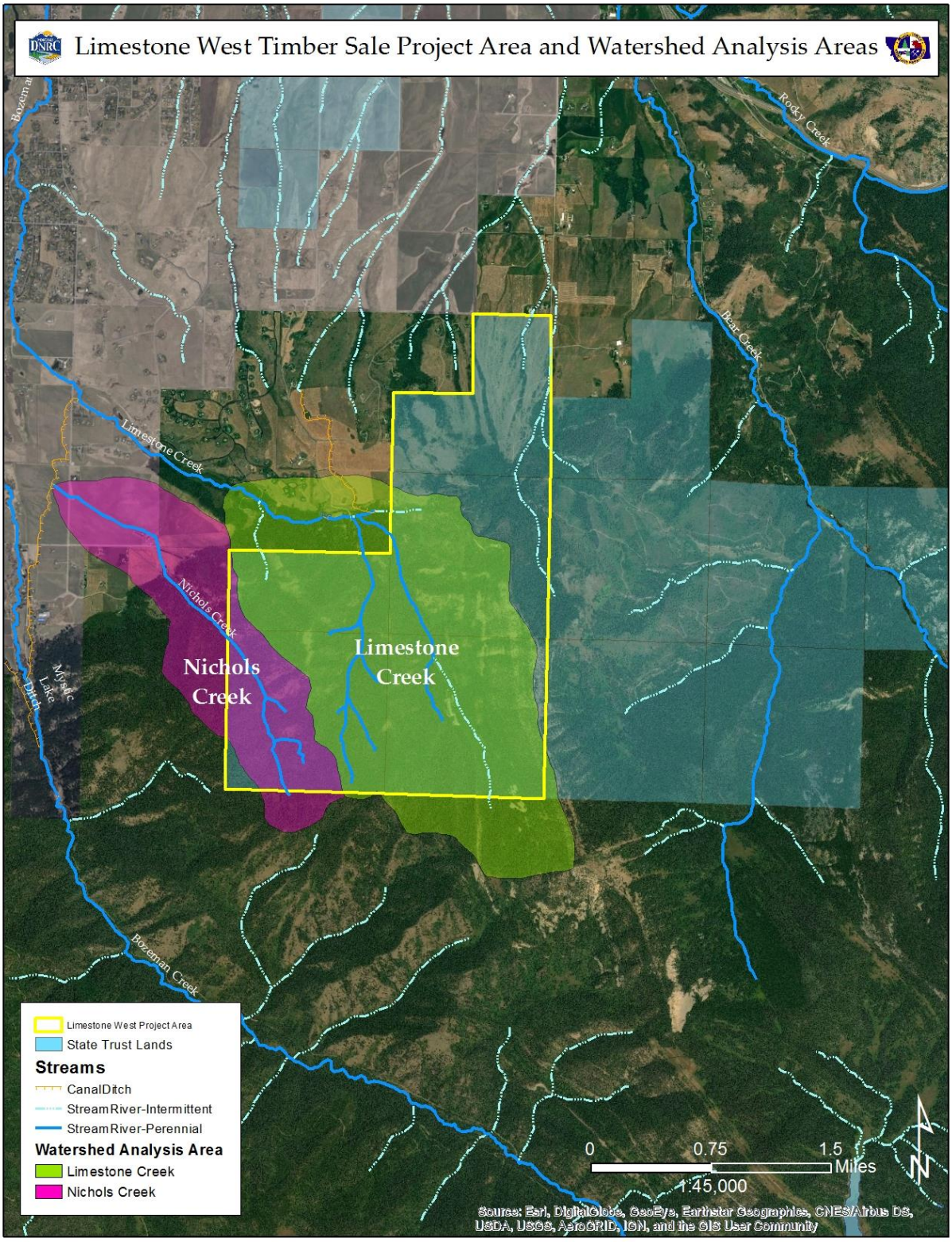
Implementing either of these alternatives would result in no timber harvesting or road construction activities any watershed analysis area for a period of at least 10 years. Processes controlling channel form and function would continue in both watershed analysis areas as described in Affected Environment. As a result, **no measurable or detectable cumulative effects** to channel form and function would occur.

- ***Cumulative Effects of Action Alternative A and B***

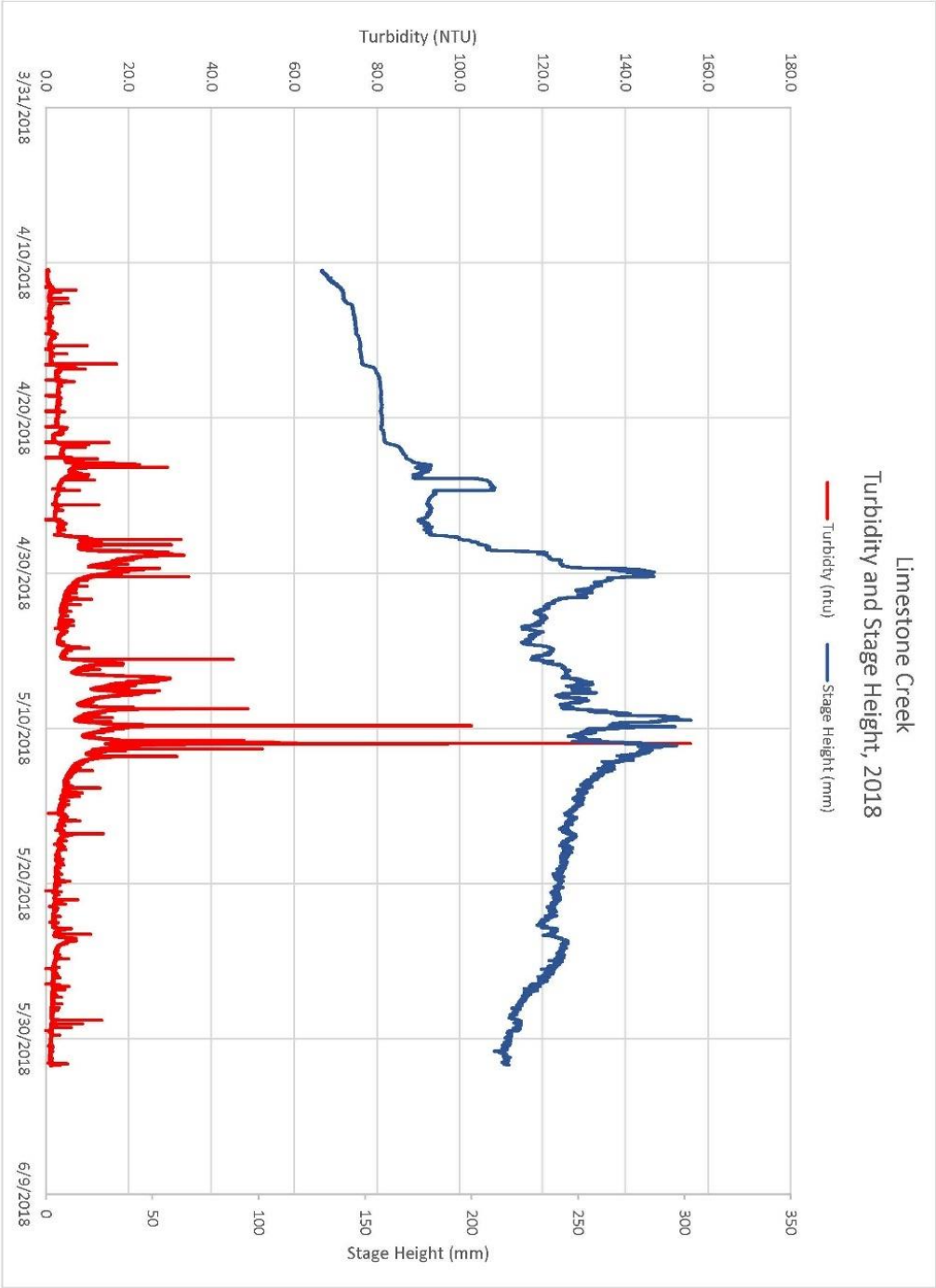
The existing condition of channel form and function in both watershed analysis areas is currently highly functioning. Considering this in combination with the low probability of low level direct and indirect effects to channel form and function resulting from the timber harvest

alternatives results in a **low probability of low level cumulative effects** to channel form and function in both Limestone and Nichols creek. Both sediment and water yields would continue to be within the natural range of variability that these channels evolved with thus presenting a low level of risk to channel stability and downstream fish habitats.

Appendix I; MAP WS1 –LIMESTONE WEST PROJECT AREA AND WATERSHED ANALYSIS AREAS



Appendix II – STAGE HEIGHT AND TURBIDITY OF LIMESTONE CREEK DURING SPRING RUNOFF IN 2018



WILDLIFE ANALYSIS

INTRODUCTION

The following sections address the anticipated direct, indirect, and cumulative effects to wildlife resources from the proposed action alternatives in the project area and cumulative-effects analysis areas for each resource category. Past and ongoing activities on all ownerships and planned future agency actions were taken into account in each cumulative-effects analysis for each resource topic. For all species where habitats and or conditions are present to support a species, the species is presumed present and appropriate mitigations are implemented. For additional supporting see the Vegetation, Recreation, and Transportation sections contained in this DEIS.

ISSUES AND MEASUREMENT CRITERIA

Issues regarding wildlife species and their habitat were identified through internal and public scoping. These issues are listed in TABLE I–1 – ISSUES STUDIED IN DETAIL (CHAPTER I) and are reiterated at the beginning of the following sections. Differing measurement criteria were used to evaluate the effects of the alternatives on wildlife resources, depending on the subject matter of the issue being analyzed. The measurement criteria used for evaluation of impacts are described under each issue below that is carried forward in this analysis.

ANALYSIS AREAS

The discussions of existing conditions and environmental effects within each subsection of this analysis pertain to land areas of 3 different scales. The first scale of analysis is the Project Area (2,725 acres), which is comprised of the subset of DNRC parcels where project activities are being proposed. Approximately 1,120 of these acres are in common with the project area analyzed for the Bear Canyon Timber Sale (August 2011). Direct and indirect effects of the alternatives considered for each issue carried through this analysis are evaluated at the scale of the Project Area. The Limestone West Timber Sale Project Area is located approximately 4 miles southeast of Bozeman, Montana on state trust lands in the general area between Bear Canyon and Nichols Creek (VICINITY MAP).

The second scale is the cumulative-effects analysis area, which refers to a broader surrounding landscape useful for assessing cumulative effects to wildlife and habitat associated with the alternatives under consideration. This area is 33,422 acres and it surrounds the project area. This area was identified as an appropriate adjacent land area of similar vegetation and topography where potential cumulative impacts would be most likely to be realized and detectable in relation to proposed activities and most of the issues raised pertaining to wildlife and habitat. The area generally approximates a home range size for many wide-ranging carnivores and ungulates. In the case of wolverines (*Gulo gulo*) (which may have home range areas 4 to 5 times larger than this selected size) this same analysis area was used for consistency and for the purpose of disclosing measurable effects in the context of the local affected landscape.

The larger third area was identified for analyzing potential cumulative effects to elk (*Cervus elaphus*) that use the Limestone West and Bear Canyon project areas. This area is 93,552 acres

and it was delineated as an approximation of a fall elk herd home range for elk. The general area was delineated considering conversations with J. Cunningham (R-3, DFWP Biologist, pers. comm., 4/13/11) and emphasized inclusion of lands capable of supporting coniferous forest cover. This area was deemed appropriate for this Limestone West Timber Sale Project analysis because of its inclusion of the other recent Bear Canyon Timber Sale project, the U.S. Forest Service Bozeman Municipal Watershed Project area, and it likely encompasses a substantial portion of the local elk herd's fall home range area. The area identified extends roughly in an 8-mile radius from the project area. This area also coincides closely with forested lands contained within the National Forest Boundary as well as state trust lands in, or near the project area. This area was identified as the most appropriate area to consider cumulative impacts associated with road densities and forest cover on elk.

ANALYSIS METHODS

For each wildlife-related issue, existing conditions of habitats are described and compared to the anticipated effects of the no-action alternative and the proposed action alternatives to determine the foreseeable effects. To assess the existing conditions and related impacts associated with the proposed action alternatives, a variety of techniques were used. Field visits, scientific literature, forest inventory data, review of aerial photographs, review of Montana Natural Heritage Program data, and consultations with other professionals provided information for the following discussion and effects analysis. Specialized methodologies, where applicable, are discussed under the issue in which they occur. Species were dismissed from further analysis if issues raised were beyond the scope of this analysis, if habitat did not exist in the project area, or if the habitat would not be appreciably modified by any alternative.

RELEVANT AGREEMENTS, LAWS, PLANS, PERMITS, LICENSES, AND OTHER AUTHORIZATIONS

Various legal documents provide management direction for terrestrial wildlife species and their habitats on state trust lands. The documents most pertinent to this project include DNRC Forest Management Rules (September 2003 as amended), the DNRC Forest Management HCP (DNRC 2010), the Endangered Species Act of 1973 (ESA; 16 U.S.C. § 1531 et seq.), the Migratory Bird Treaty Act (16 U.S.C. §§ 703–712), and the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d).

PAST FOREST MANAGEMENT ACTIVITIES IN THE PROJECT AREA VICINITY THAT COULD RESULT IN CUMULATIVE EFFECTS

See FIGURE I-1 MAP OF ALL HARVESTS IN THE BEAR CANYON BLOCK, which depicts all project units in the Bear Canyon-Limestone Block from 1974 to 2017.

- DNRC 1980-1981 Bear Canyon Timber Sale – Harvest on approximately 67 acres within Section 2 T3S R6E & approximately 39 acres within Section 35 T2S R6E.
- DNRC 1990-1991 Lower Bear Canyon Viewshed Harvest – Harvest on approximately 80 acres within Sections 34 T2S R6E and Section 3 T3S R6E.

- DNRC 1993-1994 Upper Bear Canyon Multi-Product Timber Permit – Harvest on approximately 12 acres within Section 2 T3S R6E.
- DNRC 2007 Eagle Rock Fuels Reduction – Harvest on approximately 11 acres within Section 4 T3S R6E.
- DNRC 2007 Pre-commercial thinning -- approximately 10 acres within Section 2 T3S R6E.
- DNRC 2010 Eight firewood permits -- 40 cords total (5 cords per permit).
- Livestock grazing Sections 34, 35 T2S, R6E.
- Permits issued across approximately 66 acres from 1974 to 2015 in Sections 1, 2, 3, T3S R6E; Section 34, T2S R6E; Section 6, T3S R7E.
- USDA Forest Service 2011, Gallatin National Forest, Bozeman Ranger District, Bozeman Municipal Watershed Project. Approximately 4,675 acres. Project duration 5 to 12 years (See detailed discussion below).
- Bear Canyon Timber Sale 2011 – Harvest on approximately 626 acres, group selection, selection and clearcutting harvest types. Approximately 7.7 miles of new roads closed with slash and debris after harvest completion.
- Forest management projects on adjacent private ownerships.
- Homes and human development along the periphery of the project area and Bear Canyon vicinity.

USDA Custer Gallatin National Forest Bozeman Watershed Project – Cumulative Effects

The USDA Forest Service, Custer Gallatin National Forest, developed and finalized an EIS for the Bozeman Municipal Watershed (BMW) Project in 2011. Under this project, treatments were planned on 4,675 acres in the vicinity of the Limestone West Timber Sale Project Area (GNF 2011). Of these acres approximately 4,173 would lie in the southwest portion of the 33,422-acre cumulative effects analysis area (13% of the area). All 4,675 proposed acres lie within the 93,552-acre Elk Security Analysis Area that was also used for analyzing elk security for the DNRC Limestone West Timber Sale Project (5.0% of the elk security analysis area). Prescribed under burning (1,430 acres), pre-commercial thinning and conifer encroachment removal (1,117 acres), and commercial harvest using partial harvest treatments (1,626 acres) were proposed activities under the BMW project that would require 10.2 miles of temporary and re-constructed roads to accomplish over a 5 to 12-year period (GNF 2011). The treatments in the BMW project were designed to reduce stand density, fuels, and fire hazard in the Hyalite and Bozeman Creek watersheds. To accomplish these broad objects, the treatments proposed would also be expected to alter cover, composition, density, structure, and age classes of forest stands to varying degrees. Proposed cover reductions would have the potential to affect habitat conditions for many wildlife species (both beneficial and adverse effects depending upon the specific habitat requirements for individual species). Given the proposed treatment types proposed, moderate reductions in forest cover amounts within treated stands overall would be likely across the 4,173 acres. Proposed treatments would also likely increase the diversity of within-stand habitat structure, patches and stand age classes within the Hyalite and Bozeman

watersheds for several decades following treatments. The proposed treatments in BMW project would generally emulate natural disturbance processes that native species would have evolved with in the Bozeman area under historical conditions (eg. effects of wildfire) (Fischer and Clayton 1983, and Gruell 1983).

Should the project be revised and implemented in the foreseeable future, added cumulative effects to habitat for a number of wildlife species would potentially occur. During the proposed 5 to 12-year operating window stated for the BMW project, additional human disturbance and motorized activities could disturb and displace moose, elk, deer, bears and other wildlife species into other portions of the analysis areas used for describing effects associated with the Limestone West Project. Hiding and security cover would be reduced on 4,173 acres for several decades by the BMW project. Considering these potential cover reductions in combination with those proposed in the DNRC Limestone West Timber Sale, the combined acreages affected could include as much as 4,774 acres affected under the proposed US Forest Service BMW project (selected Alternative 6) and the DNRC Limestone West Project (proposed Alternative A). Similarly, the combined acreage potentially affected for both projects, assuming selection of proposed Alternative B under the DNRC Limestone West Project, would be 4,546 acres.
The majority of the specific likely disturbance and security effects of the proposed BMW project were considered and addressed in the wildlife cumulative effects analyses described below by analyzing and including the existing open and restricted road system on the landscape and by applying broad disturbance buffers of from 0.31 to 0.5 miles to each road segment. With or without the BMW project activities occurring, these roads were assumed in the Limestone West analysis to have a persistent adverse effect on wildlife security. It is also worth noting that the majority of the BMW project would rely on the existing road network to accomplish the stated project objectives and that most of the new temporary roads and re-opened roads that would be used for the BMW project would be located in relatively close proximity to other existing roads. In this manner, all roads (both existing and those proposed under the BMW project) were fully encompassed by presumed disturbance buffers used in the Limestone West Analysis. Should both projects proceed, the combined duration effect of both projects could continue for up to 15 years (DNRC project 3 yrs. and USFS BMW Project up to 12 years) (GNF 2011).

The likelihood of this project moving forward at the present time is uncertain and unlikely as it was originally proposed due to appeals, litigation, and the relatively long period that has passed since the Record of Decision was signed in 2011. Project status is currently stated by the Custer Gallatin National Forest as being "on hold." Documentation regarding the project and process is located in the Custer Gallatin National Forest NEPA document archives. (https://www.fs.usda.gov/wps/portal/fsinternet/cs/projects/custergallatin/landmanagement/projects?archive=1&sortby=1)

INFLUENCES OF CLIMATE CHANGE

Evidence of widespread climate change has been well-documented and reported (*Intergovernmental Panel on Climate Change 2013*). In Montana, effects of climate change will be related to changes in temperature and moisture availability, and the response of individual tree

species, forests and habitats will be complex and variable depending local site and stand conditions. Changes in temperature and moisture availability may affect the ability of some tree species to establish and regenerate on some sites. Forest productivity may increase in some areas due to longer growing seasons associated with increased temperature where moisture is not limited, but may decrease in other areas where increasing temperature results in decreased water availability. Drought severity is expected to increase, leading to increases in forest and tree mortality. Changing climate may also lead to changes in the range of some species, resulting in changes in forest composition and distribution. Changing climate is also expected to alter natural disturbance regimes, such as fire and insects, with the resulting effects expected to have greater impact on Montana's forests than changes in temperature and moisture availability that directly affect individual trees and species (Wade et al. 2017).

Understanding changes in tree species composition and habitat relationships in forests, and the ability of various tree species to thrive under changing climate conditions, may take decades. Predicting possible effects of climate change in forests at local levels is also difficult due to large-scale variables at play, such as possible increases in global evaporation rates, and possible changes in global ocean currents and jet stream. Such outcomes could influence locally-observed precipitation amounts and possible influences on natural disturbance regimes (such as changing the average intensity, frequency and scale of fire events). Normal year to year variation in weather also confounds the ability to identify, understand, predict, and respond to influences of climate change.

Given the many variables and difficulty in understanding the ramifications of changing climate, detailed assessment of possible direct, indirect, or cumulative effects of climate change in association with project activities described in this DEIS is beyond the scope of this analysis. In the face of current uncertainty associated with climate change, DNRC is continuing to manage for biodiversity as guided under the SFLMP. Under the management philosophy of the SFLMP, DNRC will continue to manage for biodiversity and wildlife using coarse and fine-filter approaches. The coarse filter approach favors an appropriate mix of stand structures and compositions on state lands as described by *ARM 36.11.404*, while also working to understand relevant ecosystem changes as research findings and changes in climate evolve.

WILDLIFE CORRIDORS, HABITAT CONNECTIVITY, AND LINKAGE ISSUE

There is concern that the removal of trees and the road system established for this project and cumulative effects associated with other projects in this roadless area would fragment and adversely affect wildlife habitat and movement corridors for elk, mule deer (*Odocoileus hemionus),* white-tailed deer *(O. virginianus*), black bears (*Ursus americanus*), grizzly bears (*Ursus arctos horribilis*), moose (*Alces alces*), birds and other species in one of the last pieces of habitat relatively undisturbed by people in this section of the Gallatin Valley. There is concern that specifically, habitat within the Gallatin Bridger Big Belt Wildlife Corridor will suffer degradation and lowered effectiveness.

MEASUREMENT CRITERIA

The management criteria used to evaluate impacts related to this issue include: species being considered; potential barrier factors; size and juxtaposition of streams and prominent geographic features; the duration of proposed activities; location of past and proposed activities on DNRC, and neighboring ownerships; scale of proposed activities; quantified cover amounts; quantified road amounts; stand level inventory summaries of stand age classes and cover types; and visual assessments of aerial photography for visual evaluation of cover and topography as related to potential linkage areas and movement corridors.

AFFECTED ENVIRONMENT

Habitat connectivity has been defined in many different ways in the literature and the concept is dependent on the types of species and habitats of concern. Habitat connectivity refers to the extent that a species or population can move among landscape features in a mosaic of habitat conditions, and it is important for promoting movements of species that are hesitant to cross nonforested expanses (Hilty et al. 2006). Corridors are one way that that connectivity may be achieved. Generally, the more effective corridors are those that are relatively wide, unfragmented, diverse, and associated with riparian areas (Fischer and Fischenich 2000).

Linkage zones are defined as "the area between larger blocks of habitat where animals can live at certain seasons and where they can find the security they need to successfully move between these larger habitat blocks" (Servheen et al. 2003). Linkage zones differ from corridors in that the area is not just used for travel. Areas appropriate for linkage zones can occur at different spatial scales, particularly when considering the species of interest. The main factors generally considered to affect the quality of linkage zones are major highways, open roads, railroads, road density, human site development, availability of hiding cover, and the presence of riparian areas (Hilty et al. 2006, USFS 2005, Servheen et al. 2003, Craighead et al. 2001). Associated motorized use of open roads and non-motorized recreational use of closed road systems have the potential to displace wildlife from preferred habitats (Servheen et al. 2003). Maintaining linkage and connectivity between isolated populations can benefit wildlife species in several ways by: (1) allowing immigrant individuals to bolster a resident population in an area that has been affected by catastrophic events or negative environmental conditions, and (2) preserving genetic diversity by reducing negative effects from inbreeding. This analysis considers potential environmental effects associated with alteration of vegetation, road construction and related mechanized disturbance on a variety of native wildlife species including very mobile species such as elk, deer, bears, moose, and birds, and less mobile species such as small mammals, amphibians and reptiles.

Dense patches of mature forest are abundant in the project area and cumulative effects analysis area, and areas of dense forest on this local landscape are likely more abundant currently than they were under historical conditions (Gruell 1983). Approximately 2,095 acres of the 2,725-acre project area (77%) currently possess greater than 40% overstory canopy cover in mature forest patches (Table W-1). Approximately 27,618 acres (83%) of the 33,422-acres cumulative effects analysis area currently possess greater than 40% overstory canopy cover in mature forest patches (Table W-2). Existing patches have variable tree density and comprise a diverse mosaic of habitat conditions. Existing patch shapes and sizes in the project area have been influenced by natural disturbances, limited past logging, road and construction that have occurred during the past 125 years. Mature forest stands in the project area and cumulative effects analysis area

are generally well connected and provide a suitable network of cover capable of facilitating movements of many terrestrial species across the local landscape. Mature forest patches of several hundred acres to those over 1,000 acres are present in the project and cumulative effects analysis areas. There are currently no open roads in the Limestone West Project Area and 5.3 miles of permanent restricted roads. In the 33,422-acre cumulative effects analysis area there are approximately 48.7 miles of existing permanent open roads and 26.9 miles of existing permanent restricted roads (Table W-6).

The project area lies just west of Bear Canyon and the Bozeman Pass areas and it is approximately 2.3 miles southwest of possible wildlife crossing sites across U.S. Interstate 90 – termed here for this analysis as the "Gallatin Bridger Big Belt Wildlife Corridor." This general vicinity in relation to U.S. Interstate 90 has been recognized by various agencies and interest groups as an area important for maintaining and promoting wildlife linkage and movement corridors between the Gallatin and Absaroka mountain ranges to the south and the Bridger and Bangtail mountains to the north (Walker and Craighead 1997, MDT 2010, Peck et al. 2017). The U.S. Forest Service (USFS) has also recognized this area as potentially important for maintaining habitat connectivity for Canada lynx (USFS 2007). Agricultural lands, a number of homes, and several subdivisions occur within one mile of the project area. The Limestone Creek, New World Gulch, Triple Tree and Bear Canyon areas are popular recreation destinations for people from the city of Bozeman and local area during all seasons of the year. Popular activities include hiking, biking, skiing, horseback riding, and hunting.

ENVIRONMENTAL EFFECTS

- ***Direct and Indirect Effects of the No-Action Alternative***

Under the No-Action Alternative no trees would be removed, and no roads would be built in the project area at this time. Thus, changes in habitat conditions that could fragment habitat and adversely affect movement corridors and linkage areas would not occur as a result of this project. Also, as no roads would be constructed, no additional indirect increases in human use and recreation that could disturb wildlife would be expected as a result of this project. However, as the community of Bozeman continues to grow and expand, public access and recreational use of lands and related impacts in the project area are expected to continue to increase over time. No direct or indirect project-related effects to wildlife associated with habitat connectivity, movement corridors or linkage areas would be anticipated under this alternative.

- ***Direct and Indirect Effects of Action Alternative A***

Under Action Alternative A, habitat connectivity associated with riparian areas would not be appreciable altered as limited riparian timber harvesting would occur in the project. A 100 to 350-foot variable width no harvest RMZ would be maintained along Limestone Creek and 100-foot no harvest RMZs would be retained along all other class 1 streams in the project area (200 ft. total width including both stream sides for No-name Creek, and Nichols Creek).

Across the project area, some dense patches of mature forest cover would remain, and cover would be retained to provide connectivity of mature forest cover in the project area. Dense forest cover in areas logged using the clear cut with reserve treatment would be more fragmented and additional forest edge habitat would be created, which could benefit some species such as white-tailed deer, but be detrimental to species such as marten that use dense continuous cover. Of the 2,725-acre project area, 1,724 acres (63%) would remain in mature forest cover with >40% overstory canopy closure, that would facilitate occupancy and movement of wildlife (Table W-1). Of these 1,724 acres, 1,450 (53% of the project area) would continue to maintain high canopy cover levels of 60% to 100%. Species that prefer non-forested conditions would benefit from openings in cover on 371 acres where lodgepole pine stands would be removed. Some species such as American marten (*Martes americana*) that are known to occur in the area (Gehman 2017), may be displaced from local areas intensively logged for several decades, due to cover reductions. Following logging, forest patches on the project area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions comprised of cover and foraging areas suitable for use by habitat generalist species, such as moose, elk, deer and bears. Areas where advanced regeneration of subalpine fir, spruce, and Douglas-fir are present would be retained to provide visual screening and habitat structure to facilitate use by wildlife. Overall, stand density would be reduced on 601 acres of mature forest. Mature forest stands in the project area would generally remain moderately connected via interspersed stringers of unharvested stands and riparian buffer areas, which would provide a suitable network of cover capable of facilitating movements of both wide-ranging and small terrestrial species across the local landscape. Within harvested stands, individual trees and patchy tree retention would remain, which would continue to provide some, albeit reduced amount of escape cover and visual screening.

Approximately 9.1 miles of road would be constructed and used to complete this alternative, of which 3.8 miles would be reclaimed following project completion. No new open roads would be constructed under this alternative. However, 5.3 miles of the 9.1 miles constructed for the project would be gated and retained on the landscape. Only motorized activities for administrative purposes would be allowed on these roads, which would pose minimal disturbance to local wildlife in the years following the logging disturbance. However, depending on the degree that these new closed roads might be used in the future by the public for recreation, additional displacement for a longer term (several decades) until logged stands regenerate would be possible. The actual extent that restricted roads would receive recreational use is uncertain. Habitats in section 10 in the project area would be minimally affected by logging or roads and would help maintain undisturbed habitat connectivity and linkage across the broader landscape.

During operations, most large carnivores and ungulates would likely be displaced to some degree for the duration of activities (approximately 2-3 years) due to motorized disturbance and increased human activity in the area. Overall, timber harvesting associated with Alternative A would have a moderate adverse impact on species that prefer interior forest conditions and well-connected mature forest cover. Tree density in harvested patches would be reduced, which would improve habitat conditions for species that prefer young and more open forest conditions such as the olive-sided flycatcher (*Contopus cooperi*), but would reduce security and habitat quality for species that benefit from large expanses of mature forest cover, such as the

marten. While birds that more exclusively use mature, forested habitats would likely be adversely affected on approximately 371 acres, no adverse effects associated with habitat connectivity would be expected for any bird species, due to their high inherent degree of mobility.

The project area is situated along a forest/grassland ecotone just south of the city of Bozeman, Montana. While habitat is present on the project area that would serve as an important linkage habitat in association with the Gallatin Bridger Big Belt Wildlife Corridor, direct lines of travel to and from the identified corridor are impeded by subdivisions, human dwellings, agricultural land uses, open public road systems, and U.S. Interstate 90. Thus, the ability for habitats in the project area to serve as a functional stepping stone or unique identifiable corridor to this larger, broader landscape feature are somewhat limited. Following timber harvest, large species such as elk, deer, bears and moose would be expected to alter the way they use and move through individual forested stands in the project area, but would continue to use the project area after motorized logging disturbance has ceased. Given: 1) the sizable amounts of moderate to dense mature stands that would remain following harvest (1,724 acres with >40% canopy cover), 2) the mosaic of habitat conditions that would remain following harvest, 3) that there would be no long-term increases in motorized access associated with the project, 4) an additional uncertain level of increase in non-motorized recreation and long-term disturbance would be possible on 5.3 miles of new restricted roads, and 4) that there would be no other forms of permanent human development associated with the project, there would be low risk of appreciable adverse effects to wildlife linkage or future linkage potential in the Gallatin Bridger Big Belt Wildlife Corridor associated with this project.

Table W-1. Acreages by alternative of sparse forest, moderately dense forest, and dense forest structural classes based on overstory forest canopy cover classes in the DNRC Limestone West Timber Sale Project Area (Data source USFS R-1 VMap Remote-sensing Database -- 2015).

Forest Structural Classes	No Action Alternative Acres (%)	Action Alternative A Acres Post Harvest (%)	Action Alternative B Acres Post Harvest (%)	Action Alternative C Acres Post Harvest (%)
Non-Forest/Sparse Forest (0 to 39% Canopy Cover)	630 (23%)	1,001 (37%)	914 (33%)	630 (23%)
Moderately Dense Forest (40 to 59% Canopy Cover)	44 (2%)	274 (10%)	133 (5%)	44 (2%)
Dense Forest (60 to 100% Canopy Cover)	2,051 (75%)	1,450 (53%)	1,678 (62%)	2,051 (75%)
Total	2,725	2,725	2,725	2,725

- ***Direct and Indirect Effects of Action Alternative B***

Under Action Alternative B, habitat connectivity associated with riparian areas would also not be appreciable altered as limited riparian timber harvesting would occur in the project. A 100 to 350-foot variable width no harvest RMZ would be maintained along Limestone Creek and 100-foot no harvest RMZs would be retained along all other class 1 streams in the project area (200 ft. total width including both stream sides for No-name Creek, and Nichols Creek).

Across the project area, some dense patches of mature forest cover would remain, and cover would be retained to provide connectivity of mature forest cover in the project area. Dense forest cover in areas logged using the clear cut with reserve treatment would be more fragmented and additional forest edge habitat would be created, which could benefit some species such as white-tailed deer, but be detrimental to species such as marten that use dense continuous cover. Of the 2,725-acre project area, 1,811 acres (66%) would remain in mature forest cover with >40% overstory canopy closure, that would facilitate occupancy and movement of wildlife. Of these 1,811 acres, 1,678 (62% of the project area) would continue to maintain high canopy cover levels of 60% to 100% (Table W-1). Species that prefer non-forested conditions would benefit from openings in cover on 284 acres where lodgepole pine stands would be removed. Some species such as American marten (*Martes americana*) that are known to occur in the area (Gehman 2017), may be displaced from local areas intensively logged for several decades, due to cover reductions. Following logging, forest patches on the project area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions comprised of cover and foraging areas suitable for use by habitat generalist species, such as moose, elk, deer and bears. Areas where advanced regeneration of subalpine fir, spruce, and Douglas-fir are present would be retained to provide visual screening and habitat structure to facilitate use by wildlife. Overall, stand density would be reduced on 373 acres of mature forest. Mature forest stands in the project area would generally remain moderately connected via interspersed stringers of unharvested stands and riparian buffer areas, which would provide a suitable network of cover capable of facilitating movements of both wide-ranging and small terrestrial species across the local landscape. Within harvested stands, individual trees and patchy tree retention would remain, which would continue to provide some, albeit reduced amount of escape cover and visual screening.

Approximately 6.2 miles of road would be constructed and used to complete this alternative, of which 1.6 miles would be reclaimed following project completion. No new open roads would be constructed under this alternative. However, 4.6 miles of the 6.2 miles constructed for the project would be gated and retained on the landscape. Only motorized activities for administrative purposes would be allowed on these roads, which would pose minimal disturbance to local wildlife in the years following the logging disturbance. However, depending on the degree that these new closed roads might be used in the future by the public for recreation, additional displacement for a longer term (several decades) until logged stands regenerate would be possible. The actual extent that restricted roads would receive recreational use is uncertain, but would likely be proportionally less than that retained under Alternative A. Habitats in section 10 in the project area would also be minimally affected by logging or roads

and would help maintain undisturbed habitat connectivity and linkage across the broader landscape.

During operations, most large carnivores and ungulates would likely be displaced to some degree for the duration of activities (approximately 2-3 years) due to motorized disturbance and increased human activity in the area. The duration of activities would be expected to be slightly less than under Alternative A. Overall, timber harvesting associated with Alternative B would have a moderate adverse impact on species that prefer interior forest conditions and well-connected mature forest cover. Tree density in harvested patches would be reduced, which would improve habitat conditions for species that prefer young and more open forest conditions such as the olive-sided flycatcher (*Contopus cooperi*), but would reduce security and habitat quality for species that benefit from large expanses of mature forest cover, such as the marten. While birds that more exclusively use mature forest habitats would likely be adversely effected on approximately 284 acres, no adverse effects associated with habitat connectivity would be expected for any bird species, due to their high inherent degree of mobility.

The project area is situated along a forest/grassland ecotone just south of the city of Bozeman, Montana. While habitat is present on the project area that would serve as an important linkage habitat in association with the Gallatin Bridger Big Belt Wildlife Corridor, direct lines of travel to and from the identified corridor are impeded by subdivisions, human dwellings, agricultural land uses, open public road systems, and U.S. Interstate 90. Thus, the ability for habitats in the project area to serve as a functional stepping stone or unique identifiable corridor to this larger, broader landscape feature are somewhat limited. Following timber harvest, large species such as elk, deer, bears and moose would be expected to alter the way they use and move through individual forested stands in the project area, but would continue to use the project area to some degree after motorized logging disturbance has ceased. Given: 1) the sizable amounts of moderate to dense mature stands that would remain following harvest (1,811 acres with >40% canopy cover), 2) the mosaic of habitat conditions that would remain following harvest, 3) that there would be no long-term increases in motorized access associated with the project, 4) an additional uncertain level of increase in non-motorized recreation and long-term disturbance would be possible on 4.6 miles of new restricted roads, and 4) that there would be no other forms of permanent human development associated with the project, there would be low risk of appreciable adverse effects to wildlife linkage or future linkage potential in the Gallatin Bridger Big Belt Wildlife Corridor associated with this project.

- ***Direct and Indirect Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternative A and B). Under Alternative C, no trees would be removed, and no roads would be built in the project area at this time. Thus, changes in habitat conditions related to the proposed timber sale alternatives that could fragment habitat and adversely affect movement corridors and linkage for wildlife would not occur. Also, as no roads would be constructed, no additional indirect increases in human use and recreation that could disturb wildlife would be expected due to the presence of additional

roads. No direct or indirect effects to wildlife associated with habitat fragmentation, movement corridors or linkage areas would be anticipated under this alternative.

Cumulative Effects

- ***Cumulative Effects of the No-Action Alternative***

Under the No-Action Alternative no trees would be removed, and no roads would be built in the project area at this time. Thus, changes in habitat conditions that could fragment habitat and adversely affect movement corridors and linkage areas within the cumulative effects analysis area would not occur as a result of this project. Also, as no roads would be constructed, no additional indirect increases in human use and recreation that could disturb wildlife would be expected as a result of this project that would contribute to additional cumulative effects. However, as the community of Bozeman continues to grow and expand, public access and recreational use of lands and related impacts in the project area are expected to continue to increase over time. No project-related cumulative effects to wildlife associated with movement corridors or linkage areas would be anticipated under this alternative.

- ***Cumulative Effects of Action Alternative A***

Across the 33,422-acre cumulative effects analysis area considerable areas of dense, roadless mature forest conditions would remain. Of the 33,422-acre cumulative effects analysis area, 27,247 acres (82%) would remain in mature forest cover with >40% overstory canopy closure, that would facilitate occupancy and movement of wildlife (Table W-2). Of these 27,247 acres, 22,221 (67% of the cumulative effects analysis area) would continue to maintain high canopy cover levels of 60% to 100%. Species that prefer non-forested conditions would benefit from openings in cover on 371 acres where lodgepole pine stands would be removed. Some species such as American marten (*Martes americana*) that are known to occur in the area (Gehman 2017), may be displaced from local areas intensively logged for several decades, due to cover reductions. Overall, stand density would be reduced on 601 acres of mature forest in the cumulative effects analysis area. Mature forest stands in the project area would generally remain moderately connected to other large forested patches in the cumulative effects analysis area via interspersed stringers of unharvested stands and riparian buffer areas, which would provide a suitable network of cover capable of facilitating movements of both wide-ranging and small terrestrial species across the landscape.

Approximately 9.1 miles of road would be constructed and used to complete this alternative, of which 3.8 miles would be reclaimed following project completion. No new open roads would be constructed under this alternative. However, 5.3 miles of the 9.1 miles constructed for the project would be gated and retained on the landscape. This increase under Alternative A would boost restricted road amounts from 26.9 miles to 32.2 miles in the cumulative effects analysis area. This increase would translate into an overall increase in total road density in the cumulative effects analysis area of from 1.45 miles per square mile to 1.55 miles per square mile. Only motorized activities for administrative purposes would be allowed on new roads, which would pose minimal disturbance to local wildlife in the years following the logging disturbance. However, depending on the degree that these new closed roads might be used in the future by the public for recreation, additional displacement for a longer term (several

decades) until logged stands regenerate would be possible. The actual extent that restricted roads would receive recreational use is uncertain. Habitats and roadless areas within the cumulative effects analysis area would facilitate habitat connectivity and linkage across the broader landscape.

During operations, most large carnivores and ungulates would likely be displaced to some degree for the duration of activities (approximately 2-3 years) due to motorized disturbance and increased human activity in the area. Overall, timber harvesting associated with Alternative A would have minimal adverse impact on species that prefer interior forest conditions and well-connected mature forest cover at the scale of the 33,422-acre cumulative effects analysis area.

Following timber harvest under Alternative A, large species such as elk, deer, bears and moose would be expected to alter the way they use and move through individual forested stands in the project area, but would continue to use the broader landscape contained in the 33,422-acre cumulative effects analysis area similarly. Thus, adverse cumulative effects or increased cumulative risk associated with impairment of the Gallatin Bridger Big Belt Wildlife Corridor would be minimal. Given: 1) the sizable amounts of moderate to dense mature stands that would remain in the cumulative effects analysis area following harvest (27,247 acres with >40% canopy cover), 2) the mosaic of habitat conditions that would remain following harvest, 3) the relatively small area of the project area that would be affected of the cumulative effects analysis area [601 acres of 33,422 (1.8%), 4) that there would be no long-term increases in motorized access associated with the project, 5) an additional uncertain level of increase in non-motorized recreation and long-term disturbance would be possible on 5.3 miles of new restricted roads, and 6) that there would be no other forms of permanent human development associated with the project, there would be low risk of appreciable adverse cumulative effects to habitat connectivity, wildlife linkage or future linkage potential in the Gallatin Bridger Big Belt Wildlife Corridor associated with this project.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add considerably to disturbance displacement potential for wildlife species sensitive to disturbance. Following treatments, hiding and security cover could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total cumulative effects analysis area that could be affected by both projects would be 14.3% under DNRC's Action Alternative A. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would include broadcast burning, thinning and commercial harvesting and would add cumulative disturbance to the area. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

Table W-2. Acreages by alternative of sparse forest, moderately dense forest, and dense forest structural classes based on overstory forest canopy cover classes in the DNRC Limestone West Timber Sale Cumulative Effects Analysis Area (Data source USFS R-1 VMap Remote-sensing Database -- 2015).

Forest Structural Classes	No Action Alternative Acres (%)	Action Alternative A Acres Post Harvest (%)	Action Alternative B Estimated Acres Post Harvest (%)	Action Alternative C Estimated Acres Post Harvest (%)
Non-Forest/Sparse Forest (0 to 39% Canopy Cover)	5,804 (17.4%)	6,175 (18.5%)	6,088 (18.2%)	5,804 (17.4%)
Moderately Dense Forest (41 to 59% Canopy Cover)	4,796 (14.3%)	5,026 (15.0%)	4,885 (14.6%)	4,796 (14.3%)
Dense Forest (60 to 100% Canopy Cover)	22,822 (68.3%)	22,221 (66.5%)	22,449 (67.2%)	22,822 (68.3%)
Total	33,422	33,422	33,422	33,422

- ***Cumulative Effects of Action Alternative B***

Across the 33,422-acre cumulative effects analysis area considerable areas of dense, roadless mature forest conditions would remain. Of the 33,422-acre cumulative effects analysis area, 27,334 acres (82%) would remain in mature forest cover with >40% overstory canopy closure, that would facilitate occupancy and movement of wildlife (Table W-2). Of these 27,334 acres, 22,449 (67% of the project area) would continue to maintain high canopy cover levels of 60% to 100%. Species that prefer non-forested conditions would benefit from openings in cover on 284 acres where lodgepole pine stands would be removed. Some species such as American marten (*Martes americana*) that are known to occur in the area (Gehman 2017), may be displaced from local areas intensively logged for several decades, due to cover reductions. Overall, stand density would be reduced on 373 acres of mature forest in the cumulative effects analysis area. Mature forest stands in the project area would generally remain moderately connected to other large forested patches in the cumulative effects analysis area via interspersed stringers of unharvested stands and riparian buffer areas, which would provide a suitable network of cover capable of facilitating movements of both wide-ranging and small terrestrial species across the landscape.

Approximately 6.2 miles of road would be constructed and used to complete this alternative, of which 1.6 miles would be reclaimed following project completion. No new open roads would

be constructed under this alternative. However, 4.6 miles of the 6.2 miles constructed for the project would be gated and retained on the landscape. This increase under Alternative B would boost restricted road amounts from 26.9 miles to 31.5 miles in the cumulative effects analysis area. This increase would translate into an overall increase in total road density in the cumulative effects analysis area of from 1.45 miles per square mile to 1.54 miles per square mile. Only motorized activities for administrative purposes would be allowed on new roads, which would pose minimal disturbance to local wildlife in the years following the logging disturbance. However, depending on the degree that these new closed roads might be used in the future by the public for recreation, additional displacement for a longer term (several decades) until logged stands regenerate would be possible. The actual extent that restricted roads would receive recreational use is uncertain. Habitats and roadless areas within the cumulative effects analysis area would continue to facilitate habitat connectivity and linkage across the broader landscape.

During logging operations, most large carnivores and ungulates would likely be displaced to some degree for the duration of activities (approximately 2-3 years) due to motorized disturbance and increased human activity in the area. Overall, timber harvesting associated with Alternative B would have minimal adverse impact on species that prefer interior forest conditions and well-connected mature forest cover at the scale of the 33,422-acre cumulative effects analysis area.

Following timber harvest under Alternative B, large species such as elk, deer, bears and moose would be expected to alter the way they use and move through individual forested stands in the project area, but would continue to use the broader landscape contained in the 33,422-acre cumulative effects analysis area similarly. Thus, adverse cumulative effects or increased cumulative risk associated with impairment of the Gallatin Bridger Big Belt Wildlife Corridor for such species would be minimal. Given: 1) the sizable amounts of moderate to dense mature stands that would remain in the cumulative effects analysis area following harvest (27,334 acres with >40% canopy cover), 2) the mosaic of habitat conditions that would remain following harvest, 3) the relatively small area of the project area that would be affected of the cumulative effects analysis area [373 acres of 33,422 (1.1%), 4) that there would be no long-term increases in motorized access associated with the project, 5) an additional uncertain level of increase in non-motorized recreation and long-term disturbance would be possible on 4.6 miles of new permanent restricted roads, and 6) that there would be no other forms of permanent human development associated with the project, there would be low risk of appreciable adverse cumulative effects to habitat connectivity, wildlife linkage or future linkage potential in the Gallatin Bridger Big Belt Wildlife Corridor associated with this project.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add considerably to disturbance displacement potential for wildlife species sensitive to disturbance. The percentage of the total cumulative effects analysis area that could be affected by both projects wound be 13.6% under DNRC's Action Alternative B. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads

would be used to access treatment units in the BMW Project that would involve broadcast burning, thinning and commercial harvesting. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternative A and B). Under Alternative C, no trees would be removed, and no roads would be built in the project area at this time. Thus, changes in habitat conditions related to the proposed timber sale alternatives that could fragment habitat and adversely affect movement corridors and linkage for wildlife would not occur within the cumulative effects analysis area. Also, as no roads would be constructed, no additional indirect increases in human use and recreation that could disturb wildlife would be expected due to the presence of additional roads. No cumulative effects to wildlife associated with habitat fragmentation, movement corridors or linkage areas would be anticipated under this alternative.

SNAGS AND COARSE WOODY DEBRIS
ISSUE
There is concern that proposed logging would reduce snags and coarse woody debris, which could adversely affect species that depend on these habitat attributes.
MEASUREMENT CRITERIA
Visual field assessments of the abundance of snags and coarse woody debris. Evaluate estimated levels using professional judgment, considering results of 15 years of DNRC snag and coarse woody debris programmatic monitoring data to predict post-harvest retention levels and effects to wildlife. Consideration of other projects within the cumulative effects analysis area that could affect the abundance of snags and coarse woody debris at the landscape scale.
AFFECTED ENVIRONMENT
Downed logs, snags and large defective trees (eg. partially dead, spiked top, broken top etc.) are used by a wide variety of wildlife species for nesting, denning, roosting, feeding, and cover (Bull et al. 1997). The quantity, quality, and distribution of snags can affect the quality and suitability of habitat for many of these species. Snags provide foraging sites for insectivorous species and sites for nesting and roosting birds and animals. Primary excavators of nest cavities (i.e. woodpeckers) create holes and nest sites for secondary cavity users, which include many other birds and mammals. Snags and defective trees can also provide nesting sites for cavity-using species where cavities are formed by broken tops and fallen limbs. Without trees and snags that provide for cavities or substrate for cavity excavation, primary and secondary cavity species would not be able to survive and/or reproduce (Bull et al. 1997). Primary risk factors for snags and large defective trees include loss to legal and illegal firewood cutting, prescribed burning, removal for wood fiber, purposeful felling for human safety during timber harvesting operations, and incidental loss during logging due to equipment operation and yarding activities. Given various tree mortality agents, it can take at least 40 years to grow a small tree capable of becoming a small snag, whereas it typically takes 100 to several hundred years to grow large trees capable of becoming large, high quality snags.

Coarse woody debris provides structural diversity and promotes biological diversity by providing habitat for many wildlife species (Bull et al. 1997). Many small mammals require coarse woody debris to survive. In turn, these species distribute fungi that are beneficial for seedling establishment and tree growth (Graham et al. 1994). Additionally, coarse woody debris can provide feeding substrates for species such as pileated woodpeckers and black bears, as logs will often host high densities of insects (Aney and McClelland 1985). Forest carnivores such as pine marten and Canada lynx rely on coarse woody debris to provide resting and denning habitat (Patton and Escano 1990, Squires et al. 2008). Loss or removal of coarse woody debris through logging and other forest management activities can reduce habitat quality and availability for species that rely on this important habitat attribute.

Amounts of snags and coarse woody debris vary considerably across the project area and few large old trees and snags greater than 20 inches dbh occur on the project area (<1 per acre). Those that exist are primarily Douglas-fir, and some scattered spruce in cool, moist areas. Most of the forest stands on the project area are young and were established following large fires that occurred over 100 years ago (GNF 2010), which likely influenced the observed low number larger trees and snags on the landscape today. Coarse woody debris in Douglas-fir stands and mixed Douglas-fir/lodgepole pine stands is highly variable and ranges from about 3 to 40 tons per acre and averages approximately 10 tons per acre. Some localized sites have very heavy downed log concentrations with >50 tons per acre. In portions of some stands that have large quantities of beetle-infested lodgepole pine (8 to 12 inches dbh), snag amounts approach 50 per acre. Snags in old harvest units are relatively uncommon and occur at densities of 0 to 1 per acre -- the majority being less than 20 inches dbh. Coarse woody debris amounts in old logging units generally range from 1 to 5 tons per acre and the material is comprised of 3 to 10-inch diameter logs.

There are currently approximately 2,095 acres of forested stands that possess greater than 40% canopy cover in the project area that are capable of providing snag and coarse woody debris habitat attributes. There are currently 27,618 acres of similar forested stands that possess greater than 40% canopy cover in the cumulative effects analysis area.

ENVIRONMENTAL EFFECTS

- ***Direct and Indirect Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging or road construction would occur, and no short-term changes would occur in the abundance or distribution of snags or coarse woody debris in the project area. Thus, no short-term effects would be anticipated. Over time, snags and downed logs would likely increase and be well-distributed across the project area as a result of insect and disease-caused mortality and the natural attrition of live trees. Such expected increases would improve the availability of these habitat attributes over time for associated wildlife species that depend on them in the project area.

- ***Direct and Indirect Effects of Action Alternative A***

Under Action Alternative A, snags would be reduced from existing levels on the 601 acres (22%) proposed for harvest on the 2,725-acre project area due to timber felling operations and removal

of dead and dying beetle-infested trees. Additional snags may also be lost in the short term following treatments due to wind throw. Given operability and human safety concerns, existing non-merchantable snags would be left standing where possible. During harvest operations, at least 2 large snags and 2 large recruitment trees per acre (both >21 inches dbh) would be retained across the project area. In situations where snags and recruitment trees meeting this minimum size are not present, the largest available snags and trees would be retained. Available snag habitat would be reduced on all treated acres in the project area, which would be expected to reduce the local abundance of species that require snags as a life requisite in proportion to the acreage and numbers affected. However, snags and future recruitment trees would be retained in a well distributed manner across the project area, which could maintain habitat albeit for fewer individuals. Existing snag amounts would not be influenced on 1,494 acres (71%) of the 2,095 total forested acres in the project area under Alternative A.

Effects on the abundance and distribution of coarse woody debris would be variable, however, post-harvest monitoring on DNRC projects from 2001 to 2011 has indicated that ample amounts have been attained in most logging units to meet minimum recommended levels of Graham et al. (1994) (DNRC 2005, DNRC 2011). Areas with currently high concentrations of coarse woody debris (i.e., >50 tons per acre) would likely have amounts reduced due to operability needs and harvest operations. Whereas, the amounts of material in areas where down woody material is relatively sparse would likely increase following harvest (DNRC 2005, DNRC 2011). Post-harvest, coarse woody debris levels would range from 5 to 20 tons/acre and average approximately 10 tons/acre across harvest units. While some changes in the amount and distribution of woody material would occur across the project area, ample amounts would be expected to remain, which would provide for soil structure, habitat structure and feeding substrate for many species that utilize woody material to meet life requisites (Graham et al. 1994). Retained snags and snag recruitment trees would further ensure the presence of downed woody material across the project area over time.

- ***Direct and Indirect Effects of Action Alternative B***

Under Action Alternative B, snags would be reduced from existing levels on the 373 acres (14%) proposed for harvest on the 2,725-acre project area due to timber felling operations and removal of dead and dying beetle-infested trees. Additional snags may also be lost in the short term following treatments due to wind throw. Given operability and human safety concerns, existing non-merchantable snags would be left standing where possible. During harvest operations, at least 2 large snags and 2 large recruitment trees per acre (both >21 inches dbh) would be retained across the project area. In situations where snags and recruitment trees meeting this minimum size are not present, the largest available snags and trees would be retained. Available snag habitat would be reduced on all treated acres in the project area, which would be expected to reduce the local abundance of species that require snags as a life requisite in proportion to the acreage and numbers affected. However, snags and future recruitment trees would be retained in a well distributed manner across the project area, which could maintain habitat albeit for fewer individuals. Existing snag amounts would not be influenced on 1,722 acres (82%) of the 2,095 total forested acres in the project area under Alternative B.

Effects on the abundance and distribution of coarse woody debris would be variable, however, post-harvest monitoring on DNRC projects from 2001 to 2011 has indicated that ample amounts have been attained in most logging units to meet minimum recommended levels of Graham et al. (1994) (DNRC 2005, DNRC 2011). Areas with currently high concentrations of coarse woody debris (i.e., >50 tons per acre) would likely have amounts reduced due to operability needs and harvest operations. Whereas, the amounts of material in areas where down woody material is relatively sparse would likely increase following harvest (DNRC 2005, DNRC 2011). Post-harvest, coarse woody debris levels would range from 5 to 20 tons/acre and average approximately 10 tons/acre across harvest units. While some changes in the amount and distribution of woody material would occur across the project area, ample amounts would be expected to remain, which would provide for soil structure, habitat structure and feeding substrate for many species that utilize woody material to meet life requisites (Graham et al. 1994). Retained snags and snag recruitment trees would further ensure the presence of downed woody material across the project area over time.

- ***Direct and Indirect Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternative A and B). Under Alternative C, no trees, snags or coarse woody debris would be removed, and no roads would be built in the project area at this time. Thus, changes in habitat conditions related to the proposed timber sale alternatives that could affect the abundance and distribution of snags and coarse woody debris would not occur. Also, as no roads would be constructed, there would be no potential for increased risk of legal or illegal firewood cutting, which could result in losses of snags and downed logs. No direct or indirect effects to wildlife associated with reductions of snags or coarse woody debris would be anticipated under this alternative.

Cumulative Effects

- ***Cumulative Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging or road construction would occur, and no short-term changes would occur in the abundance or distribution of snags or coarse woody debris in the project area. Thus, no short-term effects would be anticipated that could contribute to cumulative reductions of snags and coarse woody debris, which could adversely affect wildlife within the cumulative effects analysis area. Over time, snags and downed logs would likely increase and be well-distributed across the project area as a result of insect and disease-caused mortality and the natural attrition of live trees. Such expected increases would improve the availability of these habitat attributes over time for associated wildlife species that depend on them in the cumulative effects analysis area.

- ***Cumulative Effects of Action Alternative A***

Under Action Alternative A, snags would be reduced from existing levels on the 601 acres (1.8%) proposed for harvest within the 33,422-acre cumulative effects analysis area due to timber felling operations and removal of dead and dying beetle-infested trees. Additional snags

may also be lost in the short term following treatments due to wind throw. Given operability and human safety concerns, existing non-merchantable snags would be left standing where possible. During harvest operations, at least 2 large snags and 2 large recruitment trees per acre (both >21 inches dbh) would be retained across the project area. In situations where snags and recruitment trees meeting this minimum size are not present, the largest available snags and trees would be retained. Available snag habitat would be reduced on all treated acres in the locality of the project area, which would be expected to reduce the local abundance of species that require snags as a life requisite in proportion to the acreage and numbers affected. However, snags and future recruitment trees would be retained in a well distributed manner across portions of the project area, and would be uninfluenced in other portions of the cumulative effects analysis area, which could maintain appreciable levels of habitat. Existing snag amounts would not be influenced on 27,017 acres (98%) of the 27,618 total forested acres in the cumulative effects analysis area under Alternative A.

Effects on the abundance and distribution of coarse woody debris would be variable, however, post-harvest monitoring on DNRC projects from 2001 to 2011 has indicated that ample amounts have been attained in most logging units to meet minimum recommended levels of Graham et al. (1994) (DNRC 2005, DNRC 2011). Areas with currently high concentrations of coarse woody debris (eg., >50 tons per acre) would likely have amounts reduced due to operability needs and harvest operations. Whereas, the amounts of material in areas where down woody material is relatively sparse would likely increase following harvest (DNRC 2005, DNRC 2011). Post-harvest, coarse woody debris levels would range from 5 to 20 tons/acre and average approximately 10 tons/acre across harvest units. While some changes in the amount and distribution of woody material would occur across the project area, ample amounts would be expected to remain, which would provide for soil structure, habitat structure and feeding substrate for many species that utilize woody material to meet life requisites (Graham et al. 1994). Retained snags and snag recruitment trees would further ensure the presence of downed woody material across the affected portions of the cumulative effects analysis area over time.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add considerably to disturbance displacement potential for wildlife species sensitive to disturbance. Following treatments, hiding cover, security cover, snags, and coarse woody debris could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total cumulative effects analysis area that could be affected by both projects would be 14.3% under DNRC's Action Alternative A. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would include broadcast burning, thinning and commercial harvesting and would add cumulative disturbance and potential risk off snag reductions in the area. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative B***

Under Action Alternative B, snags would be reduced from existing levels on the 373 acres (1.1%) proposed for harvest within the 33,422-acre cumulative effects analysis area due to timber felling operations and removal of dead and dying beetle-infested trees. Additional snags may also be lost in the short term following treatments due to wind throw. Given operability and human safety concerns, existing non-merchantable snags would be left standing where possible. During harvest operations, at least 2 large snags and 2 large recruitment trees per acre (both >21 inches dbh) would be retained across the project area. In situations where snags and recruitment trees meeting this minimum size are not present, the largest available snags and trees would be retained. Available snag habitat would be reduced on all treated acres in the locality of the project area, which would be expected to reduce the local abundance of species that require snags as a life requisite in proportion to the acreage and numbers affected. However, snags and future recruitment trees would be retained in a well distributed manner across portions of the project area, and would be uninfluenced in other portions of the cumulative effects analysis area, which could maintain appreciable levels of habitat. Existing snag amounts would not be influenced on 27,245 acres (99%) of the 27,618 total forested acres in the cumulative effects analysis area under Alternative B.

Effects on the abundance and distribution of coarse woody debris would be variable, however, post-harvest monitoring on DNRC projects from 2001 to 2011 has indicated that ample amounts have been attained in most logging units to meet minimum recommended levels of Graham et al. (1994) (DNRC 2005, DNRC 2011). Areas with currently high concentrations of coarse woody debris (eg., >50 tons per acre) would likely have amounts reduced due to operability needs and harvest operations. Whereas, the amounts of material in areas where down woody material is relatively sparse would likely increase following harvest (DNRC 2005, DNRC 2011). Post-harvest, coarse woody debris levels would range from 5 to 20 tons/acre and average approximately 10 tons/acre across harvest units. While some changes in the amount and distribution of woody material would occur across the project area, ample amounts would be expected to remain, which would provide for soil structure, habitat structure and feeding substrate for many species that utilize woody material to meet life requisites (Graham et al. 1994). Retained snags and snag recruitment trees would further ensure the presence of downed woody material across the affected portions of the cumulative effects analysis area over time.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add considerably to disturbance displacement potential for wildlife species sensitive to disturbance. Following treatments, hiding cover, security cover, coarse woody debris, and snags could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total cumulative effects analysis area that could be affected by both projects wound be 13.6% under DNRC's Action Alternative B. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would involve broadcast burning, thinning and commercial harvesting. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternative A and B). Under Alternative C, no trees, snags or coarse woody debris would be removed, and no roads would be built in the project area at this time. Thus, changes in habitat conditions related to the proposed timber sale alternatives that could affect the abundance and distribution of snags and coarse woody debris would not occur. Also, as no roads would be constructed, there would be no potential for increased risk of legal or illegal firewood cutting, which could result in losses of snags and downed logs. No direct or indirect effects to wildlife associated with reductions of snags or coarse woody debris would be anticipated under this alternative.

SPECIES DIVERSITY

ISSUE

There is concern that alteration of vegetation, disturbance caused by logging could reduce the abundance and diversity of birds and other wildlife species.

MEASUREMENT CRITERIA

Consideration of the duration of proposed activities, timing of proposed activities, location of proposed activities, scale of activities, quantified cover amounts, quantified road amounts, stand level inventory summaries of stand age classes and cover types, visual field assessments, landscape cover assessment using USFS R-1 VMap Remote-sensing Database (USFS 2015) the Montana Natural Heritage Program Land Cover Summary (2018), and visual assessments of aerial photography for visual evaluation of cover and topography.

AFFECTED ENVIRONMENT

The proposed project area and cumulative effects analysis area contain forested and non-forested habitats characteristic of southwest Montana. The Gallatin Range is located north of Yellowstone National Park and it is known for its rich diversity of habitats and wildlife (Gehman 2010). Notable habitats include diverse forest communities dominated by Douglas-fir, aspen, and lodgepole pine, and non-forested communities consisting of agricultural lands, riparian wetlands, sagebrush steppe, lower foothill grasslands, and subalpine mesic meadows (MNHP 2018). Numerous wildlife species have been detected on or near the project area (Gehman 2017).

Fire has historically played an important role in shaping vegetation community types in the Bear Canyon area (Gruell 1983). Habitat types (Pfister et al. 1977) characteristic of the project area are consistent with those found in Fire Groups 5 (cool, dry Douglas-fir), 6 (moist Douglas-fir dominated), 7 (lodgepole pine dominated), and 8 (dry subalpine fir dominated) (Fischer and Clayton 1983). Mean fire intervals in forest types dominated by Douglas-fir have been estimated to average around 40 years, whereas types dominated by lodgepole pine and subalpine fir can vary from 50 years to well over 100 years (Fischer and Clayton 1983). Since the

turn of the century, conifer encroachment has made dramatic advances across previously non-forested openings in the Bozeman Pass area (Gruell 1983).

Timber harvesting can affect habitat conditions in various ways (Harris 1984). Tree removal can alter cover and simplify structural diversity of habitats important for some species of wildlife such as Canada lynx (ILBT 2013). Roads that are often constructed in conjunction with timber harvesting can also adversely affect security for some species of wildlife for a number of years after their creation (Mace et al. 1996, Lyon et al. 1985). Cover reductions can influence solar radiation and snow accumulation and indirectly increase energetic costs for some species, such as white-tailed deer (Moen 1976). Ground disturbance associated with logging can also increase the abundance and spread of noxious weeds which can reduce forage quality and availability for some native species, such as elk (Thompson 1996). In addition to the physical changes logging can create, mechanized disturbance and the increased presence of humans during the activity can temporarily displace wildlife (McLellan and Shackleton 1988). Conversely, timber harvesting can reduce the influences of forest encroachment into native grassland communities and improve the abundance and distribution of herbaceous and shrub forage (Severson et al. 2017). When properly applied, timber harvesting can be used to improve the representation of different cover types and increase forest age class diversity, tree density and structural diversity of habitat patches (Harris 1984, Kohm and Franklin 1997, DeStefano and Haight 2002). Selective tree removal, treatments that reduce abundant ladder fuels, and thinnings can also be applied to promote sustainability and the growth of large trees (Arno et al. 1995).

In the project area habitats are comprised of 54% Douglas-fir forest, 12% aspen forest, 10% lodgepole pine forest, 5% sagebrush steppe, 4% subalpine mesic meadow, 4% deciduous shrubland, 3% lower foothill riparian hardwood/shrub, 3% subalpine-spruce forest (MNHP 2018). Similarly, types in the cumulative effects analysis area consist of approximately 43% Douglas-fir forest, 11% aspen forest, 8% lodgepole pine forest, 7% agricultural pasture, 5% lower foothill riparian hardwood/shrub, 4% sagebrush steppe, 4% foothill grasslands, 3% subalpine mesic meadow, 3% deciduous shrubs, 3% cultivated crops, and 3% subalpine-spruce forest (MNHP 2018).

ENVIRONMENTAL EFFECTS

- ***Direct and Indirect Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur. Thus, no appreciable short-term changes to habitat conditions or disturbance that may adversely affect the abundance or diversity of birds and other wildlife species would be expected as a result of this project. Also, as no roads would be constructed, no additional indirect increases in human use and recreation that could disturb wildlife would be expected as a result of this project. However, as the community of Bozeman continues to grow and expand, public access and recreational use of lands and related impacts in the project area are expected to continue to increase over time. Direct and indirect effects to birds and other wildlife species

that occupy lands within the project area that would be attributable to vegetation alteration and logging disturbance associated with this project would not be anticipated.

- ***Direct and Indirect Effects of Action Alternative A***

Under Action Alternative A, habitat associated with riparian areas would not be appreciable altered as limited riparian timber harvesting would occur in the project. A 100 to 350-foot variable width no harvest RMZ would be maintained along Limestone Creek and 100-foot no harvest RMZs would be retained along all other class 1 streams in the project area (200 ft. total width including both stream sides for No-name Creek, and Nichols Creek). These areas would continue to provide usable habitat for numerous riparian-associated terrestrial, aquatic and avian species.

Across the project area, dense patches of mature forest cover with >40% overstory canopy closure would remain on 1,724 acres (63%) of the 2,725-acre project area (Table W-1). Such patches would continue to provide hiding cover, foraging areas and potential nesting sites for many species. Of these 1,724 acres, 1,450 (53% of the project area) would continue to maintain high canopy cover levels of 60% to 100%, which would be capable of providing greater levels of security and winter cover. Moderately stocked forest stands that are more open and patchy would increase following logging on 230 acres, which would create additional structural and patch diversity. Conditions that would be created post-harvest would be within the range that would have been expected under historical conditions.

Species that prefer non-forested conditions would benefit from openings in cover on 371 acres where lodgepole pine stands would be removed. Some species such as American marten that are known to occur in the area (Gehman 2017), may be displaced from local areas intensively logged for several decades, due to cover reductions. Following logging, forest patches on the project area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions comprised of cover and foraging areas suitable for use by habitat generalist species, such as moose, elk, deer and bears. Forest age class diversity and patch diversity would increase as young age classes would be created across the 371 clear-cut acres over the next 2 to 4 decades which can be beneficial for species such as snowshoe hares, lynx, and olive-sided flycatchers. Young stands and open mature forest stands can also provide desirable foraging habitat conditions for species such as the northern goshawk (*Accipiter gentilis*). Areas where advanced regeneration of subalpine fir, spruce, and Douglas-fir are present would be retained to provide visual screening and habitat structure to facilitate use by wildlife. Approximately 2 to 3 slash piles >10 feet in diameter would also be retained within each harvest unit to provide denning sites and cover for small mammals (J. Cunningham, DFWP Biologist, pers. comm. 9/21/2016). Overall, stand density and mature forest cover would be reduced on 601 acres of mature forest. Mature forest stands in the project area would generally remain moderately connected via interspersed stringers of unharvested stands and riparian buffer areas, which would provide a suitable network of cover capable of providing habitat for both wide-ranging and small terrestrial species found in the local landscape. Within harvested stands, individual trees and patchy tree retention would remain, which would

continue to provide some, albeit reduced amount of escape cover, nesting and roosting sites, and visual screening cover for wildlife.

Approximately 9.1 miles of road would be constructed and used to complete this alternative, of which 3.8 miles would be reclaimed following project completion. No new open roads would be constructed under this alternative. However, 5.3 miles of the 9.1 miles constructed for the project would be gated and retained on the landscape. Only motorized activities for administrative purposes would be allowed on these roads, which would pose minimal disturbance to local wildlife in the years following the logging disturbance. However, depending on the degree that these new closed roads might be used in the future by the public for recreation, additional displacement for a longer term (several decades) until logged stands regenerate would be possible. The actual extent that restricted roads would receive recreational use is uncertain. Habitats in section 10 in the project area would be minimally affected by logging or roads and would help maintain undisturbed habitat across the broader landscape.

During operations, most large carnivores and ungulates would likely be displaced to some degree for the duration of activities (approximately 2-3 years) due to motorized disturbance and increased human activity in the area, which could temporarily lower the abundance of some species that might otherwise use habitats within the project area. However, the diversity of wildlife (i.e., the number of individual species observed in the project area) would be minimally affected. Overall, timber harvesting associated with Alternative A would have a moderate adverse impact on species that prefer interior forest conditions and well-connected mature forest cover. Tree density in harvested patches would be reduced, which would improve habitat conditions for species that prefer young and more open forest conditions such as the olive-sided flycatcher, but would reduce security and habitat quality for species that benefit from large expanses of mature forest cover, such as the marten. While birds that more exclusively use mature forest habitats would likely be adversely affected on approximately 371 acres, bird species that prefer open forest or grassland conditions such as the vesper sparrow (*Pooecetes gramineus*) would benefit.

Given: 1) the sizable amounts of moderate to dense mature stands that would remain following harvest (1,724 acres with >40% canopy cover), 2) the mosaic of habitat conditions that would remain following harvest, 3) that there would be no long-term increases in motorized access associated with the project, 4) an additional uncertain level of increase in non-motorized recreation and long-term disturbance would be possible on 5.3 miles of new restricted roads, 5) cover associated with riparian habitats would be retained, 6) and forest age class and structural diversity would be increased over the next several decades -- we would expect the abundance of species sensitive to humans and forest cover reduction to decrease, while species less sensitive to human activity and those that prefer forest openings and more park-like stand conditions to increase. These changes, however, would be expected to occur on a scale of approximately 1 to 2 square miles. Minimal change in the observed diversity of wildlife would be expected in the project area following the completion of harvest activities.

- ***Direct and Indirect Effects of Action Alternative B***

Under Action Alternative B, habitat associated with riparian areas would also not be appreciable altered as limited riparian timber harvesting would occur in the project. A 100 to 350-foot variable width no harvest RMZ would be maintained along Limestone Creek and 100-foot no harvest RMZs would be retained along all other class 1 streams in the project area (200 ft. total width including both stream sides for No-name Creek, and Nichols Creek). These areas would continue to provide usable habitat for numerous riparian-associated terrestrial, aquatic and avian species.

Across the project area, dense patches of mature forest cover with >40% overstory canopy closure would remain on 1,811 acres (66%) of the 2,725-acre project area (Table W-1). Such patches would continue to provide hiding cover, foraging areas and potential nesting sites for many species. Of these 1,724 acres, 1,678 (62% of the project area) would continue to maintain high canopy cover levels of 60% to 100%, which would be capable of providing greater levels of security and winter cover. Moderately stocked forest stands that are more open and patchy would increase following logging on 89 acres, which would create additional structural and patch diversity. Conditions that would be created post-harvest would be within the range that would have been expected under historical conditions.

Species that prefer non-forested conditions would benefit from openings in cover on 284 acres where lodgepole pine stands would be removed. Some species such as American marten that are known to occur in the area (Gehman 2017), may be displaced from local areas intensively logged for several decades, due to cover reductions. Following logging, forest patches on the project area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions comprised of cover and foraging areas suitable for use by habitat generalist species, such as moose, elk, deer and bears. Forest age class diversity and patch diversity would increase as young age classes would be created across the 284 clear-cut acres over the next 2 to 4 decades which can be beneficial for species such as snowshoe hares, lynx, and olive-sided flycatchers. Young stands and open mature forest stands can also provide desirable foraging habitat conditions for species such as the northern goshawk. Areas where advanced regeneration of subalpine fir, spruce, and Douglas-fir are present would be retained to provide visual screening and habitat structure to facilitate use by wildlife. Approximately 2 to 3 slash piles >10 feet in diameter would also be retained within each harvest unit to provide denning sites and cover for small mammals (J. Cunningham, DFWP Biologist, pers. comm. 9/21/2016). Overall, stand density and mature forest cover would be reduced on 373 acres of mature forest. Mature forest stands in the project area would generally remain moderately connected via interspersed stringers of unharvested stands and riparian buffer areas, which would provide a suitable network of cover capable of providing habitat for both wide-ranging and small terrestrial species found in the local landscape. Within harvested stands, individual trees and patchy tree retention would remain, which would continue to provide some, albeit reduced amount of escape cover, nesting and roosting sites, and visual screening cover for wildlife.

Approximately 6.2 miles of road would be constructed and used to complete this alternative, of which 1.6 miles would be reclaimed following project completion. No new open roads would be constructed under this alternative. However, 4.6 miles of the 6.2 miles constructed for the project would be gated and retained on the landscape. Only motorized activities for

administrative purposes would be allowed on these roads, which would pose minimal disturbance to local wildlife in the years following the logging disturbance. However, depending on the degree that these new closed roads might be used in the future by the public for recreation, additional displacement for a longer term (several decades) until logged stands regenerate would be possible. The actual extent that restricted roads would receive recreational use is uncertain. Habitats in section 10 in the project area would be minimally affected by logging or roads and would help maintain undisturbed habitat across the broader landscape.

During operations, most large carnivores and ungulates would likely be displaced to some degree for the duration of activities (approximately 2-3 years) due to motorized disturbance and increased human activity in the area, which could temporarily lower the abundance of some species that might otherwise use habitats within the project area. However, the diversity of wildlife (i.e., the number of individual species observed in the project area) would be minimally affected. Overall, timber harvesting associated with Alternative B would have a moderate adverse impact on species that prefer interior forest conditions and well-connected mature forest cover. Tree density in harvested patches would be reduced, which would improve habitat conditions for species that prefer young and more open forest conditions such as the olive-sided flycatcher, but would reduce security and habitat quality for species that benefit from large expanses of mature forest cover, such as the American marten. While birds that more exclusively use mature-forest habitats would likely be adversely affected on approximately 284 acres, bird species that prefer open forest or grassland conditions such as the vesper sparrow would benefit slightly.

Given: 1) the sizable amounts of moderate to dense mature stands that would remain following harvest (1,811 acres with >40% canopy cover), 2) the mosaic of habitat conditions that would remain following harvest, 3) that there would be no long-term increases in motorized access associated with the project, 4) an additional uncertain level of increase in non-motorized recreation and long-term disturbance would be possible on 4.6 miles of new restricted roads, 5) cover associated with riparian habitats would be retained, 6) and forest age class and structural diversity would be increased over the next several decades -- we would expect the abundance of species sensitive to humans and forest cover reduction to decrease, while species less sensitive to human activity and those that prefer forest openings and more park-like stand conditions to increase. These changes, however, would be expected to occur on a scale of approximately 1 to 2 square miles. Minimal change in the observed diversity of wildlife would be expected in the project area following the completion of harvest activities.

- ***Direct and Indirect Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternative A and B). Under Alternative C, no trees would be removed, and no roads would be built in the project area at this time. Thus, mechanical disturbance and changes in structural habitat conditions related to the proposed timber sale alternatives that could adversely affect the abundance or diversity of birds and other wildlife species would not occur. Also, as no roads would be constructed, no additional

indirect increases in human use and recreation that could disturb wildlife would be expected due to the presence of additional roads. No direct or indirect effects that could decrease the abundance or diversity of wildlife in the project area would be anticipated under this alternative.

Cumulative Effects

- ***Cumulative Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur. Thus, no appreciable short-term changes to habitat conditions or disturbance that may adversely affect the abundance or diversity of birds and other wildlife species would be expected as a result of this project within the cumulative effects analysis area. Also, as no roads would be constructed, no additional indirect increases in human use and recreation that could disturb wildlife would be expected as a result of this project. However, as the community of Bozeman continues to grow and expand, public access and recreational use of lands and related impacts in the project area are expected to continue to increase over time. Cumulative effects to birds and other wildlife species that occupy lands within the cumulative effects analysis area that would be attributable to vegetation alteration and logging disturbance associated with this project would not be anticipated.

- ***Cumulative Effects of Action Alternative A***

Under Action Alternative A, habitat associated with riparian areas would not be appreciable altered as limited riparian timber harvesting would occur in the project. A 100 to 350-foot variable width no harvest RMZ would be maintained along Limestone Creek and 100-foot no harvest RMZs would be retained along all other class 1 streams in the project area (200 ft. total width including both stream sides for No-name Creek, and Nichols Creek). These areas would continue to provide usable habitat for numerous riparian-associated terrestrial, aquatic and avian species.

Overall, stand density and mature forest cover would be reduced on 601 acres of mature forest in the cumulative effects analysis area. Across the 33,422-acre cumulative effects analysis area, patches of mature forest cover with >40% overstory canopy closure would remain on 27,247 acres (82%) (Table W-2). Such patches would continue to provide hiding cover, foraging areas and potential nesting sites for many species. Of these 27,247 acres, 22,221 (67% of the cumulative effects analysis area) would continue to maintain high canopy cover levels of 60% to 100%, which would be capable of providing greater levels of security and winter cover. Moderately stocked forest stands that are more open and patchy would increase following logging on 230 acres, which would create additional structural and patch diversity. Conditions that would be created post-harvest would be within the range that would have been expected under historical conditions.

Approximately 9.1 miles of road would be constructed and used to complete this alternative, of which 3.8 miles would be reclaimed following project completion. No new open roads would be constructed under this alternative. However, 5.3 miles of the 9.1 miles constructed for the

project would be gated and retained on the landscape. This increase under Alternative A would boost restricted road amounts from 26.9 existing miles to 32.2 miles post project in the cumulative effects analysis area. This increase would translate into an overall increase in total road density in the cumulative effects analysis area of from 1.45 miles per square mile to 1.55 miles per square mile. Only motorized activities for administrative purposes would be allowed on the new roads, which would pose minimal disturbance to local wildlife in the years following the logging disturbance. However, depending on the degree that these new closed roads might be used in the future by the public for recreation, additional displacement for a longer term (several decades) until logged stands regenerate would be possible. The actual extent that restricted roads would receive recreational use is uncertain. Habitats and roadless areas within the cumulative effects analysis area would continue to facilitate habitat connectivity and linkage across the broader landscape.

During harvest operations, most large carnivores and ungulates would likely be displaced to some degree for the duration of activities (approximately 2-3 years) due to motorized disturbance and increased human activity in the project area. However, the effect of this displacement at the scale of the 33,422-acre cumulative effects analysis area would be minimal. The diversity of wildlife (i.e., the number of individual species observed in the cumulative effects analysis area) would be minimally affected. Overall, timber harvesting associated with Alternative A would have a minor adverse impact on species that prefer interior forest conditions and well-connected mature forest cover at the scale of the cumulative effects analysis area. Tree density in harvested patches would be reduced locally in the project area, which would improve habitat conditions for species that prefer young and more open forest conditions such as the olive-sided flycatcher, but would reduce security and habitat quality for species that benefit from large expanses of mature forest cover, such as the American marten. At the scale of the cumulative effects analysis area, the expected effects would be minimal.

Given: 1) the sizable amounts of moderate to dense mature stands that would remain following harvest (27,247 acres with >40% canopy cover), 2) the mosaic of habitat conditions that would remain following harvest, 3) the relatively small portion of the project area that would be affected of the cumulative effects analysis area [601 acres of 33,422 (1.8%)], 4) that there would be no long-term increases in motorized access associated with the project, 5) an additional uncertain level of increase in non-motorized recreation and long-term disturbance would be possible on 5.3 miles of new restricted roads, 6) cover associated with riparian habitats would be retained, 7) and forest age class and structural diversity in minor amounts at the cumulative effects scale would be increased over the next several decades -- we would expect the abundance of species sensitive to humans and forest cover reduction to decrease, while species less sensitive to human activity and those that prefer forest openings and more park-like stand conditions to increase. These changes, however, would be expected to occur on a scale of approximately 1 to 2 square miles. Minimal change in the observed abundance or diversity of wildlife would be expected in the cumulative effects analysis area following the completion of harvest activities.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add considerably to disturbance displacement potential for wildlife species sensitive to disturbance. Following treatments, hiding and security cover could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total cumulative effects analysis area that could be affected by both projects would be 14.3% under DNRC's Action Alternative A. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would include broadcast burning, thinning and commercial harvesting and would add cumulative disturbance to the area. Habitat patch diversity could be enhanced by both commercial and non-commercial treatments associated with the BMW Project. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative B***

Under Action Alternative B, habitat associated with riparian areas would not be appreciable altered as limited riparian timber harvesting would occur in the project. A 100 to 350-foot variable width no harvest RMZ would be maintained along Limestone Creek and 100-foot no harvest RMZs would be retained along all other class 1 streams in the project area (200 ft. total width including both stream sides for No-name Creek, and Nichols Creek). These areas would continue to provide usable habitat for numerous riparian-associated terrestrial, aquatic and avian species.

Overall, stand density and mature forest cover would be reduced on 373 acres of mature forest in the cumulative effects analysis area. Across the 33,422-acre cumulative effects analysis area, patches of mature forest cover with >40% overstory canopy closure would remain on 27,334 acres (82%) (Table W-2). Such patches would continue to provide hiding cover, foraging areas and potential nesting sites for many species. Of these 27,334 acres, 22,449 (67% of the cumulative effects analysis area) would continue to maintain high canopy cover levels of 60% to 100%, which would be capable of providing greater levels of security and winter cover. Moderately stocked forest stands that are more open and patchy would increase following logging on 89 acres, which would create additional structural and patch diversity. Conditions that would be created post-harvest would be within the range that would have been expected under historical conditions.

Approximately 6.2 miles of road would be constructed and used to complete this alternative, of which 1.6 miles would be reclaimed following project completion. No new open roads would be constructed under this alternative. However, 4.6 miles of the 6.2 miles constructed for the project would be gated and retained on the landscape. This increase under Alternative B would boost restricted road amounts from 26.9 existing miles to 31.5 miles post project in the cumulative effects analysis area. This increase would translate into an overall increase in total

road density in the cumulative effects analysis area of from 1.45 miles per square mile to 1.54 miles per square mile. Only motorized activities for administrative purposes would be allowed on the new roads, which would pose minimal disturbance to local wildlife in the years following the logging disturbance. However, depending on the degree that these new closed roads might be used in the future by the public for recreation, additional displacement for a longer term (several decades) until logged stands regenerate would be possible. The actual extent that restricted roads would receive recreational use is uncertain. Habitats and roadless areas within the cumulative effects analysis area would continue to facilitate habitat connectivity and linkage across the broader landscape.

During harvest operations, most large carnivores and ungulates would likely be displaced to some degree for the duration of activities (approximately 2-3 years) due to motorized disturbance and increased human activity in the project area. However, the effect of this displacement at the scale of the 33,422-acre cumulative effects analysis area would be minimal. The diversity of wildlife (i.e., the number of individual species observed in the cumulative effects analysis area) would be minimally affected. Overall, timber harvesting associated with Alternative B would have a minor adverse impact on species that prefer interior forest conditions and well-connected mature forest cover at the scale of the cumulative effects analysis area. Tree density in harvested patches would be reduced locally in the project area, which would improve habitat conditions for species that prefer young and more open forest conditions such as the olive-sided flycatcher, but would reduce security and habitat quality for species that benefit from large expanses of mature forest cover, such as the American marten. At the scale of the cumulative effects analysis area, the expected effects would be minimal.

Given: 1) the sizable amounts of moderate to dense mature stands that would remain following harvest (27,334 acres with >40% canopy cover), 2) the mosaic of habitat conditions that would remain following harvest, 3) the relatively small portion of the project area that would be affected of the cumulative effects analysis area [373 acres of 33,422 (1.1%)], 4) that there would be no long-term increases in motorized access associated with the project, 5) an additional uncertain level of increase in non-motorized recreation and long-term disturbance would be possible on 5.3 miles of new restricted roads, 6) cover associated with riparian habitats would be retained, 7) and forest age class and structural diversity in minor amounts at the cumulative effects scale would be increased over the next several decades -- we would expect the abundance of species sensitive to humans and forest cover reduction to decrease, while species less sensitive to human activity and those that prefer forest openings and more park-like stand conditions to increase. These changes, however, would be expected to occur on a scale of approximately 1 to 2 square miles. Minimal change in the observed abundance or diversity of wildlife would be expected in the cumulative effects analysis area following the completion of harvest activities.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects

analysis area, which could add considerably to disturbance displacement potential for wildlife species sensitive to disturbance. Following treatments, hiding and security cover could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total cumulative effects analysis area that could be affected by both projects wound be 13.6% under DNRC's Action Alternative B. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would involve broadcast burning, thinning and commercial harvesting. Habitat patch diversity could be enhanced in the cumulative effects analysis area by both commercial and non-commercial treatments as proposed. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternative A and B). Under Alternative C, no trees would be removed, and no roads would be built in the cumulative effects analysis area at this time. Thus, mechanical disturbance and changes in structural habitat conditions related to the proposed timber sale alternatives that could adversely affect the abundance or diversity of birds and other wildlife species would not occur. Also, as no roads would be constructed, no additional indirect increases in human use and recreation that could disturb wildlife would be expected due to the presence of additional roads. No cumulative effects that could decrease the abundance or diversity of wildlife in the project area would be anticipated under this alternative.

RECREATIONAL USE
ISSUE
There is concern that the road system established for this project would appreciably increase recreational use of the project area, which could disturb and displace wildlife and affect their ability to move through the area.

MEASUREMENT CRITERIA
Road amounts by open and restricted classes within the project area and cumulative effects analysis area. Duration of proposed activities. Assessment of potential increases in recreational use routes and 0.31 mile road disturbance buffers. Roads were buffered by 0.31 miles (IGBC 1998) to estimate how much habitat effectiveness may be affected by human disturbance on roads along adjacent areas.

AFFECTED ENVIRONMENT
The state trust lands in the Limestone West Project Area are located about 3 miles southeast of Bozeman. Due to their location, these lands provide a convenient and popular access to outdoor recreational opportunities. Public access to these lands is located at parking areas off Sourdough Road and Mount Ellis Lane.

Recreational use is facilitated by trailheads, maintained trails, illegal trails pioneered by users, parking areas, and existing infrastructure developed for previous land management projects such as roads. There are approximately 16 miles of trails in addition to existing restricted roads on the approximately 5,760 acres of DNRC lands west of Bear Canyon. The recreational activities generally associated with these lands and the project area include hiking, skiing, running, birding, mountain biking, horseback riding, hunting, and rock climbing. Motorized use in not allowed as a recreational activity by the public on these state trust lands.

Recreational use of the road system is present throughout the year, but uses differ seasonally. During winter and early spring, the road system provides a base for cross-country skiing and snowshoeing. Spring breakup typically has the least use due to the wet and muddy conditions, but still supports occasional hikers. The area receives the greatest and most diverse use during late spring and summer and activities include hiking, mountain biking, wildlife viewing, running, horseback riding, dog walking, and wildflower viewing. In the fall the primary use transitions to hunting, however, other summer uses are still present to a lesser degree.

The presence and human use of roads on the landscape can have a number of different effects on wildlife. The type and severity of effect can depend on a several variables, such as the species of concern, the season, level of road use, type of road use, habitat availability and quality on the surrounding landscape (Canfield et al. 1999). Increasing human access into high quality habitat with relatively high animal densities can result in greater potential for human-wildlife conflicts (eg. bear attacks, unnatural food conflicts, conflicts with pets etc.) For this analysis we considered the potential effects of forest roads receiving non-motorized uses throughout the year on mobile terrestrial wildlife species that can be moderately to highly sensitive to human disturbance associated with roads (eg. elk, grizzly bear, black bear, and moose).

Currently there are approximately 4.3 miles of restricted roads within the 2,725-acre project area. These roads are used for recreation throughout the project area and facilitate access to lands elsewhere in the cumulative effects analysis area. Habitat security is currently affected by these roads on approximately 880 acres in the northmost portion of the project area (32.3% of the project area affected).

Within the 33,422-acre cumulative effects analysis area there are approximately 75.6 total miles of roads (48.7 miles open and 26.9 miles restricted), most of which area outside of DNRC ownership. These roads are used for recreation throughout the project area and to access lands located in the cumulative effects analysis area. Habitat security is currently affected by these roads on approximately 13,425 acres in the cumulative effects analysis area (40.2% of cumulative effects analysis area affected).

ENVIRONMENTAL EFFECTS

- ***Direct and Indirect Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur. Thus, no changes to habitat conditions, increases in road amounts or related disturbance that could displace wildlife or affect their ability to move through the landscape would be expected as a result of this project. However, recreational pressure on the State lands has increased over the past 30 years concurrent with the population increases in Bozeman and the Gallatin Valley. Increases in recreational use have been observed on DNRC lands through increased trail pioneering and use of the trails. As the local communities continue to grow and expand, recreational activities would be expected to continue to increase and could disturb wildlife, fragment habitat and adversely affect movement corridors and linkage areas. Direct and indirect project-related effects to wildlife species that occupy lands within the project area that would be attributable to increases in new roads and subsequent increases in project-related recreational use would not be anticipated.

- ***Direct and Indirect Effects of Action Alternative A***

Under Action Alternative A, total road amounts would increase from 4.3 miles to 9.6 miles in the project area, which could cause a proportional increase in disturbance and displacement of wildlife that use the 2,725-acre project area. When applying a disturbance buffer of 0.31 miles to the existing and new road segments that would be constructed and retained, approximately 1,980 acres of secure area (72.7% of the 2,725-acre project area) would be affected in the project area, resulting in greater disturbance potential for species such as elk, moose and bears.

Displacement of some species could occur for several decades depending on how much recreational use the area receives (user days), and the types of recreation. Both of these are somewhat uncertain into the future. Disturbance associated with walking an active barking dog as an example may be greater for many species than single hikers walking quietly. Disturbance and displacement caused by new roads would also be expected to vary by species of concern and season. For example, many user days of cross country skiing traffic in winter could displace elk and moose at important wintering sites. Whereas, most overwintering birds using the area would likely be affected little by such activity. Some new road segments would also likely receive greater recreational use, such as the long, proposed road segment which somewhat bisects sections 4 and 9. This 1.8-mile road segment runs along the ridge between No-name Creek and Nichols Creek in the project area and would likely have the greatest potential to introduce additional long-term disturbance and displacement of wildlife associated with future levels of recreational use during all seasons. Given that this road segment is long and extends into a scenic area, it may become its own destination route. Future users could also use that segment to access ridgetops at higher elevations in the upper reaches of Nichols, No Name and Limestone creeks. The short 0.7-mile segment of permanent restricted road proposed under Action Alternative A in the southwest ¼ of section 4 could facilitate additional access from the Triple Tree Trail. This new short road segment could indirectly and effectively "link" public users of the Triple Tree Trail with all of the other roads and trails in the project area. This could potentially increase the level of public use on the project area considerably, when compared with the existing condition. The degree that use would actually increase is uncertain. The new permanent restricted road system under Action Alternative A would

generally allow easier and greater levels of access to popular routes and destinations in the project area from both the east and west utilizing existing roads, new roads and the network of unauthorized trails than that which would be expected under Action Alternative B.

Trees would be expected to regenerate over the next 2 to 4 decades in treated harvest units and they would begin to provide cover and greater security, which would lessen disturbance and displacement impacts to wildlife associated with the created roads. Should displacement occur, individuals displaced would most likely travel back onto other forested lands in the southeast and southwest portions of the project area due to the presence of cover and greater topographic relief there, versus moving into the populated, flat, open valley bottoms near Bozeman. Some use of non-forested valley bottom lands by species such as elk, deer and bears occurs and is expected, particularly at night, given the availability of high quality foods that can be found there on private agricultural lands.

Displacement might cause elk, bears and moose to leave preferred feeding areas in spring, and winter, potentially affecting some individual animals. Nighttime use of the project area and sites within buffers near roads would be likely be influenced very little by the presence of the new roads. The presence of the new roads and associated use on the roads would be expected to minimally influence the ability of most wildlife species to move across the project area, particularly for species that may travel and forage at night. Disturbance and displacement effects would primarily be localized and in association with the parcels contained in the project area. Some habituation of wildlife to human use on the new road systems could occur, which could slightly ameliorate displacement effects, although the degree that this would occur is uncertain. Habituation in association with attractants and grizzly bears can result in adverse consequences for both humans and bears. The potential for this type of habituation would be expected to remain low.

Given that: 1) total road amounts would increase from 4.3 miles to 9.6 miles in the project area; 2) these roads could facilitate increases in recreation and affect security on approximately 1,980 acres (72.7% of the 2,725-acre project area); 3) road effects would occur in addition to similar effects associated with cover removal on 601 acres; 4) new roads are likely to be used by the public and recreational use is likely to increase; 5) disturbance and displacement of wildlife could be expected for several decades; 6) conifer regeneration in 2 to 4 decades would likely ameliorate some of the displacement effects; 7) the routes selected by users and intensity of recreation into the future are uncertain; 8) disturbance and displacement effects are expected to primarily be confined to the lands within the project area, however some displacement could occur onto National Forest lands neighboring the project area; 9) nighttime use of the project area by wildlife is expected to be minimally affected; and 10) impeded travel by wildlife across or through affected lands in the project area would not be expected – particularly for species that travel and forage at night – we anticipate activities under Action Alternative A would result in a moderate to high level of displacement potential due the increase in new permanent, restricted roads and associated indirect increases in recreational uses during all seasons.

- ***Direct and Indirect Effects of Action Alternative B***

Under Action Alternative B, total road amounts would increase from 4.3 miles to 8.9 miles in the project area, which could cause a proportional increase in disturbance and displacement of wildlife that use the 2,725-acre project area. When applying a disturbance buffer of 0.31 miles to the existing and new road segments that would be constructed and retained, approximately 1,803 acres of secure area (66.2% of the 2,725-acre project area) would be affected, resulting in greater disturbance potential for species such as elk, moose and bears.

Displacement of some species could occur for several decades depending on how much recreational use the area receives (user days), and the types of recreation. Both of these are somewhat uncertain into the future. Disturbance associated with walking an active barking dog as an example may be greater for many species than single hikers walking quietly. Disturbance and displacement caused by new roads would also be expected to vary by species of concern and season. For example, many user days of cross country skiing traffic in winter could displace elk and moose at important wintering sites. Whereas, most overwintering birds using the area would likely be affected little by such activity. Some new road segments would also likely receive greater recreational use, such as the long, proposed road segment which somewhat bisects sections 4 and 9. This 1.8-mile road segment runs along the ridge between No-name Creek and Nichols Creek in the project area and would likely have the greatest potential to introduce additional long-term disturbance and displacement of wildlife associated with future levels of recreational use during all seasons. Given that this road segment is long and extends into a scenic area, it may become its own destination route. Future users could also use that segment to access ridgetops at higher elevations in the upper reaches of Nichols, No Name and Limestone creeks. The short 0.7-mile segment of permanent restricted road proposed under Action Alternative A in the southwest ¼ of section 4 would not be constructed under Action Alternative B. Thus, additional access to other roads and trails in the project area from the Triple Tree Trail related to that road segment would not occur. The extent to which recreational uses would increase from other existing access points is uncertain. However, given the likelihood that expanded public access would not dramatically increase, disturbance and displacement adverse effects to wildlife would be expected to be less under this alternative than under Action Alternative A.

Trees would be expected to regenerate over the next 2 to 4 decades in treated harvest units and they would begin to provide cover and greater security, which would lessen disturbance and displacement impacts to wildlife associated with the created roads. Should displacement occur, individuals displaced would most likely travel back onto other forested lands in the southeast and southwest portions of the project area due to the presence of cover and greater topographic relief there, versus moving into the populated, flat, open valley bottoms near Bozeman. Some use of non-forested valley bottom lands by species such as elk, deer and bears occurs and is expected, particularly at night, given the availability of high quality foods that can be found there on private agricultural lands.

As under Action Alternative A, displacement might cause elk, bears and moose to leave preferred feeding areas in spring, and winter, potentially affecting some individual animals. Nighttime use of the project area and sites within buffers near roads would be likely be influenced very little by the presence of the new roads. The presence of the new roads and associated use on the roads would be expected to minimally influence the ability of most wildlife species to move across the project area, particularly for species that may travel and forage at night. Disturbance and displacement effects would primarily be localized and in association with the parcels contained in the project area. Some habituation of wildlife to human use on the new road systems could occur, which could slightly ameliorate displacement effects, although the degree that this would occur is uncertain. Habituation in association with attractants and grizzly bears can result in adverse consequences for both humans and bears. The potential for this type of habituation would be expected to remain low.

Given that: 1) total road amounts would increase from 4.3 miles to 8.9 miles in the project area; 2) these roads could facilitate increases in recreation and affect security on approximately 1,803 acres (66.2% of the 2,725-acre project area); 3) road effects would occur in addition to similar effects associated with cover removal on 373 acres; 4) new roads are likely to be used by the public and recreational use is likely to increase; 5) disturbance and displacement of wildlife could be expected for several decades; 6) conifer regeneration in 2 to 4 decades would likely ameliorate some of the displacement effects; 7) the routes selected by users and intensity of recreation into the future are uncertain; 8) disturbance and displacement effects are expected to primarily be confined to the lands within the project area, however some displacement could occur onto National Forest lands neighboring the project area; 9) nighttime use of the project area by wildlife is expected to be minimally affected; and 10) impeded travel by wildlife across or through affected lands in the project area would not be expected – particularly for species that travel and forage at night – we anticipate activities under Action Alternative B would result in a moderate to high level of displacement potential due the increase in new permanent, restricted roads and associated indirect increases in recreational uses during all seasons.

- ***Direct and Indirect Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternative A and B). Under Alternative C, no trees would be removed, and no roads would be built in the project area at this time. Thus, mechanical disturbance, additional roads and increased potential recreational use related to the proposed timber sale alternatives that could disturb and displace wildlife, or affect their ability to move across the landscape would not occur. No direct or indirect effects that could disturb and displace wildlife, or affect their ability to move across the project area would be anticipated under this alternative.

Cumulative Effects

- ***Cumulative Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur. Thus, no changes to habitat conditions, increases in road amounts or related disturbance that could displace wildlife or affect their ability to move through the landscape would be expected as a result of this project. However, recreational pressure on the State lands has increased over the past 30 years concurrent with the population increases in Bozeman and the Gallatin Valley. Increases in recreational use have been observed on DNRC lands through increased trail pioneering and use of the trails. As the local communities continue to grow and expand, recreational activities would be expected to continue to increase and could disturb wildlife, fragment habitat and adversely affect movement corridors and linkage areas. Cumulative effects to wildlife species that occupy lands within the cumulative effects analysis area that would be attributable to increases in new roads and subsequent increases in project-related recreational use would not be anticipated.

- ***Cumulative Effects of Action Alternative A***

Under Action Alternative A, total road amounts would increase from 4.3 miles to 9.6 miles in the project area, which could cause a proportional increase in disturbance and displacement of wildlife that use the 33,422-acre cumulative effects analysis area. When applying a disturbance buffer of 0.31 miles to the existing (880 acres) and new road segments (1,100 acres) that would be constructed and retained, approximately 1,980 acres of secure area would be affected, resulting in greater disturbance and displacement potential for species such as elk, moose and bears. This would result in acres adversely affected by new roads in the cumulative effects analysis area to increase from 13,425 to 14,525 acres (1,100-acre increase) in the cumulative effects analysis area.

Displacement of some species could occur for several decades depending on how much recreational use the area receives (user days), and the types of recreation. Both of these are somewhat uncertain into the future. Disturbance associated with walking an active barking dog as an example may be greater for many species than single hikers walking quietly. Disturbance and displacement caused by new roads would also be expected to vary by species of concern and season. For example, many user days of cross country skiing traffic in winter could displace elk and moose at important wintering sites. Whereas, most overwintering birds using the area would likely be affected little by such activity. Some new road segments would also likely receive greater recreational use, such as the long, proposed road segment which somewhat bisects sections 4 and 9. This 1.8-mile road segment runs along the ridge between No-name Creek and Nichols Creek in the project area and would likely have the greatest potential to introduce additional long-term disturbance and displacement of wildlife associated with future levels of recreational use during all seasons. Given that this road segment is long and extends into a scenic area, it may become its own destination route. Future users could also use that segment to access ridgetops at higher elevations in the upper reaches of Nichols, No Name and Limestone creeks. The short 0.7-mile segment of permanent restricted road proposed under Action Alternative A in the southwest ¼ of section 4 could facilitate additional access from the Triple Tree Trail. This new short road segment could indirectly and effectively "link" public users of the Triple Tree Trail with all of the other roads and trails in the project

area. This could potentially increase the cumulative level of public use on the project area considerably, when compared with the existing condition. The degree that use would actually increase is uncertain. The new permanent restricted road system under Action Alternative A would generally allow easier and greater levels of access to popular routes and destinations in the project area from both the east and west utilizing existing roads, new roads and the network of unauthorized trails than that which would be expected under Action Alternative B.

Trees would be expected to regenerate over the next 2 to 4 decades in treated harvest units and they would begin to provide cover and greater security, which would lessen disturbance and displacement impacts to wildlife associated with the created roads. Post-harvest forest conditions with >40% canopy cover in the cumulative effects analysis area would remain on approximately 27,247 acres (81.5%). Should displacement occur, individuals displaced would most likely travel back onto other forested lands in the southeast and southwest portions of the project area and further south within the cumulative effects analysis area due to the presence of cover and greater topographic relief there, versus moving into the populated, flat, open valley bottoms near Bozeman. Some use of non-forested valley bottom lands by species such as elk, deer and bears occurs and is expected, particularly at night, given the availability of high quality foods that can be found there on private agricultural lands. The presence of the new roads and associated use on the roads would be expected to minimally influence the ability of most wildlife species to move within the cumulative effects analysis area. Disturbance and displacement effects would primarily be localized and in association with the parcels contained in the project area.

Given that: 1) total road amounts would increase from 4.3 miles to 9.6 miles in the project area; 2) these roads could facilitate increases in recreation and affect security on approximately 1,100 acres in the project area increasing the overall area affected in the 33,422-acre cumulative effects analysis area from 13,425 existing acres affected (40.2%) to 14,525 acres (43.5%) affected; 3) road effects would occur in addition to similar effects associated with cover removal on 601 acres; 4) new roads are likely to be used by the public and recreational use is likely to slightly increase at the scale of the cumulative effects area; 5) disturbance and displacement of wildlife could be expected for several decades; 6) conifer regeneration in 2 to 4 decades on the project area would likely ameliorate some of the displacement effects; 7) the routes selected by users and intensity of recreation into the future are uncertain; 8) disturbance and displacement effects are expected to primarily be confined to the lands within the project area, however some displacement could occur onto neighboring National Forest lands in the cumulative effects analysis area; 9) nighttime use of the project area by wildlife is expected to be minimally affected; and 10) impeded travel by wildlife across or through affected lands in the cumulative effects analysis area would not be expected (particularly for species that travel and forage at night) – we anticipate activities under Action Alternative A would result in a low level of displacement potential due the increase in new permanent, restricted roads and associated indirect increases in recreational uses during all seasons at the scale of the 33,422-acre cumulative effects analysis area. Measurable population-level effects to wildlife species such as elk, bears, and moose would not be anticipated at the scale of a Hunting District as defined by DFWP.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add considerably to disturbance displacement potential for wildlife species sensitive to disturbance. Following treatments, hiding and security cover could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total cumulative effects analysis area that could be affected by both projects would be 14.3% under DNRC's Action Alternative A. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would include broadcast burning, thinning and commercial harvesting and would add cumulative disturbance to the area. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative B***

Under Action Alternative B, total road amounts would increase from 4.3 miles to 8.9 miles in the project area, which could cause a proportional increase in disturbance and displacement of wildlife that use the 33,422-acre cumulative effects analysis area. When applying a disturbance buffer of 0.31 miles to the existing (880 acres) and new road segments (923 acres) that would be constructed and retained, approximately 1,803 acres of secure area would be affected, resulting in greater disturbance and displacement potential for species such as elk, moose and bears. This would result in acres adversely affected by new roads in the cumulative effects analysis area to increase from 13,425 to 14,348 acres (923-acre increase) in the cumulative effects analysis area.

Displacement of some species could occur for several decades depending on how much recreational use the area receives (user days), and the types of recreation. Both of these are somewhat uncertain into the future. Disturbance associated with walking an active barking dog as an example may be greater for many species than single hikers walking quietly. Disturbance and displacement caused by new roads would also be expected to vary by species of concern and season. For example, many user days of cross country skiing traffic in winter could displace elk and moose at important wintering sites. Whereas, most overwintering birds using the area would likely be affected little by such activity. Some new road segments would also likely receive greater recreational use, such as the long, proposed road segment which somewhat bisects sections 4 and 9. This 1.8-mile road segment runs along the ridge between No-name Creek and Nichols Creek in the project area and would likely have the greatest potential to introduce additional long-term disturbance and displacement of wildlife associated with future levels of recreational use during all seasons. Given that this road segment is long and extends into a scenic area, it may become its own destination route. Future users could also use that segment to access ridgetops at higher elevations in the upper reaches of Nichols, No Name and Limestone creeks. The short 0.7-mile segment of permanent restricted road proposed under Action Alternative A in the southwest ¼ of section 4 would not be constructed under Action Alternative B. Thus, additional access to other roads and trails in the project area

from the Triple Tree Trail related to that road segment would not occur. The extent to which recreational uses would increase from other existing access points is uncertain. However, given the likelihood that expanded public access would not dramatically increase, cumulative disturbance and displacement adverse effects to wildlife would be expected to be less under this alternative than under Action Alternative A.

Trees would be expected to regenerate over the next 2 to 4 decades in treated harvest units and they would begin to provide cover and greater security, which would lessen disturbance and displacement impacts to wildlife associated with the created roads. Post-harvest forest conditions with >40% canopy cover in the cumulative effects analysis area would remain on approximately 27,334 acres (81.8%). Should displacement occur, individuals displaced would most likely travel back onto other forested lands in the southeast and southwest portions of the project area and further south within the cumulative effects analysis area due to the presence of cover and greater topographic relief there, versus moving into the populated, flat, open valley bottoms near Bozeman. Some use of non-forested valley bottom lands by species such as elk, deer and bears occurs and is expected, particularly at night, given the availability of high quality foods that can be found there on private agricultural lands. The presence of the new roads and associated use on the roads would be expected to minimally influence the ability of most wildlife species to move within the cumulative effects analysis area. Disturbance and displacement effects would primarily be localized and in association with the parcels contained in the project area.

Given that: 1) total road amounts would increase from 4.3 miles to 8.9 miles in the project area; 2) these roads could facilitate increases in recreation and affect security on approximately 923 acres in the project area increasing the overall area affected in the 33,422-acre cumulative effects analysis area from 13,425 existing acres affected (40.2%) to 14,348 acres (42.9%) affected; 3) road effects would occur in addition to similar effects associated with cover removal on 373 acres; 4) new roads are likely to be used by the public and recreational use is likely to slightly increase at the scale of the cumulative effects area; 5) disturbance and displacement of wildlife could be expected for several decades; 6) conifer regeneration in 2 to 4 decades on the project area would likely ameliorate some of the displacement effects; 7) the routes selected by users and intensity of recreation into the future are uncertain; 8) disturbance and displacement effects are expected to primarily be confined to the lands within the project area, however some displacement could occur onto neighboring National Forest lands in the cumulative effects analysis area; 9) nighttime use of the project area by wildlife is expected to be minimally affected; and 10) impeded travel by wildlife across or through affected lands in the cumulative effects analysis area would not be expected (particularly for species that travel and forage at night) – we anticipate activities under Action Alternative B would result in a low level of displacement potential due the increase in new permanent, restricted roads and associated indirect increases in recreational uses during all seasons at the scale of the 33,422-acre cumulative effects analysis area. Measurable population-level effects to wildlife species such as elk, bears, and moose would not be anticipated at the scale of a Hunting District as defined by DFWP.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add considerably to disturbance displacement potential for wildlife species sensitive to disturbance. Following treatments, hiding and security cover could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total cumulative effects analysis area that could be affected by both projects wound be 13.6% under DNRC's Action Alternative B. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would involve broadcast burning, thinning and commercial harvesting. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternative A and B). Under Alternative C, no trees would be removed, and no roads would be built in the cumulative effects analysis area at this time. Thus, mechanical disturbance, additional roads and increased potential recreational use related to the proposed timber sale alternatives that could disturb and displace wildlife, or affect their ability to move across the landscape would not occur. No cumulative effects that could disturb and displace wildlife or affect their ability to move across the project area would be anticipated under this alternative.

FINE FILTER

In the fine-filter analysis, individual species of concern are evaluated. These species include wildlife species federally listed under the Endangered Species Act, species listed as sensitive by DNRC, and species managed as big game by DFWP. In western Montana, 2 terrestrial species are federally classified as threatened; the grizzly bear and Canada lynx (*Lynx canadensis*). Wolverines (*Gulo gulo*) have been proposed for listing and are currently under review for listing as a threatened species. The anticipated completion date for the status review of wolverines is September 2018. An analysis of the potential for project-related effects to wolverines is also provided below. The yellow-billed cuckoo (*Coccyzus americanus*) and the northern long-eared bat (*Myotis septentrionalis)* are two other species recently federally listed as "threatened" in Montana. However, the project area is likely well outside of their distribution.

THREATENED AND ENDANGERED SPECIES

There is concern that the proposed removal of trees and construction of roads may adversely affect federally-listed threatened and/or endangered wildlife species. The effects of the proposed alternatives are addressed for Canada lynx, grizzly bears and wolverines below.

CANADA LYNX
ISSUE

Timber harvesting and associated activities could remove canopy closure, alter stand conditions, and/or cause motorized disturbance, which could alter lynx habitat, rendering it unsuitable for supporting Canada lynx.

MEASUREMENT CRITERIA

Assess suitable lynx habitat and potential reductions and effects related to the proposed action alternatives using DNRC SLI habitat data and model (2018) for direct and indirect effects at the project area scale (2,725 acres). Estimate potential lynx habitat at elevations >6,000 feet using the U.S. Forest Service R-1 VMap Remote-sensing Database (USFS 2015) and evaluate anticipated reductions and effects from the proposed action alternatives to assess cumulative effects within the 33,422-acre cumulative effects analysis area.

AFFECTED ENVIRONMENT

Canada lynx are currently federally listed as a threatened species in Montana. Canada lynx prey primarily on snowshoe hares (*Lepus americanus*) (Squires and Ruggiero 2007) and live in subalpine fir/spruce forests, generally between 4,000 to 7,000 feet in elevation in western Montana (Ruediger et al. 2000, ILBT 2013). Lynx may be adversely affected when dense horizontal cover is removed within their home range areas, which has the potential to reduce the abundance and availability of snowshoe hares and security (Squires et al. 2010). Lynx typically do not appear to be sensitive to gravel forest roads and trails (ILBT 2013).
The proposed project area ranges from approximately 5,300 to 7,700 feet in elevation. DNRC lands within the project area are dominated by mature stands containing Douglas-fir and lodgepole pine. Relatively pure stands of both tree species are present, as well as mixed species stands of varying composition. Lesser amounts of Engelmann spruce, subalpine fir and aspen are present on cool and moist sites, and trace amounts of limber pine are present on drier, exposed sites.

In western Montana, lynx prefer stands dominated by spruce and subalpine fir that possess high horizontal cover and provide habitat for snowshoe hares (Squires et al. 2010). In northwestern Montana lynx home range size varies from approximately 16,000 to 60,000 acres (ILBT 2013). Dense, mature stands are preferred by lynx in winter, whereas younger dense, stands with high horizontal cover are preferred in summer (Squires et al. 2010). Mature subalpine fir stands containing abundant coarse woody debris are valuable for denning and provide cover for kittens, and they provide forested cover for travel and security (Squires et al. 2008). Historically, high intensity, stand-replacing fires of long fire intervals (150 to 300 years) occurred in continuous dense forests comprised of lodgepole pine, subalpine fir, and Engelmann spruce. These fires created extensive even-aged patches of regenerating forest intermixed with old stands that maintained a mosaic of snowshoe hare and lynx habitat on the landscape. While many of the current forest cover types within the project area are considered suitable for use by lynx (ILBT 2013), most typically do not contain high horizontal cover comprised of subalpine and spruce bows described by Squires et al. (2010). Thus, even considering the common presence of several habitat attributes within the project area that are known to be important for lynx and snowshoe hares (eg. dense overstory canopy, dense shrubs and downed logs), most habitat in the project area is likely best suited as travel habitat or matrix

habitat (USFWS 2009) that would facilitate movement, linkage, and provide habitat for secondary prey species such as red squirrels.

For this analysis the three habitat classes that will be considered are: 1) non-habitat (i.e., rocks, ice, water and cover types that will never be habitat), 2) suitable habitat (i.e., habitat that provides structure and cover that facilitate occupancy and travel), and 3) temporary non-suitable habitat (i.e., habitat that temporarily does not have structural attributes necessary for suitable habitat, but will acquire them back over time as stands re-grow and age.). Currently in the 2,725-acre project area there are approximately 1,738 acres of suitable habitat (63.8%), 226 acres of temporarily non-suitable habitat (8.3%), and 761 acres of non-habitat (27.9%). Lynx habitat was modeled at the 33,422 cumulative effects analysis scale by considering stands most likely to be lynx habitat as those moderate to well-stocked stands generally existing above 6,000 feet elevation. The 33,422-acre scale was used as an approximation for the home range size of a lynx in a landscape likely possessing relatively low densities of snowshoe hares. Approximately 27,618 acres of existing suitable lynx habitat (82.6%) are present within the 33,422-acre cumulative effects analysis area.

Under requirements of the federal listing of lynx as a threatened species, a draft recovery plan outline was written (USFWS 2005), and federally designated Critical Habitat has been described for in the Greater Yellowstone Area in Unit 5 (USFWS 2009). However, the project area occurs outside of the Critical Habitat boundary and no federal funding or permitting would be required for the proposed project. Thus, federal measures required under the Critical Habitat designation would not be applicable to this project.

ENVIRONMENTAL EFFECTS

- ***Direct and Indirect Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur at this time. Thus, no changes to habitat conditions for lynx would be expected within the project area. No direct or indirect effects to lynx would be anticipated.

- ***Direct and Indirect Effects of Action Alternative A***

Under Action Alternative A, approximately 371 acres (21.3%) of the 1,738 acres of existing suitable lynx habitat would be removed within the 2,725-acre project area and converted to temporary non-habitat (Table W-3). The 371 treated acres would be non-forested following harvest and would likely take 20 to 30 years to regenerate into a suitable habitat condition comprised of new lodgepole pine and Douglas-fir sapling stands. Prior to the regeneration of new stands on treated sites, minimal use of these acres by lynx would be expected (Squires et al. 2010). Approximately 230 acres of Douglas-fir and mixed conifer stands would be partially harvested and would be expected to continue providing suitable habitat. Following proposed logging treatments, approximately 1,367 acres (50.2% of project area) of suitable habitat would remain in the 2,725-acre project area.

Should any individual lynx be present in the project area at the time logging activities were initiated, there would be increased risk of their displacement due to the increased level of noise and disturbance for the duration of the project (potentially 2 to 3 years). Risk of any displacement attributable to motorized project activities beyond 3 years would not be expected. Given the moderate size and location of the patches of lynx habitat affected, habitat connectivity would be diminished. However, some connected routes would be retained along class 1 streams and non-harvested patches. Similarly, maintenance of linkage potential associated with the Gallatin Bridger Big Belt Wildlife Corridor would be minimally influenced as ample amounts of forest cover and lynx habitat would remain after timber harvest, and no additional open roads or human developments would occur as a part of this proposal. In summary, given that: 1) the 371 acres of habitat that would be removed is a relatively small amount in the context of an average lynx home range size (16,000 to 60,000 acres) but any expected appreciable use of habitat on these acres following harvest would not be expected for 2 to 3 decades, 2) that any associated habitat effects would be temporary, 3) approximately 50.2% of the project area would contain habitat suitable for use by lynx following harvest (13.6% reduction from existing 63.8%), 4) risk of displacement due to motorized activities would be temporary and short-term at 2 to 3 years, 5) habitat connectivity would be altered and reduced but suitable habitat and habitat patches suitable for travel would remain across the project area -- low adverse direct and indirect effects to lynx would be expected.

Table W-3. Acreages (and percent of the project area) by alternative of lynx habitat on the DNRC Limestone West Timber Sale Project Area (Data source DNRC SLI 2018).

Lynx Habitat Element	No Action Alternative Acres (%)	Action Alternative A Acres Post Harvest (%)	Action Alternative B Acres Post Harvest (%)	Action Alternative C Acres Post Harvest (%)
Suitable Habitat	1,738.2 (63.8%)	1,367.2 (50.2%)	1,454.2 (53.4%)	1,738 (63.8%)
Temporary Non-suitable Habitat	225.7 (8.3%)	596.7 (21.9%)	509.7 (18.7%)	225.7 (8.3%)
Non-Habitat	761.2 (27.9%)	761.2 (27.9%)	761.2 (27.9%)	761.2 (27.9%)
Total	2,725	2,725	2,725	2,725

- ***Direct and Indirect Effects of Action Alternative B***

Under Action Alternative B, approximately 284 acres (16.3%) of the 1,738 acres of existing suitable lynx habitat would be removed within the 2,725-acre project area and converted to temporary non-habitat (Table W-3). The 284 treated acres would be non-forested following harvest and would likely take 20 to 30 years to regenerate into a suitable habitat condition comprised of new lodgepole pine and Douglas-fir sapling stands. Prior to the regeneration of new stands on treated sites, minimal use of these acres by lynx would be expected (Squires et al. 2010). Approximately 83 acres of Douglas-fir and mixed conifer stands would be partially

harvested and would be expected to continue providing suitable habitat. Following proposed logging treatments, approximately 1,454 acres (53.4% of project area) of suitable habitat would remain in the 2,725-acre project area.

Should any individual lynx be present in the project area at the time logging activities were initiated, there would be increased risk of their displacement due to the increased level of noise and disturbance for the duration of the project (potentially 2 to 3 years). Risk of any displacement attributable to motorized project activities beyond 3 years would not be expected. Given the moderate size and location of the patches of lynx habitat affected, habitat connectivity would be diminished. However, some connected routes would be retained along class 1 streams and non-harvested patches. Similarly, maintenance of linkage potential associated with the Gallatin Bridger Big Belt Wildlife Corridor would be minimally influenced as ample amounts of forest cover and lynx habitat would remain after timber harvest, and no additional open roads or human developments would occur as a part of this proposal. In summary, given that: 1) the 284 acres of habitat that would be removed is a relatively small amount in the context of an average lynx home range size (16,000 to 60,000 acres) but any expected appreciable use of habitat on these acres following harvest would not be expected for 2 to 3 decades, 2) that any associated habitat effects would be temporary, 3) approximately 53.4% of the project area would contain habitat suitable for use by lynx following harvest (10.4% reduction from existing 63.8%), 4) risk of displacement due to motorized activities would be temporary and short-term at 2 to 3 years, 5) habitat connectivity and would be altered and reduced but suitable habitat and habitat patches suitable for travel would remain across the project area -- low adverse direct and indirect effects to lynx would be expected.

- ***Direct and Indirect Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternative A and B). Under Alternative C, no trees would be removed, and no roads would be built in the project area at this time. Thus, mechanical disturbance and changes in structural habitat conditions related to the proposed timber sale alternatives, which could alter lynx habitat, rendering it unsuitable for supporting lynx would not occur. No direct or indirect effects that could adversely alter lynx habitat in the project area would be anticipated under this alternative.

Cumulative Effects

- ***Cumulative Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur at this time. Thus, no changes to habitat conditions for lynx would be expected within the project area or cumulative effects analysis area. No cumulative effects to lynx would be anticipated.

- ***Cumulative Effects of Action Alternative A***

Lynx habitat was modeled at the 33,422 cumulative effects analysis scale by considering stands most likely to be lynx habitat as those moderate to well-stocked stands generally existing above 6,000 elevation. The 33,422-acre scale was used as an approximation for the home range size of a lynx in a landscape likely possessing relatively low densities of snowshoe hares. Under the action alternative, approximately 371 acres (1.3%) of the 27,618 acres of existing suitable lynx habitat would be removed within the 33,422-acre cumulative effects analysis area and converted to temporary non-habitat. The 371 treated acres would be non-forested following harvest and would likely take 20 to 30 years to regenerate into a suitable habitat condition comprised of lodgepole pine and Douglas-fir sapling stands. A high percentage of existing suitable lynx habitat with moderate to high levels of horizontal cover would be retained in the cumulative effects analysis area post-treatment (i.e., 27,247 acres (98.7%) retained of 27,618 existing acres) (Table W-4).

Should any individual lynx be present in the cumulative effects analysis area at the time logging activities were initiated, there would be increased risk of their displacement due to the increased level of noise and disturbance for the duration of the project (potentially 2 to 3 years). Should lynx be present in the vicinity, such disturbance could render habitat temporarily unavailable for denning or foraging in the local areas where project activities would take place. Risk of any displacement attributable to motorized project activities beyond 3 years would not be expected. Disturbance associated with motorized human activities conducted in conjunction with timber harvest would be in addition to existing levels of human disturbance attributable to dispersed recreational activities occurring outside of active logging areas during all seasons of the year.

Given the proposed treatment types and relatively small size and location of the patches of lynx habitat affected, habitat connectivity would not be appreciably altered at the scale of the cumulative effects analysis area. Similarly, maintenance of linkage potential associated with the Gallatin Bridger Big Belt Wildlife Corridor would be minimally influenced as ample amounts of forest cover and lynx habitat would remain after timber harvest, and no additional open roads or human developments would occur as a part of this proposal.

In summary, given that: 1) the 371 acres of habitat that would be affected is a relatively small amount in the context of an average lynx home range size (16,000 to 60,000 acres) but any expected appreciable use of habitat on these acres by lynx following harvest would not be expected for 2 to 3 decades, 2) that any associated habitat effects would be temporary, 3) approximately 81.5% of the project area would contain habitat suitable for use by lynx following harvest (1.1% reduction from existing 82.6% -- See Table W-4), 4) risk of displacement due to motorized activities would be temporary and short-term at 2 to 3 years, 5) habitat connectivity and would be altered and reduced but suitable habitat and habitat patches suitable for travel would remain across the project area – minimal adverse cumulative effects to lynx would be expected at the scale of the cumulative effects analysis area.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. For the BMW Project, the Northern Rockies Lynx Management Direction was applied and the U.S. Fish and Wildlife Service was consulted. The BMW Project Area lies within the North Gallatin LAU

which is 103,334 acres. Approximately 66% of the LAU (67,910 acres) is in habitat types preferred by lynx (GNF 2011). The U.S. Forest Service estimated that 2,673 acres of suitable lynx habitat could be affected on the BMW Project in some way, and under Alternative 6, approximately 1,164 acres (8%) of the lynx habitat in the Project area would be rendered "Unsuitable" (GNF 2011). Cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add to disturbance displacement potential for lynx and have lasting habitat and connectivity effects for several decades. Following treatments, hiding and security cover could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total DNRC cumulative effects analysis area that could be affected by both projects would be 14.3% under DNRC's Action Alternative A. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would include broadcast burning, thinning and commercial harvesting and would add cumulative disturbance to the area. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

Table W-4. Acreages by alternative of lynx habitat on the 33,422-acre DNRC Limestone West Timber Sale Cumulative Effects Analysis Area (Data sources DNRC SLI 2018, and USFS R-1 VMap Remote-Sensing Database 2015). Suitable lynx habitat is defined as areas greater than approximately 6,000 ft. elevation possessing forest cover with >40% canopy. Non-lynx habitat includes all forest and non-forest <40% canopy cover and forested habitat below 6,000 feet.

Lynx Habitat Element	No Action Alternative Acres (%)	Action Alternative A Acres Post Harvest (%)	Action Alternative B Acres Post Harvest (%)	Action Alternative C Acres Post Harvest (%)
Suitable Lynx Habitat (>6,000 ft. elev. with >40% cover)	27,618 (82.6%)	27,247 (81.5%)	27,334 (81.8%)	27,618 (82.6%)
Non-Habitat	5,804 (17.4%)	6,175 (18.5%)	6,088 (18.2%)	5,804 (17.4%)
Total	33,422	33,422	33,422	33,422

- ***Cumulative Effects of Action Alternative B***

Lynx habitat was modeled at the 33,422 cumulative effects analysis scale by considering stands most likely to be lynx habitat as those moderate to well-stocked stands generally existing above 6,000 elevation. The 33,422-acre scale was used as an approximation for the home range size of a lynx in a landscape likely possessing relatively low densities of snowshoe hares. Under the action alternative, approximately 284 acres (1.0%) of the 27,618 acres of existing suitable lynx habitat would be removed within the 33,422-acre cumulative effects analysis area and converted to temporary non-habitat. The 284 treated acres would be non-forested following harvest and would likely take 20 to 30 years to regenerate into a suitable habitat condition comprised of

lodgepole pine and Douglas-fir sapling stands. A high percentage of existing suitable lynx habitat with moderate to high levels of horizontal cover would be retained in the cumulative effects analysis area post-treatment (i.e., 27,334 acres (98.9%) retained of 27,618 existing acres) (Table W-4).

Should any individual lynx be present in the cumulative effects analysis area at the time logging activities were initiated, there would be increased risk of their displacement due to the increased level of noise and disturbance for the duration of the project (potentially 2 to 3 years). Should lynx be present in the vicinity, such disturbance could render habitat temporarily unavailable for denning or foraging in the local areas where project activities would take place. Risk of any displacement attributable to motorized project activities beyond 3 years would not be expected. Disturbance associated with motorized human activities conducted in conjunction with timber harvest would be in addition to existing levels of human disturbance attributable to dispersed recreational activities occurring outside of active logging areas during all seasons of the year.

Given the proposed treatment types and relatively small size and location of the patches of lynx habitat affected, habitat connectivity would not be appreciably altered at the scale of the cumulative effects analysis area. Similarly, maintenance of linkage potential associated with the Gallatin Bridger Big Belt Wildlife Corridor would be minimally influenced as ample amounts of forest cover and lynx habitat would remain after timber harvest, and no additional open roads or human developments would occur as a part of this proposal.

In summary, given that: 1) the 284 acres of habitat that would be affected is a relatively small amount in the context of an average lynx home range size (16,000 to 60,000 acres) but any expected appreciable use of habitat on these acres by lynx following harvest would not be expected for 2 to 3 decades, 2) that any associated habitat effects would be temporary, 3) approximately 81.8% of the project area would contain habitat suitable for use by lynx following harvest (0.8% reduction from existing 82.6% -- See Table W-4), 4) risk of displacement due to motorized activities would be temporary and short-term at 2 to 3 years, 5) habitat connectivity and would be altered and reduced but suitable habitat and habitat patches suitable for travel would remain across the project area – minimal adverse cumulative effects to lynx would be expected at the scale of the cumulative effects analysis area.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. For the BMW Project, the Northern Rockies Lynx Management Direction was applied and the U.S. Fish and Wildlife Service was consulted. The BMW Project Area lies within the North Gallatin LAU which is 103,334 acres. Approximately 66% of the LAU (67,910 acres) is in habitat types preferred by lynx (GNF 2011). The U.S. Forest Service estimated that 2,673 acres of suitable lynx habitat could be affected on the BMW Project in some way, and under Alternative 6, approximately 1,164 acres (8%) of the lynx habitat in the Project area would be rendered "Unsuitable" (GNF 2011). Cover would be removed over a 5 to 12-year period on an additional 12.5% of the DNRC cumulative effects analysis area, which could add to disturbance displacement potential for lynx and have lasting habitat and connectivity effects for several

decades. Following treatments, hiding and security cover could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total DNRC cumulative effects analysis area that could be affected by both projects wound be 13.6% under DNRC's Action Alternative B. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would involve broadcast burning, thinning and commercial harvesting. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternative A and B). Under Alternative C, no trees would be removed, and no roads would be built in the cumulative effects analysis area at this time. Thus, mechanical disturbance and changes in structural habitat conditions related to the proposed timber sale alternatives, which could alter lynx habitat, rendering it unsuitable for supporting lynx would not occur. No cumulative effects that could adversely alter lynx habitat in the project area would be anticipated under this alternative.

GRIZZLY BEAR

ISSUE

There is concern that timber harvesting activities could remove security cover, cause displacement of bears, increase roads, and increase presence of unnatural attractants and bear foods, which could adversely affect grizzly bears.

MEASUREMENT CRITERIA

Assessment of extent of cover removal [data sources DNRC SLI habitat and road data (2018) and the U.S. Forest Service R-1 VMap Remote-sensing Database (USFS 2015)]; type, season and duration of proposed activities; and assessment of changes in road types and amounts.

AFFECTED ENVIRONMENT

In April 2007, the USFWS delisted grizzly bears in the Greater Yellowstone Ecosystem (GYE). In September 2009, the US District Court vacated the delisting rule, placing bears in that ecosystem back to listed status as a threatened species. In June 2017, the USFWS again delisted grizzly bears in the GYE and they currently remain delisted. However, they will continue to be a species of high conservation emphasis for many years to come.

Forest-management activities may affect grizzly bears by altering cover and/or by increasing access to humans into otherwise secure areas by creating roads (Mace et al. 1996). Forest management operations can reduce the ability of vegetation and cover to conceal grizzly bears, which can lower effective bear use of habitat and render bears more vulnerable to human-caused mortality (Servheen et al. 1999). These actions could lead to the displacement of grizzly bears from preferred areas and/or result in an increased risk of human-caused mortality by bringing humans and bears closer together, which can increase their risk of being killed.

Displacing bears from preferred areas may increase their energetic costs, which may in turn lower their ability to survive and/or reproduce successfully. The greatest sources of grizzly bear mortality in both the GYE and Northern Continental Divide Ecosystem (NCDE) in Montana are attributable to human-related causes -- particularly associated with the acquisition of unnatural foods (Schwartz et al. 2006, Haroldson et al. 2006, Servheen 2009). If people implementing forest management activities on the project area were to possess bear attractants that were stored in a non-secure manner, the risk of creating bear management situations could be elevated -- resulting in the prompt of future removal of a problem bear(s).
The project area lies approximately 20.2 miles due north of the GYE grizzly bear recovery zone, and occurs at the northerly edge of the occupied habitat boundary described by Wittinger (2002). There have been a number of confirmed grizzly bear sightings in the Bear Canyon/Mount Ellis area during the last 34 years, 4 of which have occurred during the last 10 years (Kevin Frey, R-3, DFWP Biologist, pers. comm., 5/02/11). More recent sightings have also been reported in the vicinity of Little Bear Creek approximately 8.7 miles southwest of the project area (J. Cunningham, DFWP Biologist, pers. comm. 9/20/2016). Given the frequency and types of observations, it is possible that a few grizzly bears may periodically use the general area as part of their home ranges during the non-denning seasons (Kevin Frey, R-3, DFWP Biologist, pers. comm., 5/02/11; J. Cunningham, DFWP Biologist, pers. comm. 9/20/2016). There are currently high levels of recreational use that occur within the project area and 33,422-acre cumulative effects analysis area during all seasons, which may influence use of the area by grizzly bears.

ENVIRONMENTAL EFFECTS

- ***Direct and Indirect Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur at this time. Thus, no changes to habitat conditions for grizzly bears would be expected within the project area that would be associated with this project. However, as the community of Bozeman continues to grow and expand, public access and recreational use of lands and related impacts in the project area are expected to continue to increase over time. No direct or indirect effects to grizzly bears associated with this project would be anticipated.

- ***Direct and Indirect Effects of Action Alternative A***

Under Action Alternative A, cover and habitat connectivity associated with riparian areas would not be appreciable altered as minimal riparian timber harvesting would occur in the project area, and ample no harvest buffers would be established along all class 1 streams. Given the moderate size and location of cover patches affected and removed, habitat connectivity would be diminished. However, some connected routes of hiding cover would be retained along class 1 streams and unharvested patches. Similarly, maintenance of linkage potential associated with the Gallatin Bridger Big Belt Wildlife Corridor would be minimally influenced as ample amounts of forest cover would remain after timber harvest, and no additional open roads or human developments would occur as a part of this proposal. Of the 2,095 acres of hiding cover in the project area, 1,724 acres (82.3%) would remain in mature forest cover with

>40% overstory canopy closure (Table W-5). Of these acres 1,724 acres, approximately 1,450 would possess >60% overstory cover (84.1%). Following logging, forest patches on the project area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions. Overall, stand density would be reduced or removed on 601 acres of mature forest. Within harvested stands, individual trees and patchy tree retention would remain, which would continue to provide some escape cover and visual screening. Cover would be completely removed on 371 acres that would receive clearcut treatments. Opening sizes would be restricted for these intensively harvested stands, such that hiding cover would remain nearby (within 600 feet) from any point within each unit. On the 371 acres proposed for clearcut treatment, bears could wander into such areas and they would be more detectable by humans, which would result in their displacement and minor added risk of human-bear conflicts, particularly in fall during the big game general hunting season.

Under Action Alternative A, 9.1 miles of new road would be constructed to access logging units, and 4.3 miles of restricted roads currently exist in the project area. In total, 13.4 miles of road would be subject to motorized and/or non-motorized uses during project activities for a duration of 2 to 3 years. This would result in a temporary increase in road density from an existing level of 1.0 miles/square mile, to 3.1 miles/square mile that would be subject to active operations on the 4.3 square mile project area. Immediately following project completion, 3.8 miles of the total 13.4 miles would be made impassible with slash and debris. Following harvest activities, the remaining total road amount and density consisting roads with restrictions on motorized access (allowable uses foot travel and periodic DNRC administrative uses only) would be 9.6 miles at a density of 2.3 miles per square mile respectively (Table W-5).

During harvest operations disturbance from motorized equipment could disturb and displace bears, and habitat in the project area and nearby vicinity may temporarily be unusable due to the level of noise and human activity. Public motorized access is prohibited in this area and no public motorized access would be allowed in the project area while harvest activities are underway, thus no added risk due to this cause would be present. There would be short-term added risk of disturbance and displacement of grizzly bears that could result in minor adverse effects associated with logging operations, short term road construction, and road use. However, due to the construction of 5.3 miles of new permanent road into previously unroaded areas, and increased potential for additional future recreational uses on these roads, moderate long-term adverse effects associated with grizzly bear disturbance and displacement would be expected.

Under Action Alternative A, DNRC field staff and contractors would be required to keep any unnatural bear foods or attractants (such as garbage) in a bear resistant manner. It is unlikely that contractors would request to camp on or near the project area, however, should they choose to do so, they would be required by the operating contract to store any unnatural bear foods and attractants in a bear resistant manner. Compliance with contract terms would frequently be evaluated and would be enforced by a DNRC contract administrator. Any added risk to grizzly bears associated with unnatural bear foods or attractants directly associated with the project would be minimal. However, some additional minor risk to bears from attractants associated with increased recreational use on new restricted roads would be possible.

TABLE W-5. Grizzly bear habitat parameters within the Limestone West Timber Sale Project Area for all of the alternatives considered. Road density calculations are simple linear calculations.

PARAMETER	ALTERNATIVES			
	NO ACTION	ACTION		
		A	B	C
Acres of Hiding Cover Removed (Percent of Existing Hiding Cover Removed)	0 (0%)	371 (17.7%)	284 (13.5%)	0 (0%)
Acres of Hiding Cover Retained in the Project Area After Implementation of Each Alternative (Percent of Existing Cover in Project Area)	2,095 (100%)	1,724 (82.3%)	1,811 (86.4%)	2,095 (100%)
Linear Miles of New Permanent, Restricted Road Constructed	0.0	5.3	4.6	0.0
Linear Miles of Total Permanent Restricted Road (Percent Increase)	4.3 (00%)	9.6 (123.3%)	8.9 (107.0%)	4.3 (00%)
Miles of New Permanent Open Road Constructed	0	0	0	0
Miles of Permanent Open Road (percent increase)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)
Open Road Density – mi./mi.^{2}	0.0	0.0	0.0	0.0
Total Road Density -- mi./mi.^{2}	1.0	2.3	2.1	1.0

Direct and Indirect Effects of Action Alternative B

Under Action Alternative B, cover and habitat connectivity associated with riparian areas would not be appreciable altered as minimal riparian timber harvesting would occur in the project area, and ample no harvest buffers would be established along all class 1 streams. Given the moderate size and location of cover patches affected and removed, habitat connectivity would be diminished. However, some connected routes of hiding cover would be retained along class 1 streams and unharvested patches. Similarly, maintenance of linkage potential associated with the Gallatin Bridger Big Belt Wildlife Corridor would be minimally influenced as ample amounts of forest cover would remain after timber harvest, and no additional open roads or human developments would occur as a part of this proposal. Of the 2,095 acres of hiding cover in the project area, 1,811 acres (86.4%) would remain in mature forest cover with >40% overstory canopy closure (Table W-5). Of these acres 1,811 acres, approximately 1,678 would possess >60% overstory cover (92.3%). Following logging, forest patches on the project area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions. Overall, stand density would be reduced or removed on 373 acres of mature forest. Within harvested stands, individual trees and patchy tree retention would remain, which would continue to provide some escape cover and visual screening. Cover would be

completely removed on 284 acres that would receive clearcut treatments. Opening sizes would be restricted for these intensively harvested stands, such that hiding cover would remain nearby (within 600 feet) from any point within each unit. On the 284 acres proposed for clearcut treatment, bears could wander into such areas and they would be more detectable by humans, which would result in their displacement and minor added risk of human-bear conflicts, particularly in fall during the big game general hunting season.

Under Action Alternative B, 6.2 miles of new road would be constructed to access logging units, and 4.3 miles of restricted roads currently exist in the project area. In total, 10.5 miles of road would be subject to motorized and/or non-motorized uses during project activities for a duration of 2 to 3 years. This would result in a temporary increase in road density from an existing level of 1.0 miles/square mile, to 2.5 miles/square mile that would be subject to active operations on the 4.3 square mile project area. Immediately following project completion, 1.6 miles of the total 10.5 miles would be made impassible with slash and debris. Following harvest activities, the remaining total road amount and density consisting roads with restrictions on motorized access (allowable uses foot travel and periodic DNRC administrative uses only) would be 8.9 miles at a density of 2.1 miles per square mile respectively (Table W-5).

During harvest operations disturbance from motorized equipment could disturb and displace bears, and habitat in the project area and nearby vicinity may temporarily be unusable due to the level of noise and human activity. No public motorized access would be allowed in the project area while harvest activities are underway, thus no added risk due to this cause would be present. There would be short-term added risk of disturbance and displacement of grizzly bears that could result in minor adverse effects associated with logging operations, short term road construction, and road use. However, due to the construction of 4.6 miles of new permanent road into previously unroaded areas, and increased potential for additional future recreational uses on these roads, moderate long-term adverse effects associated with grizzly bear disturbance and displacement would be expected.

Under Action Alternative B, DNRC field staff and contractors would be required to keep any unnatural bear foods or attractants (such as garbage) in a bear resistant manner. It is unlikely that contractors would request to camp on or near the project area, however, should they choose to do so, they would be required by the operating contract to store any unnatural bear foods and attractants in a bear resistant manner. Compliance with contract terms would frequently be evaluated and would be enforced by a DNRC contract administrator. Any added risk to grizzly bears associated with unnatural bear foods or attractants directly associated with the project would be minimal. However, some additional minor risk to bears from attractants associated with increased recreational use on new restricted roads would be possible.

- ***Direct and Indirect Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternatives A and B). Under Alternative C, no trees or security cover would be removed, and no roads would be built in the project area at this

time. Thus, mechanical disturbance, potential for increases in attractants, potential increases in public recreation, and reductions in security cover related to the proposed timber sale alternatives, which could adversely affect grizzly bears would not occur. No direct or indirect effects that could adversely affect grizzly bears or alter their habitat in the project area would be anticipated under this alternative.

Cumulative Effects

- ***Cumulative Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur at this time. Thus, no project-related changes to habitat conditions for grizzly bears would be expected within the project area or cumulative effects analysis area. However, as the community of Bozeman continues to grow and expand, public access and recreational use of lands and related impacts in the cumulative effects analysis area are expected to continue to increase over time. No project-related cumulative effects to grizzly bears would be anticipated.

- ***Cumulative Effects of Action Alternative A***

Under Action Alternative A, cover and habitat connectivity associated with riparian areas would not be appreciable altered as minimal riparian timber harvesting would occur in the project area, and ample no harvest buffers would be established along all class 1 streams. Given the moderate size and location of cover patches affected and removed in the project area, habitat connectivity would be diminished to a minor degree at the scale of the 33,422-acre cumulative effects analysis area. Similarly, maintenance of linkage potential associated with the Gallatin Bridger Big Belt Wildlife Corridor would be minimally influenced as ample amounts of forest cover would remain after timber harvest, and no additional open roads or human developments would occur as a part of this proposal. Of the 27,618 acres of hiding cover in the cumulative effects analysis area, 27,247 acres (98.7%) would remain in mature forest cover with >40% overstory canopy closure (Table W-6). Of these 27,247 acres, approximately 22,221 would possess >60% overstory cover (81.5%). Following logging, forest patches on the project area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions. Overall, stand density would be reduced or removed on 601 acres of mature forest. Within harvested stands, individual trees and patchy tree retention would remain, which would continue to provide some escape cover and visual screening. Cover would be completely removed on 371 acres that would receive clearcut treatments. Opening sizes would be restricted for these intensively harvested stands, such that hiding cover would remain nearby (within 600 feet) from any point within each unit. On the 371 acres proposed for clearcut treatment, bears could wander into such areas and they would be more detectable by humans, which would result in their displacement and minor added risk of human-bear conflicts, particularly in fall during the big game general hunting season.

Approximately 9.1 miles of road would be constructed and used to complete activities proposed under Action Alternative A, of which 3.8 miles would be reclaimed following project completion. No new open roads would be constructed under this alternative. However, 5.3 miles of the 9.1 miles constructed for the project would be gated and retained on the landscape.

This increase under Alternative A would boost restricted road amounts from 26.9 existing miles to 32.2 miles post project in the cumulative effects analysis area (Table W-6). This increase would translate into an overall increase in total road density in the cumulative effects analysis area of from 1.45 miles per square mile to 1.55 miles per square mile (Table W-6). Only motorized activities for administrative purposes would be allowed on the new roads, which would pose minimal disturbance to grizzly bears in the years following the logging disturbance, should they be present. However, depending on the degree that these new closed roads might be used in the future by the public for recreation, additional displacement of bears and greater potential for human-bear conflicts for a longer term (several decades until stands regenerate) would be possible. The actual extent that restricted roads would receive recreational use is uncertain. Habitats and roadless areas within the cumulative effects analysis area would continue to use by grizzly bears and facilitate habitat connectivity and linkage across the broader landscape.

During harvest operations disturbance from motorized equipment could disturb and displace bears to areas elsewhere in the cumulative effects analysis area, and habitat in the project area and nearby vicinity may temporarily be unusable due to the level of noise and human activity. There would be short-term added risk of disturbance and displacement of grizzly bears that could result in minor adverse effects associated with logging operations, short term road construction, and road use. However, these effects at the scale of the cumulative effects analysis area would be minimal. Due to the construction of 5.3 miles of new permanent road into previously unroaded areas, and increased potential for additional future recreational uses on these roads, minor additional long-term adverse effects associated with grizzly bear disturbance and displacement would be expected in the 33,422-acre cumulative effects analysis area.

Under Action Alternative A, DNRC field staff and contractors would be required to keep any unnatural bear foods or attractants (such as garbage) in a bear resistant manner. It is unlikely that contractors would request to camp on or near the project area, however, should they choose to do so, they would be required by the operating contract to store any unnatural bear foods and attractants in a bear resistant manner. Compliance with contract terms would frequently be evaluated and would be enforced by a DNRC contract administrator. Any added cumulative risk to grizzly bears associated with unnatural bear foods or attractants directly associated with the project would be minimal. However, some additional minor cumulative risk to bears from attractants associated with increased recreational use on new restricted roads would be possible.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add considerably to disturbance displacement potential for grizzly bears. Following treatments, hiding and security cover could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total cumulative effects analysis area that could be affected by both projects would be 14.3% under DNRC's Action Alternative A. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would include broadcast

burning, thinning and commercial harvesting and would add cumulative disturbance and potential risk to grizzly bears in the area. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

TABLE W-6. Grizzly bear habitat parameters within the Limestone West Timber Sale Cumulative Effects Analysis Area for all of the alternatives considered. Road density calculations are simple linear calculations.

PARAMETER	ALTERNATIVES			
	NO ACTION	ACTION		
		A	B	C
Acres of Hiding Cover Removed (Percent of Existing Hiding Cover Removed)	0.0 (0%)	371 (17.7%)	284 (13.5%)	0.0 (0%)
Acres of Hiding Cover Retained in the Cumulative Effects Analysis Area After Implementation of Each Alternative (Percent of Project Area)	27,618 (100%)	27,247 (81.5%)	27,334 (81.8%)	27,618 (100%)
Linear Miles of New Permanent, Restricted Road Constructed	0.0	5.3	4.6	0.0
Linear Miles of Total Permanent Restricted Road (Percent Increase)	26.9 (00.0%)	32.2 (19.7%)	31.5 (17.1%)	26.9 (00.0%)
Miles of New Permanent Open Road Constructed	0.0	0.0	0.0	0.0
Miles of Permanent Open Road (percent increase)	48.68 (0.0%)	48.68 (0.0%)	48.68 (0.0%)	48.68 (0.0%)
Open Road Density – mi./mi.^{2}	0.93	0.93	0.93	0.93
Total Road Density -- mi./mi.^{2} -- total of combined open and restricted road classes	1.45	1.55	1.54	1.45

- ***Cumulative Effects of Action Alternative B***

Under Action Alternative B, cover and habitat connectivity associated with riparian areas would not be appreciable altered as minimal riparian timber harvesting would occur in the project area, and ample no harvest buffers would be established along all class 1 streams. Given the moderate size and location of cover patches affected and removed in the project area, habitat connectivity would be diminished to a minor degree at the scale of the 33,422-acre cumulative effects analysis area. Similarly, maintenance of linkage potential associated with the Gallatin Bridger Big Belt Wildlife Corridor would be minimally influenced as ample amounts of forest cover would remain after timber harvest, and no additional open roads or human developments would occur as a part of this proposal. Of the 27,618 acres of hiding cover in the cumulative effects analysis area, 27,334 acres (98.9%) would remain in mature forest cover with >40% overstory canopy closure (Table W-6). Of these 27,334 acres, approximately 22,449 would possess >60% overstory cover (82.1%). Following logging, forest patches on the project area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions. Overall, stand density would be reduced or removed on 373 acres of mature forest.

Within harvested stands, individual trees and patchy tree retention would remain, which would continue to provide some escape cover and visual screening. Cover would be completely removed on 284 acres that would receive clearcut treatments. Opening sizes would be restricted for these intensively harvested stands, such that hiding cover would remain nearby (within 600 feet) from any point within each unit. On the 284 acres proposed for clearcut treatment, bears could wander into such areas and they would be more detectable by humans, which would result in their displacement and minor added risk of human-bear conflicts, particularly in fall during the big game general hunting season.

Approximately 6.2 miles of road would be constructed and used to complete activities proposed under Action Alternative B, of which 1.6 miles would be reclaimed following project completion. No new open roads would be constructed under this alternative. However, 4.6 miles of the 6.2 miles constructed for the project would be gated and retained on the landscape. This increase under Alternative B would boost restricted road amounts from 26.9 existing miles to 31.5 miles post project in the cumulative effects analysis area (Table W-6). This increase would translate into an overall increase in total road density in the cumulative effects analysis area of from 1.45 miles per square mile to 1.54 miles per square mile (Table W-6). Only motorized activities for administrative purposes would be allowed on the new roads, which would pose minimal disturbance to grizzly bears in the years following the logging disturbance, should they be present. However, depending on the degree that these new closed roads might be used in the future by the public for recreation, additional displacement of bears and greater potential for human-bear conflicts for a longer term (several decades until stands regenerate) would be possible. The actual extent that restricted roads would receive recreational use is uncertain. Habitats and roadless areas within the cumulative effects analysis area would continue to use by grizzly bears and facilitate habitat connectivity and linkage across the broader landscape.

During harvest operations disturbance from motorized equipment could disturb and displace bears to areas elsewhere in the cumulative effects analysis area, and habitat in the project area and nearby vicinity may temporarily be unusable due to the level of noise and human activity. There would be short-term added risk of disturbance and displacement of grizzly bears that could result in minor adverse effects associated with logging operations, short term road construction, and road use. However, these effects at the scale of the cumulative effects analysis area would be minimal. Due to the construction of 4.6 miles of new permanent road into previously unroaded areas, and increased potential for additional future recreational uses on these roads, minor additional long-term adverse effects associated with grizzly bear disturbance and displacement would be expected in the 33,422-acre cumulative effects analysis area.

Under Action Alternative B, DNRC field staff and contractors would be required to keep any unnatural bear foods or attractants (such as garbage) in a bear resistant manner. It is unlikely that contractors would request to camp on or near the project area, however, should they choose to do so, they would be required by the operating contract to store any unnatural bear foods and attractants in a bear resistant manner. Compliance with contract terms would frequently be evaluated and would be enforced by a DNRC contract administrator. Any added cumulative risk to grizzly bears associated with unnatural bear foods or attractants directly

associated with the project would be minimal. However, some additional minor cumulative risk to bears from attractants associated with increased recreational use on new restricted roads would be possible.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add considerably to disturbance displacement potential for grizzly bears. Following treatments, hiding and security cover could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total cumulative effects analysis area that could be affected by both projects would be 13.6% under DNRC's Action Alternative B. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would include broadcast burning, thinning and commercial harvesting and would add cumulative disturbance and potential risk to grizzly bears in the area. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternative A and B). Under Alternative C, no trees or security cover would be removed, and no roads would be built in the cumulative effects analysis area at this time. Thus, mechanical disturbance, potential for increases in attractants, potential increases in public recreation, and reductions in security cover related to the proposed timber sale alternatives, which could adversely affect grizzly bears would not occur. No cumulative effects that could adversely affect grizzly bears or alter their habitat in the project area would be anticipated under this alternative.

WOLVERINE

ISSUE

There is concern that activities associated with timber harvesting could disturb and displace denning female wolverines and adversely affect their habitat.

MEASUREMENT CRITERIA

Zones of persistent snowpack into late June were identified, typically above 7,200 ft. elevation using MODIS satellite data from 2008 (NOHRSC 2004). Potential wolverine denning habitat in the 33,422-acre cumulative effects analysis area was estimated by identifying and summing all high elevation lands >7,200 feet elevation using a digital elevation model (DEM) for Bozeman Unit lands. DNRC SLI data and harvest polygon layers were used to evaluate cover reductions associated with proposed harvest units. Timing of project activities and duration of proposed activities were also considered.

AFFECTED ENVIRONMENT

Wolverines (*Gulo gulo*) are a rare, wide-ranging species that has been proposed for federal listing under the Endangered Species Act. They are currently under review as a threatened species. The anticipated completion date for the current status review of wolverines by the U.S. Fish and Wildlife Service is September 2018.

Wolverines are a medium-sized carnivore that is an opportunistic scavenger in the winter and opportunistic omnivore in summer, consuming prey that includes snowshoe hares, marmots (*Marmota spp.*), ground squirrels (*Spermophilus spp.*), red squirrels (*Tamiasciurus hudsonicus*), salmon (*Oncorhynchus spp.*), porcupine (*Erethizon dorsatum*), mice (*Peromyscus spp.*), voles (*Microtus spp.*), and berries. At the landscape scale, the presence of abundant food supplies (i.e., ungulate carrion) and sparsely inhabited wilderness areas that contain persistent snow until late spring tend to define wolverine habitat (Kelsall 1981; Banci and Harestad 1990; Aubry et al. 2007). At the landscape scale, the types and presence of forests and other vegetation do not appear to define wolverine habitat as much as the presence of abundant food supplies (i.e., ungulate carrion) and sparsely inhabited wilderness areas that contain persistent snow until late spring (Kelsall 1981; Banci 1994; Aubry et al. 2007). Wolverines occur at relatively low densities (i.e., one per 65 square kilometers in northwestern Montana) (Hornocker and Hash 1981). Home ranges of males are larger than those of females which may encompass over one hundred square miles. In Montana, Hornocker and Hash (1981) found the mean annual home range of males to be 163 square miles, and 150 square miles for females.

Wolverine tracks have recently been observed in the project area (Gehman 2017), and South of Bozeman Creek in the vicinity of Hyalite Reservoir (Gehman 2010). The majority of the project area (85%) occurs at lower elevations that would not support deep, persistent snow in spring. However, approximately 407 acres of habitat in the project area occur at elevations greater than 7,200 feet that maintain persistent snow in late spring, which may be suitable for denning female wolverines. Approximately 471 additional acres of similar potential habitat occur on DNRC lands in the cumulative effects analysis area outside of the project area. These combined acreages total 878 acres of habitat on DNRC lands in the 33,422-acre cumulate effects analysis area. Similar habitat at high elevations is present outside of the project area on National Forest lands in the vicinity of Mount Ellis and high ridges and geographic features above New World Gulch. Across all ownerships in the 33,422-acre cumulative effects analysis area, approximately 4,116 acres of potential wolverine habitat is present at elevations greater than 7,200 feet, that are the most likely remote places persistent snow would exist in late spring. Approximately 80% of the 4,116 acres of potential wolverine denning habitat is located >1 mile from the project area.

ENVIRONMENTAL EFFECTS

- ***Direct and Indirect Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur at this time. Thus, no associated wintertime disturbance would occur and no changes to habitat conditions for wolverines would occur in the project area. However, as the community of

Bozeman continues to grow and expand, public access and recreational use of lands and related impacts in the project area are expected to continue to increase over time. No direct or indirect project-related effects to wolverines would be anticipated.

- ***Direct and Indirect Effects of Action Alternatives A and B***

Under both Alternatives A and B, approximately 8 acres of high elevation wolverine habitat would be affected in association with harvest units C13 and C14 that are common to both alternatives. To minimize potential for disturbance caused by motorized activities and associated adverse effects to wolverines, no winter logging would be allowed in these two harvest units in winter and spring from January 15 to June 15 each operating season. The remaining 463 acres of wolverine habitat in the project area would not be affected. Individuals could occasionally use lands in the project area while foraging or dispersing, and they could be displaced by project-related disturbance if they are in the area for the 2 to 3-year duration of project activities. However, given their large home range sizes (~150 sq. mi. -- Hornocker and Hash 1981), and manner in which they use a broad range of forested and non-forested habitats, the proposed activities and alterations of forest vegetation on the project area would have low potential for adverse effects to wolverines. Cover removed at lower elevations in the project area under both Alternatives A and B (601 and 373 treated acres respectively) would be expected to have minimal effect on wolverine movements, prey availability, or habitat use within an established home range. However, the construction of 5.3 miles of new permanent roads under Alternative A, or 4.6 miles under Alternative B, could be a source of additional disturbance and displacement during all seasons of the year due to additional recreational activity that could occur in the area.

Some new road segments would likely receive greater recreational use, such as the long, proposed road segment which somewhat bisects sections 4 and 9. This 1.8-mile road segment runs along the ridge between No-name Creek and Nichols Creek in the project area and would likely have the greatest potential to introduce additional long-term disturbance and displacement of wolverines associated with future levels of recreational use. Given that this road segment is long and extends into a scenic area, it may become its own destination route. Future users could also use that segment to access ridgetops at higher elevations in the upper reaches of Nichols, No Name and Limestone creeks. The short 0.7-mile segment of permanent restricted road proposed under Action Alternative A in the southwest ¼ of section 4 could facilitate additional access from the Triple Tree Trail. This new short road segment could indirectly and effectively "link" public users of the Triple Tree Trail with all of the other roads and trails in the project area. This could potentially increase the level of public use on the project area considerably, when compared with the existing condition. The degree that use would actually increase is uncertain. The new permanent restricted road system under Action Alternative A would generally allow easier and greater levels of access to popular routes and destinations in the project area from both the east and west utilizing existing roads, new roads and the network of unauthorized trails than that which would be expected under Action Alternative B. The short 0.7-mile segment of permanent restricted road in the southwest ¼ of section 4 would not be constructed under Action Alternative B. Thus, additional access to other

roads and trails in the project area from the Triple Tree Trail related to that road segment would not occur. The extent to which recreational uses would increase from other existing access points is uncertain. However, given the likelihood that expanded public access would not dramatically increase, disturbance and displacement adverse effects to wolverines would be expected to be less under Action Alternative B than under Action Alternative A.

Displacement effects, should wolverines be in the area, would likely be greatest in winter when food resources are most limited. The extent to which disturbance and displacement of wolverines would occur in relation to the newly constructed permanent roads and associated future recreational use is uncertain. Considering: 1) the limited amount of habitat that would be affected by both action alternatives, 2) the limited scope of the project area in the context of the size of a typical wolverine home range, 3) the amount of new permanent roads that would be constructed and uncertain levels of associated recreational use, 4) the operational restrictions in winter that would be in place under both alternatives, and 5) the limited affect vegetation has on defining wolverine habitat (Kelsall 1981; Banci 1994; Aubry et al. 2007) – moderate adverse direct and indirect effects to wolverines would be expected in the project area under both alternatives A and B.

- ***Direct and Indirect Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternatives A and B). Under Alternative C, no trees or cover would be removed, and no roads would be built in the project area at this time. Thus, mechanical disturbance in winter months important for denning female wolverines would not occur and reductions in cover related to the proposed timber sale alternatives would not occur. No direct or indirect effects that could adversely affect wolverines or alter their habitat in the project area would be anticipated under this alternative.

- ***Cumulative Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur at this time. Thus, no associated wintertime disturbance would occur and no changes to habitat conditions for wolverines would occur in the cumulative effects analysis area. However, as the community of Bozeman continues to grow and expand, public access and recreational use of lands and related impacts in the cumulative effects analysis area are expected to continue to increase over time. No project-related cumulative effects to wolverines would be anticipated under this alternative.

- ***Cumulative Effects of Action Alternative A and B***

Under both Alternatives A and B, approximately 8 acres of high elevation wolverine habitat would be affected in association with harvest units C13 and C14 that are common to both alternatives. This acreage is insignificant at the scale of a wolverine home range and the fact that vegetation has little effect on defining wolverine habitat (Kelsall 1981; Banci 1994; Aubry et

al. 2007). Nonetheless, to minimize potential for disturbance caused by motorized activities and associated adverse effects to wolverines, no winter logging would be allowed in these two harvest units in winter and spring from January 15 to June 15 each operating season. Individuals could occasionally use lands in the project area while foraging or dispersing, and they could be displaced by project-related disturbance, if they are in the area for the 2 to 3-year duration of project activities, into portions of the 33,422-acre cumulative effects analysis area and beyond. However, given their large home range sizes (~150 sq. mi. -- Hornocker and Hash 1981), and manner in which they use a broad range of forested and non-forested habitats, the proposed activities and alterations of forest vegetation would have low potential for adverse effects to wolverines. Cover removed at lower elevations in the project area under both Alternatives A and B (601 and 373 treated acres respectively) would be expected to have minimal effect on wolverine movements, prey availability, or habitat use within the cumulative effects analysis area. However, the construction of 5.3 miles of new permanent roads under Alternative A, or 4.6 miles under Alternative B, could be a source of additional disturbance and displacement during all seasons of the year due to additional recreational activity that could be introduced into the area.

Some new road segments would likely receive greater recreational use, such as the long, proposed road segment which somewhat bisects sections 4 and 9. This 1.8-mile road segment runs along the ridge between No-name Creek and Nichols Creek in the project area and would likely have the greatest potential to introduce additional long-term disturbance and displacement of wolverines associated with future levels of recreational use. Given that this road segment is long and extends into a scenic area, it may become its own destination route. Future users could also use that segment to access ridgetops at higher elevations in the upper reaches of Nichols, No Name and Limestone creeks. The short 0.7-mile segment of permanent restricted road proposed under Action Alternative A in the southwest ¼ of section 4 could facilitate additional access from the Triple Tree Trail. This new short road segment could indirectly and effectively "link" public users of the Triple Tree Trail with all of the other roads and trails in the project area. This could potentially increase the level of public use on the project area considerably, when compared with the existing condition. The degree that use would actually increase is uncertain. The new permanent restricted road system under Action Alternative A would generally allow easier and greater cumulative levels of access to popular routes and destinations in the cumulative effects analysis area from both the east and west utilizing existing roads, new roads and the network of unauthorized trails than that which would be expected under Action Alternative B. The short 0.7-mile segment of permanent restricted road in the southwest ¼ of section 4 would not be constructed under Action Alternative B. Thus, additional access to other roads and trails in the cumulative effects analysis area from the Triple Tree Trail related to that road segment would not occur. The extent to which recreational uses would increase from other existing access points is uncertain. However, given the likelihood that expanded public access would not dramatically increase, disturbance and displacement adverse cumulative effects to wolverines would be expected to be less under Action Alternative B than under Action Alternative A.

The new roads and associated uses under either alternative would be cumulative to the existing 75.6 miles in the cumulative effects analysis area. Displacement effects, should wolverines be in the area, would likely be greatest in winter when food resources are most limited. The extent to which disturbance and displacement of wolverines would occur in relation to the newly constructed permanent roads and associated future recreational use is uncertain. However, the new roads and uncertain levels of associated recreational use would not be likely to appreciably influence wolverine occupancy of the 33,422-acre cumulative effects analysis area or movements or habitat use elsewhere within that broader area. Considering: 1) the limited amount of habitat that would be affected by both action alternatives, 2) the limited scope of the project in the context of the cumulative effects analysis and size of a typical wolverine home range, 3) the amount of new permanent roads that would be constructed under either alternative and uncertain levels of associated recreational use, 4) the operational restrictions in winter from January 15 through June 15 that would be in place under both alternatives, 5) the limited affect vegetation has on defining wolverine habitat (Kelsall 1981; Banci 1994; Aubry et al. 2007), and the amount of other potential denning habitat on approximately 4,108 acres in the cumulative effects analysis area that would not be affected – minor adverse cumulative effects to wolverines would be expected in the cumulative effects analysis area under both alternatives A and B.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add considerably to disturbance displacement potential for wolverines. Following treatments, forest cover could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total cumulative effects analysis area that could be affected by both projects would be 14.3% under DNRC's Action Alternative A or 13.6% under Action Alternative B. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would include broadcast burning, thinning and commercial harvesting and would add cumulative disturbance to the area that may contribute to the displacement of wolverines. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternatives A and B). Under Alternative C, no trees or cover would be removed, and no roads would be built in the project area at this time. Thus, mechanical disturbance in winter months important for denning female wolverines would not occur and reductions in cover related to the proposed timber sale alternatives would not occur. No cumulative effects that could adversely affect wolverines or alter their habitat in the project area would be anticipated under this alternative.

SENSITIVE SPECIES

The potential for direct, indirect and cumulative effects was considered for the sensitive species included in the table below. The assessment rationale for each species is presented in each corresponding description cell in the table.

ISSUE

There is concern that the proposed removal of trees and construction of roads may adversely affect sensitive species.

MEASUREMENT CRITERIA

The management criteria used to evaluate impacts related to the following issues and species included: MNHP species occurrence record search (7/30/18), Species specific assessments of distribution and habitat suitability, field reviews, assessment of anecdotal information obtained from local biologists on species occurrence, assessment of risk factors for each species, timing of proposed activities, location of proposed activities, scale of activities, cover amounts, road amounts as applicable.

DNRC Sensitive Species	[Y/N] Potential Impacts and Mitigation Measures N = Not Present or No Impact is Likely to Occur Y = Impacts May Occur (Explain Below)
Bald Eagle (*Haliaeetus leucocephalus*) Habitat: late-successional forest <1 mile from open water	[N] No bald eagle nests, feeding areas, known roosting areas or suitable nesting habitat occur within 1 mile of the project area. Thus, no direct, indirect or cumulative effects to bald eagles would be anticipated under any of the alternatives considered.
Golden Eagle (*Aquila chrysaetos*) Habitat: Prairies and open woodlands, cliffs and large trees	[N] Golden eagles have been observed in the vicinity of the project area, however no recently occupied nest sites within one mile of the project area have been documented (MNHP 2018). Proposed harvest activities are not likely to appreciably reduce or alter important preferred nest sites, perch sites or cliff features. Thus, no adverse direct, indirect, or cumulative effects to golden eagles would be anticipated.
Gray Wolf (*Canis lupus*) Habitat: ample big game pops., security from human activity	[N] No known denning or rendezvous sites occur within 1 mile of the project area. However, wolves may occasionally use the project area and occasional sightings have been noted in the area (J. Cunningham, R-3 DFWP Biologist, pers. comm. 4/13/11, 09/21/2016). Minimal risk of direct, indirect or cumulative effects that would result in harm to wolves would be anticipated under either of the alternatives considered. If wolves or an active

	den site were detected in the immediate area, operations would cease, and a DNRC biologist would be consulted. Appropriate mitigations would be developed and applied prior to resuming activities.
Black-Backed Woodpecker (*Picoides arcticus*) Habitat: mature to old burned forest	[N] No recent burns within the last 5 years occur on the project area or within 1 mile of the project area. Thus, no direct, indirect or cumulative effects to black-backed woodpeckers would be anticipated under any of the alternatives considered.
Black-tailed Prairie Dog (*Cynomys ludoviscianus*) Habitat: Prairie, shortgrass prairie, badlands	[N] Black-tailed prairie dogs have not been documented in the project area or surrounding vicinity (MNHP/DFWP Montana Field Guide -- search 5/19/11, 7/30/2018). No grassland habitat suitable for use by black-tailed prairie dogs occurs in or near the project area. Thus, no direct, indirect or cumulative effects to prairie dogs would be anticipated under any of the alternatives considered.
Flammulated Owl (*Otus flammeolus*) Habitat: late-successional ponderosa pine and Douglas.-fir forest	[N] The project area occurs on the fringe of the distribution of flammulated owls in Montana, and warm forest types suitable for use by flammulated owls do not occur in or near the project area. Thus, no direct, indirect or cumulative effects to flammulated owls would be anticipated under any of the alternatives considered.
Greater Sage-grouse (*Centrocercus urophasianus*) Habitat: sagebrush semi-desert	**[** N **]** The project area does not occur within "core" or "general habitat" areas identified by the Montana Sage Grouse Habitat Conservation Program (07/31/2018). No occurrence records for greater sage grouse exist for the quarter-latilong containing the project area since 1991 (MNHP/DFWP Montana Field Guide – search 2018, and MNHP 2018). Also, extensive stands of sagebrush community types do not occur within or near the project area. Thus, no direct, indirect or cumulative effects to greater sage grouse would be anticipated under any of the alternatives considered.
	[N] No known streams supporting harlequin ducks occur within or near the project area,

Harlequin Duck (*Histrionicus histrionicus*) Habitat: white-water streams, boulder and cobble substrates	and no recent observations have been reported for the general area (MNHP 2018). Thus, no direct, indirect or cumulative effects to harlequin ducks would be anticipated for the alternatives considered.
Mountain Plover (*Charadrius montanus*) Habitat: short-grass prairie, alkaline flats, prairie dog towns	[N] No grassland habitat suitable for use by mountain plovers occurs within or near the project area. Thus, no direct, indirect or cumulative effects to mountain plovers would be anticipated under the alternatives considered.
Northern Bog Lemming (*Synaptomys borealis*) Habitat: sphagnum meadows, bogs, fens with thick moss mats	[N] No sphagnum meadows, bogs or fens occur within or near the project area, and the project area occurs outside of the known distribution of northern bog lemmings in Montana (MNHP 2018). Thus, no direct, indirect or cumulative effects to bog lemmings would be anticipated for the alternatives considered.
Peregrine Falcon (*Falco peregrinus*) Habitat: cliff features near open foraging areas and/or wetlands	[N] Peregrine falcon observations have been made in the vicinity of Mount Ellis (MNHP 2018). However, no suitable cliff features for nesting occur within 1 mile of the project area, and no known nest sites occur within or near the project area (MNHP 2018). Thus, no direct, indirect or cumulative effects to peregrine falcons would be anticipated for the alternatives considered.
Pileated Woodpecker (*Dryocopus pileatus*) Habitat: late-successional ponderosa pine and larch-fir forest	[N] The project area occurs outside of the normal distribution of pileated woodpeckers in Montana. One species occurrence record exists from 2010 in the vicinity of the project area of a pileated woodpecker excavating a cavity in an aspen tree approximately 5 miles northeast of the project area (MNHP 2018). While it is possible that pileated woodpeckers may occasionally be detected in the vicinity of the project area, habitat conditions tend to be less suitable compared to mixed-conifer forests west of the continental divide. Thus, minimal direct, indirect or cumulative effects to pileated woodpeckers would be anticipated for the alternatives considered.
Townsend's Big-Eared Bat (*Plecotus townsendii*)	[N] Townsend's big-eared bats have been documented in hibernacula approximately 5 miles from the project area (MNHP 2018). However, no caves, caverns, or old mines

Habitat: caves, caverns, old mines	suitable for use by bats are known to occur within 1 mile of the project area. Rugged, rocky features and cliffs would be avoided during proposed logging activities. Thus, no direct, indirect or cumulative effects to Townsend's big-eared bats would be anticipated for either of the alternatives considered.

BIG GAME SPECIES

ISSUE

There is concern that increases in roads, logging disturbance, cover loss, and long-term non-motorized recreational use associated with new restricted roads will adversely affect moose calving areas, habitat suitability and security, resulting in their displacement and/or reduced carrying capacity.

MEASUREMENT CRITERIA

The management criteria used to evaluate impacts related to the following issues pertaining to big game species included: the timing of proposed activities, location of proposed activities, scale of activities, quantified cover amounts [data sources DNRC SLI habitat and road data (2018), and USFS R-1 VMap Remote-sensing Database (USFS 2015)], road amounts, visual assessments of aerial photography and visual evaluation of cover and topography as related to linkage areas. For cumulative effects analysis, pre-harvest canopy cover estimates were obtained from the USFS R-1 VMap Remote-sensing Database (USFS 2015) and post-harvest cover estimates were derived by estimating the percent canopy retained given the proportion of volume expected to be removed in each harvest unit.

AFFECTED ENVIRONMENT

Moose are frequently observed on the project area (Gehman 2017) and they have commonly been observed there in winter (J. Cunningham, R-3, DFWP Biologist, pers. comm., 7/29/10; 6/21/2016). Moose have been a species of interest in this general area for many years (Schladweiler 1974).

Recently, concerns regarding possible moose population declines in Montana resulted in the initiation of a 10-year ongoing study to examine moose vital rates, limiting factors, and monitoring methods. Preliminary results indicate that some populations may be slightly increasing (Cabinet Mountains and Rocky Mountain Front) while others such as the Big Hole study population may be in decline (DeCesare and Newby 2017). Potential causes for declines are numerous and vary, and they may include such things as disease, parasites, malnutrition, predation, and/or other factors (DeCesare and Newby 2017).

Moose are a solitary, wide-ranging species that use a broad range of habitats. In summer, moose frequent mountain meadows, river valleys, swamps, and clearcuts. In northwest Montana, moose used 15 to 30-year-old clearcuts more than expected in Northwest Montana (Mattson and Despain 1985). Because moose are large and have heavy coats, they are more capable of withstanding harsh winter conditions than other cervid species such as elk and white-tailed deer (Jenkins and Wright 1988). In winter, moose often use willow bottoms, brush fields, and mature coniferous forest (MNHP/DFWP 2018). Poole and Stuart-Smith (2004) found that in late winter, selection of open-forage habitats was greatest, including wet logged areas 10-30 years old, riparian areas and shrub bottoms. Lodgepole pine stands were highly available and used considerably in their study, but they were not preferred. Poole and Stuart-Smith (2004) found in British Columbia that lower snow depths at lower elevations play a large role in winter habitat selection of moose, and under conditions they observed, moose used open foraging areas with abundant browse forage, as well as mature forest stands of variable canopy density. The availability of mature conifer forest may help moose ameliorate the energetic effects of severe winter conditions, however Poole and Stuart-Smith (2004) did not find selection for the densest forest stands in their study.

Moose may be migratory or reside within a resident home range (Hundertmark 2007). As such, home ranges can vary greatly (0.3 to 746 square miles). In northwest Montana, Langley (1993) found that non-migratory moose had home ranges averaging 45 square miles, while those of migratory individuals averaged 56 square miles. In late winter moose often move very little when snow conditions are crusted and their body condition is poor (Hundertmark 2007). Studies on habitat selection of pregnant moose have documented a wide range of habitat conditions where parturition occurs (Langley 1993). Some have indicated proximity to water and high-quality forage is important, while others have not. McGraw et al. (2011) found that moose in Minnesota used areas with more dense conifer and shrubland or regenerating young forest cover types that expected. Some appear to use larger dense patches of heavy cover, whereas others may use small clumps for several days, venturing into more open meadows within a few days after parturition. Moose when calving are capable of effectively using relatively small cover patches. These differences may be a result of differing predator avoidance strategies used by calving moose (Langley 1993). Bowyer et al. (1999) found that pregnant female moose selected microsites with high variability in forest cover that also possessed high visibility. Bowyer et al. (1999) also observed that cover and forage (primarily willows, *Salix* spp.) was more than twice as abundant on birth sites than random sites, and their selection of sites may have helped them avoid predation. Langley (1993) found that for 11 cow moose in northwest Montana with calves, the length of stay in one spot ranged from 4 to 9 days. Tremblay et al. (2007) observed that pregnant moose showed some fidelity to the same general areas year after year, and that human activity may disturb them and influence their choices of calving sites and their fidelity.

Dense patches of mature forest are abundant in the project area and cumulative effects analysis area, and areas of dense forest on this local landscape are likely more abundant currently than they were under historical conditions (Gruell 1983). Approximately 2,095 acres of the 2,725-acre

project area (77%) currently possess greater than 40% overstory canopy cover in mature forest patches (Table W-1). Approximately 27,618 acres (83%) of the 33,422-acres cumulative effects analysis area currently possess greater than 40% overstory canopy cover in mature forest patches (Table W-2). Existing patches have variable tree density and comprise a diverse mosaic of habitat conditions. Existing patch shapes and sizes in the project area have been influenced by natural disturbances, limited past logging, and road construction that have occurred during the past 125 years. Mature forest stands in the project area and cumulative effects analysis area are generally well connected and provide a suitable network of cover capable of facilitating movements of moose across the local landscape. Mature forest patches of several hundred acres to those over 1,000 acres are present in the project and cumulative effects analysis areas. There are currently no open roads in the Limestone West Project Area and 4.34 miles of permanent restricted roads. In the 33,444-acre cumulative effects analysis area there are approximately 48.7 miles of existing permanent open roads and 26.9 miles of existing permanent restricted roads (Table W-6).

The hunting season for moose is heavily regulated, which reduces risk of overharvest by humans. The project area lies within Moose Hunting District 315 established and managed by DFWP. Current regulations allow the harvest of 2 antlered bull moose annually (DFWP 2018).

ENVIRONMENTAL EFFECTS

- ***Direct and Indirect Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur at this time. Thus, no associated habitat changes or project-related disturbance would occur that could affect moose or their habitat in the project area. However, as the community of Bozeman continues to grow and expand, public access and recreational use of lands and related impacts in the project area are expected to continue to increase over time. No direct or indirect project-related effects to moose would be anticipated.

- ***Direct and Indirect Effects of Action Alternative A***

Under Action Alternative A, stand density and cover would be reduced on 601 acres of mature forest in the project area. Of the 2,725-acre project area, 1,724 acres (63% of project area) would remain in mature forest cover with >40% overstory canopy closure that would facilitate continued use of the project area by moose. Of these acres 1,725 acres, approximately 1,450 (84%) would possess >60% overstory cover (53% of project area), which would provide quality hiding cover, severe winter cover, and security cover for moose during all seasons. Following logging, forest patches on the project area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions suitable for use by moose. Mature forest stands of variable size and density in the project area would continue to provide a network of cover suitable for providing calving sites for moose following harvest. Within harvested stands, individual trees and patchy tree retention would remain, which would continue to provide some escape cover, visual screening and potential microsites suitable for calving. Given the ability of moose to use a broad range of habitats and conditions, harvest

units and interspersed stringers of unharvested stands and riparian buffer areas would provide a suitable network of cover capable of facilitating movements and maintaining potential preferred feeding areas following treatment.

Under Action Alternative A, total road amounts would increase from 4.3 miles to 9.6 miles in the project area, which could cause a proportional increase in disturbance and displacement of moose that use the 2,725-acre project area. Short-term disturbance and displacement associated with active logging activities during the 2 to 3 years of operations would be expected. This disturbance and displacement would be confined to the summer, fall and winter months. Disturbance in spring from April 1 to June 15 would be prohibited to minimize displacement potential during calving and lessen potential disturbance to grizzly bears. Motorized disturbance and displacement associated with timber harvesting activities would not be expected extend beyond the length of the project. However, longer-term displacement potential and adverse effects associated with increased recreational use of 5.3 miles of new, restricted permanent roads would be possible.

Some displacement of moose could occur for several decades depending on how much recreational use new roads may receive (i.e., user days), and the types of recreation that would occur, which are somewhat uncertain into the future. Disturbance and displacement caused by these new roads would also be expected to vary by season. Many user days of cross country skiing traffic in winter, for example, could displace moose from important wintering sites and cause individuals to spend important energy reserves during severe winters (Hundertmark 2007). In spring, some individual pregnant moose could be displaced by human traffic on new roads. However, given how female moose select sites they perceive as secure for temporary parturition sites and the amount of cover and retained patches of forest cover that would remain in the project area following logging, it is unlikely that the number and availability of suitable calving sites would be limiting for moose in this area.

Displacement of moose could occur for several decades depending on how much recreational use the area receives (user days), and the types of recreation. Both of these are somewhat uncertain into the future. Some new road segments would likely receive greater recreational use, such as the long, proposed road segment which somewhat bisects sections 4 and 9. This 1.8-mile road segment runs along the ridge between No-name Creek and Nichols Creek in the project area and would likely have the greatest potential to introduce additional long-term disturbance and displacement of moose associated with future levels of recreational use during winter. Given that this road segment is long and extends into a scenic area, it may become its own destination route. Future users could also use that segment to access ridgetops at higher elevations in the upper reaches of Nichols, No Name and Limestone creeks. The short 0.7-mile segment of permanent restricted road proposed under Action Alternative A in the southwest ¼ of section 4 could facilitate additional access from the Triple Tree Trail. This new short road segment could indirectly and effectively "link" public users of the Triple Tree Trail with all of the other roads and trails in the project area. This could potentially increase the level of public use on the project area considerably, when compared with the existing condition. The degree

that use would actually increase is uncertain. The new permanent restricted road system under Action Alternative A would generally allow easier and greater levels of access to popular routes and destinations in the project area from both the east and west utilizing existing roads, new roads and the network of unauthorized trails than that which would be expected under Action Alternative B.

Trees would be expected to regenerate over the next 2 to 4 decades in treated harvest units and they would begin to provide cover and greater security for moose, which would lessen disturbance and displacement impacts attributable to the new permanent roads. Should displacement occur, individual displaced moose would most likely travel back onto other secure forested lands in the southeast and southwest portions of the project area and National Forest Lands due to the presence of cover and greater topographic relief there. Disturbance and displacement effects would primarily be localized and in association with the parcels contained in the project area.

Given that: 1) total road amounts would increase from 4.3 miles to 9.6 miles in the project area; 2) these roads could facilitate increases in recreation and affect security on approximately 1,980 acres (72.7% of the 2,725-acre project area – see the Recreation section in this wildlife analysis portion of the document); 3) over half of the project area acreage (53%) would maintain high levels of forest cover, 4) moose use a wide range of habitats and have relatively large home ranges; 5) new roads are likely to be used by the public and recreational use is likely to increase to an uncertain degree; 6) disturbance and displacement of wildlife could be expected for several decades; 7) conifer regeneration in 2 to 4 decades would likely ameliorate some of the displacement effects; 8) the routes selected by users and intensity of recreation into the future are uncertain; 9) disturbance and displacement effects are expected to primarily be confined to the lands within the project area, however, some displacement could occur onto National Forest lands neighboring the project area; 10) the habitat selection behavior of pregnant moose, and 11) impeded travel by moose across or through affected lands in the project area would not be expected – we anticipate activities under Action Alternative A would result in a moderate to high level of direct and indirect displacement potential that could cause adverse effects to individual moose due the increase in new permanent, restricted roads and associated indirect increases in recreational uses during all seasons (but particularly winter). We further anticipate a low level of adverse effects to pregnant moose given the variety of places and types of sites they select for very short periods during calving.

- ***Direct and Indirect Effects of Action Alternative B***

Under Action Alternative B, stand density and cover would be reduced on 373 acres of mature forest in the project area. Of the 2,725-acre project area, 1,811 acres (66% of project area) would remain in mature forest cover with >40% overstory canopy closure that would facilitate continued use of the project area by moose. Of these acres 1,811 acres, approximately 1,678 (93%) would possess >60% overstory cover (62% of project area), which would provide quality hiding cover, severe winter cover, and security cover for moose during all seasons. Following logging, forest patches on the project area would continue to have variable tree density and

would continue to provide a mosaic of habitat conditions suitable for use by moose. Mature forest stands of variable size and density in the project area would continue to provide a network of cover suitable for providing calving sites for moose following harvest. Within harvested stands, individual trees and patchy tree retention would remain, which would continue to provide some escape cover, visual screening and potential microsites suitable for calving. Given the ability of moose to use a broad range of habitats and conditions, harvest units and interspersed stringers of unharvested stands and riparian buffer areas would provide a suitable network of cover capable of facilitating movements and maintaining potential preferred feeding areas following treatment.

Under Action Alternative B, total road amounts would increase from 4.3 miles to 8.9 miles in the project area, which could cause a proportional increase in disturbance and displacement of moose that use the 2,725-acre project area. Short-term disturbance and displacement associated with active logging activities during the 2 to 3 years of operations would be expected. This disturbance and displacement would be confined to the summer, fall and winter months. Disturbance in spring from April 1 to June 15 would be prohibited to minimize displacement potential during calving and lessen potential disturbance to grizzly bears. Motorized disturbance and displacement associated with timber harvesting activities would not be expected to extend beyond the length of the project. However, longer-term displacement potential and adverse effects associated with increased recreational use of 4.6 miles of new, restricted permanent roads would be possible.

Some displacement of moose could occur for several decades depending on how much recreational use new roads may receive (i.e., user days), and the types of recreation that would occur, which are somewhat uncertain into the future. Disturbance and displacement caused by these new roads would also be expected to vary by season. Many user days of cross country skiing traffic in winter, for example, could displace moose from important wintering sites and cause individuals to spend important energy reserves during severe winters (Hundertmark 2007). In spring, some individual pregnant moose could be displaced by human traffic on new roads. However, given how female moose select sites they perceive as secure for temporary parturition sites and the amount of cover and retained patches of forest cover that would remain in the project area following logging, it is unlikely that the number and availability of suitable calving sites would be limiting for moose in this area.

Displacement of moose could occur for several decades depending on how much recreational use the area receives (user days), and the types of recreation. Both of these are somewhat uncertain into the future. Some new road segments would likely receive greater recreational use, such as the long, proposed road segment which somewhat bisects sections 4 and 9. This 1.8-mile road segment runs along the ridge between No-name Creek and Nichols Creek in the project area and would likely have the greatest potential to introduce additional long-term disturbance and displacement of moose associated with future levels of recreational use during winter. Given that this road segment is long and extends into a scenic area, it may become its own destination route. Future users could also use that segment to access ridgetops at higher

elevations in the upper reaches of Nichols, No Name and Limestone creeks. The short 0.7-mile segment of permanent restricted road proposed under Action Alternative A in the southwest ¼ of section 4 would not be constructed under Action Alternative B. Thus, additional access to other roads and trails in the project area from the Triple Tree Trail related to that road segment would not occur. The extent to which recreational uses would increase from other existing access points is uncertain. However, given the likelihood that expanded public access would not dramatically increase, disturbance and displacement adverse effects to moose in spring would be expected to be less under this alternative than under Action Alternative A.
Trees would be expected to regenerate over the next 2 to 4 decades in treated harvest units and they would begin to provide cover and greater security for moose, which would lessen disturbance and displacement impacts attributable to the new permanent roads. Should displacement occur, individual displaced moose would most likely travel back onto other secure forested lands in the southeast and southwest portions of the project area and National Forest Lands due to the presence of cover and greater topographic relief there. Disturbance and displacement effects would primarily be localized and in association with the parcels contained in the project area.

Given that: 1) total road amounts would increase from 4.3 miles to 8.9 miles in the project area; 2) these roads could facilitate increases in recreation and affect security on approximately 1,803 acres (66.2% of the 2,725-acre project area – see analysis in the Recreational effects section in this wildlife analysis portion of the document); 3) over half of the project area acreage (62%) would maintain high levels of forest cover, 4) moose use a wide range of habitats and have relatively large home ranges; 5) new roads are likely to be used by the public and recreational use is likely to increase to an uncertain degree; 6) disturbance and displacement of wildlife could be expected for several decades; 7) conifer regeneration in 2 to 4 decades would likely ameliorate some of the displacement effects; 8) the routes selected by users and intensity of recreation into the future are uncertain; 9) disturbance and displacement effects are expected to primarily be confined to the lands within the project area, however, some displacement could occur onto National Forest lands neighboring the project area; 10) the habitat selection behavior of pregnant moose, and 11) impeded travel by moose across or through affected lands in the project area would not be expected – we anticipate activities under Action Alternative A would result in a moderate to level of direct and indirect displacement potential that could cause adverse effects to individual moose due the increase in new permanent, restricted roads and associated indirect increases in recreational uses during all seasons (but particularly winter). We further anticipate a low level of adverse effects to pregnant moose given the variety of places and types of sites they select for very short periods during calving.

- ***Direct and Indirect Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternatives A and B). Under Alternative C, no trees or cover would be removed, and no roads would be built in the project area at this time. Thus, no habitat alterations or disturbance would occur that would adversely affect moose in

the project area. No direct or indirect effects that could adversely affect moose or alter their habitat in the project area would be anticipated under this alternative.

Cumulative Effects

- ***Cumulative Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur at this time. Thus, no project-related habitat changes or disturbance would occur that could affect moose or their habitat in the cumulative effects analysis area. However, as the community of Bozeman continues to grow and expand, public access and recreational use of lands and related impacts in the cumulative effects analysis area are expected to continue to increase over time. No cumulative effects to moose would be anticipated.

- ***Cumulative Effects of Action Alternative A***

Under Action Alternative A, stand density and cover would be reduced on 601 acres of mature forest in the 33,422-acre cumulative effects analysis area. Of the 33,422-acre cumulative effects analysis area, 27,247 acres (82% of the cumulative effects analysis area) would remain in mature forest cover with >40% overstory canopy closure that would facilitate continued use of the area by moose. Of these acres 27,247 acres, approximately 22,221 (82%) would possess >60% overstory cover (66% of cumulative effects analysis area), which would provide quality hiding cover, severe winter cover (portions at lower elevations), and security cover for moose during all seasons. Following logging, forest patches on the cumulative effects analysis area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions suitable for use by moose. Mature forest stands of variable size and density in the cumulative effects analysis area would continue to provide a network of cover suitable for providing calving sites for moose following harvest. Given the ability of moose to use a broad range of habitats and conditions, harvest units and interspersed stringers of unharvested stands and riparian buffer areas would provide a suitable network of cover capable of facilitating movements within the cumulative effects analysis area.

Under Action Alternative A, total road amounts would increase from 75.6 existing miles to 80.9 miles in the cumulative effects analysis area, which could cause a minor proportional increase in disturbance and displacement of moose that use the 33,422-acre cumulative effects analysis area. Short-term disturbance and displacement associated with active logging activities during the 2 to 3 years of operations would be expected. This disturbance and displacement would be confined to the summer, fall and winter months. Disturbance in spring from April 1 to June 15 would be prohibited. Motorized disturbance and displacement associated with timber harvesting activities would not be expected extend beyond the length of the project. However, longer-term displacement potential and adverse effects associated with increased recreational use of 5.3 miles of new, restricted permanent roads would be possible. This disturbance would be cumulative to that other motorized disturbance and non-motorized recreational disturbance in the cumulative effects analysis area.

Some displacement of moose to other areas within the cumulative effects analysis area could occur for several decades depending on how much recreational use new roads may receive (i.e., user days) in the project area, and the types of recreation that would occur, which are somewhat uncertain into the future. Disturbance and displacement caused by these new roads would also be expected to vary by season. Many user days of cross country skiing traffic in winter, for example, could displace moose from important wintering sites and cause individuals to spend important energy reserves during severe winters (Hundertmark 2007). New roads and harvest units could increase vulnerability of bull moose to hunting mortality, however annual harvest is closely regulated and capped at two antlered bulls annually (DFWP 2018). Given how female moose select sites they perceive as secure for temporary parturition sites and the amount of cover and retained patches of forest cover that would remain in the cumulative effects analysis area following logging, it is very unlikely that the number and availability of suitable calving sites would be limiting for moose in this area.

Displacement of moose could occur for several decades depending on how much recreational use the area receives (user days), and the types of recreation. Both of these are somewhat uncertain into the future. Some new road segments would likely receive greater recreational use, such as the long, proposed road segment which somewhat bisects sections 4 and 9. This 1.8-mile road segment runs along the ridge between No-name Creek and Nichols Creek in the project area and would likely have the greatest potential to introduce additional long-term adverse disturbance and displacement of moose associated with future levels of recreational use during winter. Given that this road segment is long and extends into a scenic area, it may become its own destination route. Future users could also use that segment to access ridgetops at higher elevations in the upper reaches of Nichols, No Name and Limestone creeks. The short 0.7-mile segment of permanent restricted road proposed under Action Alternative A in the southwest ¼ of section 4 could facilitate additional access from the Triple Tree Trail. This new short road segment could indirectly and effectively "link" public users of the Triple Tree Trail with other roads and trails in the project area and cumulative effects analysis area. This could potentially increase the level of public use in the cumulative effects analysis area, when compared with the existing condition. The degree that use would actually increase is uncertain. The new permanent restricted road system under Action Alternative A would generally allow easier and greater levels of access to popular routes and destinations in the project area and cumulative effects analysis area from both the east and west utilizing existing roads, new roads and the network of unauthorized trails than that which would be expected under Action Alternative B.

Trees would be expected to regenerate over the next 2 to 4 decades in treated harvest units and they would begin to provide cover and greater security for moose, which would lessen disturbance and displacement impacts attributable to the new permanent roads. Should displacement occur, individual displaced moose would most likely travel back into more remote areas elsewhere in the cumulative effects analysis area given the presence of cover and greater topographic relief there. Disturbance and displacement effects would primarily be localized and in association with the parcels contained in the project area.

Given that: 1) total road amounts would increase from 75.6 existing miles to 80.9 miles in the cumulative effects analysis area; 2) these roads could facilitate increases in recreation and affect security on approximately 1,980 acres (acres affected by road disturbance would increase from 13,425 existing to 14,525 (8% increase) in the cumulative effects analysis area – see the Recreation section in this wildlife analysis portion of the document); 3) well over half of the cumulative effects analysis area acreage (82%) would maintain moderate to high levels of forest cover, 4) moose use a wide range of habitats and have relatively large home ranges; 5) new roads are likely to be used by the public and recreational use is likely to increase to an uncertain degree; 6) disturbance and displacement of wildlife could be expected for several decades; 7) conifer regeneration in 2 to 4 decades on the project area would likely ameliorate some of the displacement effects; 8) the routes selected by users and intensity of recreation into the future are uncertain; 9) disturbance and displacement effects are expected to primarily be confined to the lands within the project area, however, some animals could be displaced to other areas within the cumulative effects analysis area; 10) the habitat selection behavior of pregnant moose, and 11) impeded travel by moose across or through affected lands in the project area and cumulative effects analysis area would not be expected – we anticipate activities under Action Alternative A would result in a minor level of cumulative effects associated with disturbance and displacement potential that could cause adverse effects to individual moose due the increase in new permanent, restricted roads and associated indirect increases in recreational uses during all seasons (but particularly winter). We further anticipate minor adverse cumulative effects: 1) to pregnant moose given the variety of places and types of sites they select for very short periods during calving, 2) associated with short-term motorized logging disturbance and displacement (2-3 years), 3) associated with cover loss. No discernable effects would be expected regarding reductions in carrying capacity or effects that would be detectable at the scale of the DFWP Hunting District.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add considerably to disturbance displacement potential for moose. Following treatments, hiding, thermal, and security cover could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total cumulative effects analysis area that could be affected by both projects would be 14.3% under DNRC's Action Alternative A. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would include broadcast burning, thinning and commercial harvesting and would add cumulative disturbance to the area. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative B***

Under Action Alternative B, stand density and cover would be reduced on 373 acres of mature forest in the 33,422-acre cumulative effects analysis area. Of the 33,422-acre cumulative effects

analysis area, 27,334 acres (82% of the cumulative effects analysis area) would remain in mature forest cover with >40% overstory canopy closure that would facilitate continued use of the area by moose. Of these acres 27,334 acres, approximately 22,449 (82%) would possess >60% overstory cover (67% of cumulative effects analysis area), which would provide quality hiding cover, severe winter cover (portions at lower elevations), and security cover for moose during all seasons. Following logging, forest patches on the cumulative effects analysis area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions suitable for use by moose. Mature forest stands of variable size and density in the cumulative effects analysis area would continue to provide a network of cover suitable for providing calving sites for moose following harvest. Given the ability of moose to use a broad range of habitats and conditions, harvest units and interspersed stringers of unharvested stands and riparian buffer areas would provide a suitable network of cover capable of facilitating movements within the cumulative effects analysis area.

Under Action Alternative B, total road amounts would increase from 75.6 existing miles to 80.2 miles in the cumulative effects analysis area, which could cause a minor proportional increase in disturbance and displacement of moose that use the 33,422-acre cumulative effects analysis area. Short-term disturbance and displacement associated with active logging activities during the 2 to 3 years of operations would be expected. This disturbance and displacement would be confined to the summer, fall and winter months. Disturbance in spring from April 1 to June 15 would be prohibited. Motorized disturbance and displacement associated with timber harvesting activities would not be expected extend beyond the length of the project. However, longer-term displacement potential and adverse effects associated with increased recreational use of 4.6 miles of new, restricted permanent roads would be possible. This disturbance would be cumulative to that other motorized disturbance and non-motorized recreational disturbance in the cumulative effects analysis area.

Some displacement of moose to other areas within the cumulative effects analysis area could occur for several decades depending on how much recreational use new roads may receive (i.e., user days) in the project area, and the types of recreation that would occur, which are somewhat uncertain into the future. Disturbance and displacement caused by these new roads would also be expected to vary by season. Many user days of cross country skiing traffic in winter, for example, could displace moose from important wintering sites and cause individuals to spend important energy reserves during severe winters (Hundertmark 2007). New roads and harvest units could increase vulnerability of bull moose to hunting mortality, however annual harvest is closely regulated and capped at two antlered bulls annually (DFWP 2018). Given how female moose select sites they perceive as secure for temporary parturition sites and the amount of cover and retained patches of forest cover that would remain in the cumulative effects analysis area following logging, it is very unlikely that the number and availability of suitable calving sites would be limiting for moose in this area.

Displacement of moose could occur for several decades depending on how much recreational use the area receives (user days), and the types of recreation. Both of these are somewhat

uncertain into the future. Some new road segments would likely receive greater recreational use, such as the long, proposed road segment which somewhat bisects sections 4 and 9. This 1.8-mile road segment runs along the ridge between No-name Creek and Nichols Creek in the project area and would likely have the greatest potential to introduce additional long-term adverse disturbance and displacement of moose associated with future levels of recreational use during winter. Given that this road segment is long and extends into a scenic area, it may become its own destination route. Future users could also use that segment to access ridgetops at higher elevations in the upper reaches of Nichols, No Name and Limestone creeks. The short 0.7-mile segment of permanent restricted road proposed under Action Alternative A in the southwest ¼ of section 4 would not be constructed under this alternative. Thus, it would not be present to facilitate additional access from the Triple Tree Trail. The establishment of new permanent restricted roads could still potentially increase the level of recreational use in the cumulative effects analysis area, when compared with the existing condition. The degree that use would actually increase is uncertain. The new permanent restricted road system under Action Alternative B would generally allow lower levels of access to popular routes and destinations in the project area and cumulative effects analysis area than would be expected under Action Alternative A.

Trees would be expected to regenerate over the next 2 to 4 decades in treated harvest units and they would begin to provide cover and greater security for moose, which would lessen disturbance and displacement impacts attributable to the new permanent roads. Should displacement occur, individual displaced moose would most likely travel back into more remote areas elsewhere in the cumulative effects analysis area given the presence of cover and greater topographic relief there. Disturbance and displacement effects would primarily be localized and in association with the parcels contained in the project area.
Given that: 1) total road amounts would increase from 75.6 existing miles to 80.2 miles in the cumulative effects analysis area; 2) these roads could facilitate increases in recreation and affect security on approximately 1,803 acres (acres affected by road disturbance would increase from 13,425 existing to 14,348 (7% increase) in the cumulative effects analysis area – see the Recreation section in this wildlife analysis portion of the document); 3) well over half of the cumulative effects analysis area acreage (82%) would maintain moderate to high levels of forest cover, 4) moose use a wide range of habitats and have relatively large home ranges; 5) new roads are likely to be used by the public and recreational use is likely to increase to an uncertain degree; 6) disturbance and displacement of wildlife could be expected for several decades; 7) conifer regeneration in 2 to 4 decades on the project area would likely ameliorate some of the displacement effects; 8) the routes selected by users and intensity of recreation into the future are uncertain; 9) disturbance and displacement effects are expected to primarily be confined to the lands within the project area, however, some animals could be displaced to other areas within the cumulative effects analysis area; 10) the habitat selection behavior of pregnant moose, and 11) impeded travel by moose across or through affected lands in the project area and cumulative effects analysis area would not be expected – we anticipate activities under Action Alternative B would result in a minor level of cumulative effects associated with disturbance and displacement potential that could cause adverse effects to individual moose

due the increase in new permanent, restricted roads and associated indirect increases in recreational uses during all seasons (but particularly winter). We further anticipate minor adverse cumulative effects: 1) to pregnant moose given the variety of places and types of sites they select for very short periods during calving, 2) associated with short-term motorized logging disturbance and displacement (2-3 years), 3) associated with cover loss. No discernable effects would be expected regarding reductions in carrying capacity or effects that would be detectable at the scale of the DFWP Hunting District.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add considerably to disturbance displacement potential for moose. Following treatments, hiding, thermal, and security cover could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total cumulative effects analysis area that could be affected by both projects wound be 13.6% under DNRC's Action Alternative B. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would involve broadcast burning, thinning and commercial harvesting. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternatives A and B). Under Alternative C, no trees or cover would be removed, and no roads would be built in the cumulative effects analysis area at this time. Thus, no habitat alterations or disturbance would occur that would adversely affect moose in the cumulative effects analysis area. No cumulative effects that could adversely affect moose or alter their habitat in the cumulative effects analysis area would be anticipated under this alternative.

ISSUE

There is concern that increases in roads, logging disturbance, cover loss, and long-term non-motorized recreational use associated with new restricted roads will lower habitat effectiveness for elk and reduce security resulting in bull elk vulnerability and displacement of herds to neighboring agricultural lands, which could increase game damage conflicts in the local area.

MEASUREMENT CRITERIA

The management criteria used to evaluate impacts related to the following issues pertaining to big game species included: the timing of proposed activities, location of proposed activities, scale of activities, quantified cover amounts [data sources DNRC SLI habitat and road data (2018), and USFS R-1 VMap Remote-sensing Database (USFS 2015)], road amounts, visual assessments of aerial photography and visual evaluation of cover and topography. For

cumulative effects analysis, pre-harvest canopy cover estimates were obtained from the USFS R-1 VMap Remote-sensing Database (USFS 2015) and post-harvest cover estimates were derived by estimating the percent canopy retained given the proportion of volume expected to be removed in each harvest unit.

AFFECTED ENVIRONMENT

The project area is located just within the northerly boundary of DFWP Hunting District 301. Approximately 200 to 300 use the DNRC Bear Canyon block of lands and foothill areas in winter. They are part of a larger overall heard of approximately 600 (J. Cunningham, R-3, DFWP Biologist, pers. comm., 9/21/16). Private agricultural lands to the north and west of the project area nearer the city of Bozeman are within Hunting District 309, which is restricted to primitive means of take only, to maintain safety near private homes and neighborhoods. Elk within this herd periodically frequent private lands and agricultural fields located in Hunting District 309, and crop depredation has been a problem (J. Cunningham, R-3, DFWP Biologist, pers. comm., 7/29/10, 9/21/16). Hunting regulations for the general season in Hunting District 301 allow harvest of brow-tined bull elk or antlerless elk from October 20 to November 4, 2018 and then become more restrictive thereafter to allow harvest of brow-tined bulls only for the remainder of the season from November 4 to November 25, 2018. Youth hunters may harvest either sex elk for the full duration of the season. For Hunting District 309, hunting with primitive weapons is allowed for either sex elk from September 1 to November 25, 2018. Then from November 26 until January 15, 2019, harvest of antlerless elk only is allowed (DFWP 2018).

Timber harvest can increase elk vulnerability by changing the size, structure, juxtaposition and accessibility of areas that provide security during hunting season (Hillis et al. 1991). As visibility and accessibility increase within forested landscapes, elk have a greater probability of being observed and subsequently harvested by hunters. Because the cow segment of the harvest is normally regulated carefully, primary concerns are related to substantial reduction of the bull segment and subsequent decrease in hunter opportunity. The presence of fewer mature bulls at the beginning of the hunting season, reduces the odds of any given hunter to see or harvest such an animal throughout the remainder of the hunting season. In the current situation involving lands in the project area vicinity and neighboring agricultural lands in Hunting District 309, both cow and bull elk may become unavailable to rifle hunters in Hunting District 301 if security is reduced, because groups of elk could be displaced and seek refuge and forage on nearby agricultural lands serving as refuges (Proffitt 2013). In either situation, elk may become less available to hunters for harvest during the general season.

To evaluate the potential for adverse impacts to elk security associated with the action alternatives, existing elk security in the project area and cumulative effects analysis area was evaluated following the methods of Hillis et al. (1991). While other security considerations have been brought to light in recent years concerning elk seeking refuge on private lands (Proffitt 2013), methods of Hillis et al. (1991) serve as a useful tool for consistently evaluating cover, security, and disturbance on forested and partially forested landscapes. Only moderately dense to closed canopy mature forested stands with patch size >250 acres were considered to

contribute to elk security. All forested patches that met these criteria also had to be >0.5 miles from any open road or intensively traveled trail to be counted towards security. Hillis et al. (1991) recommended that at least 30 percent of an elk herd's home range during hunting season should be comprised of large forested patches meeting this acreage and road-distance criteria to provide reasonable security for bull elk throughout hunting season.

A larger cumulative effects analysis area was delineated to evaluate elk security for this project. The size of this area is 93,552 acres and it was delineated to approximate the fall elk herd home range for elk that use the Bear Canyon Project Area vicinity. The area identified extends roughly in an 8-mile radius from the DNRC Bear Canyon Block (J. Cunningham, R-3, DFWP Biologist, pers. comm., 4/13/11). This area coincides closely with forested lands contained within the National Forest Boundary as well as state trust lands in, or near the project area. This area was identified as the most appropriate to consider cumulative impacts associated with road densities, disturbance, and potential reductions in forest cover on elk. There are large roadless portions of this analysis area and areas that receive non-motorized recreational use. It is bounded on several sides by private lands. The USFS manages the majority of lands within the elk security analysis area, followed by private landowners, and DNRC (Table W-7). DNRC manages approximately 7% of the elk security cumulative effects analysis area.

Table W-7. APPROXIMATE LAND OWNERSHIP WITHIN THE DNRC LIMESTONE WEST TIMBER SALE ELK SECURITY ANALYSIS AREA

Landowner	Acres (%)
DNRC	6,400 (7%)
Private	21,120 (23%)
USFS	66,032 (71%)
Total	93,552 (100%)

ENVIRONMENTAL EFFECTS

- ***Direct and Indirect Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur at this time. Thus, no project-related habitat changes or disturbance would occur that could affect elk, their habitat or neighboring agricultural lands in the project area. However, as the community of Bozeman continues to grow and expand, public access and recreational use of lands and related elk-security impacts in the project area are expected to continue to increase over time. No project-related direct or indirect effects to elk would be anticipated.

- ***Direct and Indirect Effects of Action Alternative A***

Under Action Alternative A, tree density within harvested stands would be reduced on 601acres of mature forest. Of the existing 1,845 acres of security habitat patches on the project area that are >250 acres with >40% mature canopy cover and that are >0.5 miles from an open road, 1,566 would be removed or affected by timber harvest and/or the presence of new restricted roads (likely to receive appreciable non-motorized use) leaving 279 acres (10%) (Table W-8). Across the project area moderate to dense patches of mature forest cover would be present. Of the 2,725-acre project area, 1,724 total acres (63%) would remain in mature forest cover with >40% overstory canopy closure. Of these acres, approximately 1,450 would possess >60% overstory cover (53% of project area). Following logging, forest patches on the project area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions. Within harvested stands, individual trees and patchy tree retention would remain, which would continue to provide some amount of escape cover and visual screening for elk. Although there would be 1,566 less acres of security cover following timber harvest and road development, hiding cover and connected mature forest patches would remain in the project area for elk, which would be expected to continue to use the project area. Although elk are likely to continue to use the project area following project activities, they would likely change their use patterns and potentially use lands in the project area less frequently, particularly in hunting season and winter.

Under Action Alternative A, 5.3 miles of new road would be constructed to access logging units. These roads would be retained in restricted status for future administrative use in the project area. This would result in an increase in restricted road density from an existing level of 1.0 miles per square mile, to 2.3 miles per square mile that would be subject to long-term administrative uses on the 4.25 square mile project area. These new restricted roads on the landscape are likely to contribute to a new long-term level of disturbance during all seasons associated with non-motorized recreational uses. Increased use and access is also possible during hunting season. It is possible that this change in access and open logged areas could: 1) increase vulnerability of mature bull elk, 2) increase hunter harvest of both sexes, 3) and/or reduce harvest by displacing elk into more remote backcountry areas or onto private lands where they are more inaccessible. The extent to which any of these outcomes may occur is uncertain. For additional detailed discussion regarding the potential for increased recreational disturbance on wildlife associated with newly constructed roads, see the Recreation section earlier in this wildlife analysis.

During active logging operations that may occur during fall months during the 2 to 3-year operating period, elk could be displaced from the project area. This displacement would likely be short-term due to the increase in human presence and high level of motorized activity. During the period that management activities would be occurring, elevated risk of elk displacement onto neighboring private lands would be present. Thus, some additional game damage situations could arise as a result of DNRC project activities, however, long-term displacement of elk onto private lands would not be expected as a result of proposed project

activities. New forest openings would be created by logging and slash burning that could provide minor benefits for elk and other ungulates for foraging, which could encourage their continued general use of the forest area away from private lands. The extent that this would occur is uncertain. Given the highly palatable and preferred forage species grown on nearby agricultural lands in the area (eg. hay meadows, winter wheat and alfalfa etc.), it is unlikely that elk would easily be discouraged from using such areas, regardless of whether or not any habitat changes or disturbance occurred on the project area or other neighboring forest lands. No public motorized access would be allowed in the project area while harvest activities are underway, thus no added risk of displacement or decreased security due to this cause would be present.

Given that: 1) 1,845-acres of existing security habitat would be reduced to 279 acres, 2) that 63% of the project area would remain in mature forest cover greater than 40% canopy, 3) that 1,450 acres would remain in cover at high canopy density (53% of project area), 4) that 5.3 miles of permanent restricted roads would be constructed in addition to the existing 4.3 miles, 5) no new open roads would be constructed, 6) long-term increases in non-motorized recreational use on new restricted roads is expected, 7) the extent of additional recreational use and elk response is uncertain, 8) motorized disturbance associated with the timber harvesting would be localized and short term – we anticipate that there would be both short and long-term added risk of disturbance and displacement of elk that could result in moderate and uncertain direct and indirect adverse effects.

Table W-8. ELK SECURITY HABITAT WITHIN THE LIMESTONE WEST TIMBER SALE PROJECT AREA FOR ALL THE ALTERNATIVES CONSIDERED

PARAMETER	ALTERNATIVES			
	NO ACTION	ACTION		
		A	B	C
Acres of Elk Security Habitat Reduced Through Harvest and Permanent Roads (Percent of Existing Security Habitat Reduced)	0.0 (0.0%)	1,566 (84.8%)	1,566 (84.8%)	0.0 (0%)
Acres of Elk Security Habitat Retained in the Project Area After Implementation of Each Alternative (Percent of Project Area)	1,845 (67.7%)	279 (10.2%)	279 (10.2%)	1,845 (67.7%)

- ***Direct and Indirect Effects of Action Alternative B***

Under Action Alternative B, tree density within harvested stands would be reduced on 373 acres of mature forest. Of the existing 1,845 acres of security habitat patches on the project area that are >250 acres with >40% mature canopy cover and that are >0.5 miles from an open road, 1,566 would be removed or affected by timber harvest and/or the presence of new restricted roads (likely to receive appreciable non-motorized use) leaving 279 acres (15%). This observed

reduction is the same under both alternatives due to the closely interspersed nature of the logging units, similar road amounts and locations. Across the project area moderate to dense patches of mature forest cover would be present. Of the 2,725-acre project area, 1,811 total acres (66%) would remain in mature forest cover with >40% overstory canopy closure. Of these acres, approximately 1,678 would possess >60% overstory cover (62% of project area). Following logging, forest patches on the project area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions. Within harvested stands, individual trees and patchy tree retention would remain, which would continue to provide some amount of escape cover and visual screening for elk. Although there would be 1,566 less acres of security cover following timber harvest and road development, hiding cover and connected mature forest patches would remain in the project area for elk, which would be expected to continue to use the project area. Although elk are likely to continue to use the project area following project activities, they would likely change their use patterns and potentially use lands in the project area less frequently, particularly in hunting season and winter.

Under Action Alternative B, 4.6 miles of new road would be constructed to access logging units. These roads would be retained in restricted status for future administrative use in the project area. This would result in an increase in restricted road density from an existing level of 1.0 miles per square mile, to 2.1 miles per square mile that would be subject to long-term administrative uses on the 4.25 square mile project area. These new restricted roads on the landscape are likely to contribute to a new long-term level of disturbance during all seasons associated with non-motorized recreational uses. Increased use and access is also possible during hunting season. It is possible that this change in access and open logged areas could: 1) increase vulnerability of mature bull elk, 2) increase hunter harvest of both sexes, 3) and/or reduce harvest by displacing elk into more remote backcountry areas or onto private lands where they are more inaccessible. The extent to which any of these outcomes may occur is uncertain. For additional detailed discussion regarding the potential for increased recreational disturbance on wildlife associated with newly constructed roads, see the Recreation section earlier in this wildlife analysis.

During active logging operations that may occur during fall months during the 2 to 3-year operating period, elk could be displaced from the project area. This displacement would likely be short-term due to the increase in human presence and high level of motorized activity. During the period that management activities would be occurring, elevated risk of elk displacement onto neighboring private lands would be present. Thus, some additional game damage situations could arise as a result of DNRC project activities, however, long-term displacement of elk onto private lands would not be expected as a result of proposed project activities. New forest openings would be created by logging and slash burning that could provide minor benefits for elk and other ungulates for foraging, which could encourage their continued general use of the forest area away from private lands. The extent that this would occur is uncertain. Given the highly palatable and preferred forage species grown on nearby agricultural lands in the area (eg. hay meadows, winter wheat and alfalfa etc.), it is unlikely that elk would easily be discouraged from using such areas, regardless of whether or not any habitat changes or disturbance occurred on the project area or other neighboring forest lands. No

public motorized access would be allowed in the project area while harvest activities are underway, thus no added risk of displacement or decreased security due to this cause would be present.

Given that: 1) 1,845-acres of existing security habitat would be reduced to 279 acres, 2) that 66% of the project area would remain in mature forest cover greater than 40% canopy, 3) that 1,678 acres would remain in cover at high canopy density (62% of project area), 4) that 4.6 miles of permanent restricted roads would be constructed in addition to the existing 4.3 miles, 5) no new open roads would be constructed, 6) long-term increases in non-motorized recreational use on new restricted roads is expected, 7) the extent of additional recreational use and elk response is uncertain, 8) motorized disturbance associated with the timber harvesting would be localized and short term – we anticipate that there would be both short and long-term added risk of disturbance and displacement of elk that could result in moderate and uncertain direct and indirect adverse effects.

- ***Direct and Indirect Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternatives A and B). Under Alternative C, no trees or cover would be removed, and no roads would be built in the project area at this time. Thus, no habitat alterations or disturbance would occur that would adversely affect elk in the project area or neighboring agricultural lands. No direct or indirect effects that could adversely affect elk or alter their habitat in the project area would be anticipated under this alternative.

Cumulative Effects

- ***Cumulative Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur at this time. Thus, no associated habitat changes or disturbance would occur that could affect elk, their habitat or neighboring agricultural lands in the cumulative effects analysis area. However, as the community of Bozeman continues to grow and expand, public access and recreational use of lands and related elk-security impacts in the elk security analysis area are expected to continue to increase over time. No project-related cumulative effects to elk would be anticipated.

- ***Cumulative Effects of Action Alternative A***

Under Action Alternative A, tree density within harvested stands would be reduced on 601 acres of mature forest. Of the existing 47,227 acres of security habitat patches (i.e., >250-acre patches with >40% canopy cover, >0.5 miles from open roads), 45,661 acres (48.8%) would remain after logging on the 93,552-acre cumulative effects analysis area (Table W-9). This amount exceeds the 30% threshold level recommended by Hillis et al. (1991). Across the elk security analysis area, other dense patches of mature forest cover would also be present and remain well-connected. Of the 93,552-acre cumulative effects analysis area, approximately

70,118 total acres (74.9%) would remain in mature forest cover with >40% overstory canopy closure. Of these acres, approximately 57,209 (61.2% of the 93,552-acre area) would possess >60% overstory cover (Table W-10). Within harvested stands, individual trees and patchy tree retention would remain, which would continue to provide some limited escape cover and visual screening for elk. Although there would be 1,566 less acres of security cover following timber harvest on DNRC lands (primarily attributable to new permanent restricted roads), ample amounts of hiding cover and connected mature forest patches would remain elsewhere in the project area, which would maintain suitable cover conditions for elk, which would be expected to continue to use the cumulative effects analysis area.

There are currently approximately 93.3 miles of restricted roads and 107.1 miles of open roads in the elk security analysis area (Table W-10). Under Action Alternative A, restricted road amounts would increase to 98.7 miles (5.8% increase). For the elk security analysis area total road density (combined total of restricted and open roads) is 1.37 miles per square mile and open road density is 0.73 miles per square mile (Table W-10). Under Action Alternative A, 5.3 miles of new road would be constructed to access logging units. These roads would be retained in restricted status for future administrative use in the project area. This would result in an increase in total road density from an existing level of 1.37 miles per square mile, to1.41 miles per square mile that would be subject to long-term administrative uses on the 4.25 square mile project area. These new restricted roads on the landscape are likely to contribute to a new long-term level of disturbance during all seasons associated with non-motorized recreational uses. Increased use and access is also possible during hunting season. At the scale of the 93,552-acre analysis area, it is possible that proposed changes in access and more logging units on the landscape could cause minor: 1) increases in vulnerability of mature bull elk, 2) increases hunter harvest of both sexes, 3) and/or reduce harvest by displacing elk into more remote backcountry areas or onto private lands where they are more inaccessible. The extent to which any of these outcomes may occur is uncertain. For additional detailed discussion regarding the potential for increased recreational disturbance on wildlife associated with newly constructed roads, see the Recreation section earlier in this wildlife analysis.

During active logging operations that may occur during fall months during the 2 to 3-year operating period, elk could be displaced from the project area. This displacement would likely be short-term due to the increase in human presence and high level of motorized activity. During the period that management activities would be occurring, elevated risk of elk displacement onto neighboring private lands would be present. Thus, some additional game damage situations could arise as a result of DNRC project activities, however, long-term displacement of elk onto private lands would not be expected as a result of proposed project activities. New forest openings would be created by logging and slash burning that could provide minor benefits for elk and other ungulates for foraging, which could encourage their continued general use of the forest area away from private lands. The extent that this would occur is uncertain. Given the highly palatable and preferred forage species grown on nearby agricultural lands in the area (eg. hay meadows, winter wheat and alfalfa etc.), it is unlikely that elk would easily be discouraged from using such areas, regardless of whether or not any habitat changes or disturbance occurred on the project area or other neighboring forest lands. No

public motorized access would be allowed in the project area while harvest activities are underway, thus no added risk of displacement or decreased security due to this cause would be present.

Given that: 1) 45,661 acres (48.8%) of security patches would remain after logging on the 93,552-acre cumulative effects analysis area, 2) that 74.9% of the project area would remain in mature forest cover greater than 40% canopy, 3) that 57,209 acres would remain in cover at high canopy density (61.2% of 93,552-acre area), 4) total road density would increase from 1.37 miles per square mile to 1.41 miles per square mile, 5) no new open roads would be constructed, 6) long-term increases in non-motorized recreational use on new restricted roads is expected, 7) the extent of additional recreational use and elk responses are uncertain, 8) localized motorized disturbance could displace elk for 2-3 years during active operations, 9) ample security patches exist in the elk analysis area that exceed the 30% threshold of Hillis et al. (1991), 10) motorized disturbance associated with the timber harvesting would be localized and short term – we anticipate that there would be both short and long-term added risk of disturbance and displacement of elk that could result in minor and uncertain direct and indirect adverse effects. Also, at the scale of the elk analysis area, there could be minor increases in bull elk vulnerability, however, discernable population-level effects at the scale of a DFWP Hunting District would not be anticipated.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,675 acres in the 93,552-acre elk security analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 5.0% of the elk security analysis area, which could add considerably to disturbance and displacement of elk and lowered security. Following treatments, hiding and security cover could be reduced on 4,675 acres for several decades by the BMW project. The percentage of the total elk security analysis area that could be affected by both projects combined would be 5.6% under DNRC's Action Alternative A. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would include broadcast burning, thinning and commercial harvesting, and would add cumulative disturbance to the area. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

TABLE W-9. ELK SECURITY HABITAT PARAMETERS WITHIN THE LIMESTONE WEST TIMBER SALE ELK SECURITY ANALYSIS AREA FOR ALL THE ALTERNATIVES CONSIDERED. *Road density calculations are simple linear calculations.*

PARAMETER	ALTERNATIVES			
	NO ACTION	ACTION		
		A	B	C
Acres of Elk Security Cover Removed (Percent of Existing Security Cover Removed)	0.0 (0.0%)	1,566 (3.3%)	1,566 (3.3%)	0.0 (0.0%)
Acres of Elk Security Cover Retained in the	47,227	45,661	45,661	47,227

93,552-Acre Elk Security Analysis Area After Implementation of Each Alternative (Percent of Elk Security Analysis Area)	(50.5%)	(48.8%)	(48.8%)	(50.5%)
Linear Miles of New Permanent, Restricted Road Constructed	0.0	5.3	4.6	0.0
Linear Miles of Total Permanent Restricted Road (Percent Increase)	93.37 (00.0%)	98.67 (5.7%)	97.97 (4.9%)	93.37 (00.0%)
Miles of New Permanent Open Road Constructed	0.0	0.0	0.0	0.0
Miles of Permanent Open Road (percent increase)	107.1 (0.0%)	107.1 (0.0%)	107.1 (0.0%)	107.1 (0.0%)
Open Road Density – mi./mi.^{2}	0.73	0.73	0.73	0.73
Total Road Density -- mi./mi.^{2}	1.37	1.41	1.40	1.37

TABLE W-10. ACREAGES BY ALTERNATIVES OF SPARCE FOREST, MODERATELY DENSE FOREST, AND DENSE FOREST STRUCTURAL CLASSES BASED ON OVERSTORY FOREST CANOPY COVER CLASSES IN THE DNRC LIMESTONE WEST TIMBER SALE ELK SECURITY ANALYSIS AREA *(Data source USFS R-1 VMap Remote-sensing Database -- 2015).*

Forest Structural Classes	**No Action Alternative Acres (%)** *[Existing Condition]*	**Action Alternative A Acres Post Harvest (%)**	**Action Alternative B Acres Post Harvest (%)**	**Action Alternative C Acres Post Harvest (%)**
Non-Forest/Sparse Forest (0 to 39% Canopy Cover)	23,063 (24.7%)	23,434 (25%)	23,347 (25%)	23,063 (24.7%)
Moderately Dense Forest (41 to 59% Canopy Cover)	12,679 (13.6%)	12,909 (13.8%)	12,768 (13.6%)	12,679 (13.6%)
Dense Forest (60 to 100% Canopy Cover)	57,810 (61.8%)	57,209 (61.2%)	57,437 (61.4%)	57,810 (61.8%)
Total	93,552	93,552	93,552	93,552

- ***Cumulative Effects of Action Alternative B***

Under the Action Alternative B, tree density within harvested stands would be reduced on 373 acres of mature forest. Of the existing 47,227 acres of security habitat patches (i.e., >250-acre patches with >40% canopy cover, >0.5 miles from open roads), 45,661 acres (48.8%) would remain after logging on the 93,552-acre cumulative effects analysis area (Table W-9). This observed reduction is the same under both alternatives due to the closely interspersed nature of the logging units, similar road amounts and locations. This 45,661-acre amount exceeds the 30% threshold level recommended by Hillis et al. (1991). Across the elk security analysis area, other dense patches of mature forest cover would also be present and remain well-connected. Of the 93,552-acre cumulative effects analysis area, approximately 70,205 total acres (75.0%) would remain in mature forest cover with >40% overstory canopy closure. Of these acres, approximately 57,437 (61.4% of the 93,552-acre area) would possess >60% overstory cover (Table W-10). Within harvested stands, individual trees and patchy tree retention would remain, which would continue to provide some limited escape cover and visual screening for elk. Although there would be 1,566 less acres of security cover following timber harvest on DNRC lands (primarily attributable to new permanent restricted roads), ample amounts of hiding cover and connected mature forest patches would remain elsewhere in the project area, which would maintain suitable cover conditions for elk, which would be expected to continue to use the cumulative effects analysis area.

There are currently approximately 93.3 miles of restricted roads and 107.1 miles of open roads in the elk security analysis area (Table W-10). Under Action Alternative B, restricted road amounts would increase to 98.0 miles (5.0% increase). For the elk security analysis area total road density (combined total of restricted and open roads) is 1.37 miles per square mile and open road density is 0.73 miles per square mile (Table W-10). Under Action Alternative A, 4.6 miles of new road would be constructed to access logging units. These roads would be retained in restricted status for future administrative use in the project area. This would result in an increase in total road density from an existing level of 1.37 miles per square mile, to1.40 miles per square mile that would be subject to long-term administrative uses on the 4.25 square mile project area. These new restricted roads on the landscape are likely to contribute to a new long-term level of disturbance during all seasons associated with non-motorized recreational uses. Increased use and access is also possible during hunting season. At the scale of the 93,552-acre analysis area, it is possible that proposed changes in access and more logging units on the landscape could cause minor: 1) increases in vulnerability of mature bull elk, 2) increases hunter harvest of both sexes, 3) and/or reduce harvest by displacing elk into more remote backcountry areas or onto private lands where they are more inaccessible. The extent to which any of these outcomes may occur is uncertain. For additional detailed discussion regarding the potential for increased recreational disturbance on wildlife associated with newly constructed roads, see the Recreation section earlier in this wildlife analysis.

During active logging operations that may occur during fall months during the 2 to 3-year operating period, elk could be displaced from the project area. This displacement would likely be short-term due to the increase in human presence and high level of motorized activity.

During the period that management activities would be occurring, elevated risk of elk displacement onto neighboring private lands would be present. Thus, some additional game damage situations could arise as a result of DNRC project activities, however, long-term displacement of elk onto private lands would not be expected as a result of proposed project activities. New forest openings would be created by logging and slash burning that could provide minor benefits for elk and other ungulates for foraging, which could encourage their continued general use of the forest area away from private lands. The extent that this would occur is uncertain. Given the highly palatable and preferred forage species grown on nearby agricultural lands in the area (eg. hay meadows, winter wheat and alfalfa etc.), it is unlikely that elk would easily be discouraged from using such areas, regardless of whether or not any habitat changes or disturbance occurred on the project area or other neighboring forest lands. No public motorized access would be allowed in the project area while harvest activities are underway, thus no added risk of displacement or decreased security due to this cause would be present.

Given that: 1) 45,661 acres (48.8%) of security patches would remain after logging on the 93,552-acre cumulative effects analysis area, 2) that 75% of the project area would remain in mature forest cover greater than 40% canopy, 3) that 57,437 acres would remain in cover at high canopy density (61.4% of 93,552-acre area), 4) total road density would increase from 1.37 miles per square mile to 1.40 miles per square mile, 5) no new open roads would be constructed, 6) long-term increases in non-motorized recreational use on new restricted roads is expected, 7) the extent of additional recreational use and elk responses are uncertain, 8) localized motorized disturbance could displace elk for 2-3 years during active operations, 9) ample security patches exist in the elk analysis area that exceed the 30% threshold of Hillis et al. (1991), 10) motorized disturbance associated with the timber harvesting would be localized and short term – we anticipate that there would be both short and long-term added risk of disturbance and displacement of elk that could result in minor and uncertain direct and indirect adverse effects. Also, at the scale of the elk analysis area, there could be minor increases in bull elk vulnerability, however, discernable population-level effects at the scale of a DFWP Hunting District would not be anticipated.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,675 acres in the 93,552-acre elk security analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 5.0% of the elk security analysis area, which could add to disturbance and displacement of elk and lowered security. Following treatments, hiding and security cover could be reduced on 4,675 acres for several decades by the BMW project. The percentage of the total elk security analysis area that could be affected by both projects combined would be 5.4% under DNRC's Action Alternative B. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would include broadcast burning, thinning and commercial harvesting, and would add cumulative disturbance to the area. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternatives A and B). Under Alternative C, no trees or cover would be removed, and no roads would be built in the project area at this time. Thus, no habitat alterations or disturbance would occur that would adversely affect elk in the cumulative effects analysis area or neighboring agricultural lands. No cumulative effects that could adversely affect elk or alter their habitat in the cumulative effects analysis area would be anticipated under this alternative.

ISSUE

There is concern that activities proposed in this project may create disturbance, increase road amounts, and reduce forest thermal and hiding cover, which could adversely affect wintering elk, mule deer, and white-tailed deer.

MEASUREMENT CRITERIA

The management criteria used to evaluate impacts related to the following issues pertaining to big game species included: the timing of proposed activities, location of proposed activities, scale of activities, quantified cover amounts [data sources DNRC SLI data and road data (2018), and USFS R-1 VMap Remote-sensing Database (USFS 2015)]. For cumulative effects analysis, canopy cover estimates were derived from the USFS R-1 VMap Remote-sensing Database (USFS 2015). During some portion of each winter all three species are capable of using dense forest stands at all elevations. Therefore, all forested stands in the project area were considered potentially usable by wintering cervids. Logging and winter effects on moose were considered in this analysis in a separate section for that species. Cumulative effects were considered at the scale of the 33,422-acre cumulative effects analysis area.

AFFECTED ENVIRONMENT

The project area contains suitable winter range conditions for elk, mule deer and white-tailed deer. Relatively disturbance-free areas with low snow accumulation and ample cover and forage are important in winter for elk and deer herds in western Montana. Areas where these species winter are typically found at low to mid elevations (~3,000 to 6,000 ft.) and possess moderate to steep slopes – particularly associated with southerly or westerly exposures. Densely stocked thickets of conifer regeneration and densely forested mature stands provide thermal protection and hiding cover, which can reduce energy expenditures and stress associated with cold temperatures, wind, and human-caused disturbance. Areas with mature forest cover are also important for snow interception, which makes travel and foraging less stressful for elk and deer during periods when snow is deep. Because of their larger size, elk are better adapted to withstand deeper snow conditions and cold temperatures than white-tailed deer (Jenkins and Wright 1988). Dense stands that are well connected provide for animal movements across wintering areas during periods with deep snow, which improves their ability to find forage and shelter under varied environmental conditions. Thus, removing cover

that is important for wintering moose, elk, and deer through forest management activities can increase their energy expenditures and stress in winter. Reductions in cover could ultimately result in a reduction in winter range carrying capacity and subsequent increases in winter mortality within local herds. High recreational use and existing roads present in the project area and cumulative effects analysis area reduce the effectiveness and suitability of this area to provide high quality winter range.

There are currently 2,095 acres of mature forest cover with ≥40% canopy cover in the project area. Of these acres, 2,051 (98%) possess dense canopy conditions with ≥60 cover, and are capable of ameliorating severe winter conditions for deer and elk (Table W-1). There are currently 4.6 miles of restricted roads on the project area (Table W-6) and no open roads.

ENVIRONMENTAL EFFECTS

- ***Direct and Indirect Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur at this time. Thus, no project-related winter habitat changes or disturbance would occur that could affect wintering moose, elk, mule deer or white-tailed deer in the project area. However, as the community of Bozeman continues to grow and expand, public access and recreational use of lands and related impacts in the project area are expected to continue to increase over time. No direct or indirect project-related effects to winter range habitat or wintering cervids would be anticipated.

- ***Direct and Indirect Effects of Action Alternative A***

Under Action Alternative A, stand density and winter cover would be reduced on 601 acres of mature forest in the project area. Of the 2,725-acre project area, 1,724 acres (63% of project area) would remain in mature forest cover with >40% overstory canopy closure. Of these acres, approximately 1,450 would possess >60% overstory cover (53% of project area), which would provide quality thermal cover and snow intercept cover for wintering elk, and deer. However, 371 acres of existing mature forest cover would be clearcut and removed, which would reduce cover capable of intercepting snow and buffering cold temperatures. Following logging, forest patches on the project area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions. Mature forest stands in the project area would generally remain moderately connected and provide a suitable network of cover capable of facilitating movements of wintering animals across the local landscape. Within harvested stands, individual trees and patchy tree retention would remain, which would continue to provide limited escape cover and visual screening.

Under the Action Alternative A, 5.3 miles of new road would be constructed in the project area to access logging units in addition to the existing 4.3 miles (9.9 miles total). No open roads would be constructed. These additional restricted roads would be constructed and used in conjunction with logging activities for the duration of the project (2 to 3 years). This would result in an increase in road density from an existing level of 1.0 miles per square mile, to 2.3 miles per square mile that would be subject to active operations on the 4.25 square mile project

area. Following harvest activities, restricted roads would be gated, and non-motorized recreational use would be allowed. The extent that the new roads would receive appreciable use in winter is uncertain, however, disturbance to wintering deer and elk would be possible. During winter harvest operations, disturbance from motorized equipment would likely disturb and displace elk, mule deer, and white-tailed deer, and habitat in the project area and nearby vicinity may temporarily be unusable due to the level of noise and human activity. Elk and deer feeding on tree tops and slash piles is likely during periods of logging inactivity. During the winter periods when management activities would be occurring, elevated risk of displacement of wintering animals onto neighboring private lands would be present. Thus, some additional game damage situations could arise as a result of DNRC project activities, however, long-term displacement of onto private lands would not be expected as a result of proposed project activities in winter.

Several new forest openings would be created by logging and prescribed slash pile burning that could provide minor benefits for elk and deer for foraging during mild winters, and early and late portions of each winter, which could encourage their continued general use of the forest area away from private lands. Given the highly palatable and preferred forage species grown on nearby agricultural lands in the area (eg. winter wheat and alfalfa etc.), it is unlikely that elk would easily be discouraged from using such areas, regardless of whether or not any habitat changes or disturbance occurred on the project area or other neighboring forest lands. No public motorized access would be allowed in the project area while harvest activities are underway, thus no added risk of displacement from winter range due to this cause would be present. There would be short-term added risk of disturbance and displacement of wintering animals that could result in minor adverse effects associated with logging operations, short term road construction, and road use.

Given that: 1) winter cover would be reduced on 601 acres, 2) 1,724 acres (63% of project area) would remain in mature forest cover with >40% overstory canopy closure, 3) approximately 1,450 would possess >60% overstory cover (53% of project area), which would provide quality thermal cover and snow intercept cover, 4) motorized disturbance associated with logging could disturb and displace elk and deer during stressful winter conditions, 5) 5.3 miles of new permanent restricted road would be constructed, 6) new roads would likely receive winter recreational use causing displacement of wintering elk and deer in the long-term, 7) the extent of the disturbance is uncertain, 8) no open roads would be constructed, -- short term and long term moderate adverse direct and indirect effects to winter habitat and wintering elk, mule deer and white-tailed deer would be anticipated. Reductions in winter cover on 601 acres would be expected to proportionally reduce local winter carrying capacity, particularly stands at lower elevations where wintering cervids concentrate on winter range and new restricted roads would have an uncertain, but potentially lasting adverse disturbance effect.

- ***Direct and Indirect Effects of Action Alternative B***

Under Action Alternative B, stand density and winter cover would be reduced on 373 acres of mature forest in the project area. Of the 2,725-acre project area, 1,811 acres (67% of project area) would remain in mature forest cover with >40% overstory canopy closure. Of these acres, approximately 1,678 would possess >60% overstory cover (62% of project area), which would

provide quality thermal cover and snow intercept cover for wintering elk, and deer. However, 284 acres of existing mature forest cover would be clearcut and removed, which would reduce cover capable of intercepting snow and buffering cold temperatures. Following logging, forest patches on the project area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions. Mature forest stands in the project area would generally remain moderately connected and provide a suitable network of cover capable of facilitating movements of wintering animals across the local landscape. Within harvested stands, individual trees and patchy tree retention would remain, which would continue to provide limited escape cover and visual screening.

Under the Action Alternative B, 4.6 miles of new road would be constructed in the project area to access logging units in addition to the existing 4.3 miles (8.9 miles total). No open roads would be constructed. These additional restricted roads would be constructed and used in conjunction with logging activities for the duration of the project (2 to 3 years). This would result in an increase in road density from an existing level of 1.0 miles per square mile, to 2.1 miles per square mile that would be subject to active operations on the 4.25 square mile project area. Following harvest activities, restricted roads would be gated, and non-motorized recreational use would be allowed. The extent that the new roads would receive appreciable use in winter is uncertain, however, disturbance to wintering deer and elk would be possible. During winter harvest operations, disturbance from motorized equipment would likely disturb and displace elk, mule deer, and white-tailed deer, and habitat in the project area and nearby vicinity may temporarily be unusable due to the level of noise and human activity. Elk and deer feeding on tree tops and slash piles is likely during periods of logging inactivity. During the winter periods when management activities would be occurring, elevated risk of displacement of wintering animals onto neighboring private lands would be present. Thus, some additional game damage situations could arise as a result of DNRC project activities, however, long-term displacement of onto private lands would not be expected as a result of proposed project activities in winter.

Several new forest openings would be created by logging and prescribed slash burning that could provide minor benefits for elk and deer for foraging during mild winters, and early and late portions of each winter, which could encourage their continued general use of the forest area away from private lands. Given the highly palatable and preferred forage species grown on nearby agricultural lands in the area (eg. winter wheat and alfalfa etc.), it is unlikely that elk would easily be discouraged from using such areas, regardless of whether or not any habitat changes or disturbance occurred on the project area or other neighboring forest lands. No public motorized access would be allowed in the project area while harvest activities are underway, thus no added risk of displacement from winter range due to this cause would be present. There would be short-term added risk of disturbance and displacement of wintering animals that could result in minor adverse effects associated with logging operations, short term road construction, and road use.

Given that: 1) winter cover would be reduced on 373 acres, 2) 1,811 acres (67% of project area) would remain in mature forest cover with >40% overstory canopy closure, 3) approximately 1,678 would possess >60% overstory cover (62% of project area), which would provide quality

thermal cover and snow intercept cover, 4) motorized disturbance associated with logging could disturb and displace elk and deer during stressful winter conditions, 5) 4.6 miles of new permanent restricted road would be constructed, 6) new roads would likely receive winter recreational use causing displacement of wintering elk and deer in the long-term, 7) the extent of the disturbance is uncertain, 8) no open roads would be constructed, -- short term and long term moderate adverse direct and indirect effects to winter habitat and wintering elk, mule deer and white-tailed deer would be anticipated. Reductions in winter cover on 373 acres would be expected to proportionally reduce local winter carrying capacity, particularly stands at lower elevations where wintering cervids concentrate on winter range and new restricted roads would have an uncertain, but potentially lasting adverse disturbance effect.

- ***Direct and Indirect Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternatives A and B). Under Alternative C, no trees or cover would be removed, and no roads would be built in the project area at this time. Thus, no habitat alterations or disturbance would occur that would adversely affect wintering moose, elk, mule deer or white-tailed deer in the project area. No direct or indirect effects that could adversely affect winter cover, or cervids wintering in the project area would be anticipated under this alternative.

Cumulative Effects

- ***Cumulative Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur at this time. Thus, no project-related winter habitat changes or disturbance would occur that could affect wintering moose, elk, mule deer or white-tailed deer in the cumulative effects analysis area. However, as the community of Bozeman continues to grow and expand, public access and winter recreational use of lands and related impacts in the cumulative effects analysis area are expected to continue to increase over time. No project-related cumulative effects related to winter range habitat or wintering cervids would be anticipated under this alternative.

- ***Cumulative Effects of Action Alternative A***

Under Action Alternative A, stand density and winter cover would be reduced on 601 acres of mature forest in the cumulative effects analysis area. Of the 33,422-acre cumulative effects analysis area, 27,247 acres (82% of cumulative effects analysis area) would remain in mature forest cover with >40% overstory canopy closure. Of these acres, approximately 22,221 would possess >60% overstory cover (67% of the cumulative effects analysis area), which would provide quality thermal cover and snow intercept cover for wintering elk, and deer. However, 371 acres of existing mature forest cover would be clearcut and removed, which would reduce cover capable of intercepting snow and buffering cold temperatures. Following logging, forest

patches on the project area and across the broader cumulative effects analysis area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions. Mature forest stands in the cumulative effects analysis area would generally remain well connected and provide a suitable network of cover capable of facilitating movements of wintering animals across the broader landscape.

Under the Action Alternative A, 5.3 miles of new road would be constructed in the cumulative effects analysis area in addition to the existing 75.6 miles (80.9 miles total). No open roads would be constructed. These additional restricted roads would be constructed and used in conjunction with logging activities for the duration of the project (2 to 3 years). This would result in an increase in total road density from an existing level of 1.45 miles per square mile, to 1.55 miles per square mile. Following harvest activities, restricted roads would be gated, and non-motorized recreational use would be allowed. The extent that the new roads would receive appreciable use by recreationists in winter is uncertain, however, some disturbance to wintering deer and elk in the cumulative effects analysis area would be possible. During winter harvest operations, disturbance from motorized equipment would likely disturb and displace elk, mule deer, and white-tailed deer, and habitat to neighboring lands and elsewhere in the cumulative effects analysis area. During the winter periods when management activities would be occurring, elevated risk of displacement of wintering animals onto neighboring private lands would be present. Thus, some additional game damage situations could arise as a result of DNRC project activities, however, long-term displacement of onto private lands would not be expected as a result of proposed project activities in winter.

Several new forest openings would be created by logging and prescribed slash burning that could provide minor benefits for elk and deer for foraging during mild winters, and early and late portions of each winter, which could encourage their continued general use of the forest area away from private lands. Given the highly palatable and preferred forage species grown on nearby agricultural lands in the area (eg. winter wheat and alfalfa etc.), it is unlikely that elk would easily be discouraged from using such areas, regardless of whether or not any habitat changes or disturbance occurred on the project area or other neighboring forest lands.

Given that: 1) winter cover would be reduced on 601 acres, 2) 27,247 acres (82% of project area) would remain in mature forest cover with >40% overstory canopy closure, 3) approximately 22,221 acres would possess >60% overstory cover (67% of project area), which would provide quality thermal cover and snow intercept cover, 4) motorized disturbance associated with logging could disturb and displace elk and deer during stressful winter conditions, 5) 5.3 miles of new permanent restricted road would be constructed, 6) new roads would likely receive winter recreational use causing localized displacement of wintering elk and deer in the long-term, 7) the extent of the disturbance is uncertain, 8) no open roads would be constructed, -- short term and long term minor adverse cumulative effects to winter habitat and wintering elk, mule deer and white-tailed deer would be anticipated. Reductions in winter cover on 601 acres would be expected to proportionally and cumulatively reduce local winter carrying capacity, particularly stands at lower elevations where wintering cervids concentrate on winter range in the cumulative effects analysis area and new restricted roads would have an uncertain, but potentially lasting low adverse disturbance effect.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add to displacement potential for wintering elk and deer. Following treatments, forest cover could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total cumulative effects analysis area that could be affected by both projects would be 14.3% under DNRC's Action Alternative A. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would include broadcast burning, thinning and commercial harvesting and would add cumulative disturbance to the area. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative B***

Under Action Alternative B, stand density and winter cover would be reduced on 373 acres of mature forest in the cumulative effects analysis area. Of the 33,422-acre cumulative effects analysis area, 27,334 acres (82% of cumulative effects analysis area) would remain in mature forest cover with >40% overstory canopy closure. Of these acres, approximately 22,449 would possess >60% overstory cover (67% of cumulative effects analysis area), which would provide quality thermal cover and snow intercept cover for wintering elk, and deer. However, 284 acres of existing mature forest cover would be clearcut and removed, which would reduce cover capable of intercepting snow and buffering cold temperatures. Following logging, forest patches on the project area and across the broader cumulative effects analysis area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions. Mature forest stands in the cumulative effects analysis area would generally remain well connected and provide a suitable network of cover capable of facilitating movements of wintering animals across the broader landscape.

Under the Action Alternative B, 4.6 miles of new road would be constructed in the cumulative effects analysis area in addition to the existing 75.6 miles (80.2 miles total). No open roads would be constructed. These additional restricted roads would be constructed and used in conjunction with logging activities for the duration of the project (2 to 3 years). This would result in an increase in total road density from an existing level of 1.45 miles per square mile, to 1.54 miles per square mile. Following harvest activities, restricted roads would be gated, and non-motorized recreational use would be allowed. The extent that the new roads would receive appreciable use by recreationists in winter is uncertain, however, some disturbance to wintering deer and elk in the cumulative effects analysis area would be possible. During winter harvest operations, disturbance from motorized equipment would likely disturb and displace elk, mule deer, and white-tailed deer, and habitat to neighboring lands and elsewhere in the cumulative effects analysis area. During the winter periods when management activities would be occurring, elevated risk of displacement of wintering animals onto neighboring private lands would be present. Thus, some additional game damage situations could arise as a result of DNRC project activities, however, long-term displacement of onto private lands would not be expected as a result of proposed project activities in winter.

Several new forest openings would be created by logging and prescribed slash burning that could provide minor benefits for elk and deer for foraging during mild winters, and early and late portions of each winter, which could encourage their continued general use of the forest area away from private lands. Given the highly palatable and preferred forage species grown on nearby agricultural lands in the area (eg. winter wheat and alfalfa etc.), it is unlikely that elk would easily be discouraged from using such areas, regardless of whether or not any habitat changes or disturbance occurred on the project area or other neighboring forest lands.

Given that: 1) winter cover would be reduced on 373 acres, 2) 27,334 acres (82% of project area) would remain in mature forest cover with >40% overstory canopy closure, 3) approximately 22,449 acres would possess >60% overstory cover (67% of project area), which would provide quality thermal cover and snow intercept cover, 4) motorized disturbance associated with logging could disturb and displace elk and deer during stressful winter conditions, 5) 4.6 miles of new permanent restricted road would be constructed, 6) new roads would likely receive winter recreational use causing localized displacement of wintering elk and deer in the long-term, 7) the extent of the disturbance is uncertain, 8) no open roads would be constructed, -- short term and long term minor adverse cumulative effects to winter habitat and wintering elk, mule deer and white-tailed deer would be anticipated. Reductions in winter cover on 373 acres would be expected to proportionally and cumulatively reduce local winter carrying capacity, particularly stands at lower elevations where wintering cervids concentrate on winter range in the cumulative effects analysis area and new restricted roads would have an uncertain, but potentially lasting low adverse disturbance effect.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add to displacement potential for wintering elk and deer. Following treatments, forest cover could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total cumulative effects analysis area that could be affected by both projects would be 13.6% under DNRC's Action Alternative B. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would include broadcast burning, thinning and commercial harvesting and would add cumulative disturbance to the area. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternatives A and B). Under Alternative C, no trees or cover would be removed, and no roads would be built in the cumulative effects analysis area at this time. Thus, no habitat alterations or disturbance would occur that would adversely affect wintering moose, elk, mule deer or white-tailed deer in the cumulative effects analysis

area. No cumulative effects that could adversely affect winter cover, or cervids wintering in the project area would be anticipated under this alternative.

ISSUE

There is concern that the presence of roads and loss of cover associated with logging could adversely affect elk calving areas on the project area.

MEASUREMENT CRITERIA

The management criteria used to evaluate impacts related to the following issues pertaining to big game species included: the timing and duration of proposed activities, location of proposed activities, scale of activities, quantified cover amounts [data sources DNRC SLI data and road data (2018), and USFS R-1 VMap Remote-sensing Database (USFS 2015)]. For cumulative effects analysis, canopy cover estimates were derived from the USFS R-1 VMap Remote-sensing Database (USFS 2015).

AFFECTED ENVIRONMENT

Elk and other ungulates seek out secluded areas to have their young that are safe from disturbance and predators in May and June. In northwest Montana, elk have been documented moving to specific secure sites within 2 days of having calves, and 4 out of 5 cows gave birth within 100 meters of where they had previously (Vore and Schmidt 2001). Immediately following the birth of calves, individual cows remained isolated near their selected locations for several days before returning to mingle with other elk in local herds (Vore and Schmidt 2001). Such areas are often located along spring migration routes. While specific areas may have importance for calf recruitment, it would be difficult to identify precise sites that individual cow may select year after year. Thus, managing for broad, diverse and well-connected dense cover patches across the landscape is a logical approach to maintaining a suitable range of sites over time for elk. See earlier analysis regarding moose calving areas for further information.

ENVIRONMENTAL EFFECTS

- ***Direct and Indirect Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur at this time. Thus, no project-related habitat changes or disturbance would occur that could affect calving sites for elk in the project area. However, as the community of Bozeman continues to grow and expand, public access and recreational use of lands and disturbance-related impacts in the project area are expected to continue to increase over time. No direct or indirect project-related effects to calving habitat or elk during spring calving season would be anticipated.

- ***Direct and Indirect Effects of Action Alternative A***

As previously discussed in other sections, under Action Alternative A, stand density and cover would be reduced on 601 acres of mature forest in the project area. Of the 2,725-acre project area, 1,724 acres (63% of project area) would remain in mature forest cover with >40% overstory

canopy closure. Of these acres, approximately 1,450 would possess >60% overstory cover (53% of project area), which would provide quality hiding and security cover for elk and other ungulates in the spring season when calves are most vulnerable. Following logging, forest patches on the project area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions, patchy tree retention, and variable patch sizes. Mature forest stands in the project area would remain moderately connected and provide a network of cover suitable for providing calving sites. Within harvested stands, retained patches would continue to provide some escape cover and visual screening. Cover would be sparse on 371 acres proposed for clearcutting.

Under Action Alternative A, 5.3 miles of new road would be constructed in the project area to access logging units. Roads would be operational and used in conjunction with logging activities for the duration of the project (2 to 3 years). Construction of new permanent roads would result in an increase in road density from an existing level of 1.0 miles per square mile, to 2.3 miles per square mile that would be subject to active operations on the 4.25 square mile project area. No public motorized access would be allowed in the project area while harvest activities are underway, thus no added risk of disturbance or displacement due to this cause would be present in spring. The new roads would be restricted, but open to public non-motorized uses. They would be likely to receive recreational use, however the extent they would be used is somewhat uncertain. Disturbance risk associated with project activities would be relatively low as motorized logging activity would be restricted from April 1 to June 15 each during each year of operations. There would be minor short-term added risk of disturbance and displacement of pregnant cow elk in late spring that could result in minor adverse effects associated with logging operations, short term road construction, and road use that could occur after the June 15 activity restriction date when some individuals with young could still be in the area. However, minor long-term additional disturbance and displacement impacts to elk in spring habitat and calving areas due to increased recreational use on permanent restricted roads in the project area would be expected.

- ***Direct and Indirect Effects of Action Alternative B***

As previously discussed in other sections, under Action Alternative B, stand density and cover would be reduced on 373 acres of mature forest in the project area. Of the 2,725-acre project area, 1,811 acres (67% of project area) would remain in mature forest cover with >40% overstory canopy closure. Of these acres, approximately 1,678 would possess >60% overstory cover (62% of project area), which would provide quality hiding and security cover for elk and other ungulates in the spring season when calves are most vulnerable. Following logging, forest patches on the project area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions, patchy tree retention, and variable patch sizes. Mature forest stands in the project area would remain moderately connected and provide a network of cover suitable for providing calving sites. Within harvested stands, retained patches would continue to provide some escape cover and visual screening. Cover would be sparse on 284 acres proposed for clearcutting.

Under Action Alternative B, 4.6 miles of new road would be constructed in the project area to access logging units. Roads would be operational and used in conjunction with logging activities for the duration of the project (2 to 3 years). Construction of new permanent roads would result in an increase in road density from an existing level of 1.0 miles per square mile, to 2.1 miles per square mile that would be subject to active operations on the 4.25 square mile project area. No public motorized access would be allowed in the project area while harvest activities are underway, thus no added risk of disturbance or displacement due to this cause would be present in spring. The new roads would be restricted, but open to public non-motorized uses. They would be likely to receive recreational use, however the extent they would be used is somewhat uncertain. Disturbance risk associated with project activities would be relatively low as motorized logging activity would be restricted from April 1 to June 15 each during each year of operations. There would be minor short-term added risk of disturbance and displacement of pregnant cow elk in late spring that could result in minor adverse effects associated with logging operations, short term road construction, and road use that could occur after the June 15 activity restriction date when some individuals with young could still be in the area. However, minor long-term additional disturbance and displacement impacts to elk in spring habitat and calving areas due to increased recreational use on permanent restricted roads in the project area would be expected.

- ***Direct and Indirect Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternatives A and B). Under Alternative C, no trees or cover would be removed, and no roads would be built in the project area at this time. Thus, no habitat alterations or disturbance would occur that would adversely affect elk or calving habitat in the project area. No direct or indirect effects that could adversely affect calving elk or alter their habitat in the project area would be anticipated under this alternative.

Cumulative Effects

- ***Cumulative Effects of the No-Action Alternative***

Under the No-Action Alternative, no logging, tree removal or road construction would occur at this time in the cumulative effects analysis area. Thus, no associated habitat changes or disturbance would occur that could affect calving sites for elk in the cumulative effects analysis area. However, as the community of Bozeman continues to grow and expand, public access and recreational use of lands and related impacts in the project area are expected to continue to increase over time in the cumulative effects analysis area. No project-related cumulative effects to elk in spring, or calving habitat would be anticipated.

- ***Cumulative Effects of Action Alternative A***

Under Action Alternative A, tree density within harvested stands would be reduced on 601 acres of mature forest. Across the cumulative effects analysis area, other dense patches of mature forest cover would also be present and remain well-connected. Of the 33,422-acre

cumulative effects analysis area, approximately 27,247 total acres (82%) would remain in mature forest cover with >40% overstory canopy closure. Of these acres, approximately 22,221 (67% of the 33,422-acre area) would possess >60% overstory cover which would provide quality hiding and security cover in spring for female elk in the spring season when calves are most vulnerable. Following project completion, forest patches inn the cumulative effects analysis area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions, patchy tree retention, and variable patch sizes. Mature forest stands in the cumulative effects analysis area would remain well connected and provide a network of cover suitable for providing ample calving sites. Within harvested stands on the project area, retained patches would continue to provide some escape cover and visual screening. Cover would be sparse on 371 acres proposed for clearcutting.

Under Action Alternative A, 5.3 miles of new road would be constructed in the project area to access logging units. Roads would be operational and used in conjunction with logging activities for the duration of the project (2 to 3 years). Construction of new permanent roads would result in an increase in total road density from an existing level of 1.45 miles per square mile, to 1.55 miles per square mile in the cumulative effects analysis area. No public motorized access would be allowed in the project area while harvest activities are underway, thus no added risk of disturbance or displacement due to this cause would be present in spring. The new roads would be restricted, but open to public non-motorized uses. They would be likely to receive recreational use, however the extent they would be used is somewhat uncertain. Disturbance risk associated with project activities would be relatively low as motorized logging activity would be restricted from April 1 to June 15 each during each year of operations. There would be minor short-term added risk of disturbance and displacement of pregnant cow elk in late spring that could result in minor adverse effects associated with logging operations, short term road construction, and road use that could occur after the June 15 activity restriction date when some individuals with young could still be in the area. However, minor long-term additional disturbance and displacement impacts to elk in spring habitat and calving areas due to increased recreational use on permanent restricted roads in the cumulative effects analysis area would be expected. Due to the: 1) relatively small scale of the activity, 2) type of treatments proposed, 3) duration of the project of 2-3 years, 4) implementation of the April 1 to June 15 spring seasonal activity restriction that would be incorporated as mitigation, and 5) abundance of other available habitat and dense cover in the cumulative effects analysis area, activities associated with the proposed DNRC action would contribute minor adverse cumulative impacts involving spring habitat used during parturition for elk.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add to disturbance and displacement potential for calving elk. Following treatments, hiding and security cover could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total cumulative effects analysis area that could be affected by both projects would be 14.3% under DNRC's Action Alternative A. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would include broadcast

burning, thinning and commercial harvesting and would add cumulative disturbance to the area. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative B***

Under Action Alternative B, tree density within harvested stands would be reduced on 373 acres of mature forest. Across the cumulative effects analysis area, other dense patches of mature forest cover would also be present and remain well-connected. Of the 33,422-acre cumulative effects analysis area, approximately 27,334 total acres (82%) would remain in mature forest cover with >40% overstory canopy closure. Of these acres, approximately 22,449 (67% of the 33,422-acre area) would possess >60% overstory cover which would provide quality hiding and security cover in spring for female elk in the spring season when calves are most vulnerable. Following project completion, forest patches inn the cumulative effects analysis area would continue to have variable tree density and would continue to provide a mosaic of habitat conditions, patchy tree retention, and variable patch sizes. Mature forest stands in the cumulative effects analysis area would remain well connected and provide a network of cover suitable for providing ample calving sites. Within harvested stands on the project area, retained patches would continue to provide some escape cover and visual screening. Cover would be sparse on 284 acres proposed for clearcutting.

Under Action Alternative B, 4.6 miles of new road would be constructed in the project area to access logging units. Roads would be operational and used in conjunction with logging activities for the duration of the project (2 to 3 years). Construction of new permanent roads would result in an increase in total road density from an existing level of 1.45 miles per square mile, to 1.54 miles per square mile in the cumulative effects analysis area. No public motorized access would be allowed in the project area while harvest activities are underway, thus no added risk of disturbance or displacement due to this cause would be present in spring. The new roads would be restricted, but open to public non-motorized uses. They would be likely to receive recreational use, however the extent they would be used is somewhat uncertain. Disturbance risk associated with project activities would be relatively low as motorized logging activity would be restricted from April 1 to June 15 each during each year of operations. There would be minor short-term added risk of disturbance and displacement of pregnant cow elk in late spring that could result in minor adverse effects associated with logging operations, short term road construction, and road use that could occur after the June 15 activity restriction date when some individuals with young could still be in the area. However, minor long-term additional disturbance and displacement impacts to elk in spring habitat and calving areas due to increased recreational use on permanent restricted roads in the cumulative effects analysis area would be expected. Due to the: 1) relatively small scale of the activity, 2) type of treatments proposed, 3) duration of the project of 2-3 years, 4) implementation of the April 1 to June 15 spring seasonal activity restriction that would be incorporated as mitigation, and 5) abundance of other available habitat and dense cover in the cumulative effects analysis area, activities associated with the proposed DNRC action would contribute minor adverse cumulative impacts involving spring habitat used during parturition for elk.

Should the Custer Gallatin National Forest implement the BMW Project, similar treatments would be applied on 4,173 acres in the 33,422 cumulative effects analysis area. Thus, cover would be removed over a 5 to 12-year period on an additional 12.5% of the cumulative effects analysis area, which could add to disturbance and displacement potential for calving elk. Following treatments, hiding and security cover could be reduced on 4,173 acres for several decades by the BMW project. The percentage of the total cumulative effects analysis area that could be affected by both projects would be 13.6% under DNRC's Action Alternative B. Approximately 31 miles of existing roads and 10.3 miles of temporary and re-constructed roads would be used to access treatment units in the BMW Project that would include broadcast burning, thinning and commercial harvesting and would add cumulative disturbance to the area. Total duration of mechanized cumulative activities considering both the USFS and DNRC projects could extend to as long as 15 years.

- ***Cumulative Effects of Action Alternative C***

Under Action Alternative C, a conservation license in lieu the timber sale would be issued, which would ensure a temporary 10-year deferral of logging and road construction associated with the proposed timber sale alternatives (i.e., Alternatives A and B). Under Alternative C, no trees or cover would be removed, and no roads would be built in the cumulative effects analysis area at this time. Thus, no habitat alterations or disturbance would occur that would adversely affect calving elk in the cumulative effects analysis area. No cumulative effects that could adversely affect elk in spring or alter calving habitat in the cumulative effects analysis area would be anticipated under this alternative.

- **List of Mitigations**

- Given operability and human safety constraints, retain all existing non-merchantable snags where possible.

- Across all harvest units, retain at least 2 large snags and 2 large recruitment trees per acre (both >21 inches dbh, or largest available).

- In all harvest units retain large woody debris within ranges recommended by Graham et al. (1994), which is approximately 5 to 15 tons/ac.

- If a wolf den is found within 1 mile of active harvest units or within 0.5 miles of a rendezvous site, cease operations and consult a DNRC wildlife biologist for appropriate site-specific mitigations before resuming activities.

- In harvest units without planned broadcast burning, retain as possible 2 to 3 slash piles (>10 ft. diameter) to provide residual structure for small mammals, amphibians and other wildlife.

- Require DNRC employees and contractors to store any unnatural bear foods or attractants in a bear-resistant manner (contract clause requirement).

- Opening sizes in regeneration harvest units must be designed in a manner that requires any point within each unit to be within 600 feet of hiding cover -- in at least one direction.

- Where opportunities exist, retain leave trees and retention areas in a clumped fashion to emulate natural disturbance patterns and reduce sight distances for wildlife.

- Restrict mechanized operations from April 1 to June 15 to minimize risk of disturbance to grizzly bears, calving areas and nesting birds.

- Restrict mechanized operations from January 15 to June 15 in harvest units C13 and C14 to minimize potential for disturbance to wolverines during the denning period.

- Retain advanced regeneration thickets comprised of subalpine fir, spruce, and Douglas-fir where possible as desirable structure and species diversity for snowshoe hares and visual screening.

- Retain 100 ft. no harvest RMZs along all class 1 streams in the project area (200 ft. total including both stream sides for No Name Creek, and Nichols Creek). Retain 100 to 350-foot variable width no harvest RMZs along Limestone Creek.

- Goshawk/Great Gray Owl Active Nest Site Mitigation – In an active northern goshawk or great gray owl nest is located, operations near the nest would cease and a DNRC biologist would be contacted. Site-specific measures would be developed and implemented to protect the nest and birds prior to re-starting activities.

ECONOMIC ANALYSIS

INTRODUCTION

This analysis describes current economic conditions associated with the Limestone West Timber Sale and discloses the potential direct, indirect, and cumulative economic and trust fiduciary effects that may result under each associated alternative. This analysis also discloses the data and methods using to calculate the term length of the proposed conservation license in Action Alternative C.

ISSUES AND MEASUREMENT CRITERIA

The following issue statement was crafted to account for concerns of the economic benefits of the Limestone West Timber Sale and guide the analysis of this section:

> *The proposed action may directly affect private income and employment in the regional economy. Potential economic benefits from this sale may also include additional revenues for state trust beneficiaries, infrastructure development, and other forest improvements on state trust forestlands.*

The following measurement criteria were selected to describe the existing economic environment in the area and to 'measure' the extent of the potential direct, indirect, and cumulative economic effects under each alternative: For income, the measurement criterion is dollars distributed to the Public Buildings Trust, Montana Tech Trust, FI program, and generated in the regional economy. For employment, the measurement criterion is the number of timber-related jobs provided.

- *For all income, revenues, and prices the measurement criterion is current U.S. dollars.*
- *For employment, the measurement criterion is full-time jobs sustained for one year.*

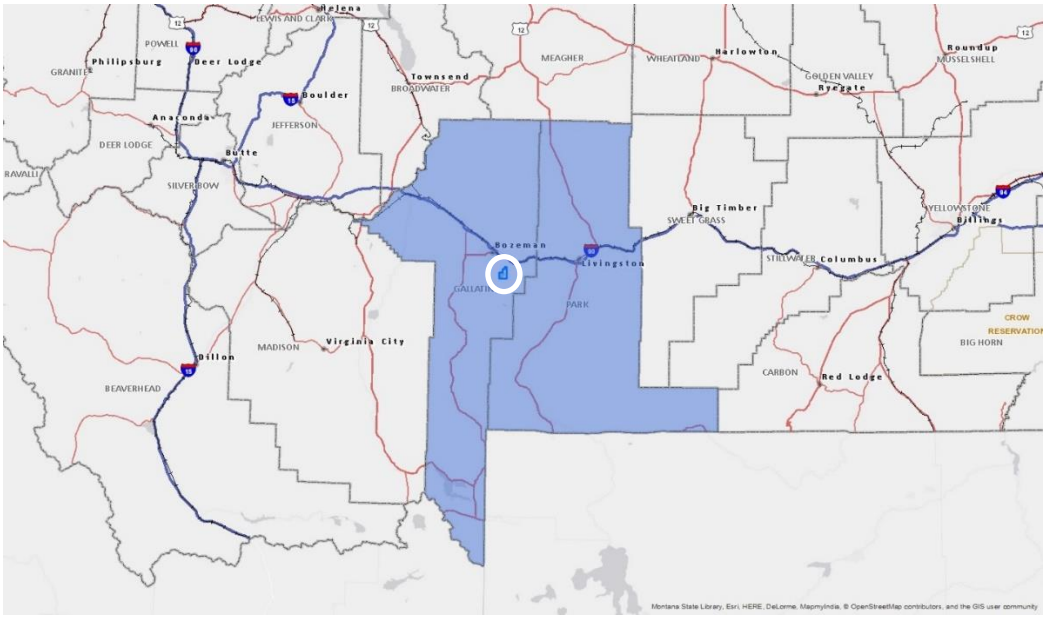
ANALYSIS AREA

The analysis area for the direct, indirect, and cumulative economic effects includes a multi-county area connected through commuting, business and trade to the project area (see *FIGURE EC1 – ECONOMIC ANALYSIS AREA*).

The counties selected for the analysis area include Gallatin and Park County. This two-county area represents the project area's functioning economic region and provides the closest markets for labor, products, and information in forestry, forest products, and a wide array of other industries.

Economic effects are considered geographically at the county-level and temporally over the duration of the proposed action. County-level is the appropriate scale to observe economic effects because industry job and income data are publicly reported and more accurate at this level.

FIGURE EC1 – ECONOMIC ANALYSIS AREA



ANALYSIS METHODS

This economic analysis of proposed timber sales is limited to the estimation of direct and indirect, income and employment opportunities occurring as a result of the proposed actions, including income opportunities for the trust beneficiaries, directly.

Project generated income, from stages of the proposed action up to the point of industrial processing, is estimated by multiplying reported regional gate prices[7] (the delivered log price paid by industrial wood processors) by the total harvest volume expected in the proposed timber sale. Stumpage prices, the contractual price paid for standing timber, are estimated using a transaction evidence appraisal to determine the portion of this total income earned by the trust beneficiaries. Stumpage prices are estimated through transaction evidence from comparable timber sales, highlighting unique characteristics of the proposed sale (i.e. species mix, wood quality, density and diameter, terrain, development requirements, and proximity to markets). State trust management expenses are estimated from annual cash-flow records from DNRC's *TLMD* forest-management program.

Direct and indirect employment opportunities, as well as direct labor income are estimated using employment and income multipliers published by the *University of Montana's Bureau of Business and Economic Research*. Additionally, data sources for the economic analysis include DNRC's *TLMD*, U.S. Department of Commerce, U.S. Department of Labor, the *Department of Labor and Industry*, *Research and Analysis Bureau*, *Western Wood Products Association* and *Random Lengths*.

[7] Surveyed gate prices are reported quarterly by the Bureau of Business and Economic Research, an industry research organization at the University of Montana.

Data and methods associated with the calculation of the conservation licenses term can be found in *Appendix I – Limestone West Conservation License Term Analysis* at the end of this analysis.

AFFECTED ENVIRONMENT

The proposed action would take place on forested State Trust Lands located on the northern boundary of the Custer Gallatin National Forest situated just to the southeast of Bozeman, MT. Timber sales in this area typically supply raw materials for nearby and statewide forest products firms producing framing lumber, boards and beams, posts and poles, house logs, home improvement products, furniture, fuels and paper products.

Gallatin and Park Counties contain parts of the statewide forest products economy. The most likely processing locations for Bozeman area timber exist in these two counties. Summary county level economic data, for both counties, are provided in *TABLE EC1 – ANALYSIS AREA ECONOMY PROFILE*. Basic information is provided on industry firms present in each county. Industry employment data are largely unavailable at the county level. It is expected that available employment data account for only a portion of the total employment in the economy due to missing data on smaller or informal businesses. Gallatin County has many small wood products licensed businesses and Park County contains one significantly sized sawmill.

TABLE EC1 – ANALYSIS AREA ECONOMY PROFILE[8]

2016 U.S. data	Gallatin County, MT	Park County, MT	Analysis Area
Population, 2016	104,502	16,114	120,616
Population % change, 1970-2016	219%	41.8%	173.4%
Employment % change, 1970-2016	510.8%	117.1%	408.7%
Personal Income % change, 1970-2016	664.2%	210.1%	543.6%
Unemployment rate, 2017	2.7%	4.0%	2.8%
Average earnings per job, 2016 (2017 $s)	$45,549	$32,782	$44,135
Per capita income, 2016 (2017 $s)	$48,966	$46,606	$48,651
Non-Labor % of total personal income, 2016	36.5%	49.3%	38.1%
Services % of total employment, 2016	70.2%	66.9%	69.8%
Government % of total employment, 2016	12.6%	7.8%	12.0%
Timber % of total private employment, 2016	0.2%	1.9%	0.4%
Mining % of total private employment, 2016	0.4%	0.06%	0.3%
Fossil fuels (oil, gas, & coal), 2016	0.0%	0.02%	0.0%
Other mining, 2016	0.4%	0.04%	0.0%
Agriculture % of total employment, 2016	2.8%	11%	3.8%
Travel & Tourism % of total private employment, 2016	25.0%	32.2%	25.7%

The total population across the analysis area is estimated around 120 thousand. A majority of this population resides in Gallatin County. Timber sales are especially important to Park county due to the presence of processing and harvesting industries.
TABLE EC2–TIMBER INDUSTRY EMPLOYMENT PROFILE provides a more detailed account of timber industry employment across counties in the analysis area, as of 2016. The two counties share an equivalent number of industry jobs, although Park County has proportionally

[8] U.S. Department of Commerce. 2016. Bureau of Economic Analysis, Regional Economic Accounts, Washington, D.C.

higher employment in timber industries overall. Park County hosts significantly more sawmill jobs, while Gallatin County has larger job numbers in wood products manufacturing. Employment opportunities supported directly, or indirectly to timber sales in the project area may occur in both of these counties.

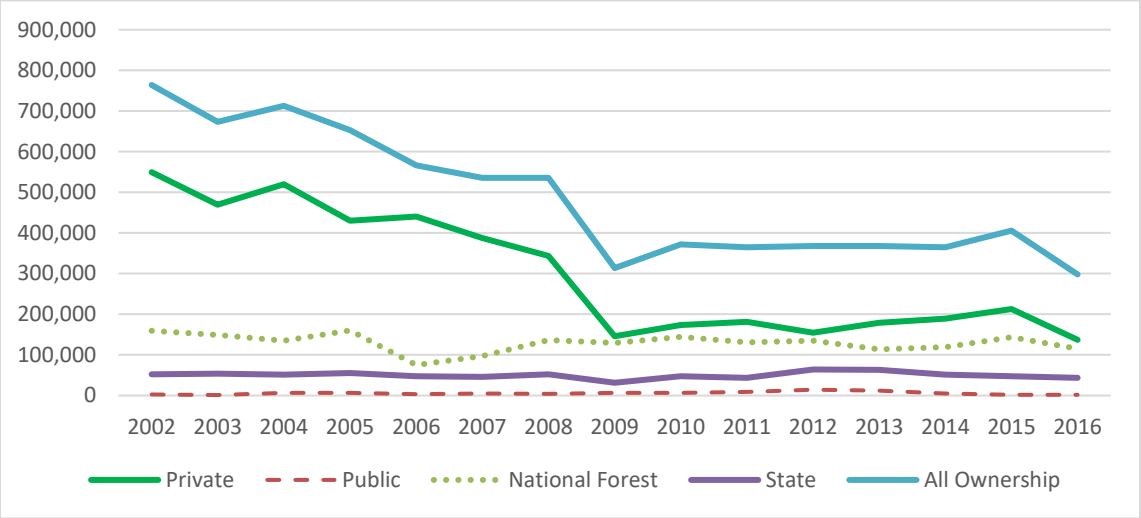
TABLE EC2–TIMBER INDUSTRY EMPLOYMENT PROFILE[9]

2016 U.S. employment data	Gallatin County, MT	Park County, MT	Analysis Area
Total Private Employment	45,778	5,083	50,861
Timber	97	98	195
Growing & Harvesting	14	4	18
Forestry & Logging	5	4	9
Support Activities for Forestry	9	0	9
Sawmills & Paper Mills	32	92	124
Sawmills & Wood Preservation	5	92	97
Pulp, Paper, & Paperboard Mills	0	0	0
Veneer, Plywood, & Engineered Wood	27	0	27
Wood Products Manufacturing	51	2	53
Other Wood Product Mfg.	18	2	20
Converted Paper Product Mfg.	33	0	33
Non-Timber	45,681	4,985	50,666

Regional commodity markets are another important perspective to consider for projects such as the proposed action. Overall, Montana timber and lumber markets have declined over recent history. *FIGURE EC2 – MONTANA TIMBER HARVEST BY OWNERSHIP, SELECT YEARS* shows this long run decline in Montana's timber supply since the 1980s. Aggregate timber supply in Montana has been affected by both changes in Federal policy and supply competition from Canada and the Pacific Northwest. Aggregate timber supply in Montana peaked in 1987 near 1.3 billion board feet and was recovering to over 400 million board feet in 2014. During this period in Montana, only state forests have continued to supply similar or increasing volumes year over year. As a result, supply of timber from state forests has increased as a percentage of aggregate supply, from approximately 3 to close to 15 percent. Over the past 10 years, state forests have supplied markets with an average of approximately 52 MMbf.

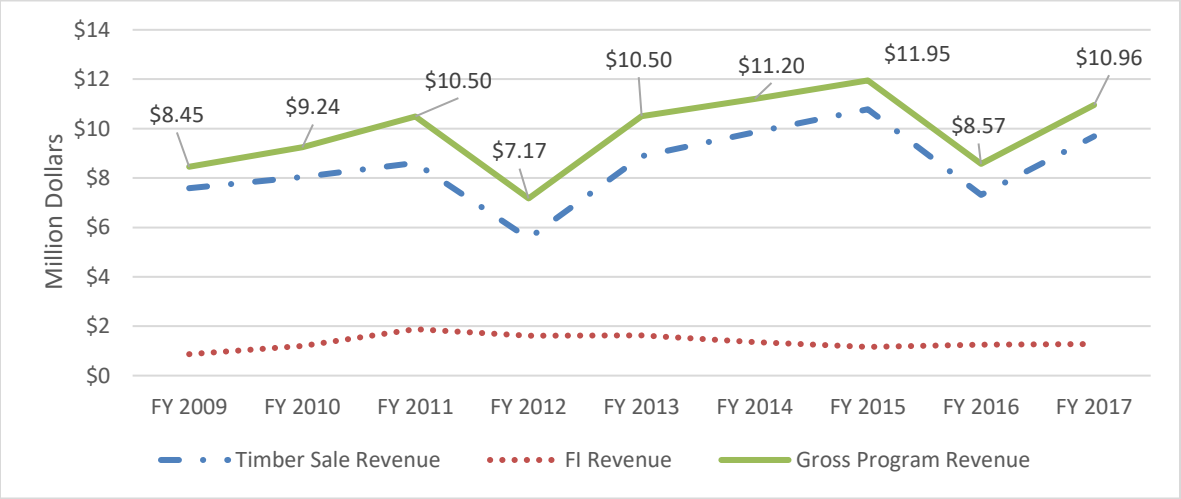
[9] U.S. Department of Commerce. 2016. Census Bureau, County Business Patterns, Washington, D.C.

FIGURE EC2 – MONTANA TIMBER HARVEST BY OWNERSHIP, SELECT YEARS[10]



In addition to supplying timber, state forests generate revenue for state trust beneficiaries. Revenue from state forests fluctuates due in part to fluctuating timber prices and other market conditions. *FIGURE EC3 – TLMD GROSS FOREST MANAGEMENT REVENUE, 9 YEARS* charts state forest gross revenue, which includes both timber sale and FI revenue. Revenues for trust beneficiaries grew in the most recent fiscal year, and expectations are for revenue growth in future years. The proposed action would contribute nearly 5% of the 5-year average TLMD statewide timber sale revenue, however in local markets it is much more significant. The proposed action would surpass the 5-year average of Trust Lands timber sales revenue within the Central Land Office, which includes Beaverhead, Madison, Gallatin, Park, Jefferson, Broadwater, Meagher, Cascade, Lewis & Clark, Teton, Pondera, Glacier, Toole and Liberty Counties.

FIGURE EC3 – TLMD GROSS FOREST MANAGEMENT REVENUE, 9 YEARS



[10] Bureau of Business and Economic Research. University of Montana, Missoula. 2018

Forest improvement (FI) revenues are a component of gross revenues earned from state forest timber sales and are used to finance projects that improve the health, productivity, and value of forested trust lands. FI investments are similar to capital improvements, as they can increase the asset value of forest lands and help yield future returns. FI activities may include the piling and disposal of logging slash, reforestation, thinning, prescribed burning, site preparation, noxious-weed control, seed collection, acquiring access and maintaining roads necessary for timber harvesting, and monitoring.

ECONOMIC EFFECTS

Direct economic effects include changes to income and employment in the timber related industries including forestry, logging, transportation, and wood-product manufacturing. Indirect economic effects include changes to other industries and sectors within the analysis area. Cumulative economic effects include any effect of the proposed action that may contribute to long-term changes in any part of the economy.
All economic effects are methodologically related to the scale and type of timber harvested and sold. TABLE EC3 –ESTIMATED DIRECT AND INDIRECT ECONOMIC EFFECTS tabulates the expected harvest volumes within the proposed action for each alternative. Between the two timber sale alternatives, Action Alternative A is expected to yield greater harvest volume.

ENVIRONMENTAL EFFECTS

- ***Direct and Indirect Effects of the No-Action Alternative***

Information organized in TABLE EC3 – ESTIMATED DIRECT AND INDIRECT ECONOMIC EFFECTS shows that under the No-Action Alternative, income effects from the project area would not be realized at this time. However, if timber from this project is not sold, equivalent volumes would need to come from sales on other trust forestlands in the State, lending to income and employment effects of an unknown scale to occur elsewhere. Local mills may not be able to substitute the potential loss of delivered logs from their regional resource supply chain. Negative economic effects can also occur from a no-action alternative concerning salvage condition trees where a particular forest stand is left unmanaged in a dead or dying state. Unmanaged dead stands can produce negative externalities and extend economic losses by promoting unwanted sylvicultural conditions and slowing down the rate at which a replacement stand matures. These effects are not quantified in this analysis but do represent an increase in the total economic opportunity costs for a no-action alternative decision concerning salvage or overgrown stands.

- ***Direct and Indirect Effects of Action Alternatives A and B***

Direct and indirect employment and income are estimated below. *TABLE EC3– ESTIMATED DIRECT AND INDIRECT ECONOMIC EFFECTS* shows an estimated total direct state revenue of $462,438 or $318,240 with a total delivered value of $1,741,600 or $1,090,600 would be created in the harvest and delivery of logs from Action Alternative A and B, respectively. A portion of this value represents the margin for operators to harvest, load, and haul the logs to mill

locations. The other portion includes revenue for state trust beneficiaries, infrastructure development, and other forest improvements on state forest. The estimated net revenue generated and distributed to trust beneficiaries is $189,600 or $130,478 for Action Alternative A and B, respectively. Management expenses are estimated using an average program revenue/cost ratio from annual accounting records highlighted and footnoted in *TABLE EC3– ESTIMATED DIRECT AND INDIRECT ECONOMIC EFFECTS*.

State income effects reported are based on a preliminary appraised timber sale contract value which references sawlog prices reported from the University of Montana Bureau of Business and Economic 2018 First Quarter Report. The estimated value in this EIS is preliminary and does not reflect the actual appraised sale values associated with any sale contract package. At the time of an actual sale, appraised values are expected to change with reported sawlog prices and other data refreshed in the timber sale contract package.

Direct labor income from harvesting and processing of timber in the proposed action is estimated at $1,070,251 or $670,197, for Action Alternative A and B, respectively. Estimated direct and indirect employment effects include the contribution to 24 or 15 full-time jobs for one year for Action Alternative A and B, respectively. The level of employment sustained by these alternatives is estimated using industry research by the *Bureau of Business and Economic Research*.

TABLE EC3– ESTIMATED DIRECT AND INDIRECT ECONOMIC EFFECTS

Measurable Effect	Formula	*Alternative*			
		No Action	Action A	Action B	Action C- Conservation License
Total harvest volume	[a]	0	4,354	2,727	0
Delivered log price ($/MBF)[11]	[b]	0	$400.00	$400.00	$400.00
Total delivered log value	[a] x [b]	0	$1,741,600	$1,090,600	$0
Timber sale revenue ($/MBF)	[c]	0	$102.61	$113.10	N/A
FI revenue ($/MBF)	[d]	0	$3.60	$3.60	$0.00
Direct state revenue	[a] x ([c] + [d])	0	$462,438	$318,240	$462,438 (Alt A) $318,240 (Alt B)
Direct trust revenue[12]	[a] x ([c] + [d]) x (.41)	0	$189,600	$130,478	$189,600 (Alt A)

[11] Estimated using species mix and current Bureau of Business and Economic Research market price for delivered sawlogs in the Eastern Montana region.

[12] State management expenses estimated with the revenue and cost summary in the FY 2017 Return on Asset Report. The 0.41 proportion is the 10-year average operating profit margin of timber management statewide.

					$130,478 (Alt B)
Estimated direct harvesting and processing employment[13]	[e]	0	24	15	0
Estimated direct harvesting and processing labor income[14]	[e]*43,926	0	$1,070,251	$670,197	$0
Estimated indirect employment	[e]*(0.54)	0	13	8	0

- ***Direct and Indirect Effects of Action Alternative C***

If conservation license applicants are the highest bidders, Action Alternative C would be implemented for a period of 10-years. Direct trust revenues would be identical to Action Alternative A or B, dependent on what timber harvest alternative is selected. Action Alternative C produces no estimated direct or indirect employment effects in the timber sale area. For a more detailed analysis of the term length that was determined for the conservation license, refer to *Appendix B – Limestone West Conservation License Term Analysis* at the end of this DEIS.

Cumulative Effects

Indirect and induced income effects are not quantified in this analysis, but they represent additional benefits to the economy as income earned in timber industries from the proposed action is recycled within the analysis area buying other goods and services.

Finally, cumulative effects have been considered and though they cannot be quantified in respect to action alternatives A and B, collectively include the minor role the proposed action has in supporting and making whole, long term capital investments made by forest product manufacturers and other timber companies in the analysis area. The infrastructure in these industries guarantees not only jobs and income in the analysis area, but also helps guarantee resource and land value for owners, public and private, of forested lands in Western Montana. Action Alternative C would defer these potential cumulative effects for a period of 10-years. Other cumulative effects of the proposed actions may include limited effects to regional and national timber and lumber markets, including the potential offsetting, or substitution, of imported timber or wood products. Again, Action Alternative C would defer these potential cumulative effects for a period of 10-years.

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[13] Sorenson, et al. 2015. Employment and Wage Impacts of Timber Harvesting and Processing in the United States. BBER University of Montana.

[14] U.S. Department of Labor. 2017. Bureau of Labor Statistics, Quarterly Census of Employment and Wages, Washington, D.C.

AIR QUALITY ANALYSIS

INTRODUCTION

This analysis describes the existing air quality and discloses the potential direct, indirect, and cumulative environmental effects the proposed action may have on air quality throughout the area.

ANALYSIS AREAS

The analysis area used to determine direct, indirect, and cumulative environmental effects to air quality includes airsheds within a 25-mile radius of the proposed project area. This area encompasses airsheds associated with the following major towns within the area: Bozeman, Belgrade, Livingston, and Four Corners.

ANALYSIS METHODS

The methodologies used to determine the environmental effects of the proposed action on air quality within the project and cumulative-effects analysis area include estimating the amount, location, timing, and duration of smoke and dust generated by activities associated with the proposed action. Cumulative effects include consideration of other actions indicated in *Chapter I – Relevant Past, Present, and Related Future Actions*.

ISSUES AND MEASUREMENT CRITERIA

Issues and Measurement Criteria

The following issues concerning air quality were raised during internal and external scoping and will be analyzed in further detail in this analysis:

- Dust produced from harvest activities, road building and maintenance, and hauling associated with this project may adversely affect local air quality.
- Smoke produced from logging slash pile and broadcast burning associated with this project may adversely affect local air quality.

Quantitative and qualitative changes to the following measurement criteria are intended to 'measure' the extent of the potential direct, indirect, and cumulative environmental effects the proposed action may have on existing air quality in the area.

- Amount/Intensity, location, timing (week, month, season), and duration (weeks, months, years) of road construction, road maintenance, and harvest-related traffic.
- Amount/Intensity (piles, acres), location, timing (week, month, season), and duration (weeks, months, years) of prescribed burning (broadcast and slash pile)

RELEVANT AGREEMENTS, LAWS, PLANS, PERMITS, LICENSES, AND OTHER AUTHORIZATIONS

Congress passed the Clean Air Act in 1963. The purpose of the act is to protect and enhance air quality while ensuring the protection of public health and welfare. *MCA 75-2-101* through *429* is known as the Clean Air Act of Montana and requires the State of Montana to provide for a coordinated statewide program to prevent, abate, and control air pollution while balancing the interest of the public.

DNRC is a member of the Montana/Idaho Airshed Group which was formed to minimize or prevent smoke impacts while using fire to accomplish land-management objectives and/or fuel hazard reduction (*Montana/Idaho Airshed Group 2010*). As a member, DNRC must submit a list of planned burns to the smoke-monitoring unit that describe the type of burn to be conducted, the size of the burn in total acres, the estimated fuel loading in tons/acre, and the location and elevation of each burn site. The smoke-monitoring unit provides timely restriction messages by airshed. DNRC and other cooperators are required to abide by those restrictions and burn only when conditions are conducive to good smoke dispersion.

The DEQ issues permits to entities that are classified as major open burners (*ARM 17.8.610).* DNRC is permitted to conduct prescribed wildland open- burning activities that are either deliberately or naturally ignited. Planned prescribed burn descriptions must be submitted to DEQ and the smoke-monitoring unit of the Montana/Idaho Airshed Group. All burns must be conducted in accordance with the major open-burning permit.

AFFECTED ENVIRONMENT

The analysis area is within the central part of Montana Airshed 8A (*Montana Idaho Airshed Group 2010*). The entire area is in attainment (an area considered to have air quality as good as or better than the National Ambient Air Quality Standards as defined in the Clean Air Act) by the Montana DEQ. The nearest non-attainment (an area that has been designated by the EPA and the appropriate state air quality agency as exceeding one or more National Ambient Air Quality Standards) area is Butte for Particulate Matter (PM-10) (85 miles to the west). All the area and the entire Gallatin National Forest is a Class II Airshed (areas can accommodate normal, well-managed industrial growth). The nearest Class I Airshed (areas allow the smallest incremental growth and accommodate only a small degree of air quality deterioration) area is Yellowstone National Park which is 33 miles to the south.

Air quality within the analysis areas is excellent with very limited local emission sources and consistent wind dispersion. Existing sources of emissions include occasional construction equipment, vehicles, road dust, residential wood burning, wood fires, and smoke from logging slash disposal.

ENVIRONMENTAL EFFECTS

- ***Direct and Indirect Effects of the No-Action Alternative***

Under the No-Action Alternative, there would be no harvest-related activities and traffic, or road construction and maintenance. Therefore, direct and indirect effects to air quality as a result of the No-Action Alternative would not be expected.

- ***Direct and Indirect Effects of Alternatives A and B***

Prescribed Burning

DNRC may conduct prescribed burning following harvest activities to remove residual logging waste and fine fuels. These burning activities would subsequently reduce fire risk within the area and prepare site conditions conducive to tree regeneration.

Under Alternative A, the total harvest over two years may produce approximately 1,770 tons of Douglas-fir slash and 5,400 tons of lodgepole pine slash. Burning would be conducted by

harvest unit and start approximately one year after a harvest unit has been completed. Due to airshed restrictions, burning could be expected to last one to 3 years after completion of a harvest unit.

Under Alternative B, the total harvest over two years may produce approximately 665 tons of Douglas-fir slash and 4,100 tons of lodgepole pine slash. Burning would be conducted by harvest unit and start approximately one year after a harvest unit has been completed. Due to airshed restrictions, burning could be expected to last one to 3 years after completion of a harvest unit.

Burning would most likely occur during the months of October through February during conditions that are conducive to good smoke dispersion. Actual burning days would be controlled and monitored by DEQ and the smoke monitoring unit of the Montana/Idaho Airshed Group and would meet EPA standards, which would further minimize the direct and indirect effects of burning activities.

Road Construction and Maintenance

Road construction and Maintenance would be expected to produce particulate matter. According to the Transportation Analysis, under Alternative A approximately 1.7 miles of county road and 2.4 miles of existing State and private road would be used and maintained and there would be approximately 9.2 miles of new road construction.

Under Alternative B, approximately 1.7 miles of county road and 2.4 miles of existing State and private road would be used and maintained and there would be approximately 6.5 miles of new road construction.

For both Alternatives A and B, a ½ acre borrow pit in Section 3 of Township 3S Range 6E, and various small rock sources along the proposed new construction route would provide rock armoring for roads and culverts.

Direct and indirect effects to air quality as a result of road construction, maintenance, and a ½ acre borrow pit are expected to be localized to the roadways and areas directly adjacent to the roadways. Vegetative barriers along the roadside and dust abatement mitigations on Mount Ellis Lane (if requested by residences) and along the private gravel road continuing from Mount Ellis Lane to the access point in Section 34 are expected to greatly limit the dispersion of particulate matter beyond these areas. Thus, direct and indirect effects to air quality throughout the analysis area as a result of road construction and maintenance are expected to be minor.

Harvest-Related Traffic

Harvest-related traffic on gravel/dirt roads would be expected to produce particulate matter. According to the analysis conducted for *Chapter 3 –Transportation*, under Alternative A approximately 1,075 trips for log hauling and 320 to 640 trips for loader operator transportation would be expected to occur per year over the 2-year operating period. Log hauling is based off 160 days per year of potential operations with no hauling on weekends or major holidays. Harvest Crew transportation could be expected 7 days a week from June 15 *through* March 15 of the following year, with 4-8 trips per day (640 to 1280 trips total). Trips by DNRC personnel for sale administration could be expected 2 to 3 times per week during the operating season (80 to 120 trips). Approximately 2,115 to 3,115 total harvest-related trips could be expected per year over the 2-year operation period.

Under Alternative B, approximately 675 trips for log hauling and 320 to 640 trips for loader operator transportation would be expected to occur per year over the 2-year operating period. Harvest Crew transportation could be expected 7 days a week from June 15 *through* March 15 of the following year, with 4-8 trips per day (640-1280 trips total). Trips by DNRC personnel for sale administration could be expected 2 to 3 times per week during the operating season (80-120 trips). Approximately 1,715 to 2,715 total harvest-related trips could be expected per year over the 2-year operation period.

Dust production on roads during the dry summer and fall months would likely be higher than during the late fall, winter, and early spring months when frozen ground conditions and/or higher levels of moisture are expected to abate particulate production. During the dry months, log and equipment hauling traffic would be expected to produce more particulate matter than the other harvest-related traffic due to the size and weight of the vehicles.

Direct and indirect effects to air quality as a result of harvest-related traffic are expected to be localized to the roadways and areas directly adjacent to the roadways. Vegetative barriers along the roadside and dust abatement mitigations are expected to greatly limit the dispersion of particulate matter beyond these areas. Thus direct and indirect effects to air quality throughout the analysis area as a result of harvest-related traffic are expected to be minor.

- ***Direct and Indirect Effects of Alternative C***

Under Alternative C, delaying action for at least 10 years would result in effects like those of no action until any future actions are initiated following expiration of the conservation license. At that time, potential treatments that could occur would have effects on air quality similar to those of Alternative A.

Cumulative Effects

- ***Cumulative Effects of the No-Action Alternative***

Cumulative effects to air quality as a result of this alternative would not be expected.

- ***Cumulative Effects of Alternatives A and B***

Cumulative Effects of burning, road construction, road maintenance, and hauling associated with ongoing and foreseeable actions on DNRC, federal, and private, lands would produce particulate matter. Existing emission sources from occasional construction equipment, vehicles, road dust, residential wood burning, wood fires, and smoke from logging slash disposal would continue. Nearby residential areas and the City of Bozeman could experience reductions in air quality during peak burning periods. All burning activities by major burners would continue to comply with emission levels authorized by the DEQ, Montana/Idaho Airshed Group, and the EPA.

All above mentioned emissions in conjunction with expected particulate production from the proposed action would occur at higher levels than currently expected. Providing that dust abatement would be used during dry conditions, half of the harvest operations would occur during frozen and/or wetter conditions, construction activities would be short in duration, and

emissions produced from burning would be appropriately controlled and monitored, the cumulative effects to air quality are not expected to exceed EPA and DEQ standards.

- ***Cumulative Effects of Action Alternative C***

Cumulative effects of delaying action for at least 10 years would result in effects like those of no action until any future actions are initiated following expiration of the conservation license. At that time, potential treatments that could occur following would have effects on air quality like those of Alternative A.

TRANSPORTATION ANALYSIS

INTRODUCTION

The Trust Lands sections in Limestone West project area are supported by an existing network of roads that provide access to both the forested state trust lands and the grazing state trust lands for the purposes of conducting forest management activities; grazing activities; fire suppression; and recreational use. In contrast to these and other benefits, roads and associated maintenance activities can affect many aspects of the natural environment, including stream connectivity, water quality (e.g., increased sedimentation from road surface erosion or mass wasting), habitat quality (e.g. increased fragmentation, avoidance of habitats), and wildlife use (e.g., increased human contact or hunting pressures).

The network of roads on the state trust lands in the Limestone West project area are benefited by County Road access, providing legal access for forest and grazing management activities and the public for recreation. In contrast to these benefits an increase in use or scope of the road system supporting trust lands may have a cumulative effect on the access roads (e.g., increased traffic volume both public and management related, decrease in air quality, condition of road surface). Most of the basic road infrastructure leading to the project area is accessed by the DNRC's Bear Canyon Timber Sale Project. The Limestone West road system builds on the existing Bear Canyon road access.

This section describes the affected environment and environmental consequences of the various alternatives on DNRC's management of its transportation (road) resources in the Limestone West area. Specific road-related effects on other resources are discussed in the chapters on Geology & Soils, Watershed & Fisheries, Wildlife, Air Quality, Recreation, and Aesthetics. The following discussion of affected environment describes the policies, rules, and regulations that guide DNRC's management of roads on its lands, as well as the current status of the DNRC managed roads in the Bear Canyon and Limestone West Timber Sale area. The subsequent analysis of environmental consequences addresses issues raised during public scoping and describes likely changes to DNRC's road network in the Bear Canyon and Limestone West area and its management under the various alternatives.

ANALYSIS AREAS

The project area will be the analysis area used to determine direct and indirect environmental effects of the transportation system included in the proposed action.
The analysis area used to determine the cumulative environmental effects of the transportation system included in the proposed action will include the all of the land under state ownership in the Bear Canyon and Limestone West area and the County Roads accessing the project area form US interstate 90. This analysis area will herein be referred to as the cumulative-effects analysis area.

ANALYSIS METHODS

ISSUES AND MEASUREMENT CRITERIA

Concerns were raised during the scoping period regarding how potential impacts to the transportation system may affect the project area and the neighbors of the project area. The following issue statements accounts for those concerns and ultimately guides this analysis, they can be generally broken into two categories, the effect of proposed roads and on the public, and the effect of proposed roads on the natural landscape.

Trails and Recreation Management

- Concern that harvest activities may disturb the Triple Tree Trail.
- Increase in road densities may result in motorized use of the area which may adversely affect current recreational use of the area.
- Increased public use would occur as a result of increased road densities associated with the project.

Roads and Resource Management

- Traffic and other harvest activities may adversely affect the public along the haul route both within the project area and on the public roads leading to the harvest area.

Measurement Criteria

Quantitative and qualitative changes to the following measurement criteria are intended to 'measure' the extent of potential direct, indirect, and cumulative environmental effects the transportation system included in the proposed action may have on the area:

- Amount and Distribution of Roads
- Traffic
- Access Route to the harvest

RELEVANT AGREEMENTS, LAWS, PLANS, PERMITS, LICENSES, AND OTHER AUTHORIZATIONS

DNRC's road-related activities supporting forest management activities on trust lands include construction, reconstruction, abandonment, reclamation, maintenance, and use. These activities are typically conducted and funded through timber sale contracts, although some road maintenance is partially funded through DNRC's forest improvement program. Road management standards were established in the State Forest Land Management Plan (SFLMP) and subsequently adopted as part of the Forest Management ARMs, specifically **ARM 36.11.421 Road Management**

DNRC categorizes Roads using three criteria, Road Class, Restriction Class and Restriction Dates. Road Class refers to the legal status, physical condition, and presence and timing of travel restrictions. The Limestone West project area has three types of roads existing and proposed, as defined in the DNRC Forest Management Bureau Road Classifications:

- **Open Roads.** Highways, county roads, unrestricted DNRC roads, roads with unknown access restrictions, and roads restricted by non-DNRC owners (either seasonally or year-round).
- **Restricted Class A:** Roads with a physical barrier that can be easily opened and/or made passable for periodic administrative or seasonal public use.
- **Reclaimed**: A road that is impassible to motorized vehicles and is restricted by an impassible barrier or vegetation and drainage structures have been removed.

All restricted roads in the Limestone West Project Area are "Restricted Class A" roads with season long restrictions. For the purposes of this section these roads will be referred to simply as "restricted" roads.

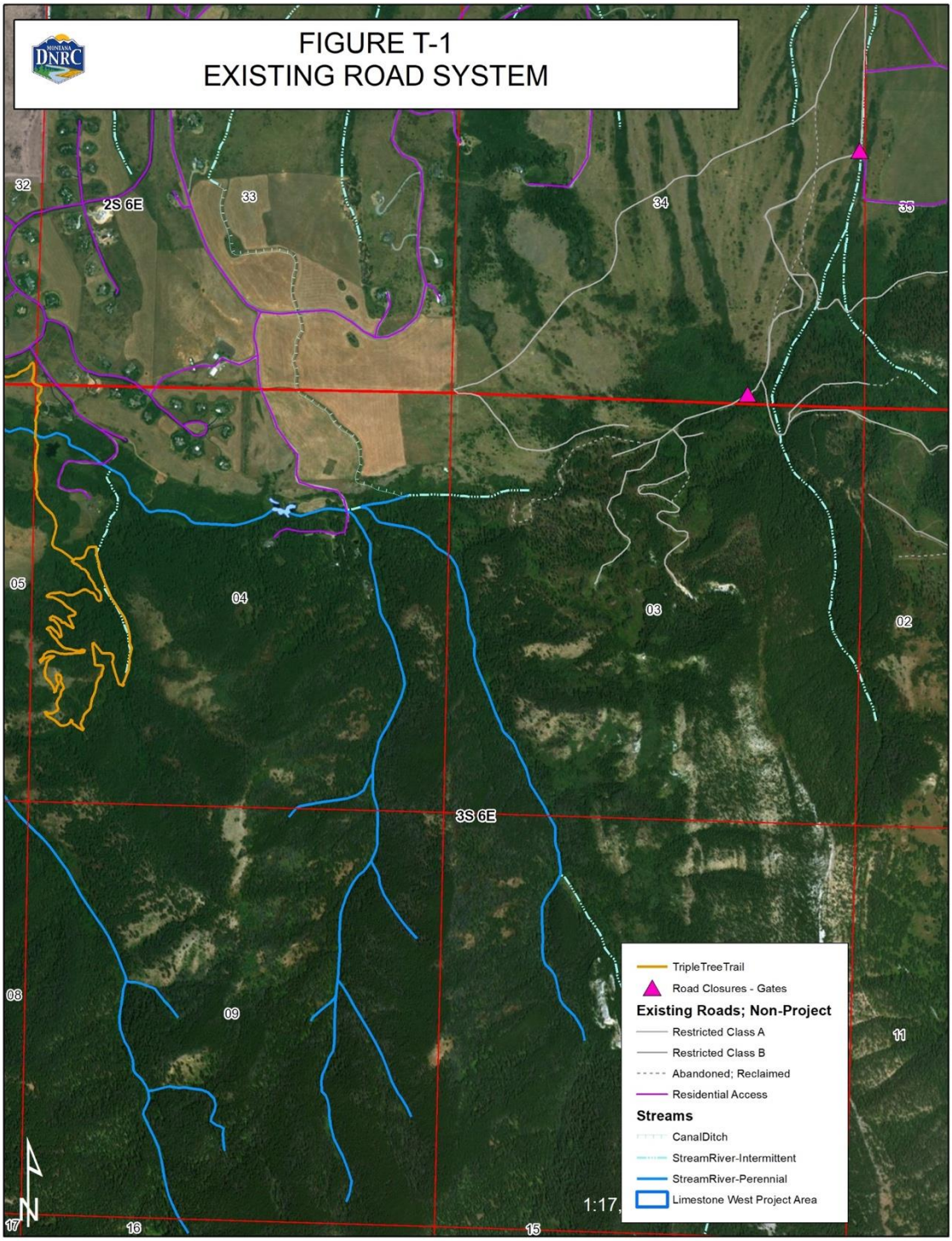
AFFECTED ENVIRONMENT

The existing road system to the Limestone West project area consists of County road to the parking area by the northeast corner of Section 34. From this point south, all road is either Restricted or Reclaimed. The Restricted management designation allows for motorized use by state officials and commercial use in association with our trust land management activities (e.g. timber harvest, grazing, firewood), but does not allow for public or recreational motorized use. The public in possession of a recreational use permit or a hunting license while hunting is allowed to use the existing road system within the State ownership for non-motorized travel. Maintenance on the existing road system is generally funded by forest management projects, without which it is not maintained.

Road Condition

The existing road system in the Limestone West project area, as depicted on Map T-1 below, consists of approximately 1 mile of gravel road and 4.3 miles of vegetated native surface roads. This system was originally developed to support the 1981 clear cut harvest in section 2 T3S R6E and the Douglas fir harvest in section 34 T2S R6E, then expanded and used again for the 1991 viewshed harvest in section 3 T3S R6E and 35 T2S R6E. In 2011, this road system was expanded to support the Bear Canyon Timber Sale in Sections 34 and 35, T2S R6E and Sections 1, 2, 3 and 11, T3S R6E. Most of the road system developed to support these previous harvests are still serviceable, after maintenance and drainage improvements to meet BMPs.

FIGURE T1 – EXISTING TRANSPORTATION SYSTEM



Amount and Distribution of Roads

Miles of road present within an area can provide an indication of the degree of potential environmental impacts. All roads impact the natural environment to some degree; however, open roads receive more traffic than restricted roads and consequently can impact the environment to a greater degree.

The current road system in the Limestone West project area consist of approximately .4 miles of shared private driveway/access road that begins at the end of Mount Ellis Lane, and 5 miles of improved forest road that that begins on the West boundary of Sect. 34. and provided access to the Bear Canyon Timber Sale. All road system miles are Restricted and designated "Motorized Use Restricted Year-Round". There are no "Open Roads" within the Limestone West project area.

While the miles of road, as discussed above, provides a measure of total potential impacts, road density (mi/mi^2) measures road impacts relative to the amount of land covered by those roads. A higher road density within an area generally indicates a higher potential for effects on that area. The density of open roads measures the level of roads in an area receiving the heaviest use relative to the total amount of land area accessed by those roads. The total density of roads currently existing in the Limestone West project area is approximately 1.26 mi/mi^2 with specific sections as high as 3.91 mi/mi^2.

Traffic

With the exception of the Bear Canyon Timber Sale (November 2011 – July 2014), the motorized traffic the past 15 years on the Bear Canyon road system has consisted of occasional administrative visits by state personnel (about once or twice a month during summer and fall), use by our grazing lessee, weed abatement contractor, and the occasional firewood permit holder. The majority of the traffic has been non-motorized recreational traffic, consisting of hikers, hunters, bicyclist, horseback riders and cross-country skiers. The recreational users have used not only the existing road system, but the surrounding lands in accordance with the recreational use permit system. As the population pressures have increased in the Gallatin Valley the recreational use of the roads and surrounding lands have shown a corresponding increase, as evidenced by the use of the parking at the end of Mt. Ellis Lane.

Access Routes Leading up to Limestone West Project Area

Access to the Limestone West project area is provided by the County Roads, Mt. Ellis Lane, and Bozeman Trail Rd. Besides servicing the residents and providing administrative access to the State land, these roads provide recreational access for the public to the State land. As County roads, maintenance is performed on a regular basis by the County, funded by taxes paid by the road users though vehicle registrations, property and fuel taxes. To protect users and the road infrastructure, the county has established speed limits and seasonal weight limits for all vehicles using these roads.

Mt. Ellis Lane is a 1 ¾ mile gravel road servicing approximately 20 residences leading from Bozeman Trail Road to the State Land. Daily trips were measured in 2011 with a total of 206 average daily trips. The County maintains the road as needed when their resources are available throughout the year. During periods of wet conditions, primarily in the spring, the County Road Department places weight restrictions of 300 pounds per square inch of tire width on vehicles to protect the road from damage. In 2004, the County established a 35 mile per hour

speed limit on the road. Some residents along the road contract for magnesium chloride treatments to control dust in the vicinity of their residences.

Bozeman Trail Road is a chip sealed road providing access to I-90 approximately ¾ mile from Mt. Ellis Lane. In 2016, 1448 average daily trips were measured by the MTDOT. The speed limit on the road is 40 mph with a speed zone of 15 mph just prior to the Mt. Ellis Academy and Ft. Ellis Fire Department. The County has the ability to restrict the weight on the road if it appears necessary to reduce damage.

ENVIRONMENTAL EFFECTS

- ***Direct and Indirect Effects of the No-Action Alternative***

The management on the existing DNRC road system would continue as Motorized Use Restricted year-round. General maintenance would not be conducted. The roads would continue to be used for administrative purposes and support the recreational uses associated with non-motorized travel.

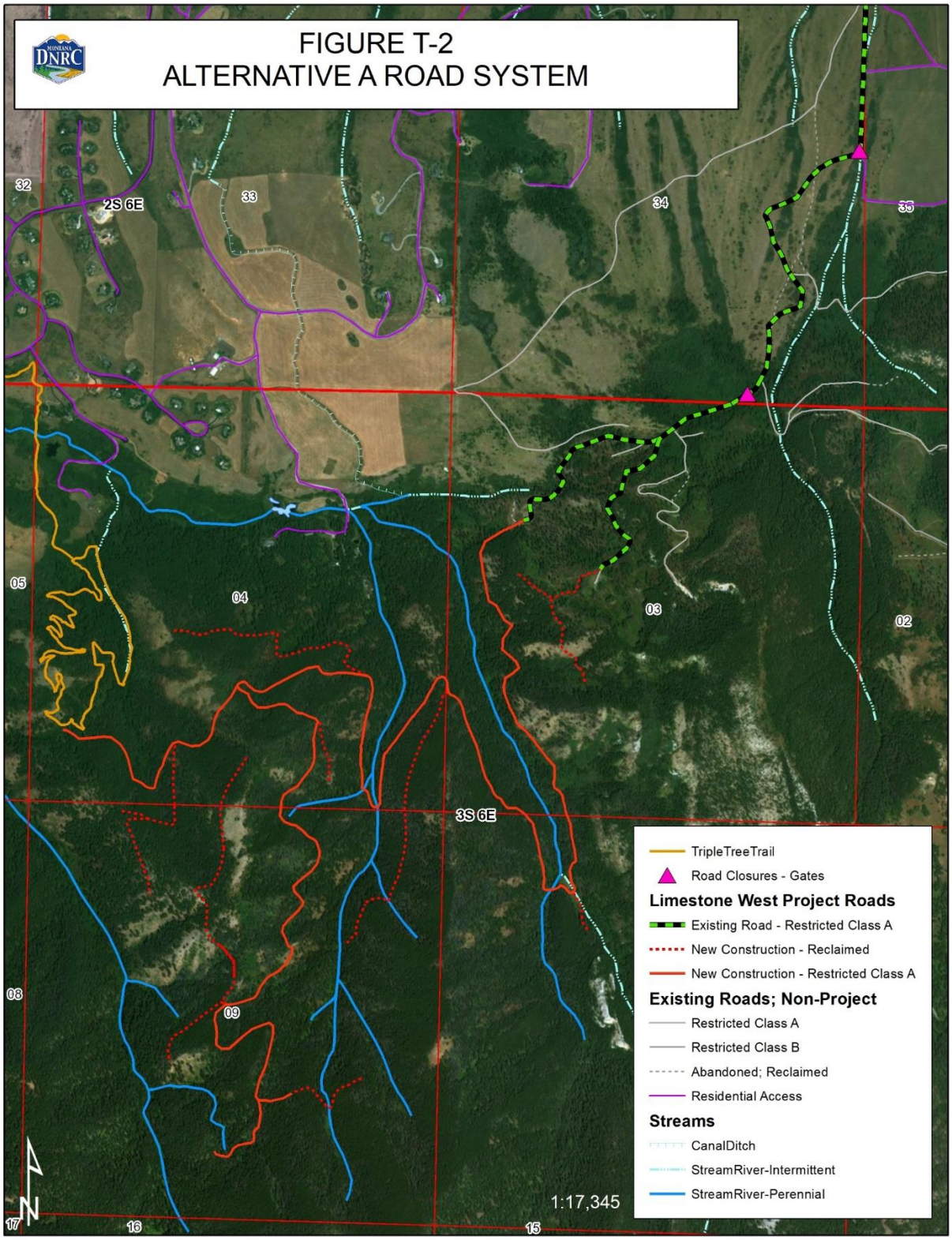
The amount and distribution of roads within the project area would not change. Motorized traffic by state personnel and associated Trust land management activities would remain occasional. The recreational traffic would continue to increase reflecting the recreational pressures exhibited by a growing population.

- ***Direct and Indirect Effects of Action Alternative A***

Approximately 1.4 miles of the proposed main haul route consists of road which is currently in usable condition. Approximately 0.5 miles of this existing haul route has been abandoned, seeded to grass and debris closed leaving the road prism in place. This 0.5 mile portion of the haul route would be cleared of slash and debris and graded to prepare it for use under Alternative A.

Up to 9.2 miles of new road would be constructed in accordance with the SFLMP to facilitate the timber harvest. At the completion of harvest 3.8 miles of the new road constructed would be abandoned, all culverts removed, seeded to grass and closed with debris leaving the road prism in place. 5.3 miles of the new road would remain usable for administrative purposes and future harvest as Restricted road.

FIGURE T2 – ALTERNATIVE A TRANSPORTATION SYSTEM



The existing roads and the new roads constructed for temporary use would be managed as Motorized Use Restricted year-round. This management designation would only allow for use by state officials and by the commercial users associated with our trust land management activities. Signs informing the public of the road use activities would be placed at the trails head at New World Gulch and at the entrance to the State Land at the end of Mt. Ellis Lane. The roads that are reclaimed and closed by slash and debris would be administratively closed for travel to allow them to re-vegetate.

Table T-4 – Road Length and Density in Project Area				
Project Actions	**Existing Conditions**	**Action Alternatives**		
		A (tractor and line)	**B (tractor)**	**C (license)**
Miles of Existing Restricted Class A Road	5.3	5.3	5.3	5.3
Miles of existing Reclaimed road to be changed to Restricted Class A road	N/A	.5	.5	N/A
Miles of new road Restricted	N/A	5.4	4.8	N/A
Miles of new road Reclaimed	N/A	3.8	1.7	N/A
Present Project Area Road Density mi/mi²	1.2	N/A	N/A	N/A
Present Max Section Road Density mi/mi²	3.9	N/A	N/A	N/A
Post Project Area Road Density mi/mi²	N/A	2.6	2.5	N/A
Post Project Max Section Road Density mi/mi²	N/A	4.2	4.2	N/A

The Limestone West Timber Sale transportation system will result in increased non-motorized access the project area. The 5.4 miles of Restricted Class A road remaining at the end of the project will be available for non-motorized recreation after the harvest and into the foreseeable future. Infrastructure associated with these roads including culverts, drainage structures, and a bridge over the South Fork of Limestone Creek will remain in place at the conclusion of the timber sale. This road system will provide bicycle, pedestrian, and horseback access to the southwest portion of the project area.

The Limestone West Timber Sale would result in increased traffic for both administrative purposes and the commercial harvesting activities. Administrative activities that would increase would include inspections of conditions, harvesting activities, weed management, and slash treatment including burning of piles or prescriptive fire. The commercial activities associated with a timber harvest that would increase traffic include the hauling of timber and transporting crews to the worksite. Some activities would possibly decrease, such as the commercial use by firewood permit holders since that activity is likely to be curtailed due to conflicts with the timber sale itself. Details are included in the Transportation Summary Table T-5.

The increase in administrative motorized traffic from State of Montana Trust lands personnel for the administration of the sale (e.g. inspections of conditions, harvesting activities, etc.) and as part of the post-harvest closure activities (e.g. weed management, prescribed fire) could be expected to be the most intense at the beginning and end of harvest operations. In general, administrative trips could be expected to be around 2-3 a week with the exception that there could be multiple trips in one day depending on the issues being addressed.

The harvest of up to 4.3 million board feet (4,300 MBF) of timber over a 2-year period would result in an increase in motorized traffic on the Bear Canyon road system during the harvest period, as compared to the use over the last 15 years during non-timber harvest activities. The times of year when conditions are suitable for harvest activities are between June 15 and March 15 of the following year, after considering days when hauling activities could not be conducted (e.g. ground not dry (<20% soil moisture) or frozen, weekends, major holidays) would leave approximately 160 days available for the active hauling of timber per season. The hauling of 4,300 MBF of timber would require approximately 1075 truckloads, averaged over 160 hauling days would be approximately 7 loads a day. Since conditions and timber may not be available on as consistent basis as is illustrated by an average, the loads per day are likely to vary with no hauling on some days and 15 or more loads on other days. In conjunction with the hauling of the timber, traffic would be generated by the crews harvesting the timber itself. Depending on the number of crew being used to facilitate the harvest they could be expected to regularly generate 6 trips per day and on occasion up to 12.

People recreating would encounter crews in the early morning, at the end of day and throughout the day during harvest activities. Log trucks could be encountered delivering logs to the mill or returning from the mill though timber hauling activities would be restricted on weekends and major holidays to eliminate traffic conflict from recreational use. To provide for safety the travel routes for the crews and the log trucks would be posted at the entrance to the State land at the end of Mt. Ellis Lane and at the trail head at Triple Tree Trail. There would be "Logging Operations" signs placed at the entry ways to active harvest areas and there may be some additional "Log Truck" signs placed on state lands.

Table T-5– Transportation Systems Use Summary

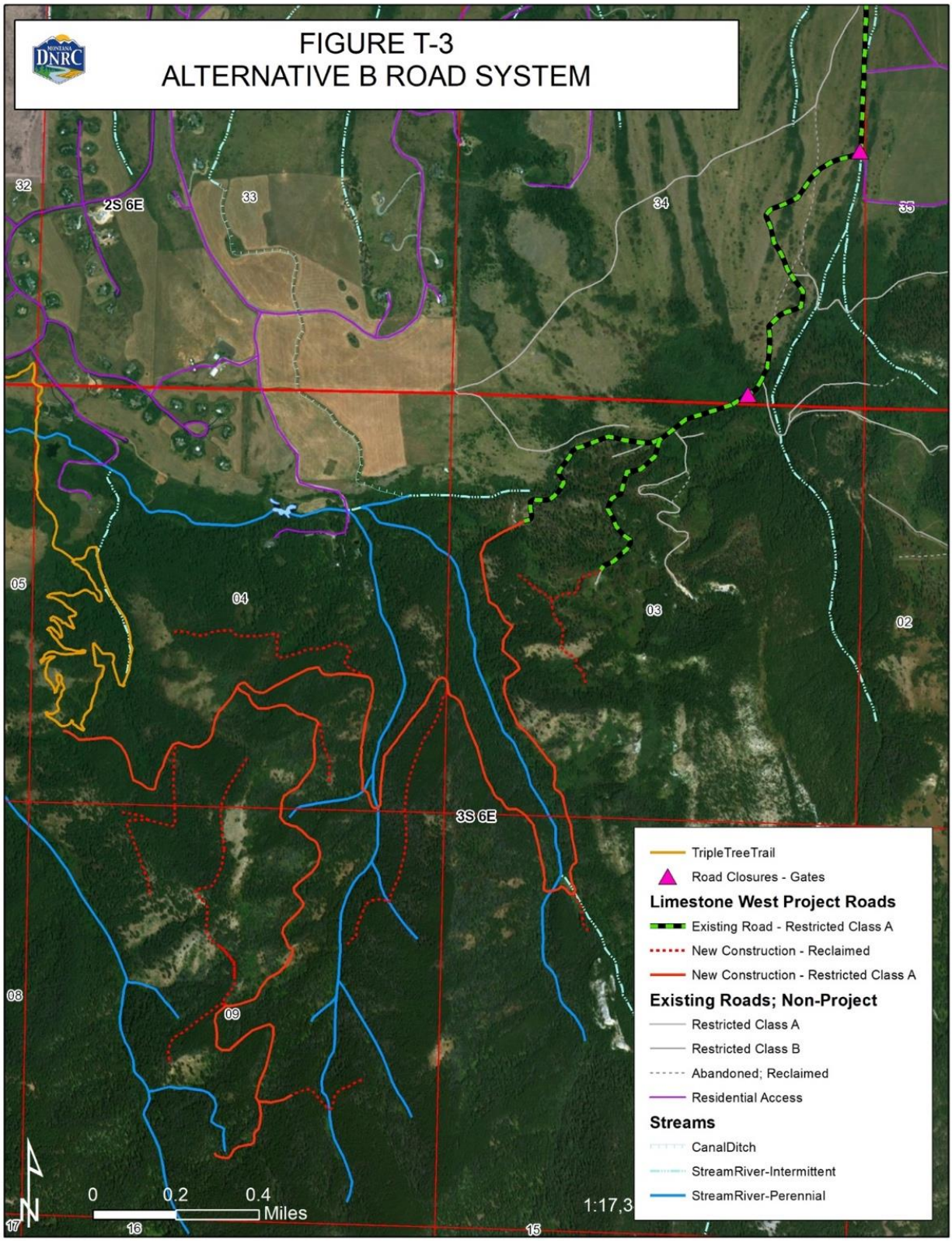
Activity	Daily Operation	Weekly Operation	Monthly Operation	Conditions of Use	Comments
Road Reconstruction, Construction and Maintenance	5:30 AM – 6:30 PM	Up to 7 days a week	Late Spring through early Winter – 2 to 3 months total	Soil Moisture <20% or Frozen conditions	2-4 trips per day
Log Hauling (1-5 Trucks on rotation) General Conditions	5:30am-6:00pm Hauling out 4:00 am arrival for days work	Monday – Friday (except Major Holidays)	June 15 thru Mar 15 of following year (160-day expectation)	Dry or Frozen conditions (estimate 160 days per year)	For 2-year harvest & 160 days per year of potential operations, expect 7 loads per day with peaks of 15+ loads per day
Loader operator (1-2 vehicles)	4:00 am-6:30pm	Monday – Friday (except Holidays)	June 15 thru Mar 15 of following year (160-day expectation)	Dry or Frozen conditions (estimate 160 days per year)	2-4 trips per operational day
Harvest Crews (2-4 vehicles)	5:30 AM – 6:30 PM	Up to 7 days a week	June 15 thru Mar 15 of following year	Soil Moisture <20% or Frozen conditions	4-8 trips per day
Administration (beginning & end of harvest season)	8:00 AM-6:00PM	3-5 days per week	2 months @ beginning of Harvest Season 1 month @ end of Harvest Season		2-4 trips per day
Administration (Mid season Harvest)	8:00 AM-6:00PM	2-3 days per week	During Harvest		1-2 trips per day

- ***Direct and Indirect Effects of Action Alternative B***

Approximately 1.4 miles of the proposed main haul route consists of road which is currently in usable condition. Approximately 0.5 miles of this existing haul route has been abandoned, seeded to grass and debris closed leaving the road prism in place. This 0.5 mile portion of the haul route would be cleared of slash and debris and graded to prepare it for use under Alternative B.

Up to 6.5 miles of new road would be constructed in accordance with the SFLMP to facilitate the timber harvest. At the completion of harvest 1.7 miles of the new road constructed would be abandoned, all culverts removed, seeded to grass and closed with debris leaving the road prism in place. 4.8 miles of the new road would remain usable for administrative purposes and future harvest as Restricted road. The roads that are reclaimed and closed by slash and debris would be administratively closed for travel to allow them to re-vegetate.

FIGURE T3 – ALTERNATIVE B TRANSPORTATION SYSTEM



The existing roads and the new roads constructed for temporary use would be managed as Motorized Use Restricted Year Round. This management designation would only allow for use by state officials and by the commercial users associated with our trust land management activities. Signs informing the public of the road use activities would be placed at the trails head at New World Gulch and at the entrance to the State Land at the end of Mt. Ellis Lane.

The Limestone West Timber Sale transportation system will result in increased non-motorized access the project area. The 4.8 miles of Restricted Class A road remaining at the end of the project will be available for non-motorized recreation after the harvest and into the foreseeable future. Infrastructure associated with these roads including culverts, drainage structures, and a bridge over the South Fork of Limestone Creek will remain in place at the conclusion of the timber sale. This road system will provide bicycle, pedestrian, and horseback access to the southwest portion of the project area.

The Limestone West Timber Sale would result in increased traffic for both administrative purposes and the commercial harvesting activities. Administrative activities that would increase would include inspections of conditions, harvesting activities, weed management, and slash treatment including burning of piles or prescriptive fire. The commercial activities associated with a timber harvest that would increase traffic include the hauling of timber and transporting crews to the worksite. Some activities would possibly decrease, such as the commercial use by firewood permit holders since that activity is likely to be curtailed due to conflicts with the timber sale itself. Details are included in the Transportation Summary Table T-5.

The increase in administrative motorized traffic from State of Montana Trust lands personnel for the administration of the sale (e.g. inspections of conditions, harvesting activities, etc.) and as part of the post-harvest closure activities (e.g. weed management, prescribed fire) could be expected to be the most intense at the beginning and end of harvest operations. In general, administrative trips could be expected to be around 2-3 a week with the exception that there could be multiple trips in one day depending on the issues being addressed.

The harvest of up to 2.7 million board feet (2,700 MBF) of timber over a 2 year period would result in an increase in motorized traffic on the Bear Canyon road system during the harvest period, as compared to the use over the last 15 years during non-timber harvest activities. The times of year when conditions are suitable for harvest activities are between June 15 and March 15 of the following year, after considering days when hauling activities could not be conducted (e.g. ground not dry (<20% soil moisture) or frozen, weekends, major holidays) would leave approximately 160 days available for the active hauling of timber per season. The hauling of 2,700 MBF of timber would require approximately 675 truckloads, averaged over 160 hauling days would be approximately 4 loads a day. Since conditions and timber may not be available on as consistent basis as is illustrated by an average, the loads per day are likely to vary with no hauling on some days and 15 or more loads on other days. In conjunction with the hauling of the timber, traffic would be generated by the crews harvesting the timber itself. Depending on

the number of crew being used to facilitate the harvest they could be expected to regularly generate 6 trips per day and on occasion up to 12.

People recreating would encounter crews in the early morning, at the end of day and throughout the day during harvest activities. Log trucks could be encountered delivering logs to the mill or returning from the mill though timber hauling activities would be restricted on weekends and major holidays to eliminate traffic conflict from recreational use. To provide for safety the travel routes for the crews and the log trucks would be posted at the entrance to the State land at the end of Mt. Ellis Lane and at the trail head at Triple Tree Trail. There would be "Logging Operations" signs placed at the entry ways to active harvest areas and there may be some additional "Log Truck" signs placed on state lands.

Cumulative Effects

- ***Cumulative Effects of the No-Action Alternative***

Project Area
The transportation system roads managed as Motorized Use Restricted year-round would continue to be used for administrative purposes including; weed management, grazing management, firewood permits, and future forest management activities including timber permits and sales.

Project Area Access
Traffic and maintenance would continue in roughly the same pattern that they have been on for the last few years. An increase in recreational traffic could be expected since recreational traffic has increased regularly in the Gallatin valley at most of the access points to public lands.

- ***Cumulative Effects of Action Alternative A***

Project Area
At project completion, the transportation system roads managed as Motorized Use Restricted year-round would continue to be used for administrative purposes including; weed management, grazing management, firewood permits, and future forest management activities including timber permits and sales. The improved access through Sections 3 and 4 may provide for more opportunities to use permits to facilitate small forest management projects in the future. Future permits or sales would require an environmental analysis to comply with MEPA.

Project Area Access
Log hauling and support traffic would increase during the seasons of harvest on the corridor including Mt. Ellis Lane and Bozeman Trail Road between the State land and I-90. During the 160 days potentially available to haul an average of 7 loads a day would be required to remove the timber in 2 years and since hauling doesn't occur at the same rate every available day some days 15 or more loads of logs could be transported off of the state land in a day. The first log trucks could be expected to leave the State land as early as 5:30 in the morning and the last truck

would be expected to be completed by 6:00 in the evening. Support traffic including loader operators, harvesting crews and State of Montana Administrative personnel, could generate up to 12 trips a day during the harvest season between June 15th and March 15 of the following year. Logs trucks and support traffic could result in up to 30 or more trips a day during peak use.

Log hauling and support traffic on Mt. Ellis lane could result in up to 16% increase traffic on days that experience peak use. The log trucks and support traffic would be contractually obligated to follow county regulations of speed and weight limits. The county has indicated that Mt. Ellis Lane has weight restrictions placed on it primarily in the spring due to concerns over degradation of the road base exacerbated by moisture, but if moist conditions were to occur at other times of the year the weight could be restricted as needed.

Log hauling and support traffic on Bozeman Trail Road could result in up to a 2% increase in traffic on days that experience peak use. Gallatin County has concerns regarding the degradation of the chip seal on the road during periods of moist conditions and could apply weight limits if conditions are warranted.

Mitigations to the haul route would include limiting hauling on both roads to dry or frozen conditions, just as they would be on the State transportations system. As a measure to limit dust and reduce the needed maintenance on Mt. Ellis Lane, a treatment of magnesium chloride would be applied once conditions were dry enough to for it to be effective. Light grading to the road surface would be provided to help maintain a smooth the driving surface for the hauling activities. The use of compression brakes "jake brakes" would be contractually prohibited on the Mt. Ellis Lane haul route to reduce noise. At the intersections of Mt. Ellis Rd. and Bozeman Trail Road signs would be places within 500 feet of the intersection on both direction of traffic indicating that Log truck would be entering the roadway.

- ***Cumulative Effects of Action Alternative B***

Project Area

At project completion the transportation system roads managed as Motorized Use Restricted year-round would continue to be used for administrative purposes including; weed management, grazing management, firewood permits, and future forest management activities including timber permits and sales. The improved access through Sections 3 and 4 may provide for more opportunities to use permits to facilitate small forest management projects in the future. Future permits or sales would require an environmental analysis to comply with MEPA.

Project Area Access

Log hauling and support traffic would increase during the seasons of harvest on the corridor including Mt. Ellis Lane and Bozeman Trail Road between the State land and I-90. During the 160 days potentially available to haul an average of 4 loads a day would be required to remove the timber in 2 years and since hauling doesn't occur at the same rate every available day some

days 15 or more loads of logs could be transported off of the state land in a day resulting in up to 30 trips. The first load of Logs could be expected to leave the State land as early as 5:30 in the morning and the last load would be expected to be completed by 6:00 in the evening. Support traffic including loader operators, harvesting crews and State of Montana Administrative personnel, could generate up to 15 trips a day during the harvest season between June 15th and March 15 of the following year.

Log hauling and support traffic on Mt. Ellis lane could result in up to 16% increase traffic on days that experience peak use. The log trucks and support traffic would be contractually obligated to follow county regulations of speed and weight limits. The county has indicated that Mt. Ellis Lane has weight restrictions placed on it primarily in the spring due to concerns over degradation of the road base exacerbated by moisture, but if moist conditions were to occur at other times of the year the weight could be restricted as needed.

Log hauling and support traffic on Bozeman Trail Road could result in up to a 2% increase in traffic on days that experience peak use. Gallatin County has concerns regarding the degradation of the chip seal on the road during periods of moist conditions and could apply weight limits if conditions are warranted.
Mitigations to the haul route would include limiting hauling on both roads to dry or frozen conditions, just as they would be on the State transportations system. As a measure to limit dust and reduce the needed maintenance on Mt. Ellis Lane a treatment of magnesium chloride would be applied once conditions were dry enough to for it to be effective. Light grading to the road surface would be provided to help maintain a smooth the driving surface for the hauling activities. The use of compression brakes "jake brakes" would be contractually prohibited on the Mt. Ellis Lane haul route to reduce noise. At the intersections of Mt. Ellis Rd. and Bozeman Trail Road signs would be places within 500 feet of the intersection on both direction of traffic indicating that Log truck would be entering the roadway.

- ***Cumulative Effects of Action Alternative C***

Project Area
The transportation system roads managed as Motorized Use Restricted year-round would continue to be used for administrative purposes including; weed management, grazing management, firewood permits, and future forest management activities including timber permits and sales.

Project Area Access
Traffic and maintenance would continue in roughly the same pattern that they have been on for the last few years. An increase in recreational traffic could be expected since recreational traffic has increased regularly in the Gallatin valley at most of the access points to public lands.

RECREATION ANALYSIS

INTRODUCTION

There are 2,725 acres of blocked state trust land in the Limestone West project area. The public enjoys opportunities to hunt, hike, mountain bike, run, bird watch, ski and generally enjoy the flora and fauna of the Gallatin Front. This analysis describes the existing environment of recreational uses and infrastructure in the project area and surrounding areas, and discloses the potential environmental effects the proposed action (*see Chapter 1 – Purpose and Need*) may have on those.

ANALYSIS AREAS

The analysis area used to determine direct and indirect environmental effects of the proposed action on the recreation resource will be the project area (*see description in Chapter 1 – Purpose and Need*).

The analysis area used to determine cumulative environmental effects of the proposed action will include all legally accessible blocked state trust lands in and adjacent to the Limestone West project area and the roads used to access those lands. This analysis area will herein be referred to as the cumulative effects analysis area.

ANALYSIS METHODS

The methodologies used to portray the existing environment and determine the environmental effects of the proposed action on recreational uses within the project and cumulative effects analysis areas include: determining amounts and types of existing recreational uses; determining the existing condition of each of the measurement criteria; and estimating any changes to the measurement criteria that may result under each alternative. Cumulative effects include consideration of other actions indicated in *Chapter I – Relevant Past, Present, and Related Future Actions*.

ISSUES AND MEASUREMENT CRITERIA

Issues

A number of concerns were raised during the scoping period regarding potential impacts the proposed action may have on recreation throughout the area. The following issue statements were crafted to account for those concerns and to ultimately guide the analysis of this section.

- Harvest activities may adversely affect recreational experiences within the project area including hiking, skiing, hunting, horseback riding, birding, mountain biking, and general enjoyment of the area.
- Harvest activities may affect the amount, location, use, and condition of many existing trails and other developed facilities within the project area.
- Increase in road densities may result in increased recreational use and trails, changing the character of the project area.

Measurement Criteria

Quantitative and qualitative changes to the following measurement criteria are intended to 'measure' the extent of the potential direct, indirect, and cumulative environmental effects

the proposed action may have on existing recreational uses in the area:

- amount, location, use, and condition of developed recreational facilities
- general recreational use of the area
- amount, duration, time of year and location of forest-management activities in the area
- amount of roads in the area

RELEVANT AGREEMENTS, LAWS, PLANS, PERMITS, LICENSES, AND OTHER AUTHORIZATIONS

DNRC Recreational Use Rules

DNRC Recreational Use Rules (*ARM 36.25.146 through 162*) regulate and provide for the reasonable recreational use of legally accessible school trust lands. Recreational use is divided into two categories and, subsequently, requires two different types of recreational licenses for those wishing to engage in recreational activities on school trust lands.

Triple Tree Trail Easement

The Triple Tree Trail is accessed from Sourdough Road. This trail was established in the mid-1990s as part of the development of the Triple Tree Subdivision. In 2014, DNRC granted a perpetual easement to Gallatin County to locate, construct, use, manage, maintain, improve, and repair the Triple Tree Trail on state land. Gallatin County has contracted with Gallatin Valley Land Trust to oversee and maintain the trail.

General Recreational Use License

General recreational use refers to recreational activities that are non-concentrated and noncommercial. Examples of these activities include snowmobiling, hiking, bicycling, hunting, motorized use, horseback riding, and berry picking. Any person over the age of 12 who wishes to engage in activities that pertain to general recreational uses is required to obtain a 12-month General Recreational Use License from state license providers (i.e. FWP). For recreationists younger than 17 or older than 60, the license is $5. For recreationists between the ages of 17 and 60, the license is $10. All license holders are required to abide by current restrictions, closures, and regulations.

Special Recreational Use License

Special recreational use refers to recreational commercial activities in which an entity charges a participant a fee, specific non-commercial organized group activities, and overnight activities using non-designated campground areas. Specific examples of such activities include outfitting, non-commercial recreational lodges or retreats, and overnight horse camping. Any person who wishes to engage in activities that pertain to special recreational uses is required to obtain a Special Recreational Use License from DNRC. The cost of the license is determined by DNRC and assessed at what DNRC considers to be the full market value of that use.

Memorandum of Agreement Affecting Recreational Use of State Trust Lands

This agreement entered into by FWP and DNRC requires FWP to reimburse DNRC 2 dollars for every wildlife conservation license and certain game animal licenses sold in accordance with *MCA 87-2-202, 505, 510,* and *511*.

Land Use License

DNRC Surface Management Rules [*ARM 36.25.102(14)*] define and allow for the use of State lands for uses other than for which the land is classified. Such uses are allowed for a specific fee and a term not to exceed 10 years [*ARM 36.25.106(2)*].

AFFECTED ENVIRONMENT

The state trust lands in the Limestone West project are located about 5 miles southeast of Bozeman and are blocked together in a 2,725 acre unit. Due to their size and location as well as being adjacent to USFS lands, these lands provide a convenient and popular access to outdoor recreational opportunities within a few miles of Bozeman. Public access to these lands is located at a parking area off Mt. Ellis Lane.

Recreational use is facilitated by the use of developed facilities such as trailheads, trails, and parking areas; use of existing infrastructure developed for previous land management projects such as roads; trails pioneered by users; and backcountry use (off-trail/road use). The recreational activities generally associated with these lands include hiking, skiing, running, birding, mountain biking, horseback riding, hunting, rock climbing and general enjoyment of flora and fauna. Motorized use in not allowed as a recreational activity by the public on these state trust lands.

General Recreational Use

The general recreational use within the area depends on the use of one hiking trail and existing infrastructure not specifically developed by the DNRC for recreation. This infrastructure includes state trust land management roads and trails pioneered by users. Currently there are approximately 5.3 miles of road within the project area designated as "Motorized Use Restricted Year-Round". These roads, in addition to trails, pioneered by users are used for recreation throughout the project area and to access lands located in the cumulative effects analysis area.

Recreational use of the road system is present throughout the year, but the types of use change seasonally. During winter and early spring, the road system provides a base for cross-country skiing and snowshoeing. Spring breakup typically has the least use due to the wet and muddy conditions but still supports occasional hikers. During late spring and summer, the area sees the heaviest and most diverse recreational use which includes; hiking, mountain biking, birding, running, horseback riding, dog walking, and wildflower viewing. In the fall the primary use transitions to hunting activities, though most of the summer uses are still present to a lesser degree.

There are numerous trails pioneered by users or game trails that facilitate access to areas away from the road system within the state trust lands. Most pioneered trails receive low to moderate use by a limited number of recreationists during summer and fall.

Backcountry use (off-trail/road use) is mostly concentrated in the summer and fall and primarily associated with hunting, hiking, and birding. This use also relies on the road system, the user established trails and the game trails to facilitate access. Some backcountry use also occurs during the winter. Skiers travel through the area to reach Mt. Ellis, a popular local backcountry ski area.

Big game hunting is another popular recreational activity in the area and is focused on bear in the spring and deer, moose and elk in the fall. Hunting in the area is by both archery and firearm, there are no restrictions with the exception that firearms cannot be discharged within ¼ mile of occupied structures without permission of the occupant (*ARM 36.25.149c*). Specifics on the existing condition of big game populations and other wildlife are detailed in *Chapter 3 — Wildlife*.

Trails and Developed Recreational Facilities

Developed recreational facilities within the project area and the cumulative effects area include parking areas, trailheads, and trails. Facilities located in the cumulative effects analysis area includes a trailhead and parking area at the end of Bear Canyon Road and Mt. Ellis Lane and 3 developed trails: New World Gulch, Moonshine Gulch, and Bear Canyon.

The Triple Tree Trail is located at the west end of the analysis area and is accessed by the Triple Tree Trail from Sourdough Road. This trail was established in the mid-1990s as part of the development of the Triple Tree Subdivision and receives year-round use, predominately by hikers and bikers, with the heaviest use during the spring and summer.

The parking area for the Triple Tree Trail on Sourdough Road was developed by Gallatin County to provide parking for users of the state trust lands. This area is used year-round. During daylight hours it will usually have 5-10 cars parked and at times of high use there have been up to 20 with an average of two people per vehicle. The lands accessed by this location are primarily those of state ownership.

Forest Management Activities and Roads

The last major forest management activity that would have been noticeable by recreationists in the state land block at would have been the Bear Canyon Timber Sale that began in fall 2011 and continued into summer 2014.

ENVIRONMENTAL EFFECTS

- ***Direct and Indirect Effects of the No-Action Alternative and Action Alternative C***

No appreciable changes to access for the developed areas or existing infrastructure would occur. Backcountry, user-pioneered trail, and game trail access would become more difficult in the stands that are primarily lodgepole pine due to collapse of these stands through pine beetle mortality. Hunting patterns of use may also be affected by these changes. The use of these lands and the Triple Tree Trail would continue to increase as a product of population pressure in the Gallatin Valley.

- ***Direct and Indirect Effects of Action Alternative A***

General Recreational Use and Forest Management Activities

Harvest activities and harvest-related traffic would occur up to 9 months per year (June 15th through March 15th) over a 2 to 3-year operating period. After considering days when hauling activities could not be conducted, approximately 160 days would be available for the active hauling of timber per season. The hauling of 4,300 MBF of timber would require approximately 1,075 truckloads, averaged over 160 hauling days would be approximately 7 loads a day. Since conditions and timber may not be available on as consistent basis as is illustrated by an average, the loads per day are likely to vary with no hauling on some days and 15 or more loads on other days.

In conjunction with the hauling of the timber, traffic would be generated by administrative personnel and the crews harvesting the timber itself. Depending on the number of crew being used to facilitate the harvest they could be expected to regularly generate 6 trips per day and on occasion up to 12.

Traffic in the parking area for the Triple Tree Trail on Sourdough Road would be expected to increase during the spring and summer, when the area sees its heaviest recreation use, during harvest and administration activities. Use of the area by personnel involved in the sale would be unnecessary and shouldn't result in a reduction of availability of space.

Those who choose to recreate in the area during the workweek daytime hours would likely meet harvest-related traffic on designated haul routes and operators in harvest units. Direct and indirect effects on these recreationists are expected to be moderate to high. Those who choose to recreate in the area on the weekend or during the workweek evenings would likely meet minimal harvest-related traffic and harvesting operations, except for occasional operators. Direct and indirect effects to these recreationists are expected to be minimal.

Selective harvest would occur along approximately 1,000 feet of trail located in the south and southeast portion of the trail. The trail would be closed in this area for 2-3 days as a safety precaution until harvest activities are completed.

Hunting, a primary fall activity, would see the most conflict along the travel route and in the area of the harvest units. Human activity in and around the active harvest units would likely lead to temporary displacement of game during the activity. The removal of vegetative cover would potentially affect the way hunters ultimately use the area in the future (*see Chapter 3 — Wildlife for details*).

Prescribed burning operations may also temporarily displace recreationists. Slash pile burning would likely take place during appropriate conditions in the fall following harvest. If conditions were appropriate in the year following harvest, a broadcast burn operation may take place during the summer and/or fall which may also interfere with recreation. If this kind of

operation were to take place the vicinity would be closed for recreation while the operation was conducted, which could take approximately a week. Burning operations may also be carried out in multiple stages potentially creating conflicts for a greater amount of time across the project area. Appropriate signage would be posted surrounding the burn units as well as at the parking areas and trailheads.

Roads and Trails

Under Action Alternative A, approximately 9.2 miles of new road would be constructed. The Limestone West Timber Sale transportation system would result in increased non-motorized access to the project area. Those who choose to recreate on restricted roads would experience an increase in accessible lands following project completion due to the construction of 5.4 miles of new restricted roads. Infrastructure associated with these roads including culverts, drainage structures, and a bridge over the South Fork of Limestone Creek will remain in place at the conclusion of the timber sale. This road system would provide bicycle, pedestrian, and horseback access to the southwest portion of the project area. Similar to existing conditions, no roads would be managed for motorized public use.

At the completion of harvest 3.8 miles of the new road constructed would be reclaimed, all culverts removed, seeded to grass, and closed with debris leaving the road prism in place. These reclaimed roads would eventually be utilized by recreationists and become part of the pioneered trail system in the project area. Those who choose to recreate along the road system may find it difficult to travel along these abandoned roadways. These trails would be expected to receive low to moderate use in the summer and fall like the existing pioneered trails.

- ***Direct and Indirect Effects of Action Alternative B***

General Recreational Use and Forest Management Activities

Harvest activities and harvest-related traffic would occur up to 9 months per year (June 15th through March 15th) over a 2 to 3-year operating period. After considering days when hauling activities could not be conducted, approximately 160 days would be available for the active hauling of timber per season. The hauling of 2,700 MBF of timber would require approximately 675 truckloads, averaged over 160 hauling days would be approximately 4 loads a day. Since conditions and timber may not be available on as consistent basis as is illustrated by an average, the loads per day are likely to vary with no hauling on some days and 15 or more loads on other days.

In conjunction with the hauling of the timber, traffic would be generated administrative personnel and by the crews harvesting the timber itself. Depending on the number of crew being used to facilitate the harvest they could be expected to regularly generate 6 trips per day and on occasion up to 12.

Traffic in the parking area for the Triple Tree Trail on Sourdough Road would be expected to increase during the spring and summer, when the area sees its heaviest recreation use, during

harvest and administration activities. Use of the area by personnel involved in the sale would be unnecessary and shouldn't result in a reduction of availability of space.

Those who choose to recreate in the area during the workweek daytime hours would likely meet harvest-related traffic on designated haul routes and operators in harvest units. Direct and indirect effects on these recreationists are expected to be moderate to high. Those who choose to recreate in the area on the weekend or during the workweek evenings would likely meet minimal harvest-related traffic and harvesting operations, except for occasional operators. Direct and indirect effects to these recreationists are expected to be minimal. Those who choose to recreate on restricted roads would experience an increase in accessible lands following project completion due to the construction of 4.6 miles of new restricted roads. Thus, direct and indirect effects on these recreationists are expected to be moderate to high during the operating period.

Since there will be no harvest located in the Triple Tree Trail area, these recreationists would not be displaced during harvest activities.

Hunting, a primary fall activity, would see the most conflict along the travel route and in the area of the harvest units. Human activity in and around the active harvest units would likely lead to temporary displacement of game during the activity. The removal of vegetative cover would potentially affect the way hunters ultimately use the area in the future (*see Chapter 3 — Wildlife for details*).

Prescribed burning operations may also temporarily displace recreationists. Slash pile burning would likely take place during appropriate conditions in the fall following harvest. If conditions were appropriate in the year following harvest, a broadcast burn operation may take place during the summer and/or fall which may also interfere with recreation. If this kind of operation were to take place the vicinity would be closed for recreation while the operation was conducted, which could take approximately a week. Burning operations may also be carried out in multiple stages potentially creating conflicts for a greater amount of time across the project area. Appropriate signage would be posted surrounding the burn units as well as at the parking areas and trailheads.

Roads and Trails

Under Action Alternative B, approximately 6.5 miles of new road would be constructed. The Limestone West Timber Sale transportation system would result in increased non-motorized access to the project area. Those who choose to recreate on restricted roads would experience an increase in accessible lands following project completion due to the construction of 4.8 miles of new restricted roads. Infrastructure associated with these roads including culverts, drainage structures, and a bridge over the South Fork of Limestone Creek will remain in place at the conclusion of the timber sale. This road system would provide bicycle, pedestrian, and horseback access to the southwest portion of the project area. Similar to existing conditions, no roads would be managed for motorized public use.

At the completion of harvest 1.7 miles of the new road constructed would be reclaimed, all culverts removed, seeded to grass, and closed with debris leaving the road prism in place. These reclaimed roads would eventually be utilized by recreationists and become part of the pioneered trail system in the project area. Those who choose to recreate along the road system may find it difficult to travel along these abandoned roadways. These trails would be expected to receive low to moderate use in the summer and fall like the existing pioneered trails.

Cumulative Effects

- ***Cumulative Effects of the No-Action Alternative and Action Alternative C***

No appreciable changes to access for the developed areas or existing infrastructure would occur. Backcountry, user pioneered trail and game trail access would become more difficult in the stands that are primarily lodgepole pine due to collapse of these stands through pine beetle mortality, hunting patterns of use may also be affected by these changes. The use of these lands and the Triple Tree Trail would continue to increase as a product of population pressure in the Gallatin Valley.

- ***Cumulative Effects of Action Alternative A and B***

New, permanent road construction would lead to increases in public nonmotorized access. Traffic increases from project-related activities under both alternatives would temporarily displace recreationists from areas during the workweek. Those who plan to recreate during the weekend would likely meet minimal harvest-related traffic except for occasional weekend operators and homeowners in the area. Thus, cumulative effects would result in increases in roads available for nonmotorized public access and further displacement of recreationists from active harvest areas during typical business hours. Adverse cumulative effects are expected to be minor within the cumulative effects analysis area since recreationists would continue to have similar recreational opportunities on trails in New World Gulch, Moonshine Gulch, and Bear Canyon. Recreational use would be expected to increase as it has historically due to population pressures in the Gallatin Valley.

AESTHETIC ANALYSIS

INTRODUCTION

This analysis describes the existing visual quality and noise levels in to different analysis areas and discloses the potential environmental effects the proposed actions may have on those attributes.

ANALYSIS AREA

The analysis area used to determine the direct and indirect effects of the proposed action on the visual quality and noise levels will be the project area.

The analysis area used to determine cumulative environmental effects of the proposed action on the visual quality and noise levels will include state, private, city, and federal lands within the Upper East Fork Gallatin watershed surrounding the project area. The USFS is the largest landowner within the cumulative effects analysis area, owning nearly 70 percent of the land, while 10 percent is in state trust land ownership, 18 percent in private ownership, and 2 percent in city of Bozeman ownership. This analysis area will herein be referred to as the cumulative effects analysis area.

ANALYSIS METHODS

VISUAL AMOUNT AND QUALITY

The methodologies used to portray the existing environment and determine the environmental effects of the proposed actions on the visual quality in the project area and cumulative effects analysis area includes using GIS, multiple observer points and methods adapted from the Landscape Visibility section of the USFS Scenery Management System (USFS 1995).

Using a GIS viewshed analysis and historical harvest data, DNRC calculated past, present, and future DNRC acres of harvest units and miles of road visible and not visible from various observation points for both the existing environment and the environmental effects section of this analysis.

The following observation points were determined to be major areas of concentrated public-viewing use: Fort Ellis road, South Third Street, star Ridge Road and Triple Tree Road. The exact locations of these observer point can be seen on Figures AS1 and AS2 below.

Acres and road miles visible and not visible from these observation points do not account for existing or potential obstructions in the following visibility ranges: foreground (0 to 0.5 miles), middle ground (0.5 to 4.0 miles) and background (4 miles and beyond). Therefore, reported visible acres and road miles are likely to be overestimations of what would be currently or potentially visible from each observation point.

Methods adapted from the USFS Scenery Management System were used to account for obstructions in the visibility ranges and describe existing form, lines, textures, and colors and potential changes to those attributes as proposed under the Action Alternatives. Harvest units

associated with the action alternatives were displayed by stand type to more accurately disclose the potential visual quality of the harvested unit.

NOISE LEVELS

The methodologies used to portray the existing environment and determine the environmental effects of the proposed action on the noise levels in the project area and the cumulative effects analysis area includes estimating the magnitude, timing, and type of activities that produce noise.

Cumulative effects analysis for both visual amount and quality and noise levels include consideration of other actions indicated in *Chapter 1 — Relevant Past, Present, and Related Future Actions*.

ISSUES AND MEASUREMENT CRITERIA

Issues

The following issues concerning visual quality and noise levels were raised during internal and external scoping and will be analyzed in further detail.

- Harvest activities, such as road construction, slash/debris piles and harvest design, may adversely affect the visual quality of the landscape as seen from within the proposed project area, neighboring properties, and the City of Bozeman.
- Activities associated with this project may increase local noise levels.

Measurement Criteria

Quantitative and qualitative changes to the following measurement criteria are intended to "measure" the extent of the potential direct, indirect and cumulative environmental effects the proposed action may have on existing visual amount and quality and noise levels in the area. The quality of views from specific observation points are expressed in terms of texture, form, line and color.

- The number and quality of harvest-unit acres and road miles visible from specific observation points.
- The magnitude, timing and type of activities that produce noise within the area.

AFFECTED ENVIRONMENT

The project area involves the landscape visible to the southeast of Bozeman, sometimes referred to as the Gallatin Face. The view consists of foothills rising from the alluvial plain bisected by drainages at each end, predominantly timbered north slopes transitioning to generally open west slopes and meadows with brushy draws in the alluvial plain. The current visible landscape has been influenced by timber harvest, agricultural activities, development, fire suppression and insect and disease issues. The lodgepole pine stands affected by the insects are

mostly in the gray stages (up to 50 percent mortality across the Face) of the Mountain Pine Beetle epidemic, with numerous dead trees beginning to fall to the ground.

HARVEST UNITS

Forest management activities on the state trust lands in the Limestone West area began in 1981 (*see Chapter 1 — Relevant Past, Present, and Related Future Actions*). These acres of harvest resulted in a visible change in the viewshed. Approximately 1 to 26 percent of the project area, as seen from each observation point, has been altered due to forest management over the last 30 years (*TABLE AS1 – ACRES OF HISTORIC HARVEST VISIBLE WITHIN THE PROJECT AREA*).

TABLE AS1 – ACRES OF HISTORIC HARVEST VISIBLE WITHIN THE PROJECT AREA

Observation Point	Project Area Visible Acres	Historic Harvest Visible Acres	Percent of Historic Harvest Visible within Project Area
Fort Ellis Road	1,294	335	26%
South Third Street	1,151	228	20%
Star Ridge Road	1,129	219	19%
Triple Tree Road	464	4	1%

Harvest on neighboring private and USFS lands that are visible within the cumulative effects analysis area include a harvest on state land in Sections 1, 2, 3, and 11, Township 3 South (T3S), Range 6 East (R6E), and Sections 34 and 35 Township 2 South (T2S), Range 6 East (R6E) in the Bear Canyon area. Previous harvests on USFS ownership have mostly re-vegetated and in some cases, have been treated with smaller logging projects to mitigate the harsh lines of the harvests thereby creating a more natural appearance.

The visual effects of a harvest are the most noticeable during and just after the harvest, when the disturbance is at greatest contrast with the surrounding environment. As the land starts to re-vegetate the colors and textures return to a more natural state reducing the contrast to the adjacent environment. The most recent of the forest management projects in the area is the 2011 Bear Canyon Timber Sale Project.

ROADS

Within the project area there are 5.3 miles of road managed as Restricted Class A roads (*see Chapter 3- Transportation*). The current road system in the Limestone West project area consist of approximately .39 miles of shared private driveway/access road that begins at the end of Mount Ellis Lane, and 1.5 miles of improved forest road that that begins on the east boundary of Section 34 and provides access to the Limestone West Timber Sale area.

TABLE AS2 – EXISITNG ROAD MILES VISIBLE WITHIN THE PROJECT AREA

Observation Point	Existing Road Miles Visible within the Project Area	Percent of Total Existing Road Miles
Fort Ellis Road	3.8	88%
South Third Street	2.3	53%
Star Ridge Road	2.2	51%
Triple Tree Road	0	0%

NOISE LEVELS

Project Area

Current activities that generate noise within the project area and cumulative effects analysis area include:

- traffic associated with administrative use;
- firewood harvesting; and
- recreational use such as biking, dog walking, hiking and hunting.

Within the project area firewood harvesting is the most significant contributor to noise. This activity occurs at a low level and is limited by season from June 15 until October 31of a given year and rarely are there multiple firewood collectors operating at the same time. Recreation is also a contributor to noise though typically limited to daytime hours and it dispersed throughout the project area.

Cumulative Effects Analysis Area

- traffic associated with trail use, residential access and commercial use and
- construction activities, agricultural activities and recreational activities.

The cumulative effects analysis area encompasses a greater variety of activities not uncommon to any part of the Gallatin Valley, and no single activity contributes at a level that is unusual. The highest noise levels would be produced in the summer and fall in association with the construction and agricultural industries.

ENVIRONMENTAL EFFECTS

Harvest Units

- ***Direct and Indirect Effects of No-Action and Alternative C***

No harvest activities would occur. The viewshed would continue to noticeably change due to the effect of the mountain pine beetle, and no change in noise levels would be expected.

- ***Direct and Indirect Effects of Action Alternative A and B***

Under the timber sale Action Alternatives, portions of the viewshed would be altered as seen from each observation point. The magnitude of alteration would depend on the alternative selected, species harvested, harvest design, viewing perspective and the rate of recovery from harvest activities.

The harvest prescription for lodgepole pine and the other merchantable species (Douglas-fir, Engelmann spruce and subalpine fir) would be different due to different silvicultural needs and each prescription would affect the viewshed differently. For the purpose of illustrating the future visual character of the area, stands can be placed into 3 categories; Category 1, predominantly lodgepole pine (>70% BA); Category 2, predominantly Douglas-fir (>70% BA); and Category 3, mixed stands with lodgepole pine and Douglas–fir at similar proportions with other species intermixed. Harvest prescriptions applied to these 3 categories of stand types would thus result in diverse types of textures, forms, lines, and colors. A more detailed description of these visual impacts for each stand category is as follows:

Category 1: Stands that are predominantly lodgepole pine would be clearcut with reserves. These stands would appear very light in color, distinctive in form and have hard perimeter lines where the stand meets adjacent regenerating or un-harvested stands. Patches of Douglas-fir may be retained where they occur; however, retention of these patches would not be expected to be very noticeable from the observation points.

Category 2: Stands that are predominantly Douglas-fir would be treated using group selection and selection cutting leaving patches of Douglas-fir where available. These stands are expected to retain the most canopy cover out of all 3 categories of stands. Stands are expected to be darker in color, less distinctive in form, and have softer perimeter lines than stands in the other 2 categories. Due to the distribution of species throughout the harvest unit, these stands may appear patchy in nature, likely retaining groups of Douglas-fir where they exist.

Category 3: Stands that contain similar proportions of lodgepole pine and Douglas-fir would be treated using clearcutting, group selection and selection cutting. These stands are expected to have a blend of qualities from the two categories described above. Since these stands have a greater component of lodgepole pine, Douglas-fir retention patches are expected to be fewer and more infrequent than seen in Category 2 stands while group-selected areas are expected to be larger and more frequent. Like Category 1 stands, these areas are expected to appear very light in color, distinctive in form, and have hard perimeter lines where the stand meets adjacent regenerating or un-harvested stands.

Representation of the makeup of the units based on each of these 3 categories is illustrated below in *FIGURES AS1 and AS2*.

FIGURE AS1 – ALTERNATIVE A PROPOSED HARVEST UNIT BY STAND TYPE

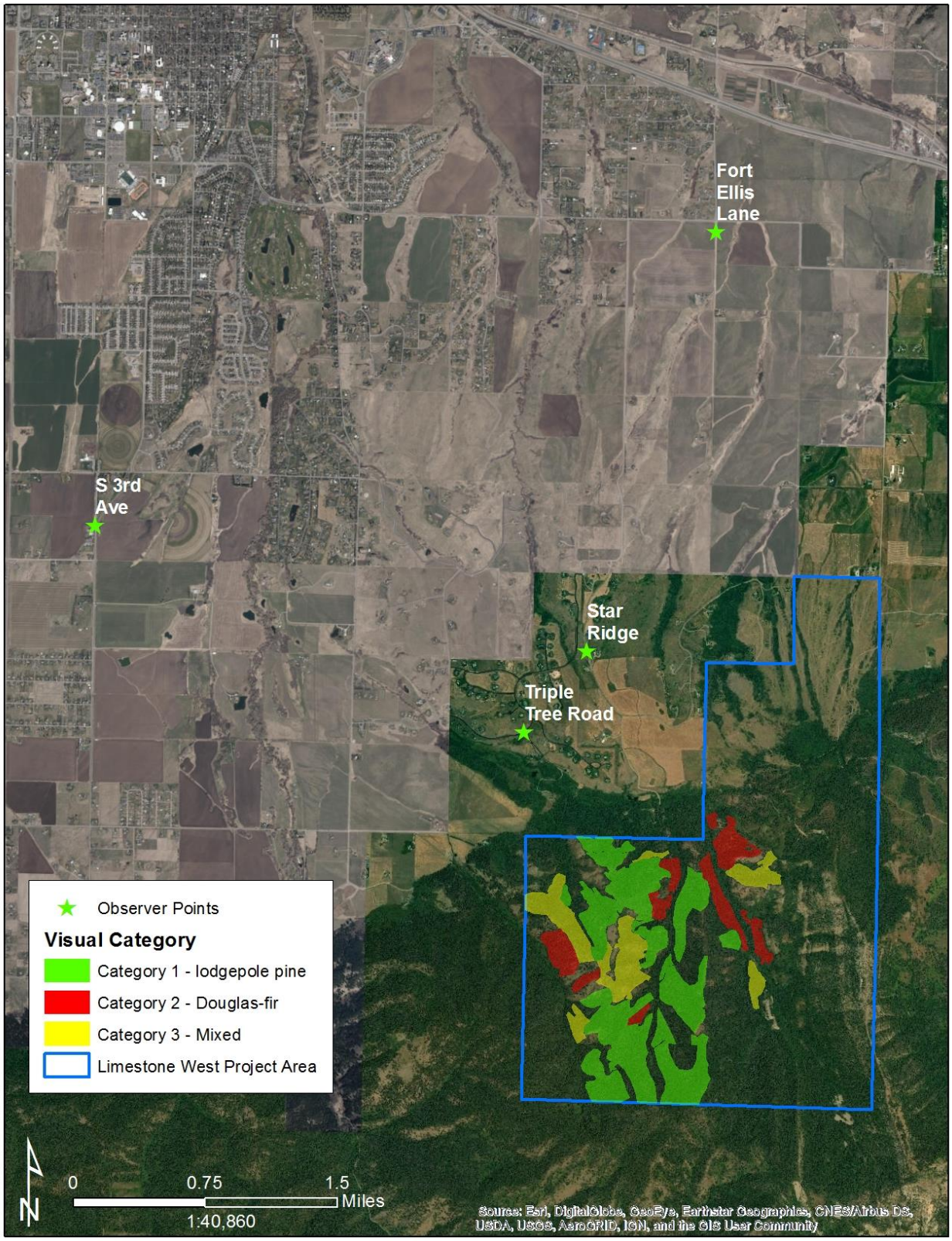
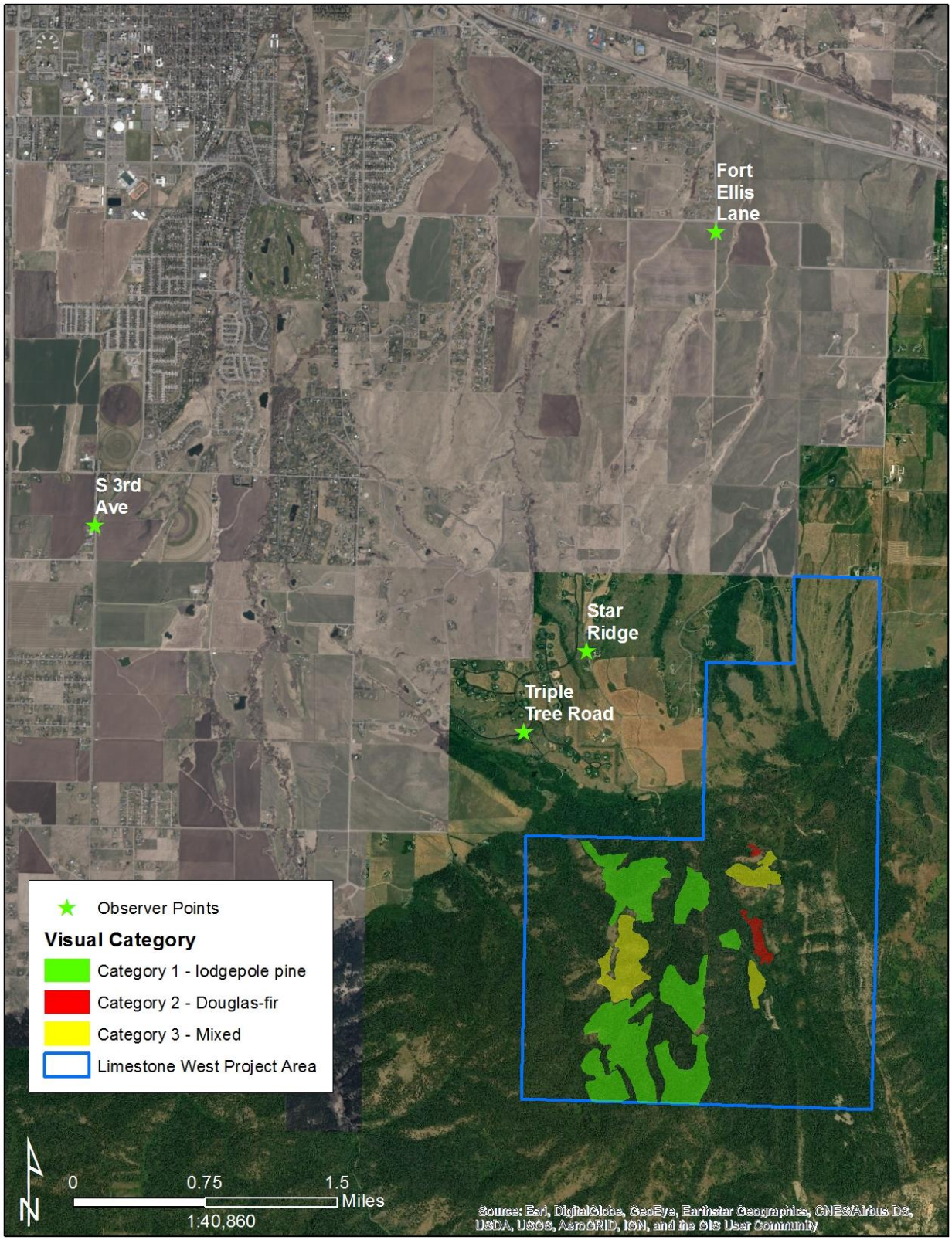


FIGURE AS2 – ALTERNATIVE B PROPOSED HARVEST UNIT BY STAND TYPE



For all categories of stands, where the opportunities exist, the edges of the cutting units would be feathered into the surrounding trees to soften the edges and to create a more natural looking transition between stands. In addition, topography would be used to reduce the acres of harvest visible from a specific observation point; opportunities to apply this would be most prevalent where Douglas-fir exists. The quantity of the viewshed disturbed by harvest activities from any particular view point is directly related to how it affects the viewshed. Depending on the observation point, the amount of harvest visible within the project area ranges from 9 percent of the visible project area (Triple Tree Road observation point) to 26 percent of the visible project area (Star Ridge Road observation point). By design, Alternative B has much less visible harvest acres than Alternative A. A breakdown of the viewshed data by Observation Point is included in TABLE AS3 below.

TABLE AS3 – ACRES OF HARVEST AREA VISIBLE FROM EACH OBSERVATION POINT

Observation Point	Analysis Area								
	Project Area			Alt. A Harvest Units			Alt. B Harvest Units		
	Visible Acres	Non-Visible Acres	% Visible	Visible Acres	Non-Visible Acres	% Visbile	Visible Acres	Non-Visible Acres	Percent of Visible Harvest Unit within Total
Fort Ellis Road	1,294	1,431	47%	240	360	40%	154	221	41%
South Third Street	1,148	1,577	42%	282	318	47%	198	177	53%
Star Ridge Road	1,132	1,593	42%	293	307	49%	177	198	47%
Triple Tree Road	465	2,260	17%	105	495	18%	44	331	12%

Alternatives are further described by visible acres by stand category. Category 1 stands, typically having the most contrast and visibility have been reduced in Alternative B as a response to public comment regarding viewshed concerns. The results of this analysis can be found in both *TABLE AS4* and *TABLE AS5* below.

TABLE AS4 – ACRES HARVEST AREA VISBILE FROM EACH OBSERVATION POINT BY STAND CATEGORY – ALTERNATIVE A

Observation Point	Action Alternative A					
	Category 1 Stands		Category 2 Stands		Category 3 Stands	
	Visible Acres	% Visible within Project Area	Visible Acres	% Visible within Project Area	Visible Acres	% Visible within Project Area
Fort Ellis Road	230	20%	10	1%	42	4%
South Third Street	196	17%	44	4%	53	5%
Star Ridge Road	167	13%	23	2%	50	4%
Triple Tree Road	79	17%	0	0%	26	6%

TABLE AS5 – ACRES HAVREST AREA VISBILE FROM EACH OBSERVATION POINT BY STAND CATEGORY – ALTERNATIVE B

Observation Point	Action Alternative B					
	Category 1 Stands		Category 2 Stands		Category 3 Stands	
	Visible Acres	% Visible within Project Area	Visible Acres	% Visible within Project Area	Visible Acres	% Visible within Project Area
Fort Ellis Road	187	16%	0	0.0%	11	1%
South Third Street	153	14%	2	0.2%	22	2%
Star Ridge Road	132	10%	6	0.5%	16	1%
Triple Tree Road	41	9%	0	0.0%	3	1%

The figures below are visual representations of Category 1 and 2 stands from the Fort Ellis, South Third Street and Star Ridge observer points for Alternative A. These figures further demonstrate the the visual impact of implementing Alternative A which would be the more visible of the two timber sale alternatives.

FIGURE AS3 – ACTION ALTERNATIVE A, CATEGORY 1 AND 2 STANDS FROM THE FORT ELLIS ROAD OBSERVATION POINT

FIGURE AS4 – ACTION ALTERNATIVE A, CATEGORY 1 AND 2 STANDS FROM THE SOUTH 3RD STREET OBSERVATION POINT

FIGURE AS4 – ACTION ALTERNATIVE A, CATEGORY 1 AND 2 STANDS FROM STAR RIDGE ROAD OBVERSATION POINT

Roads

According to *TABLE AS6* and *AS7* below, new road construction would account for 38 to 100 percent of the total road miles visible from each observation point, resulting in large increases from existing conditions. Likewise, new construction throughout the project area would be apparent particularly along steeper terrain where the cut and fill slopes would be more exaggerated. Where possible, trees would be retained along roads in attempts to minimize the impacts to the viewshed as seen from the observation points. Alternative B, by design, has fewer visible miles of new road construction than Alternative A.

TABLE AS6 – EXISTING AND NEW ROADS MILES VISIBLE IN THE PROJECT AREA FOR ALTERNATIVE A

Observation Point	Visible Road Miles - Alternative A					
	Existing Road		New Road		All Road Post Project	
	Visible Road (mi)	% of Total Existing Road Miles	Visible Road (mi)	% of Total New Road Miles	Total Visible Road (mi)	% of New Road Miles
Fort Ellis Road	3.8	88%	3.9	42%	7.7	51%
South Third Street	2.3	53%	4.1	45%	6.4	64%
Star Ridge Road	2.2	51%	3.4	37%	5.6	61%
Triple Tree Road	0	0%	2.1	23%	2.1	100%

TABLE AS7 – EXISTING AND NEW ROADS MILES VISIBLE IN THE PROJECT AREA FOR ALTERNATIVE B

Observation Point	Visible Road Miles - Alternative B					
	Existing Road		New Road		All Road Post Project	
	Visible Road (mi)	% of Total Existing Road Miles	Visible Road (mi)	% of Total New Road Miles	Total Visible Road (mi)	% of New Road Miles
Fort Ellis Road	3.8	88%	2.3	25%	6.1	38%
South Third Street	2.3	53%	2.0	22%	4.3	47%
Star Ridge Road	2.2	51%	1.7	18%	3.85	43%
Triple Tree Road	0	0%	0.4	4%	0.4	100%

Noise

Noise would be generated by harvest operations, harvest related traffic, road construction and administrative oversight. This could be expected to be present for the entire season of harvest, June 15th through March 15th of the following year, for the duration of the harvest of 2 to 3 years. Activities would mostly occur during the typical business work week (Monday through Friday) and cease each day by evening except for occasional operations. Road construction, harvesting operations and timber hauling are expected to be louder than other harvest related traffic. This louder traffic would constitute 75 to 80 percent of the expected traffic trips. For more information on type and duration of harvest activities, refer to the *TRANSPORTION ANALYSIS*.

Cumulative Effects

- ***Cumulative Effects of the No-Action and Action Alternative C***

Under the No-Action and Action Alternative C, no harvest-related activities would occur. Therefore, no cumulative effects to visual quality and noise levels would be expected if either Alternative would be implemented.

- ***Cumulative Effects of Action Alternative A and B***

As stated in the Affected Environment portion of this analysis, timber harvest has been a regularly occurring activity throughout the Gallatin Face, particularly on USFS land. Harvesting activities and road building on both City of Bozeman and USFS land are expected to continue into the future with projects concentrated within the western portion of the cumulative effects analysis area (USFS BMW Timber Sale Project and City of Bozeman thinning projects). Likewise, thinning of forested stands on private ownerships along the Face may occur in the future. These activities, in conjunction with those proposed under the Action Alternative would result in an increase of total harvested acres and road miles visible from each observation point and an increase in noise levels.

According to *TABLE AS7 – CUMULATIVE EFFECTS OF VISIBLE ACRES AFFECTED BY HARVEST UNITS*, the Action Alternatives would account for 2 to 7 percent of total acreage within the cumulative effects analysis visible from each of the observation points.

Managed acres on all ownerships throughout the cumulative effects analysis area are the most visible from Fort Ellis, South Third and Star Ridge observation points. Therefore, the increase in visible managed acres associated with the proposed actions and as seen from these points is expected to be consistent with the trend of the surrounding landscape. Since managed acres on adjacent properties are not very visible from the Triple Tree Road observation point, harvest units associated with the Action Alternatives are expected to constitute most of the managed acres that would be seen from this point.

TABLE AS7 – CUMULATIVE EFFECT OF VISIBLE ACRES AFFECTED BY HARVEST UNITS

Observation Point	Cumulative Effects Analysis Area Visible Acres	Existing Harvest Acres Visible within the Cumulative Effects Analysis Area	Percent of Visible Acres within the Cumulative Effects Analysis Area affected by Existing Harvest	Proposed Harvest Unit Acres Visible within Cumulative Effetcs Analysis Area		Percent of Visible Acres within the Cumulativ Effects Analysis Area affected by Harvest Units	
				Alternative A	Alternative B	Alternative A	Alternative B
Fort Ellis Road	8,425	335	4%	282	198	7%	6%
South Third Street	10,863	228	2%	293	177	5%	4%
Star Ridge Road	6,558	219	3%	240	154	7%	6%
Triple Tree Road	2,892	4	0.1%	105	44	4%	2%

Following harvest, the increase in the amount of managed acres visible from each observation points is expected to be very noticeable within the range of the cumulative effects analysis area especially from Fort Ellis, South Third Street and Star Ridge Road observation points. Over time, the harvest units are expected to blend in with the surrounding landscape, appearing more consistent with other managed areas throughout the area.

All the new roads construction proposed for reclamation post-harvest will blend in with the surrounding landscape overtime. Roads left open for management purposes would likely become overgrown with grass and other vegetation. Depending on type and amount of forest

management planned on adjacent ownerships, lands throughout the cumulative effects analysis area would likely continue to experience similar forms, lines, textures, and colors as they do currently. Older harvest units would continue to regenerate, blending in line, texture, form, and color while newer harvest units would continue to introduce new attributes in sharper contrast to regenerating stands.

Cumulative effects to noise during the daytime and on weekends would be expected to increase beyond current levels found within the cumulative-effects analysis area. Noise emanating from the harvest activities associated with the proposed actions would be concentrated in the areas surrounding the proposed harvest units and roads. Cumulative effects to noise during the evenings would not be expected to increase beyond current levels found within the area.

IRRETRIEVABLE

A resource that has been irretrievably committed is lost for a period of time. Many timber stands in the project area are mature. Any of the timber harvesting alternatives would cause live trees to be irretrievably lost; they would no longer contribute to future snag recruitment, stand structure and compositional diversity, aesthetics, wildlife habitat, the nutrient-recycling process, or any other important ecosystem functions.

Areas converted from timber production to permanent roads would be lost from timber production and would not function as forested lands for a period of time.

IRREVERSIBLE

A resource that has been irreversibly committed cannot be reversed or replaced. The initial loss of trees due to timber harvesting would not be irreversible. Natural regeneration combined with site preparation and artificial regeneration would promote the establishment of new trees. If management decisions allowed for the continued growth of established trees, they would ultimately become equivalent in size to the irretrievably harvested trees.

Areas that are initially lost to timber production through road construction could, over time, be reclaimed and once again produce timber and function as forested land.

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PREPARERS AND CONTRIBUTORS

DECISIONMAKER

Craig Campbell, Unit Manager
Bozeman Unit Office
2273 Boot Hill Court Suite 110
Bozeman, MT 59715-7249

ID TEAM MEMBERS

Chuck Barone, Bozeman Unit
Forester/Project Leader
Bozeman Unit Office
2273 Boot Hill Court Suite 110
Bozeman, MT 59715-7249

Michael Anderson, Fisheries Biologist
Forest Management Bureau
2705 Spurgin Road
Missoula, Montana 59804

Ross Baty, Wildlife Biologist
Forest Management Bureau
2705 Spurgin Road
Missoula, Montana 59804

Jessica Thiel, Forest Planner
Forest Management Bureau
2705 Spurgin Road
Missoula, Montana 59804

Jeff Schmalenberg, Soil Scientist
Forest Management Bureau
2705 Spurgin Road
Missoula, Montana 59804

Tim Spoelma, Silviculturist/Forest Ecologist
Forest Management Bureau
2705 Spurgin Road
Missoula, Montana 59804

Martin Balukas, CLO Trust Lands Manager
Central Land Office
8001 N. Montana Ave
Helena, MT 59602

TECHNICAL SUPPORT AND ASSISTANCE

Gary Frank, Deputy Bureau Chief
Forest Management Bureau
2705 Spurgin Road
Missoula, Montana 59804

Brett Holzer, Trust Fiscal Analyst
Department of Natural Resources and
Conservation P.O. Box 201601
Helena, MT 59620-1601

LIMESTONE WEST DEIS SCOPING LIST

Sara Schwerin
Chris Newman
Lori Mark
Ben Werner
Clint Nagel
Larry Brutger
Frank Lance Craighead
Nancy Ostlie
Brenda Davis
Jeff Yates
Greg Beardslee
George Dorsey
Jack Leddick
Mark Payne
Paul Gaffney
Sara Goulden
Gary Weiner
Walter Sopp
Elizabeth Davis
Charlie Strom
Ron Matelich
C Seibert
Howard Aaronson
Gail and John Richardson
Sara Johnson
Joe Gutkoski
Kelly Pohl
Montana Law
Bruce Granger
Pam Nordheim
Gina Carolan
Chris Christensen
Mark Pearson
Valerie Harms
Barbara Geller
Susan Seibert
Donna Murphrey
Susan O'Neill
Brandon Wold
Judy Tolliver
Chester Beezer
Jak Telly
Amanda Garant
Tom McCormick
Perry Miller
Floyd Reishus
David Peck
Patti Steinmuller
Heini Miettinen-Granger
Kate Cremer-Vogel
Aimee Lockhart
Candis Dorsch
Roger Breeding
Carol Weaver
Moiralie Berman
Julie Cunningham
Dean O Smith
Hugh Petersen
Nancy Schultz
Joel Rabinovitz
Jeff Holmes
Mary and Orme Wilson
Swithin McGrath
John and Tamie Parker
Gary and Melissa Porter
Frank Meyer
Bruce Maxwell
Hannah Downey
Sarah Webb
Lawrie Lieberman
James O'Neill
Loreene Reid
Josh Gage
Eva Patten
Dan Swanson
Elise Strong
Adam Sklar
Richard and Carol Belgrad
Susan Brooke
Nic Davis
Gail Richardson
R Bruce Campbell

Jerry Furtney
Bruce Granger
Helen Richardson
Alexandra, Marty, and Max Colon
Sayer Wickham
Anna Callen
Rick Landers
DeAnn Sparks
Dennis Hardin
Brad Ford
Emily Kniles
Paul McKenzie
Rich Headley
Dan Gannon
Stefan Michel
Steve Hoffman
Dennis Davaz
Clarinda Burke
Randy Walthall
Amanda Obery
Glenn Hockett
Tim Tousignant
Don Bachman
Darren Brown
Scott Creel
Nicole Hobbs
Henry White
Doug Kypfer
Meredith Scully
William Webb
Phil Knight
Chris and Anne Christensen
Robert Bender
Sally Uhlmann
Susannah White
Dorianne and Allen Granger
George Thompson
Steve Clark
Jerry Richardson
Ronald, Diane, and Hailey Buss
Barbara Mall
Martha and Hobart Collins
Kelly Meeker
Stacie Taylor
Wilbur Avril
L Jackson
Sandra Micken
T Jackson
Dick Dorworth
Tom Ross
Bill Sheehan
Steve Wallingford
Emily Mason
John and Sue Lambert
Tracy Nickell
Steve Wellington
Colby Hall
Markie Nathan
Faith Rose
Ann Schrader
Brad Foster
Christy Tooley
David Ogden
Gonnie Siebel
Wills Allen
Steve Kelly
Elise EEG
Steve Gehman
Elinor Ogden
Jennifer Swearingen
Susan W. Dana
Kerry Reif
James (Skip) Anderson
David Barbisan
John Jasper
Curt Vogel
Ron June
Brian Wilson
Tony Hale
Jessica Geary-Cecotti
Laramie Maxwell
Allison Peck Hughes
Colin Quinn
Henry Haselton
D Jenkins
Bill Stoddart

Michael Garrity
Kyle Felsman
Josh Covington
Kevin Bell
Toyia Hatten
Shel Sebren
Karl Johnson
Marlena Renwyck
Michael Allison
Emily Allison
Alex Russell
Helena Maydore
Corin Ostlie
JG Barkow
Mark Egge
Robin Arnold
Steve Perkins
Mildred B
Kim Swaney
Laurence Carucci
Megan Maier
A Stanley
KC Smelser
Roland Bachmann
JP Gabriel
Penelope Pierce
Carol Cone
Teri Ball
Caroline McGee
Barbara Tylka
Mary McFadzen
DeWitt Dominick
Francis Auld
Darrell "Curley" Youpee
William Big Chief
Mark Rosolowsky
Erin Jackson
Katie Coyle
Lindsay Ryder
Peggy Wood
Bronwyn Hennessy
Deanna Hash
Colleen Dockery
Yeinkel Kligerman
Theo Peterson
Michael Sirr
Mike Atwood
Kirsten Taylor
Isaac Taylor
Ashley Martens
Steven Quist
Tina Bauer
John Grassy
Harold Blattie
Julia Altemus
Noel Williams
Tom Weaver
Mike Lilly
Jonathan Windy Boy
Teanna Limpy
Kevin Chappell
Patrick Rennie
Jonathon Proctor
Arlene Montgomery
Nancy Ivy
Sharon Rose
Michael Black Wolf
Kyle Felsman
Kelsey Myers
Paige Goveia

STIPULATIONS AND SPECIFICATIONS

The stipulations and specifications for the action alternatives were identified or designed to prevent or reduce the potential effects to the resources considered in this analysis. These measures are derived from issues raised internally and by the public, *Forest Management Rules*, and other requirements with which forest-management activities must comply, as listed under *RELEVANT AGREEMENTS, LAWS, PLANS, PERMITS, LICENSES, AND OTHER REQUIREMENTS* in *CHAPTER I – PURPOSE AND NEED*.

Stipulations and specifications that apply to harvesting or road-building operations are incorporated into the *State of Montana Timber Sale Contract*. As such, they are binding and enforceable. Project administrators will enforce stipulations and specifications relating to activities that may occur during or after the contract period, such as site preparation or hazard reduction.

The following stipulations and specifications will be incorporated to mitigate effects on the resources involved with the action alternatives considered in this proposal. Each section is organized by resource.

VEGETATION

SENSITIVE PLANTS

Appropriate measures will prevent the disturbance of sensitive plant populations. Riparian areas near harvest units will be marked to protect SMZs and isolated wetlands. No harvesting will take place in wetlands or near springs on localized features. If sensitive plant populations are found, the appropriate habitat area will be excluded from the harvest units.

NOXIOUS WEED MANAGEMENT

To further limit the possibility of spreading noxious weeds, the following weed-management mitigation measures will be implemented:

- All harvesting and processing equipment will be cleaned of noxious weeds prior to beginning project operations. The Forest Officer will inspect equipment periodically during project implementation.
- Surface blading on roads affected by the proposal may result in required weed removal before the seed-set state.
- Disturbed roadside sites will be promptly reseeded with an approved grass mix. Roads used and closed as part of this proposal will be closed to all motorized access and seeded.

- Herbicide application, as designated by the Forest Officer, may be used to control weeds along roads that access the timber sale area. To reduce risk to aquatic and terrestrial resources, the following will be required:
    - All herbicides will be applied by licensed applicators in accordance with laws, rules, and regulations of the State of Montana and Lake County Weed District.
    - All applications will adhere to BMPs and the herbicides' specific label guidelines.
    - Herbicide applications will not be general, but site-specific to areas along roads where noxious weeds grow. No spray areas will be designated on the ground before applications begin.
    - Herbicides will not be applied to areas where relief may contribute runoff directly into surface water.
    - Herbicides will be applied on calm days free of rain to limit drift and the possibility of the herbicide moving off the road prisms.

WATERSHED AND FISHERIES

- Planned erosion-control measures and BMPs include:
    - installing grade breaks on roads,
    - installing water-diverting mechanisms on roads,
    - installing slash-filter windrows, and
    - grass seeding.
- All road stream crossings will be monitored for sedimentation and the deterioration of the road prism.
- Equipment traffic will be allowed at road-stream crossings only where road prisms have an adequate load-bearing capacity.
- Culvert sizing for all new road construction projects will be as recommended by the DNRC hydrologist for a 50-year flood period.
- Stream crossings, where culvert or bridge removals and installations are planned, will have the following requirements, as needed, to meet the intent of water-quality permits and BMPs and protect water quality:
    - diversion channels will be constructed and lined with plastic to divert stream flow prior to any in-channel operations,
    - slash-filter windrows will be constructed on the base of fill slopes,
    - silt fences will be installed along the stream banks prior to and following excavation at crossing sites,
    - filter-fabric fences will be in place downstream prior to and during culvert installation, and
    - stream work will be limited to periods approved by permitting agencies to minimize potential impacts to fish species present.
- Brush will be removed from existing road prisms to allow effective maintenance. Improved road maintenance will reduce sediment delivery.
- The contractor will be responsible for the immediate cleanup of any spills that may affect water quality (fuel, oil, dirt, etc.).

- Equipment that is leaking fluids will not be permitted to operate in stream crossing construction sites.
- BMPs are incorporated into the project design and operations.
- Riparian indicators would be considered in the harvest unit layout.
- The BMP audit process will continue. This sale would likely be reviewed in an internal audit and may be randomly chosen as a statewide audit sale.
    - SMZs will be evaluated as a part of the audit process.
- DNRC would use the best available methods for logging and road building for this project.
- DNRC utilizes BMPs, transportation planning, and logging-system design to minimize new road construction.
- Provisions that address BMPs are in the *State of Montana Timber Sale Contract* and would be enforced.

WILDLIFE

- If a threatened, endangered, or sensitive species of concern are encountered, consult a DNRC biologist and develop additional mitigations that are consistent with the *Forest Management Rules* for managing threatened and endangered species (*ARM 36.11.428* through *36.11.435*).
- Prohibit contractors and purchasers conducting contract operations from carrying firearms while on duty as per *ARM 36.11.444(2)* and *GB-PR2* (*USFWS and DNRC 2010)*.
- Contractors will adhere to food storage and sanitation requirements as per *GB-PR3* (*USFWS* and *DNRC 2010*).
- Public access would be restricted at all times on restricted roads that are opened for harvesting activities; signs will be used during active periods and signed closures will be used during inactive periods (nights, weekends, etc.).
- Given operability and human safety constraints, retain all existing non-merchantable snags where possible.
- Across all harvest units, retain at least 2 large snags and 2 large recruitment trees per acre (both >21 inches dbh, or largest available).
- In all harvest units retain large woody debris within ranges recommended by Graham et al. (1994), which is approximately 5 to 15 tons/ac.
- If a wolf den is found within 1 mile of active harvest units or within 0.5 miles of a rendezvous site, cease operations and consult a DNRC wildlife biologist for appropriate site-specific mitigations before resuming activities.
- In harvest units without planned broadcast burning, retain as possible 2 to 3 slash piles (>10 ft. diameter) to provide residual structure for small mammals, amphibians and other wildlife.
- Require DNRC employees and contractors to store any unnatural bear foods or attractants in a bear-resistant manner (contract clause requirement).

- Opening sizes in regeneration harvest units must be designed in a manner that requires any point within each unit to be within 600 feet of hiding cover -- in at least one direction.
- Where opportunities exist, retain leave trees and retention areas in a clumped fashion to emulate natural disturbance patterns and reduce sight distances for wildlife.
- Restrict mechanized operations from April 1 to June 15 to minimize risk of disturbance to grizzly bears, calving areas and nesting birds.
- Restrict mechanized operations from January 15 to June 15 in harvest units C13 and C14 to minimize potential for disturbance to wolverines during the denning period.
- Retain advanced regeneration thickets comprised of subalpine fir, spruce, and Douglas-fir where possible as desirable structure and species diversity for snowshoe hares and visual screening.
- Retain 100 ft. no harvest RMZs along all class 1 streams in the project area (200 ft. total including both stream sides for No Name Creek, and Nichols Creek). Retain 100 to 350-foot variable width no harvest RMZs along Limestone Creek.
- Goshawk/Great Gray Owl Active Nest Site Mitigation – In an active northern goshawk or great gray owl nest is located, operations near the nest would cease and a DNRC biologist would be contacted. Site-specific measures would be developed and implemented to protect the nest and birds prior to re-starting activities.

SOILS

COMPACTION

- Logging equipment will not operate off forest roads unless:
    - soil moisture is less than 20 percent,
    - soil is frozen to a depth of 4 inches or a depth that will support machine operations (whichever is greater), or
    - soil is snow covered to a depth of 18 inches or a depth that will prevent compaction, rutting, or displacement (whichever is greater).
- Existing skid trails and landings will be used when their design is consistent with prescribed treatments and current *BMP* guidelines are met.
- The harvest project foreman and sale administrator will agree to a skidding plan prior to operating equipment.
- To reduce the number of skid trails and the potential for erosion, designated skid trails will be required where moist soils or short steep pitches (less than 300 feet) will not allow access by other logging systems.
- Primary skid trails in a harvest area will be spaced at 60 feet to limit the potential extent of soil impacts.

DISPLACEMENT

- Ground-based logging equipment (tractors, skidders, and mechanical harvesters) is limited to sustained slopes less than 45 percent on ridges, convex slopes; and to 40 percent or less on concave slopes without winter conditions.
- Slash piling and scarification will be completed with a dozer where slopes are gentle enough to permit (less than 35 percent). Slash treatment and site preparation will be done with an excavator in areas where soils are wet or slopes are steeper (up to 45 percent). Broadcast burning may also be utilized.

EROSION

- Roads used by the purchaser will be reshaped and the ditches redefined to reduce surface erosion prior to and following use.
- Drain dips, open-topped culverts, and gravel will be installed on roads as needed to improve road drainage and reduce erosion and maintenance needs.
- Some road sections will be repaired to upgrade the roads to design standards that will reduce the potential for erosion and maintenance needs.
- Certified weed-free grass seed and fertilizer will be applied promptly to newly constructed road surfaces, cutslopes, and fillslopes. These applications will also be done on existing disturbed cutslopes, fillslopes, and landings immediately adjacent to open roads. These applications, which will stabilize soils and reduce or prevent the establishment of noxious weeds, would include:
    - seeding all road cuts and fills concurrently with construction,
    - applying 'quick cover' seed mix within 1 day of work completion at culvert-installation sites, and
    - seeding all road surfaces and reseeding culvert installation sites when the final blading is completed for each specified road segment.
- Based on ground and weather conditions and as directed by the Forest Officer, water bars, logging-slash barriers, and, in some cases, temporary culverts will be installed on skid trails where erosion is anticipated. These erosion-control features would be periodically inspected and maintained throughout the Timber Sale Contract period or extensions thereof.

AIR QUALITY

- To prevent individual or cumulative effects and provide for burning during acceptable ventilation and dispersion conditions during burning operations, burning will be done in compliance with the *Montana Idaho Airshed Group* reporting regulations and any burning restrictions imposed in Airshed 2.
- Excavator, landing, and roadwork debris will be piled clean to allow easy ignition during fall and spring when ventilation is good and surrounding fuels are wet. The Forest Officer may require that piles be covered to reduce dispersed smoke and allow the piles to ignite more easily, burn hotter, and extinguish more quickly.
- The number of piles to burn will be reduced by leaving large wood debris in the harvest units.

- Depending on the season of harvest and level of public traffic, dust abatement may be applied on some segments of the roads that will be used during hauling.

AESTHETICS

- Damaged submerchantable residual vegetation will be slashed.
- Landings will be limited in size and number and located away from main roads when possible.
- Disturbed sites directly adjacent to roads will be grass seeded.
- When possible, healthy trees not big enough to be harvest will be retained.
- When possible, techniques such as feathering, which involves marking additional timber along the harvest boundary lines, or rounding, which involves eliminating abrupt edges such as those found at property corners, will be implemented to reduce the appearance of straight boundary lines along harvest units.

ROADS

- Information about road reconstruction activities and road use associated with road construction activities will be relayed to the general public.
- Signs will be placed on restricted roads to prohibit public access while harvesting operations are in progress; these roads will be signed restricted during inactive periods (nights, weekends, holidays, shutdowns).
- BMPs will be incorporated into all planned road construction.
- Limiting hauling on county roads to dry or frozen conditions, just as they would be on the State transportations system.
- As a measure to limit dust and reduce the needed maintenance on Mt. Ellis Lane, a treatment of magnesium chloride would be applied once conditions were dry enough to for it to be effective.
- Light grading to the road surface would be provided to help maintain a smooth the driving surface for the hauling activities.
- The use of compression brakes "jake brakes" would be contractually prohibited on the Mt. Ellis Lane haul route to reduce noise.
- At the intersections of Mt. Ellis Rd. and Bozeman Trail Road signs would be places within 500 feet of the intersection on both direction of traffic indicating that Log truck would be entering the roadway.

GLOSSARY

Acre-foot

A measure of water or sediment volume equal to an amount of material that would cover 1 acre to a depth of 1 foot.

Action alternative

One of several ways of moving toward the project objectives.

Administrative road use

Road use that is restricted to DNRC personnel and contractors for purposes such as monitoring, forest improvement, fire control, hazard reduction, etc.

Airshed

An area defined by a certain set of air conditions; typically, a mountain valley where air movement is constrained by natural conditions such as topography.

Ameliorate

To make better; improve.

Appropriate conditions

Describes the set of forest conditions determined by DNRC to best meet the SFLMP objectives. The 4 main components useful for describing an appropriate mix of conditions are cover-type proportions, age class distributions, stand-structure characteristics, and the spatial relationships of stands (size, shape, location, etc.); all are assessed across the landscape.

Best Management Practices (BMPs)

Guidelines to direct forest activities, such as logging and road construction, for the protection of soils and water quality.

Biodiversity

The variety of life and its processes, including the variety of living organisms, the genetic differences among them, and the communities and ecosystems where they occur.

Board foot

144 cubic inches of wood that is equivalent to a piece of lumber 1-inch thick by 1 foot wide by 1 foot long.

Canopy

The upper level of a forest consisting of branches and leaves of the taller trees.

Canopy closure

The percentage of a given area covered by the crowns, or canopies, of trees.

Cavity

A hollow excavated in trees by birds or other animals. Cavities are used for roosting and reproduction by many birds and mammals.

Cervid

Any animal that is a member of the deer family (*Cervidae*).

Clearcut with reserves

A silvicultural treatment involving the cutting of essentially all trees, producing a fully exposed microclimate for the development of a new age class, with retention of additional trees to attain goals other than regeneration of new trees.

Compaction

The increase in soil density caused by force exerted at the soil surface, modifying aeration and nutrient availability.

Connectivity

The quality, extent, or state of being joined; unity; the opposite of fragmentation.

Coarse down woody material

Dead trees within a forest stand that have fallen and begun decomposing on the forest floor.

Crown cover or crown closure

The percentage of a given area covered by the crowns of trees.

Cull

A tree of such poor quality that it has no merchantable value in terms of the product being cut and manufactured.

Cumulative effect

The impact on the environment that results from the incremental impact of the action when added to other actions. Cumulative impacts can also result from individually minor actions, but collectively they may compound the effect of the actions.

Direct effect

Effects on the environment that occur at the same time and place as the initial cause or action.

Dominant tree

Those trees within a forest stand that extend their crowns above surrounding trees and capture sunlight from above and around the crown.

Drain dip

A graded depression built into a road to divert water and prevent soil erosion.

Ecosystem

An interacting system of living organisms and the land and water that make up their environment; the home place of all living things, including humans.

Environmental effects

The impacts or effects of a project on the natural and human environment.

Equivalent clearcut area (ECA)

The total area within a watershed where timber has been harvested, including clearcuts, partial cuts, roads, and burns.

Allowable ECA - The estimated number of acres that can be clearcut before stream-channel stability is affected.

Existing ECA - The number of acres that have been previously harvested taking into account the degree of hydrologic recovery that has occurred due to revegetation.

Remaining ECA -The calculated amount of harvesting that may occur without substantially increasing the risk of causing detrimental effects to stream-channel stability.

Excavator piling

The piling of logging residue (slash) using an excavator.

Fire regimes

Describes the frequency, type, and severity of wildfires. Examples include: frequent, nonlethal underburns; mixed-severity fires; and stand-replacement or lethal burns.

Forage

All browse and nonwoody plants available to wildlife for grazing.

Forest improvement (FI)

Activities done to promote the establishment and growing of trees after a site has been harvested. Associated activities include:

- site preparation, planting, survival checks, regeneration surveys, and stand thinnings;
- road maintenance;
- resource monitoring;
- noxious weed management; and
- right-of-way acquisition on a State forest.

Fragmentation (forest)

A reduction of connectivity and an increase in sharp stand edges resulting when large contiguous areas of forest with similar age and structural characteristics are interrupted through disturbances, such as stand-replacement fires and timber stand harvesting.

Geomorphological processes

The observed proportions of habitat types for each reach are within the broad ranges of expected conditions.

Habitat

The place where a plant or animal naturally or normally lives and grows.

Habitat type

Land areas that would produce similar plant communities if left undisturbed for a long period of time.

Harvest units

Areas of timber proposed for harvesting.

Hazard reduction

The abatement of a fire hazard by processing logging residue with methods such as separation, removal, scattering, lopping, crushing, piling and burning, broadcast burning, burying, and chipping.

Hiding cover

Vegetation capable of hiding 90 percent of a standing adult mammal from human view at a distance of 200 feet.

Historical forest condition

The condition of the forest prior to settlement by Europeans.

Indirect effects

Secondary effects that occur in locations other than the initial action or significantly later in time.

Interdisciplinary team (ID Team)

A team of resource specialists brought together to analyze the effects of a project on the environment.

K factor

The soil erodibility factor which represents both susceptibility of soil to erosion and the rate of runoff, as measured under the standard unit plot condition.

Landscape

An area of land with interacting ecosystems.

Macroporosity

The gaseous portion of a soil profile typically containing pores on the order of 3 to 100mm in diameter and are interconnected to varying degrees; thus, they can allow water to bypass the soil matrix and move rapidly to a basal saturated zone and/or move downslope as pipe flow at speeds greater than predicted by Darcy's Law.

Mitigation measure

An action or policy designed to reduce or prevent detrimental effects.

Multistoried stands

Timber stands with 2 or more distinct stories.

No-action alternative

The option of maintaining the status quo and continuing present management activities by not implementing the proposed project.

Nonforested area

A naturally occurring area, (such as a bog, natural meadow, avalanche chute, and alpine areas) where trees do not establish over the long term.

Old-growth

Working definition - Old-growth as defined by *Green et al*.

Conceptual definition - The term old-growth is sometimes used to describe the later, or older, stages of natural development of forest stands. Characteristics associated with old-growth generally include

relatively large old trees that contain a wide variation in tree sizes, exhibit some degree of a multi-storied structure, have signs of decadence, such as rot and spike-topped structure, and contain standing large snags and large down logs.

Overstory

The level of the forest canopy that include the crowns of dominant, codominant, and intermediate trees.

Overstory removal

The cutting of trees comprising an upper canopy layer in order to release trees or other vegetation in an understory.

Patch

A discrete (individually distinct) area of forest connected to other discrete forest areas by relatively narrow corridors; an ecosystem element (such as vegetation) that is relatively homogeneous internally, but differs from what surrounds it.

Project file

A public record of the analysis process, including all documents that form the basis for the project analysis.

Regeneration

The replacement of one forest stand by another as a result of natural seeding, sprouting, planting, or other methods.

Reinitiation

The first phase of the process of stand development.

Residual stand

Trees that remain standing following any cutting operation.

Road-construction

Cutting and filling of earthen material that results in a travel-way for wheeled vehicles.

Road maintenance

Maintenance and repair of existing roads that are accessible to motorized use, including but not limited to:

- blading;
- reshaping; or

- resurfacing the road to its original condition;
- cleaning culverts;
- restoring and perpetuating road surface drainage features; and
- clearing the roadside of brush.

Road reconstruction

Modifying a road to a higher standard to accommodate proposed use.

Salvage

The removal of dead trees or trees being damaged or dying due to injurious agents other than competition to recover value that would otherwise be lost.

Saplings

Trees 1.0 inches to 4.0 inches in dbh.

Sawtimber trees

Trees with a minimum dbh of 9 inches.

Scarification

The mechanized gouging and ripping of surface vegetation and litter to expose mineral soil and enhance the establishment of natural regeneration.

Scoping

The process of determining the extent of the environmental assessment task. Scoping includes public involvement to learn which issues and concerns should be addressed and the depth of the assessment that will be required. It also includes a review of other factors such as laws, policies, actions by other landowners, and jurisdictions of other agencies that may affect the extent of assessment needed.

Security

For wild animals, the freedom from the likelihood of displacement or mortality due to human disturbance or confrontation.

Sediment

Solid material, mineral or organic, that is suspended and transported or deposited in bodies of water.

Seedlings

Live trees less than 1.0 inch dbh.

Seedtree

An even-aged regeneration method in which a new age class develops from seeds that germinate in fully exposed microenvironments after removal of all the previous stand except a small number of trees left to provide seed. Seed trees are removed after regeneration is established. For the purposes of this project, 6 to 12 seed-bearing trees per acre will be retained to provide a seed source for stand regeneration.

Sediment yield

The amount of sediment that is carried to streams.

Seral

Refers to a biotic community that is in a developmental, transitional stage in ecological succession.

Shade intolerant

Describes tree species that generally can only reproduce and grow in the open or where the overstory is broken and allows sufficient sunlight to penetrate. Often these are seral species that get replaced by more shade-tolerant species during succession.

Shade tolerant

Describes tree species that can reproduce and grow under the canopy in poor sunlight conditions. These species replace less shade-tolerant species during succession.

Shelterwood

A silvicultural treatment involving the cutting of most trees, leaving those needed to produce sufficient shade to produce a new age class in a moderated microenvironment.

Single-tree selection

A method of creating new age classes in uneven-aged stands in which individual trees of all size classes are removed more-or-less uniformly throughout the stand to achieve desired stand structural characteristics.

Sight distance

The distance at which 90 percent of an animal is hidden from view by vegetation.

Silviculture

The art and science of managing the establishment, composition, and growth of forests to accomplish specific objectives.

Site Preparation

A hand or mechanized manipulation of a harvested site to enhance the success of regeneration. Treatments are intended to modify the soil, litter, and vegetation to create microclimate conditions conducive to the establishment and growth of desired species.

Slash

Branches, tops, and cull trees left on the ground following harvesting.

Snag

A standing dead tree or the portion of a broken-off tree. Snags may provide feeding and/or nesting sites for wildlife.

Stand

An aggregation of trees that are sufficiently uniform in composition, age, arrangement, and condition and occupy a specific area that is distinguishable from the adjoining forest.

Stand density

Number of trees per acre.

Stocking

The area of a piece of land that is now covered by trees is compared to what could ideally grow on that same area. The comparison is usually expressed as a percent.

Stream gradient

The slope of a stream along its course, usually expressed in percentage, indicating the amount of drop per 100 feet.

Stumpage

The value of standing trees in the forest. Sometimes used to mean the commercial value of standing trees.

Succession

The natural series of replacement of one plant (and animal) community by another over time in the absence of disturbance.

Suppressed

The condition of a tree characterized by a low-growth rate and low vigor due to overcrowding competition with overtopping trees.

Texture

A term used in visual assessments indicating distinctive or identifying features of the landscape depending on distance.

Thermal cover

For white-tailed deer, thermal cover has 70 percent or more coniferous canopy closure at least 20 feet above the ground, generally requiring trees to be 40 feet or taller. For elk and mule deer, thermal cover has 50 percent or more coniferous canopy closure at least 20 feet above the ground, generally requiring trees to be 40 feet or taller.

Timber harvesting activities

In general, all the activities conducted to facilitate timber removal before, during, and after the timber is removed. These activities may include any or all of the following:

- felling standing trees and bucking them into logs
- skidding logs to a landing
- processing, sorting, and loading logs at the landing
- hauling logs to a mill
- slashing and sanitizing residual vegetation damaged during logging
- machine piling logging slash
- burning logging slash
- scarifying, preparing the site as a seedbed
- planting trees

Understory

The trees and other woody species growing under a, more less, continuous cover of branches and foliage formed collectively by the overstory of adjacent trees and other woody growth.

Uneven-aged stand

Various ages and sizes of trees growing together on a uniform site.

Ungulates

Hoofed mammals, such as mule deer, white-tailed deer, elk, and moose, that are mostly herbivorous and many are horned or antlered.

Vigor

The degree of health and growth of a tree or stand.

Visual screening

The vegetation that obscures or reduces the length of view of an animal.

Watershed

The region or area drained by a river or other body of water.

Water yield

The average annual runoff for a particular watershed expressed in acre-feet.

Water yield increase

An increase in average annual runoff over natural conditions due to forest canopy removal.

ACRONYMS AND ABBREVIATIONS

124 Permit — Stream Preservation Act Permit
318 Authorization — Short-Term Exemption from Montana's Water Quality Standards
ADS — Aerial Detection Survey
ARM —Administrative Rules of Montana
BA — basal area
BBER — Bureau of Business and Economic Research
BMP —Best Management Practices for Forestry
BMW —Bozeman Municipal Watershed
CWD— Coarse Woody Debris
DBH — diameter at breast height
DEQ —Montana Department of Environmental Quality
DF —Douglas-fir
DFC —Desired Future Conditions
DNRC — Montana Department of Natural Resources and Conservation
EA —Environmental Assessment
ECA—Equivalent Clearcut Area
EIS —Environmental Impact Statement
FFE-FVS – Fire and Fuels Extension of the Forest Vegetation Simulator
FI — Forest Improvement
Forest Management Rules – Administrative Rules for Forest Management 36.11.401 through 456
FVS – Forest Vegetation Simulator
FWD — Fine Woody Debris
FWP — Montana Department of Fish, Wildlife, and Parks
GYE — Greater Yellowstone Ecosystem
HCP — Habitat Conservation Plan
ID Team —Interdisciplinary Team
Land Board —Board of Land Commissioners
LWD—Large Woody Debris
MCA —Montana Code Annotated
MEPA —Montana Environmental Policy Act
MMbf —million board feet
MNHP —Montana Natural Heritage Program
Project Area—Limestone West Project Area
RL — Random Lengths
RMZ — Riparian Management Zone
SFLMP—State Forest Land Management Plan
SLI —Stand Level Inventory
SMZ — Streamside Management Zone
SPTH— Site Potential Tree Height
SYC—Sustainable Yield Calculation

TLMD—Trust Land Management Division
USDA – US Department of Agriculture
USFS —United States Forest Service
USFWS —United States Fish and Wildlife Service
WWPA — Western Wood Products Association

APPENDIX A

ISSUES ELIMINATED FROM FURTHER ANALYSIS. Issues eliminated from further analysis and accompanying rationale.

ISSUES ELIMINATED FROM FURTHER ANALYSIS	RATIONALE
There are concerns about the proposed silvicultural prescriptions for timber harvesting, including clearcutting.	DNRC strives to employ silvicultural treatments that to the extent practicable emulate naturally occurring disturbance regimes (ARM 36.11.408). In this project, DNRC has limited the use of clearcutting to areas where lodgepole pine is the dominant species. Lodgepole pine's physiological characteristics are ill-suited to surviving fire, and because of that in areas where lodgepole pine is a dominant cover type and species, fires typically result in stand-replacing events. However, stand-replacing fires also create favorable conditions for lodgepole pine regeneration. Clearcutting can emulate many of the same effects of stand-replacing fire in lodgepole pine stands, and therefore it is an appropriate, if not ideal, silvicultural treatment to apply in lodgepole pine stands. Several other treatment types were also considered during project design, but these were deemed not feasible for this project because they would be less likely to accomplish project objectives, would be difficult and costly to lay out and implement, would result in a high likelihood of windthrow, or did not match the naturally occurring disturbance regimes found in this area.
Concern that DNRC may remove large, vigorous, and healthy Douglas-fir trees which may otherwise be left for aesthetic, wildlife, and reforestation purposes.	As described in *FOREST COVER TYPES, AGE CLASSES, AND STAND STRUCURE*, under *VEGETATION ANALYSIS in CHAPTER III – EXISTING ENVIRONMENT AND ENVIRONMENTAL IMPACTS*, Douglas-fir stands in the project area would be treated with a shelterwood prescription. This prescription would target removal of trees that

	are generally less vigorous and with poor form and characteristics. Vigorous and healthy trees of all sizes, including large trees, would be preferred trees to retain in treated stands, although some healthy trees may be harvested to achieve silvicultural objectives and desired tree density/stocking levels. Some large cull trees would be left for wildlife reserve trees and to meet required snag recruitments amounts of two trees per acre.
Concern about the use of firewood permits in the project area.	Issuance of firewood permits is conducted by Bozeman Unit and is separate from this project.
Concern about the potential for forest regeneration and the use of planting for post-harvest regeneration.	Our experience in this area and these stand types has shown that lodgepole pine reliably regenerates to adequate stocking levels following harvest, while Douglas-fir may require more than 30 years to regenerate to adequate levels. Post-harvest regeneration surveys would monitor the success of natural regeneration. If natural regeneration is inadequate, brush control and planting may be used to establish regeneration to desired levels as described in *FOREST COVER TYPES, AGE CLASSES, AND STAND STRUCURE*, under *VEGETATION ANALYSIS in CHAPTER III – EXISTING ENVIRONMENT AND ENVIRONMENTAL IMPACTS*.
Concern about the potential productivity and forest growth and yield in the area.	Forested stands within the project area (2,105 acres) are primarily in the Douglas-fir (PSME) series of habitat types (1,125 acres) described by *Pfister et al.* (*1977*). Douglas-fir habitat types are found on 1,125 acres of the project area, with 757 acres of those in the Douglas-fir/ninebark (PSME/PHMA) habitat type. Other Douglas-fir habitat types, listed in decreasing order of occurrence, including Douglas-fir/dwarf huckleberry (PSME/VACA), Douglas-fir/snowberry (PSME/SYAL), Douglas-fir/blue huckleberry (PSME/VAGL), Douglas-fir/elk sedge (PSME/CAGE), and Douglas-fir/pinegrass (PSME/CARU) are found in the project area. Spruce habitat types found

	in the project area include spruce/ninebark (PICEA/PHMA) (301 acres) and spruce/common horsetail (PICEA/EQAR) (5 acres). Subalpine fir habitat types, including subalpine fir/menziesia (ABLA/MEFE), subalpine fir/blue huckleberry (ABLA/VAGL), and subalpine fir/pinegrass (ABLA/CARU) are found on 185 acres in the project area. The limber pine/bluebunch wheatgrass (PIFL/AGSP) habitat type is found on 57 acres in the project area. Habitat types were not identified on 432 acres in the eastern portion of the project area that is outside the proposed harvest units where detailed stand-level inventory has not yet been collected; however, habitat types in these stands are likely among those listed above. Forested stands with potential productivity greater than 20 cubic feet/acre/year are considered suitable for commercial timber production. The productivity of most habitat types within the project area falls within the lower half of the moderate productivity range described by *Pfister et al*. (*1977*) of 50-85 cubic/feet/acre/year, which is well above the threshold for suitability for commercial timber production. The only forested stands not suitable for timber production within the project area are in the limber pine/bluebunch wheatgrass habitat type, which has a mean productivity of 16 cubic feet/acre/year. No harvesting activities are proposed in those stands.
Concern about the sustainability of forest management in the area.	DNRC conducts forest management under a sustainable yield plan that balances the growth capability of its forest lands with the legal and regulatory commitments governing its forest management program. This ensures that the forest resource is not depleted over time due to excessive harvesting, and that sufficient management occurs to meet programmatic commitments and objectives, including generation of revenue for the trust

	beneficiaries. The annual sustainable yield is determined through a complex calculation that considers the current forest resource, future growth associated the various management activities, and limitations on when and what type of management can occur. DNRC is required by law (*MCA 77-5-222*) to conduct an annual sustainable yield calculation at least once every 10 years or as directed by the Land Board. Annual sustainable yield is defined as the quantity of timber that can be harvested from forested state lands each year in accordance with all applicable state and federal laws, including but not limited to the laws pertaining to wildlife, recreation, and maintenance of watersheds, and in compliance with water quality standards that protect fisheries and aquatic life and that are adopted under the provisions of Title 75, chapter 5, taking into account the ability of state forests to generate replacement tree growth (*MCA 77-5-221*). The calculated annual sustainable yield constitutes DNRC's annual timber sale requirement (*MCA 77-5-223*). The most recent sustainable yield calculation was conducted by the natural resources consulting firm Mason, Bruce, and Girard, in 2015. The calculation process involves three steps: 1) collecting and summarizing data (forest inventory, wildlife habitat, water resources, operability) to provide a detailed description of the land base; 2) developing estimates of expected growth and yield associated with the range of management actions used by DNRC; 3) applying management constraints using an optimization model to determine the annual sustainable yield. The management constraints used in the optimization model are limitations placed on the model that restrict when, where, which, and how often harvesting treatments may be applied. These constraints reflect the requirements and management standards set

	forth in the SFLMP, ARM, and DNRC's HCP, and included operability, wildlife habitat, water resources, and timber harvest and silviculture constraints. The calculated annual sustainable yield (56.9 million board feet, statewide) reflects a harvest level that could be sustainably perpetuated on an annual basis over the modeled planning horizon (200 years). Forest lands in the Limestone West project area were included in the calculation and contribute to DNRC's annual sustainable yield.
Concern about the impacts of climate change/global warming on forest productivity and growth in the area.	Evidence of widespread climate change has been well-documented and reported (*Intergovernmental Panel on Climate Change 2013*). In Montana, effects of climate change will be related to changes in temperature and moisture availability, and the response of individual tree species and forests will be complex and variable depending on local site and stand conditions. Changes in temperature and moisture availability may affect the ability of some species to establish and regenerate on some sites. Forest productivity may increase in some areas due to longer growing seasons associated with increased temperature where moisture is not limited but may decrease in other areas where increasing temperature results in decreased water availability. Drought severity is expected to increase, leading to increases in forest and tree mortality. Changing climate may also lead to changes in the range of some species, resulting in changes in forest composition and distribution. Changing climate is also expected to alter natural disturbance regimes, such as fire and insects, with the resulting effects expected to have greater impact on Montana's forests than changes in temperature and moisture availability that directly affect individual trees and species. (*Wade et al. 2017*) Understanding changes in tree species composition in forests, and the ability of various tree species to thrive under changing

	climate conditions, may take decades. Predicting possible effects of climate change in forests at local levels is also difficult due to large-scale variables at play, such as possible increases in global evaporation rates, and possible changes in global ocean currents and jet stream. Such outcomes could influence locally-observed precipitation amounts and possible influences on natural disturbance regimes (such as changing the average intensity, frequency and scale of fire events). Normal year to year variation in weather also confounds the ability to identify, understand, predict, and respond to influences of climate change. Given the many variables and difficulty in understanding the ramifications of changing climate, detailed assessment of possible direct, indirect, or cumulative effects of climate change in association with project activities described in this EIS is beyond the scope of this analysis. In the face of current uncertainty associated with climate change, DNRC is continuing to manage for biodiversity as guided under the SFLMP. Under the management philosophy of the SFLMP, DNRC will continue to manage for biodiversity using a coarse-filter approach that favors an appropriate mix of stand structures and compositions on state lands as described by *ARM 36.11.404*, while also working to understand relevant ecosystem changes as research findings and changes in climate evolve.
Concern about the amount of prior harvesting on State lands adjacent to the project area.	Effects of prior harvesting on adjacent State lands are included in the analysis of cumulative effects for each resource analyzed in the EIS.
Concern about the use of timber harvesting to achieve biodiversity objectives.	The Omega alternative that was selected as DNRC's State Forest Land Management Plan emphasized maintaining and promoting biodiversity on state trust lands through the use of intensive timber management to

	produce long-term revenue for the trusts. The Administrative Rules for Forest Management further describe specific measures to ensure that the biodiversity standards described in the SFLMP are implemented and achieved. These include the use of coarse and fine filters (36.11.404 and 406), site specific management toward desired future conditions based on the range of forest types that have historically occurred in Montana (36.11.405), direction for managing blocked and scattered lands (36.11.407 and 416), selecting silvicultural systems that are based on natural disturbance regimes (36.11.408), specified amounts for snag and coarse woody debris retention (36.11.411 and 413), incorporating natural patterns into patch size and shape (36.11.415), management of old growth stands (36.11.418), and conducting reviews to ensure biodiversity measures are being applied.
Concern about DNRC's old growth definition.	DNRC defines old-growth as a forest stand that meets or exceeds the minimum number, size, and age of those large trees as noted in "*Old-Growth Forest Types of the Northern Region," by Green et al.* (1992) [*ARM 36.11.403(49)*]. DNRC also uses the minimum criteria for stand basal area for each old-growth type described by *Green et al*. (*1992, errata corrected 02/05, 12/07, 10/08, 12/11*) as additional criteria for identifying potential old-growth stands. Descriptions within the various resource analyses presented in this document of old-growth forests on state trust lands are consistent with this definition.
Concern about the scientific validity of the use of timber harvesting in old growth forests	*Green et al*. (*1992*) state in their report, *Old Growth Forest Types of the Northern Region*, that "old-growth is not necessarily 'virgin' or 'primeval'. Old-growth could develop following human disturbances." Additionally, there is a growing body of scientific literature addressing the use of silvicultural harvest treatments to retain and promote the

	development of old-growth forest attributes (*Larson et al. 2012, Bauhus et al. 2009, Raymond et al. 2009, Twedt and Somershoe 2009, Brewer et al. 2008, Fiedler et al. 2007, Keeton 2006, Beese et al. 2003, Latham and Tappeiner 2002, Fiedler 2000*). DNRC's management reflects and incorporates that research. *ARM 36.11.418* describes the types of silvicultural cutting treatments that may be used in old-growth stands on state trust lands. Two of those treatment types, old-growth maintenance and old-growth restoration, require that after harvesting the stand meets the minimum criteria presented by *Green et al.* (*1992*) to be defined as old-growth. When implementing such treatments, DNRC works to maintain to the extent practicable other attributes associated with old-growth forests, including multi-storied canopy structures, presence of snags and coarse woody debris. DNRC acknowledges that when treatments in old-growth stands occur, habitat attributes are altered and habitat quality for some associated species of wildlife may be reduced (*Jobes et al. 2004*). As such, because a logged old-growth stand may meet the *Green et al.* definition after treatment, does not indicate that it will provide high quality habitat for all old-growth associated species. Such stands following logging, however, will possess a definable threshold of very large, old trees that would otherwise take centuries to develop, and which provide important raw materials for other attributes found in most old-growth stands for years into the future (e.g. large snags, large downed logs etc.). Environmental impacts on old-growth are described in *FOREST COVER TYPES, AGE CLASSES, AND STAND STRUCURE,* under *VEGETATION ANALYSIS in CHAPTER III – EXISTING ENVIRONMENT AND ENVIRONMENTAL IMPACTS*.
DNRC should develop a programmatic old growth strategy	Development of a programmatic old growth strategy is beyond the scope of this project.

	DNRC manages old growth as described by the SFLMP and associated Administrative Rules for Forest Management, specifically *36.11.418*, which describes the application of silvicultural treatments in old growth stands.
DNRC should manage old growth stands on longer rotations	DNRC management decisions regarding old-growth at the project level follow *ARM 36.11.418(a)* and *(c).* When considering old-growth management at the project level, careful attention is given to many variables, including (but not limited to): cover types, stand locations, patch sizes, habitat connectivity, insect/disease risk, etc. This approach has allowed DNRC to evaluate conservation biology principles and tradeoffs at the landscape scale and have improved flexibility to address stand changes and economic losses brought about by natural-disturbance agents, such as insects, diseases, and wildfire. *DNRC* must also consider the requirements of *MCA 77-5-116*, which is a law that prohibits DNRC from establishing old-growth deferrals and set-asides without compensation to trust beneficiaries. Old-growth stands receiving uneven-aged harvesting will be managed under a relatively long rotation with DNRC's current approach. Environmental impacts on old-growth are described in *FOREST COVER TYPES, AGE CLASSES, AND STAND STRUCURE*, under *VEGETATION ANALYSIS in CHAPTER III – EXISTING ENVIRONMENT AND ENVIRONMENTAL IMPACTS*.
Forest health is an undefined concept.	The Society of American Foresters (SAF) defines forest health as the perceived condition of a forest derived from concerns about such factors as its age, structure, composition, function, vigor, presence of unusual levels of insects or disease, and resilience to disturbance (*Helms 1998*). SAF further describes that the perception of forest health is influenced by several factors including individual and

	cultural viewpoints, land management objectives, spatial and temporal scales, the relative health of the stands that comprise the forest, and the appearance of a forest at a certain point in time (*Helms 1998*). DNRC's view of forest health is largely influenced by its management objective of maintaining healthy and diverse forests as a sustainable source of long-term revenue for the trust beneficiaries. As such, each of the factors described in SAF's definition of forest health and their relationship to maintaining and promoting diversity and sustainability, are considered as DNRC's designs and implements management activities to accomplish its mission.
Concern that increased human presence associated with increased opportunities for access via the proposed transportation system will increase the risk of human-caused fires	Expected changes in human use of the area are described in *RECREATION ANALYSIS in CHAPTER III – EXISTING ENVIRONMENT AND ENVIRONMENTAL IMPACTS*. Although expected human use of the area is expected to increase, it is not possible to predict the ignition, cause, time, or location of a wildfire prior to its occurrence. However, it is possible to describe the potential behavior and effects of a wildfire under certain conditions, and these are described in *FIRE ECOLOGY and BEHAVIOR,* under *VEGETATION ANALYSIS in CHAPTER III – EXISTING ENVIRONMENT AND ENVIRONMENTAL IMPACTS*. Additionally, we believe that the proposed transportation system would enhance access to the project area for ground-based fire suppression.
Concern about the disposal of logging slash in the project area	Limited markets currently exist to utilize logging slash, so in most cases piling and burning slash is the most efficient way to dispose of that material. If a market to utilize logging slash is available, DNRC would pursue disposal of slash in that manner; however, we currently expect that most slash generated from harvesting associated with this project would be piled and burned. Slash would be reduced in harvest units to meet the

	requirements of the Administrative Rules of Montana for control of timber slash and debris (ARM 36.11.221 through 232), while retaining a sufficient amount of material for coarse woody debris retention and nutrient cycling to maintain soil productivity. The prescribed amount of logging slash left in the harvest units is 5-15 tons/acre.
Desire for DNRC to conduct long-term plant monitoring in the project area	Establishment of a long-term plant community monitoring program is beyond the scope of this project. DNRC already conducts periodic timber stand inventories as a part of its forest inventory program. As described in *NOXIOUS WEEDS* under *VEGETATION ANALYSIS in CHAPTER III – EXISTING ENVIRONMENT AND ENVIRONMENTAL IMPACTS,* DNRC would conduct noxious weed monitoring following harvest activities. DNRC also would continue to rely on observations of plant Species of Concern reported to the Montana Natural Heritage Program as described in *THREATENED, ENDANGERED, and SENSITIVE PLANTS* under *VEGETATION ANALYSIS in CHAPTER III – EXISTING ENVIRONMENT AND ENVIRONMENTAL IMPACTS.*
Concerns about logging practices, including stump height, types, viability, and environmental impacts of alternative logging systems including, and contract administration	Harvest activities and associated logging systems associated with the action alternatives were designed for use on appropriate terrain, with skyline logging systems proposed where terrain is too steep for conventional ground-based harvesting. The timber sale contract would include specifications for logging, including stump heights and utilization, which would be enforced by DNRCs contract administrator.
There is concern that the project will decrease biodiversity.	DNRC defines biodiversity as the variety of life and its processes. It includes the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur (DNRC 1996). DNRC primarily promotes biodiversity by taking a "coarse filter" approach to forest

	management, thereby favoring an appropriate mix of stand structures and compositions on state lands. A coarse filter approach "assumes that if landscape patterns and processes (similar to those species evolved with) are maintained, then the full complement of species will persist and biodiversity will be maintained" (*Jensen and Everett 1993*). Proposed treatments would emulate natural fire disturbance by removing most lodgepole pine and would retain a greater representation of Douglas-fir, and spruce and subalpine fir, which occur on wet and cool sites. Harvest units would have irregularly shaped naturally appearing boundaries emulating historic natural burn disturbance patterns. Within a decade following logging, young stands of lodgepole pine would be expected to develop following disturbance, contributing to the maintenance of a mosaic of age classes in the project area and landscape. We believe the proposed treatments are consistent with emulating natural disturbance patterns and processes that endemic species evolved with in this local area and that they would promote and help maintain habitat and species diversity over time, not decrease it.
The project area vicinity is an increasingly rare ecosystem.	The project area is a part of a geographic area with several amenities valued by many members of the local community, particularly recreation, aesthetics and wildlife habitat. DNRC is not, however, aware of any formal designation of project area lands lying within an identified "rare ecosystem." DNRC is also not aware of the presence of any particularly rare vegetation community types that should be given additional consideration.
Noxious weed infestation may lead to physical and biological changes in soil. Weed invasions may dramatically change organic matter distribution and nutrient flux.	The primary locations of noxious weed infestations and spread during the implementation of a timber sale is typically along roads and at landing locations. While nutrient flux and organic matter distribution

	can be affected by noxious weeds, their affect at these locations is minimized as DNRC would permanently convert the land use of these locations from forest products to transportation, thus limiting the potential effect on future forest vegetation. For further analysis on noxious weeds and the mitigations proposed to limit the impact see *NOXIOUS WEEDS,* under *VEGETATION ANALYSIS in CHAPTER III – EXISTING ENVIRONMENT AND ENVIRONMENTAL IMPACTS*.
Does DNRC consider soil productivity to be an "other worthy object," as defined by the §77-1-202, MCA?	DNRC defines "other worthy objects", in the context of MCA 7-1-202, as resources available to trust beneficiaries obtained by Trust revenues to accomplish the mandates outlined in The Enabling Act. Issues related to MCA 7-1-202 are outside the scope of proposed project objectives.
Please analyze and disclose the link between current conditions and cumulative soil disturbance in Bozeman-Unit watersheds to the current and cumulative impacts on water quantity and quality.	The scale analysis of the Limestone West timber sale for direct, indirect and cumulative effects will include both Limestone and Nichols Creeks to a point prior to the confluence with Bozeman Creek. The scale chosen for watershed analysis areas was determined by considering the proposed actions in each watershed, existing watershed conditions and the beneficial uses the watershed supports. The choice of scale balances the need to be small enough to accurately communicate watershed condition and potential measurable effects with the inherent problems of large scale analysis. In large scale analysis, potential effects may not be measurable or potentially masked by impacts such as urban development or agricultural practices that are scale dependent and outside the scope of analysis. Effects to watersheds on Bozeman unit, outside

	of the analysis area watersheds described above, is outside the scope of this analysis.
Please analyze and disclose measures of, or provide scientifically sound estimates of, detrimental soil disturbance or soil productivity losses (erosion, compaction, displacement, noxious weed spread) attributable to off-road vehicle use.	No off-road vehicle use is permitted within the project area, nor is any access for off road vehicles being proposed.
The topography in center of Sec. 9 is relatively unique for these drainages. The perched water table creates diverse habitats and creates logging system challenges if not carefully designed and administered. Winter logging or at least frozen ground conditions will minimize damage to moist soils. While there are certainly needs for vegetative treatment and fuel abatement in this area, road construction should be minimized and closed after post sale activities at a point north of the saddle at center of section.	Comment noted.
In the Bear Canyon Management Plan and Draft Environmental Impact Statement for 1980, the preferred alternative describes Limestone Canyon as pristine, very valuable to wildlife, moose especially, and characterized by unstable slopes unsuitable for logging. How is it that Limestone Canyon was very valuable for wildlife, especially moose, 36 years ago and now it now? How can the unstable slopes unsuitable for logging 36 years ago now be considered suitable for logging?	As stated in the SFLMP, all previous management plans do not apply to the management of state forested Trust Lands since the adoption of the SFLMP. The Bear Canyon Management Plan DEIS was produced in response to a proposal for developed recreation within a portion of state lands in the Bear Canyon area. This project was abandoned and the draft EIS was never completed or adopted. Harvest limitations 36 years ago were based largely on market conditions and forestry practices at that time. Forest practices, including logging systems, road construction techniques and data availability, have significantly improved over the past three decades (**http://dnrc.mt.gov/divisions/forestry/forestry-assistance/forest-practices**).

	Unstable slopes unsuitable for logging are still present in the Bear Canyon block. Activities proposed on those landtypes have been significantly limited by precisely locating roads and harvest unit design. For further analysis of slope stability, please refer to the Geology and Soil analysis in this document.
The EIS should fully disclose the current condition of streams in the proposed project area and develop a plan for restoring streams that are not meeting state water quality standards, or habitat requirements for a sustainable trout population.	The Watershed Analysis in this DEIS fully discloses the existing condition of all streams in the project area. All streams in the project area currently meet state water quality standards. Habitat requirements and restoration of stream habitat metrics are outside the scope of this project.
Please analyze and disclose the impact of water temperature increase on aquatic biota, including trout.	DNRC's HCP riparian timber harvest conservation strategy has been implemented and monitored for over 5 years on 13 individual sites throughout Montana. Monitoring results indicate that the conservation strategy is effective at minimizing potential effects of riparian timber harvest on a suite of riparian functions including stream temperature. The implementation of a Site Potential Tree Height as a riparian buffer width was shown to be effective at providing site specific riparian protections for stream shade, water temperature and large woody debris recruitment. As a result of this monitoring information and that no Riparian Management Zone timber harvest is proposed, the issue of stream temperature was dismissed from further analysis. For more information on monitoring results please refer to DNRC HCP 5-Year monitoring report at: **http://dnrc.mt.gov/divisions/trust/forest-management/hcp/hcp-implementation-and-monintoring**
Would like the project to be put on hold until a land trade with USFS or buyout can be arranged.	No land trade or buyout has been proposed by the USFS.
Would like the risk of disturbance to rare and endangered species in an old growth natural	No old growth harvest is proposed under any of the Action Alternatives. No currently

ecosystem to be assessed. Thinks there might be rare aquatic species that would be imperiled by sedimentation.	available data exists presenting evidence that rare aquatic species are present in the project area. BMPs for forestry will be applied during project implementation to limit sedimentation.
Concerned DNRC will not follow environmentally-sound logging practices and maintain a minimum of 50 yards distance between riparian areas and logging areas/roads.	Wet areas and riparian habitat would be restricted from harvest activities under the proposed action, alleviating the stated concerns. No impacts to these important areas and resources would be expected.
Concerned about herbicide contamination of the streams, DNRC should hire an independent consultant to take water samples before and after logging, coinciding at minimum with the first couple years of weed spraying attempts.	Herbicide application will likely be implemented to upland areas in the project area both during and after project completion though is it highly unlikely herbicide would be used near streams or within Streamside Management Zones. All spraying would be done by a licensed applicator and in accordance with label restrictions further limiting the potential of offsite transport to waterways. DNRC will monitor all herbicide application for label restriction compliance.
A much wider than 150' stream setback should be used, they advocate a 600' no disturbance area on both sides of all wetlands and streams.	DNRC's HCP riparian timber harvest conservation strategy has been implemented and monitored for over 5 years on 13 individual sites throughout Montana. Monitoring results indicate that the conservation strategy is effective at minimizing potential effects of riparian timber harvest on a suite of riparian functions. The implementation of a Site Potential Tree Height as a riparian buffer width was shown to be effective at providing site specific riparian protections for stream shade, water temperature and large woody debris recruitment. For more information on monitoring results please refer to DNRC HCP 5-Year monitoring report at: **http://dnrc.mt.gov/divisions/trust/forest-management/hcp/hcp-implementation-and-monintoring**
What will be the impact on the water table that is replenished by surface waters in the project area? Will an analysis of the soil	An analysis of forest canopy removal and associated water yield increase is presented in the Watershed Analysis. This analysis

transmissibility and sub surface water flow be done? Concerned because all houses in Eagle Rock rely on individual ground water wells and would be harmed by a change in the water table.	concludes a water yield increase in both Limestone and Nichols Creek watersheds. As a result, water tables replenished by these receiving waters will not be affected and ground water issues have been dismissed from further analysis.
Please analyze and disclose the economic impacts to property owners due to the increased public health risk of diseases such as West Nile.	The economic impact to private property owners due to West Nile diseases is outside the scope of this environmental review.
Drought is evident in the project area. Based on NOAA drought maps from the US Drought Monitor site the following information shows that from 2012-2016 there have been drought issues.	DNRC acknowledges the effect on drought on Montana forests and specifically to the management of state Trust Lands.
Concerned that predators such as black bears and mountain lions will have their territory disrupted and they will have to move into territory where other animals are established.	Both black bears and mountain lions are generally solitary species that are habitat generalists that utilize large home ranges for feeding, breeding and obtaining shelter. Home ranges of female black bears in Montana are often > 10 square miles and home ranges of both sexes of mountain lions are typically >100 square miles (Foresman 2012). Ranges of differing sexes of both species can overlap during various seasons of the year. Mountain lions will travel through and use numerous types of habitats including forested and non-forested types during daily movements and hunting forays. Similarly, black bears utilize numerous forested and non-forested habitat types seeking important foods consisting of grasses, forbs, berries, ants, and small mammals etc. Given the relatively small scale of the proposed project area (2,725 ac with less than 640 ac of proposed harvest) in relation to home range sizes of both species, there would be minimal risk of long-term displacement of individuals of either species that would influence their ability to acquire needed food resources, alter breeding or acquire shelter. Thus, this issue will not be carried further through the analysis.

Concerned the project will negatively impact wildlife for the following reasons: the forested edges provide important cover for wildlife to reach corridors, it is on the boundary of a roadless area, it is on the boundary of critical habitat for T&E species, it is on the edge of residential areas, it is within 3 miles of Highway 345, a major drainage has already been logged in the area, there are other roads in the area, the valley north of the area is full and wildlife have nowhere to go.	This comment addresses forest edges and corridors which will be addressed in the portion of the wildlife analysis discussing habitat fragmentation. The statement regarding roadless areas lying adjacent is outside the scope of this project as none of the lands affected have a roadless designation. The matter of forested patch changes across the larger landscape related to the roadless area concern will be addressed elsewhere in a number of subsections concerning the coarse filter wildlife analysis, the elk habitat analysis and associated cumulative effects discussions. Other nearby past logging projects will also be addressed as applicable in each of the various wildlife cumulative effects subsections. We are uncertain as to the reference to the wildlife-related concern of the project area being located within 3 miles of Highway 345. We do not anticipate any wildlife habitat-related effects associated with that highway. The topic of critical habitat for T & E species presumably pertains to Canada lynx. Canada lynx and critical habitat will be discussed in the analysis applicable to Canada lynx in the Wildlife subsection of the DEIS.
Concerned the sale will disrupt an area that is home to over 110 species of birds, including many species of concern listed by the Montana Natural Heritage Program and the North American Bird Conservation Initiative. Of particular significance is the Northern Goshawk.	Suitable habitat for great gray owls and northern goshawks is present in the project area. An active great gray owl nest was located in 1996 on USFS land approximately 2.8 mi. SW of the project area, and an aggressive adult goshawk was documented in 2010 approximately 1.6 mi. west of the project area during the breeding season -- indicating a potential nest site nearby. Like many other native species to the area, DNRC considers them as potentially present on the project area. Surveys have not been conducted by DNRC, and regardless of whether or not a survey would find them present or absent, DNRC will consider~~s~~ them present for purposes of project planning and analysis. DNRC provides for the general habitat needs for these species under

	the coarse filter approach of the State Forest Land Management Plan and Forest Management Rules. However, should an active or inactive nest of either species be located during project implementation, a DNRC wildlife biologist would be contacted and appropriate mitigations would be established to protect the nest and nesting birds, should they be present.
Concerned about affects to lynx critical habitat that lies immediately adjacent to project area. Wonders if DNRC will complete consultation with the USFWS on lynx.	Federally designated critical habitat for Canada lynx would not be affected by this proposal and consultation is not warranted, thus this issue was not analyzed further. Additional details can be found in Chapter 3 — Wildlife in the analysis for Canada lynx.
Request for DNRC to use all current best science in the analysis for lynx, grizzly bears, and all species of concern with a S3 rating or higher.	DNRC will use appropriate and applicable scientific information and professional judgement to analyze the impacts associated with the activities proposed in this project. All applicable species and concerns will be evaluated in the fine filter analysis.
Would like DNRC to use Hutto's inventory work in Montana to identify where relatively undisturbed forest habitat for forest bird reproduction will be in the project area. If there isn't habitat, please note that these species will be eliminated due to logging.	DNRC will use appropriate and applicable scientific information and professional judgement to analyze the impacts associated with the activities proposed in this project. All applicable species and concerns will be evaluated in the fine filter analysis. No specific references were provided by the commenter for our consideration.
Concerned about the old growth strategy for this project area, says the best science calls for at least 20-25% old growth for most species and how will management of this landscape ensure wildlife species benefited or requiring old growth will continue to breed successfully after the project is completed.	A minor amount of old growth occurs in the project area in section 10 and section 9 west of Nichols Creek. However, no old growth acres would be harvested in this project. Thus, no further analysis is warranted. No specific references were provided by the commenter for the 20-25% levels and best available science.
What is the status of goshawks and great gray owls in this project area? Have surveys been done, and if not, why? Also, what is the conservation strategy in this project area for these S3 Montana Species of Concern? Concerned the project will adversely affect	Suitable habitat for great gray owls and northern goshawks is present in the project area. An active great gray owl nest was located in 1996 on USFS land approximately 2.8 mi. SW of the project area, and an aggressive adult goshawk was documented in 2010

these species.	approximately 1.6 mi. west of the project area during the breeding season -- indicating a potential nest site nearby. Like many other native species to the area, DNRC considers them as potentially present on the project area. Surveys have not been conducted by DNRC, and regardless of whether or not a survey would find them present or absent, DNRC will considers them present for purposes of project planning and analysis. DNRC provides for the general habitat needs for these species under the coarse filter approach of the State Forest Land Management Plan and Forest Management Rules. However, should an active or inactive nest of either species be located during project implementation, a DNRC wildlife biologist would be contacted and appropriate mitigations would be established to protect the nest and nesting birds, should they be present.
Concerned that removing snags, dense forests, and habitat for most wildlife species does not improve forest health. Would like DNRC to provide a valid definition of forest health to the public that clearly excludes any management of wildlife. Also concerned about how diversity is being measured in the project area and how it will be improved with logging.	These comments are outside the scope of the proposed project and have been addressed extensively in the DNRC state Forest Land Management Plan (1996) and Forest Management Rules (September 2003). DNRC manages to promote biodiversity by taking a coarse filter approach that assumes that if landscape patterns and processes similar to those species evolved with are maintained, then the full complement of species will persist and biodiversity will be maintained. The coarse filter approach supports diverse wildlife habitat by managing for a variety of forest structures and compositions, instead of focusing on habitat needs for individual species. Should a logging alternative be selected in this project, habitat diversity would be increased through the creation of forest openings, establishment of forested stands of younger age classes, and through the provision of stand conditions with more varied tree densities at the scale of the project area, and to a lesser extent the 33,000-acre cumulative

	effects analysis area. There are numerous native species in western Montana that do not prefer dense, continuous forested habitat conditions, particularly in the Bozeman area landscape where mosaics of forest and non-forest habitat have historically been common.
Request for DNRC to provide the criteria for significant impacts for all wildlife species impacted by the project.	DNRC will used established criteria to determine the significance of impacts associated with all issues analyzed in the environmental impact statement as required by Administrative Rules of Montana (ARM 8.2.305(1) and (2).
Would like DNRC to identify any big game winter ranges in the project area and define what the conservation strategy is for such as per the current best science.	For this analysis DNRC all lands in the project area as potential winter range for moose, elk, mule deer, and white-tailed. While lower areas supporting less snow may typically receive the greatest use overall, we considered all areas potentially usable during some portion of each winter. DNRC is required by ARM 36.11.443 to consult with DFWP to understand how big game habitat values may be affected and cooperate with them to limit detrimental impacts. DNRC is unaware of any other conservation strategy in place for this local area pertaining to big game species.
Wildlife thrive in young forests that provide more food and cover than mature forests that are often sterile.	Comment noted.
Would like the 2012 forest planning process from the Custer Gallatin National Forest be applied to this project, like species of special concern and habitat and connectivity addressed.	Being a state agency, DNRC must comply with specific requirements under Administrative Rules of Montana (ARM) and the Montana Environmental Policy Act (MEPA). DNRC maintains a list of sensitive species that are likely to occur on state trust lands and considers impacts and mitigations for these species to minimize effects related to all forest management projects. DNRC must also follow requirements contained in its Forest Management Habitat Conservation Plan that is implemented in cooperation with the USFWS. While many aspects of these requirements are similar in nature and scope to what is

	contained in USFS Forest Plans, there are distinct differences and requirements associated with differing mandates of the two agencies. This issue will not be addressed further in the analysis.
Concerned about pressure on elk including loss of habitat, reintroduction of wolf, lower birth rates, and now this timber sale could cause them to lose their local elk herd.	The effects of wolf reintroduction on elk are beyond the scope of this analysis. The potential effects associated with the proposed actions will be analyzed in detail in several issues pertaining to elk.
SFLMP rules are overly broad to be considered a "conservation strategy." It is time for DNRC to quantify current habitat conditions. Local population surveys will be needed to establish a baseline for future monitoring. Sustainability and population health in this landscape is directly linked to the amount and quality of habitat. These thresholds must be established before logging and roadbuilding cause an irretrievable and irreversible loss	The Forest Management ARMs and Forest Management HCP provide comprehensive detailed measures and procedures that provide for conservation and for mitigating adverse effects to important habitat, soils and aquatic resources. Issues related to the adequacy of the Forest Management ARMs are beyond the scope of this analysis. Specific current and anticipated habitat conditions associated with the proposed action will be addressed for each issue identified and analyzed in the LSW EIS. If habitat is deemed present for any species of concern, they will be considered as "likely present" and further addressed in the analysis, and suitable mitigations would be incorporated as appropriate. Habitat amounts and relevant impacts of the proposed action alternatives will be considered in the LSW DEIS analysis. Logging and road construction and reclamation can be done in a manner that does not cause irretrievable or irreversible impacts. Irretrievable and irreversible losses will be addressed in the LSW DEIS as a requirement of MEPA.
The road and trails will disturb and block off wildlife from access to streams.	Any roads constructed as a part of an action alternative would be built and used in a manner consistent with all FM ARMs, BMPs and other relevant laws and requirements. No roads would be proposed that would block access to streams for wildlife. The impact of roads on wildlife and streams will be addressed and analyzed under a number of issues in the LSW DEIS.

Concerned that logging will destroy the environment for wildlife.	These concerns will be addressed in the vegetation and wildlife sections of the LSW EIS.
DNRC notes that timber management will be the primary tool for achieving biodiversity objectives, but these objectives are never identified to the public. Please define the specific criteria by which biodiversity is being measured.	In 1996 DNRC adopted the State Forest Land Management Plan. In this programmatic plan, 6 alternatives were analyzed in an extensive MEPA process to evaluate and ultimately adopt preferred management direction for the DNRC Forest Management Program. A seventh alternative (Omega) was identified and ultimately adopted by the State Board of Land Commissioners. Managing intensively for healthy and diverse forests that support biodiversity are core concepts under this selected alternative and a full, comprehensive discussion can be found on pp. ROD-1 to ROD-7 in the Record of Decision (May 30, 1996) at the link provided below. The standards and guidelines established for the SFLMP were codified into rule in September 2003, and DNRC completed a Habitat Conservation Plan (HCP) with the USFWS in 2011, which is now being implemented to provide conservation for several TES "Fine Filter" species as well. **http://dnrc.mt.gov/divisions/trust/forest-management/limestone-west/SFLMP_LW.pdf**
DNRC notes that one objective of the project is to improve forest health; however, forest health is never defined; the public has no idea as to how forest health is being measures, and thus managed. Please provide a specific definition of forest health, and show how it is being measured before and after the proposed project; please define how wildlife is included within this forest health definition.	In 1996 DNRC adopted the State Forest Land Management Plan. In this programmatic plan, 6 alternatives were analyzed in an extensive MEPA process to evaluate and ultimately adopt preferred management direction for the DNRC Forest Management Program. A seventh alternative (Omega) was identified and ultimately adopted by the State Board of Land Commissioners. Managing intensively for healthy and diverse forests that support biodiversity are core concepts under this selected alternative and a full, comprehensive discussion regarding what was intended can be found on pp. ROD-1 to ROD-7 in the Record of Decision (May 30, 1996) at the link provided below. The standards and guidelines established for the SFLMP were codified into

	rule in September 2003, and DNRC completed a Habitat Conservation Plan (HCP) with the USFWS in 2011, which is now being implemented to provide conservation for several TES "Fine Filter" species as well. **http://dnrc.mt.gov/divisions/trust/forest-management/limestone-west/SFLMP_LW.pdf**
Please analyze and disclose the ecological impacts of Limestone Creek becoming an intermittent or ephemeral stream, including impacts on moose, aquatic mammals, trout, waterfowl, and streamside flora. Please analyze and disclose the ecological impacts on moose, aquatic mammals, waterfowl, and streamside flora, particularly those that may be affected in the "Limestone Lake" pond located in the SE 1/4 Section 30, T2S, R6E -- approximately 2 miles NW of the northerly boundary of the project area (i.e., Sec. 4).	Timber harvesting as proposed in the LSW Timber Sale would be expected to cause minor increases in flows in Limestone Creek. Any increases that would occur would be likely to have minimal effect on the species listed, particularly any water bodies or ponds distant from the project area. More detailed analysis of water yield changes associated with the proposed alternatives will be included in the aquatic analysis. The potential for decreased flows and associated effects on wildlife species specifically will not be addressed further in the analysis.
Human population has increased. Comparing a 1980 map and 2015 map it is apparent the increase in the human footprint to the area around limestone. Basically, wildlife has had their habitat constricted.	This commenter makes two observations that: 1) human population and related impacts increased from 1980 to 2015, and 2) that wildlife habitat has been reduced as a result. While these statements are likely based in fact, they are beyond the scope of this project. Thus, the increase in human population and impacts will not be analyzed further. However, habitat changes attributable to activities involved in the LSW Timber Sale alternatives being considered and any associated cumulative effects will be analyzed for all of the wildlife and habitat-related issues that were raised during the scoping phase of the EIS analysis.
Limestone maintains its biological and ecological integrity, including old growth forest, (the importance of old growth to wildlife cannot be stated strongly enough.)	Forested stands meeting DNRC's old growth forest definitions would not be harvested under either of the proposed timber sale alternatives. Thus, these habitats would not be affected. Non-old growth habitat conditions for most of the species listed in this comment are addressed in detail in the wildlife analysis.
Limestone's position at the northern edge of the Gallatin Range is of great importance to	Comment noted. We have conducted field reviews and consulted with local wildlife

wildlife for winter range, breeding areas and migration routes.	biologists with Montana Fish, Wildlife and Parks, reviewed public input and we are aware that the LSW project area provides suitable habitat for many species of wildlife. Habitat considerations pertaining to winter range, breeding areas and migration routes for potentially affected wildlife species will be fully addressed in the LSW EIS wildlife analysis.
The project is on the boundary of critical habitat for endangered and threatened species. That boundary should be expanded into the project area with all the climate warming impact projections for this area-warmer and drier.	The LSW Project Area lies just outside of the critical habitat boundary for Canada lynx and lies approximately 25 miles north of the GYE grizzly bear recovery zone. These are federally designated boundaries that the USFWS recognizes as being necessary for the recovery of the target species. Adjusting these boundaries is beyond the scope of this project. DNRC has entered into an HCP with the USFWS, which provides incidental take protection for covered forest management activities that may adversely impact grizzly bears and Canada lynx. All applicable measures under the HCP would be applied to the LSW project. Climate change considerations related to wildlife and habitat will be addressed in the DEIS Wildlife Analysis under cumulative effect.
Conservation scientists speak to the importance of maintaining connected networks of protected areas to prevent ecosystems and wildlife population from becoming isolated and to sustain biodiversity. Keeping protected areas (National Parks, wilderness areas) is recognized as a conservation priority.	Comment noted. We agree, and habitat connectivity will be considered in the analysis.
Would like DNRC to consider Steve Gehman's reports.	Information contained in the reports by Gehman (2010 and 2017) will be considered in the analysis.
Please analyze and disclose if enough old-growth habitat exists on the Bozeman Unit to sustain viable populations of old-growth associated wildlife, including moose. Please	Forested stands meeting DNRC's old growth forest definitions would not be harvested under either of the proposed timber sale alternatives. Thus, these habitats would not be

analyze and disclose which species in the project area are associated with old growth, and how will they be impacted by the project. Same question as it relates to the Bozeman Unit.	affected. Non-old growth habitat conditions for most of the species listed in this comment are addressed in detail in the wildlife analysis. The analysis proposed by the commenters is beyond the scope of the project being proposed and will not be carried further in the analysis. Such analyses would require multiple assessments that would vary by each species considered. While moose may periodically use old growth forests, particularly in winter, they are not an old growth obligate species and they use a variety of successional forest conditions and habitats that will be addressed elsewhere in the analysis.
Please analyze and disclose the ecological impacts on moose, aquatic mammals, waterfowl, and streamside flora, particularly those that may be affected in the "Limestone Lake" pond located in the SE 1/4 Section 30, T2S, R6E -- approximately 2 miles NW of the northerly boundary of the project area (i.e., Sec. 4).	Relevant aspects of this comment will be addressed under other specific wildlife issue categories in the analysis and soils and aquatic analyses sections. The pond mentioned is outside of the scope of the project area and cumulative effects analysis area boundaries. No impacts to wildlife or habitat associated with the proposed action would be anticipated within this subdivision.
Concern that the proposed benefits of the project do not outweigh the economic and aesthetic costs.	As state trust land managers, DNRC is charged with the responsibility of generating the largest measure of reasonable and legitimate revenue to the trust beneficiaries from actions such as this proposed timber sale. While we anticipate generating revenue from the proposed action, we are also charged to protect and enhance the future income generating capacity of the land. Our proposed treatments are aimed to do this by improving the growth, vigor, and age class diversity of forested stands while also providing a measure of protection and decreased risk against catastrophic loss from insects, disease, and fire. These actions in addition to expanding the existing transportation system throughout the area are viewed as an investment in the future management of these lands. Economic costs are considered in project development and in this Final EA (see Chapter 3 — Economics). In

	addition, we do recognize that the landscape aesthetic would change under the proposed action; however, we expect the effects to diminish over time as the harvested stands regenerate and not result in a calculable and irreversible cost to the community (see Chapter 3 — Aesthetics).
Concern that harvest activities may have indirect adverse effects on the long term economic future of Gallatin Valley by diminishing the aesthetic of lands included in the proposed project area.	While DNRC understands the concern for the potential aesthetic impact associated with this project, we have found no evidence that forest management activities on landscapes within view of the city of Bozeman would hinder the economic future of the Gallatin Valley. We do recognize that the landscape aesthetic would change under the proposed action; however, we expect the effects to diminish over time as the harvested stands regenerate.
Concern that DNRC has not fully considered how much revenue can be generated from other amenities other than timber (i.e. revenue generated by ecosystem services and recreational fees).	As state trust land managers, DNRC is charged with the responsibility of generating the largest measure of reasonable and legitimate revenue to the trust beneficiaries while protecting the revenue-generating capacity of state trust lands for future generations (1972 Montana Constitution, Article X, Section 11; Montana Code Annotated [MCA] 77-1-202). According to the SFLMP, DNRC has determined that the best way to produce long-term income for the trust beneficiaries from forested state trust lands is to manage those lands intensively for healthy and biologically diverse forests through the use of timber management activities. However, the SFLMP also states that DNRC would "pursue other income opportunities as guided by changing markets for new and traditional uses. These uses may replace timber production when their revenue exceeds long-term timber production revenue potential" (DNRC 1996). It is in the best interest of the trust beneficiaries for DNRC to consider other profitable revenue generating opportunities where appropriate, and DNRC has a long history of exploring and

	implementing a diversity of revenue generating uses and project types. At this time, DNRC has determined that forest management continues to be the best use of these project area lands in producing revenue over the long-term for the trust beneficiaries.
Concern over the long term financial impact of this project on housing values.	Property value of private land within the vicinity of the project area is not within the scope of this analysis.
Traffic and other harvest activities may adversely affect the public along the haul route both within the project area and on the public roads leading to the harvest area.	DNRC foresees increased traffic along public roads (Mt Ellis Ln) tributary to the project area if a timber sale alternative is selected. For further analysis of transportation and recreation related issues, please refer to those respective analysis sections.
Would like DNRC to find alternative access to project area.	DNRC has looked for access areas that meet our needs and has been unable to acquire one besides the one we have.
Increased illegal activity would occur as a result of increased road densities associated with the project.	DNRC assumes the commenter is referring to illegal motorized activity. Only one point of access controls motorized use to the road system in the project area and road closure at this access point is close to the unit office and monitored regularly by DNRC and the surrounding landowners. Illegal motorized use has not been an issue in the past in the project area and is not foreseen to be an issue if a timber sale alternative is selected.
There is concern that DNRC may not adequately rehabilitate existing road problems or road problems that may result from harvest activities.	Public roads and public road maintenance is performed on a regular basis by the county and state, funded by taxes paid by the road users though vehicle registrations, property and fuel taxes. DNRC timber sale contracts require the Forest Officer to approve of post-harvest road conditions prior to releasing the purchaser performance bond. This requirement provides DNRC a high level of assurance that road conditions will meet BMPs and any damage resulting from the project will be corrected upon project completion.
Interest in improving the trail system to provide for better public recreation access and	DNRC appreciates that this area is highly valued for recreational purposes. Under

connectivity (creating loops).	Montana state law, persons wishing to use state trust lands for recreation must obtain the appropriate license to do so (see Chapter 3 – Recreation for a description of various licenses). Fees collected with these licenses aid the DNRC in generating revenue for the trust beneficiaries from recreational use and development of those lands. Any development of trails on state trust lands within the project area would thus require an applicant to apply for a license. This licensing procedure would then undergo its own MEPA review and decision process. To date, no user group or individual has sought a license for recreational trail development of these lands. Due to the special licensing procedures and requirements, DNRC views recreational trail modification and development as a project separate from this proposed timber sale project. Although DNRC has not considered recreation access as one of its project objectives, we have analyzed the potential impacts to recreation resulting from the proposed action (see Chapter 3 — Recreation for more details).
Concerned that not enough people buy state land use permits. Interest in improving signage at trailhead informing users of the requirement to purchase a recreation license and other information.	This is currently signed informing users of the requirement to possess a General Recreational Use License to use these lands. We have also added a bulletin board next to the gate to help direct attention to this sign along with other information that may be of interest to users, including our scoping notices for this timber sale proposal.
The DNRC needs to develop an access management plan for the entire Mt. Ellis/Limestone/Nichols Creek area.	This comment is outside of the scope of analysis for this proposed project.
Would like DNRC to consider that part of these lands are being considered for potential wilderness in connection with the Gallatin Community Collaborative and perhaps a land exchange could be done.	To date, DNRC has not received a proposal for a land exchange.
Would like DNRC to consider a land swap with another public land manager who would	No sale, exchange, swap or elimination of state lands in the area is proposed within the scope

keep it wild, selling the land, conservation easement, or some other option like that.	of this project. To date, DNRC has not received a proposal for a land exchange.
Would like DNRC to strictly and carefully administer and supervise the project.	DNRC forest Officer will strictly administer the timber sale contract, if selected, and document findings through timber sale inspection reports. This process have been shown to provide a high level of contract compliance as evidenced in DNRC monitoring reports.
Concerned the loggers will not act in ways to lessen the negative impacts caused by logging and building roads. A company may not act in the best interest of our community and local ecosystems.	DNRC conducts open bidding for timber sales. The winning contractor is unknown at this time. Under any circumstances, DNRC designs and actively manages the timber sale to our specifications.
Wants DNRC to establish a Neighbor Liaison Group with Triple Tree and Eagle Rock.	DNRC has taken comments from neighbors and any interested parties.

APPENDIX B

Limestone West Conservation License Term Analysis

January 29, 2018

Tim Spoelma, Silviculturist/Forest Ecologist, Forest Management Bureau, Missoula, MT
Jeff Schmalenberg, Science Program Director, Forest Management Bureau, Missoula, MT

Purpose:
To evaluate the biological and economic effects of various conservation license terms for the Limestone West Timber Sale.

Biological Analysis

Methods:
Forest Vegetation Simulator (FVS) growth and yield model was used to project potential growth and harvests using cruise data collected from the project area during 2016. Cruised stands were divided into two groups: stands where Douglas-fir (DF) is the predominant species and stands where lodgepole pine (LP) is the predominant species. Twelve scenarios were evaluated:

1. No management (grow only)
2. Timber sale alternative (initial harvest in 2018)
3. Ten conservation license scenarios with conservation license terms ranging from 10 to 100 years, with initial harvest occurring immediately following the expiration of the license term (e.g.—harvest for 10-year conservation license occurs in 2028, harvest for 20-year conservation license occurs in 2038, etc.)

For all model runs, volume equations were adjusted to match cruise volumes calculated by DNRC's cruise program. All model runs also included a subroutine to predict the effects of root rot on the stands.
For lodgepole pine stands, stands were projected for a 190-year period with a common starting year of 2018 (projection ending year of 2208), as this would allow at least one subsequent 90-year rotation following each evaluated conservation license term. For all model runs, no ingrowth was allowed and a specified amount of natural regeneration was added to the stand following harvesting.
For Douglas-fir stands, stands were projected for a 190-year period with a common starting year of 2018 (projection ending year of 2208), with no subsequent entries following the initial harvest entry. Ingrowth predicted by the model was included for all model runs (no ingrowth was allowed during the first cycle of the model run).

Results:
Table 1 shows the estimated harvest volumes in MBF for each scenario. The harvest volume for the timber sale scenario includes merchantable dead volume that would not be available in subsequent entries if a conservation license were in place (after 10 years, the merchantable dead volume presently in the stands would no longer be merchantable; therefore, timber harvests

under the conservation license scenarios include only live volume). It would take 20 years to harvest an amount of volume greater than or equal to the volume available immediately under the timber sale scenario. Figures 1 and 2 show post-harvest standing volume over time for both stand types under the timber harvest and conservation license scenarios. Table 2 shows the amount of standing volume present at the end of the second rotation in the areas currently proposed for harvest in the Limestone West project area.

Table1: Estimated harvest volumes (MBF) through two rotations for various timber harvest and conservation license scenarios.

Conservation License Term (years)	First Rotation		Second Rotation		Cumulative Harvest (mbf)
	Harvest Volume (mbf)	Harvest Year	Harvest Volume (mbf)	Harvest Year	
0	4,354	2018	3,379	2108	7,733
10	4,049	2028	3,330	2118	7,379
20	4,399	2038	3,276	2128	7,674
30	4,661	2048	3,297	2138	7,957
40	4,808	2058	3,267	2148	8,076
50	4,918	2068	3,275	2158	8,193
60	4,986	2078	3,303	2168	8,289
70	5,060	2088	3,365	2178	8,425
80	5,108	2098	3,386	2188	8,494
90	5,083	2108	3,574	2198	8,657
100	4,999	2118	3,692	2208	8,690

Table 2: Volume per acre (MBF) and total standing volume (MBF) at the end of the 2nd rotation under various conservation license scenarios.

Conservation License Term (years)	Per Acre Volume (MBF) at End of Second Rotation		Total Standing Volume (MBF) at End of Second Rotation		Year	Total volume (MBF)
	Lodgepole Pine	Douglas-fir	Lodgepole Pine	Douglas-fir		
0	1.00	8.7	462.3	1,186	2108	1,648
10	0.78	7.8	359.4	1,075	2118	1,435
20	0.60	7.6	279.5	1,037	2128	1,317
30	0.48	7.4	222.9	1,012	2138	1,234
40	0.38	6.7	176.1	925	2148	1,101
50	0.32	6.9	147.9	946	2158	1,094
60	0.29	6.7	134.6	916	2168	1,051
70	0.25	6.8	117.0	926	2178	1,043
80	0.24	6.8	109.8	935	2188	1,045
90	0.22	6.7	102.4	923	2198	1,026
100	0.22	7.6	102.8	1,047	2208	1,150

Figure 1: Post-harvest standing volume per acre of lodgepole pine for the 11 modeled scenarios.

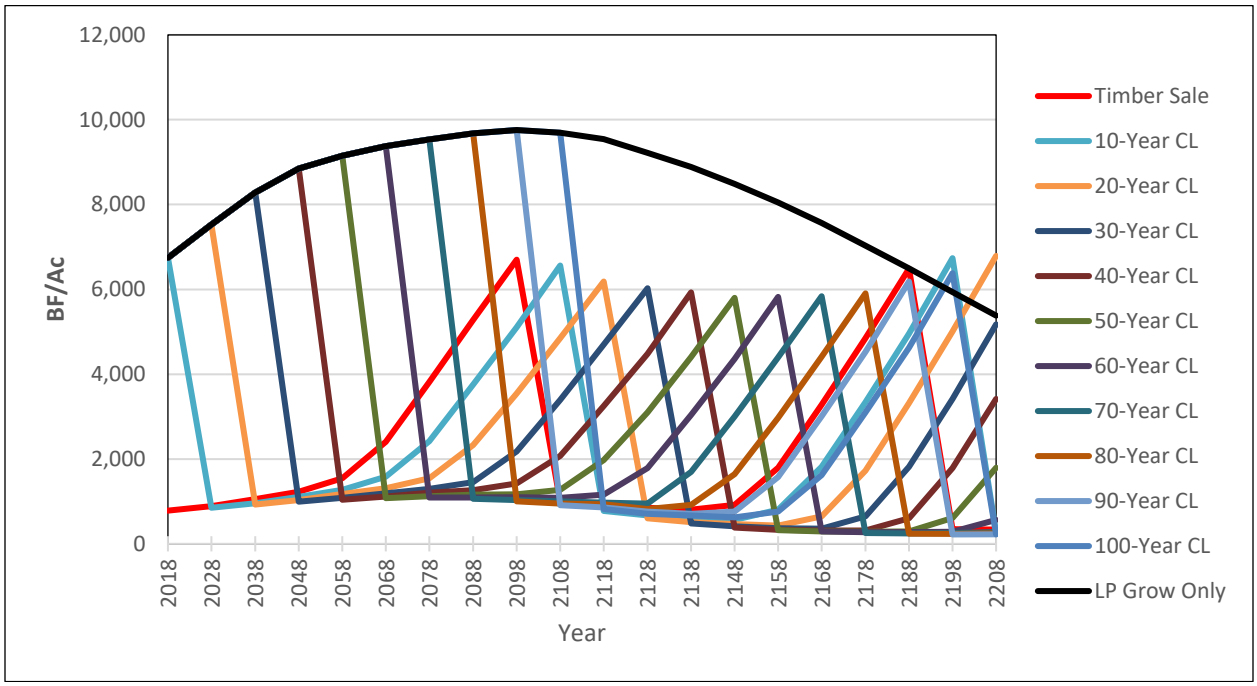
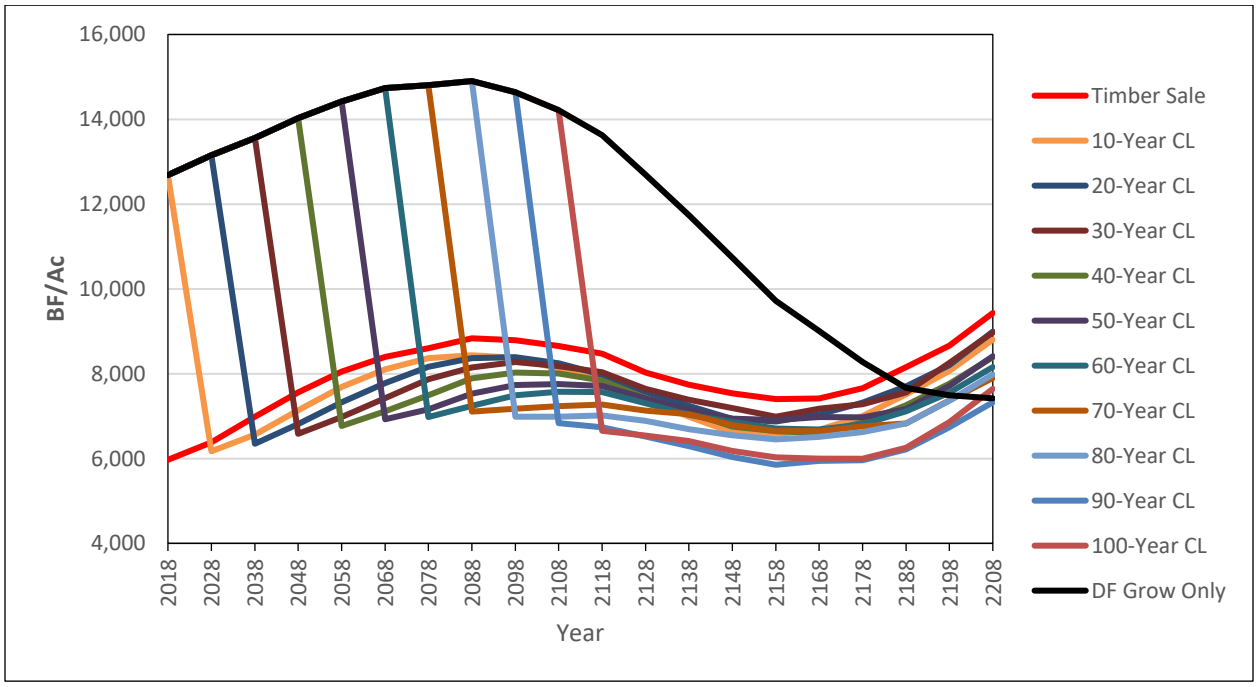


Figure 2: Post-harvest standing volume of Douglas-Fir for the five modeled scenarios.



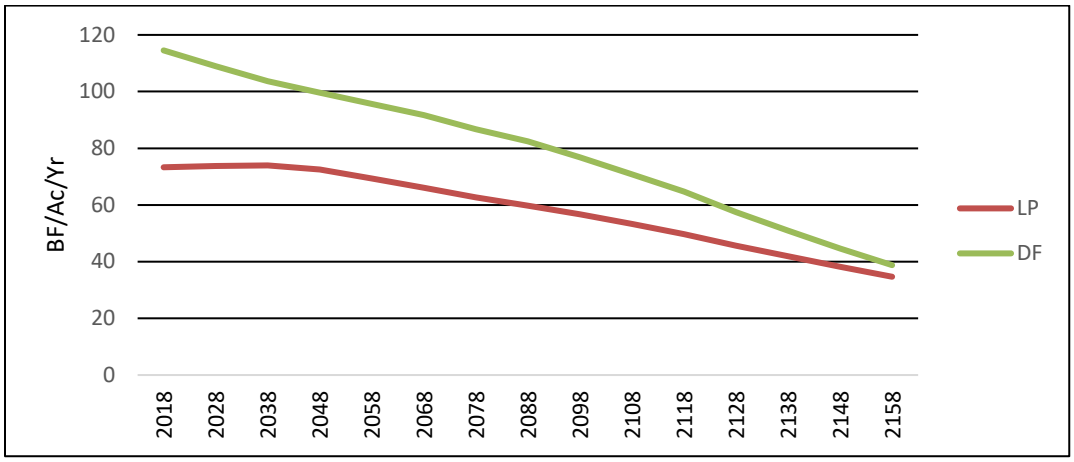
Even-aged forest stands, such as the lodgepole pine stands found in the project area, follow a predictable pattern of development over time (Nyland, 1996; Oliver and Larson, 1996). An understanding of this developmental pattern is a critical component timing the application of management activities in forest stands (Nyland, 1996). Given DNRC's mission to produce consistent revenue over a long term by sustainably managing the Trusts' forest resources,

appropriately-timed management is essential. In general, this pattern of development occurs in four phases (Nyland, 1996; Oliver and Larson, 1996):

1. Immediately after disturbance, such as wildfire, a period of stand initiation occurs where a new forest stand regenerates and establishes on the disturbed site. During this phase, there is little accumulation of biomass (volume) despite a high number of growing trees.
2. Following the stand initiation phase, a phase known as stem exclusion occurs where competition among trees reduces the number of living trees in the stand; however, biomass begins to accumulate rapidly as the remaining trees grow.
3. After stem exclusion, a phase of understory re-initiation begins. During that phase, the trees in the stand have reached reproductive maturity and new trees begin to establish and grow in gaps created by dying large trees, creating an understory layer in the stand.
4. Following understory re-initiation, the forest, in the absence of disturbance, reaches a relatively steady state where understory trees replace dying overstory trees and stand biomass remains somewhat stable.

This developmental pattern is reflected in the accumulation of biomass, or volume, in the stand over time (Nyland, 1996). One measure of the rate of volume growth is mean annual increment (MAI), which is calculated by dividing the stand's total volume (yield) by its age (Nyland, 1996). There is a point, typically during the stem exclusion phase, where the rate of volume growth reaches its peak. This point is known as the culmination of mean annual increment (CMAI) (Helms, 1998; Nyland, 1996). From the standpoint of long-term sustainable production of timber, harvesting at CMAI represents the optimum time along the stands developmental curve to maximize timber production over a long term (Smith et al., 1997; Avery and Burkhart, 1994). Harvesting beyond that point comes at the expense of realizing the long-term productivity of the site in terms of growth by both keeping an existing stand that is growing at a declining rate and delaying growth and development of a future stand that would grow at an increasing rate over time. For those reasons, harvesting at a point beyond CMAI would lower the annual sustainable yield in terms of timber production that could be realized from the site. Figure 3 shows the projected MAI of stands in the project area over time with no management. The lodgepole pine stands are currently in the stem-exclusion phase and have reached CMAI. The model indicates that current growth rates would continue through the next 10 to 20 years (2028 to 2038), after which they would be expected to decline. The Douglas-fir stands are currently past CMAI and in the understory re-initiation phase if not approaching the steady-state phase.

Figure 3: MAI for lodgepole pine and Douglas-Fir stands without management



Economic Analysis

This economic analysis compares present value timber sale revenues using a discounted cash flow model of the sale revenues including alternative revenues following various conservation license terms at 10-year increments. Discounting cash flows allows for the conversion of future values into present values and allows the effects of various conservation license scenarios on revenues to be observed.

Conservation license terms were considered at 10-year increments starting in 2018 and forecasted for a maximum term of 100 years. It should be noted that a conservation license issued by the Department such as this is statutorily limited to 99 years but for ease of modelling outputs, the maximum license term was set at 100 years. From a biological standpoint, the 10 and 20-year conservation license term lengths present a tolerable uncertainty in assets stability in terms of biologic productivity as well as acceptable risk. As term lengths exceed this, such as a 50-year term, higher risk of resource degradation or loss and diminished biologic potential present significant uncertainty as well as increased asset risk exposure.

A basic cash flow analysis requires setting aside the complexities of asset risks such as fire events, forest health events, and regional forest product market shocks. Factors that will influence cash flows include estimated harvest volumes, appraised stumpage prices, and discount rates to keep track of time-value and inflation.

Modeled standing volumes for the various conservation license terms are first converted from Table 1 in the biological analysis using a 6.5 tons/MBF. In Table 3 below, these volumes are reshown, measured in tons.

Table 3: Estimated harvest volumes (tons) through 2158 for timber harvest and conservation license scenarios.

Conservation License Term (years)	1st Rotation		2nd Rotation		Cumulative Harvest Volume (tons)
	Year of Harvest	Harvest Volume (tons)	Year of Harvest	Harvest Volume (tons)	
0	2018	28,304	2108	21,961	50,265
10	2028	26,321	2118	21,646	47,967
20	2038	28,591	2128	21,292	49,883
30	2048	30,295	2138	21,427	51,722
40	2058	31,253	2148	21,238	52,491
50	2068	31,964	2158	21,289	53,253
60	2078	32,411	2168	21,467	53,878
70	2088	32,889	2178	21,873	54,762
80	2098	33,201	2188	22,011	55,212
90	2108	33,040	2198	23,232	56,272
100	2118	32,491	2208	23,995	56,486
**The conversion from MBF to tons uses a 6.5 tons/mbf conversion factor*					

Appraised stumpage is available from DNRC transaction evidence from sales in the same area. Given gate prices and the timber sale characteristics, the estimated minimum stumpage for the sale is appraised at $16.36/ton. The resulting future value, non-discounted, revenues at this stumpage rate are shown in Table 4. All future values have for scenarios with a conservation license in place has this one-time revenue included into the harvest revenue estimates.

Table 4: Estimated non-discounted future values for timber harvest and conservation license scenarios.

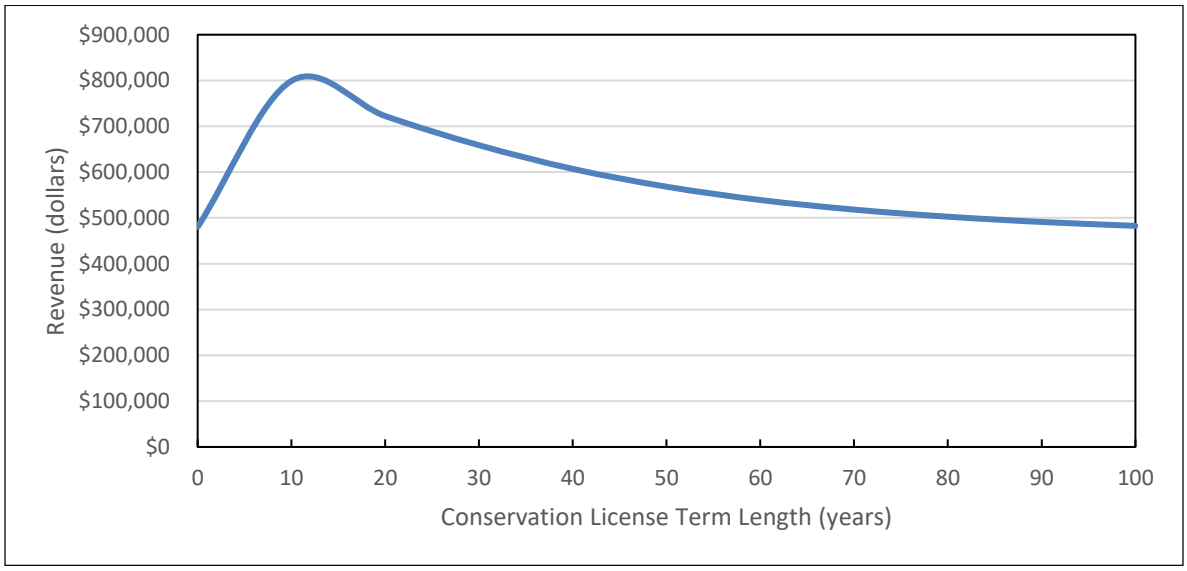
Conservation License Term (years)	1st Rotation		2nd Rotation		Cumulative Revenue (dollars)
	Year of Harvest	Harvest Revenue (dollars)	Year of Harvest	Harvest Revenue (dollars)	
0	2018	$462,489	2108	$358,844	$821,332
10	2028	$892,577	2118	$353,688	$1,246,264
20	2038	$929,668	2128	$347,912	$1,277,579
30	2048	$957,510	2138	$350,124	$1,307,634
40	2058	$973,167	2148	$347,026	$1,320,193
50	2068	$984,789	2158	$347,855	$1,332,643
60	2078	$992,092	2168	$350,768	$1,342,860
70	2088	$999,892	2178	$357,412	$1,357,304
80	2098	$1,005,001	2188	$359,656	$1,364,657
90	2108	$1,002,363	2198	$379,607	$1,381,970
100	2118	$993,388	2208	$392,084	$1,385,472

To appropriately discount these revenues a DNRC long-term internal rate of return, real discount rate of 3.4 percent is applied to all future values.[15] Table 5 shows estimated harvest revenues in present value terms.

Table 5: Estimated harvest present values (discounted) for timber harvest and conservation license scenarios.

Conservation License Term (years)	1st Rotation		2nd Rotation		Cumulative Harvest Revenue (dollars)
	Year of Harvest	Harvest Revenue (dollars)	Year of Harvest	Harvest Revenue (dollars)	
0	2018	$462,489	2108	$17,703	$480,192
10	2028	$770,348	2118	$28,822	$799,170
20	2038	$701,860	2128	$20,485	$722,346
30	2048	$644,044	2138	$14,703	$658,747
40	2058	$596,557	2148	$10,485	$607,042
50	2068	$560,640	2158	$7,513	$568,152
60	2078	$533,728	2168	$5,397	$539,125
70	2088	$514,233	2178	$3,895	$518,128
80	2098	$499,880	2188	$2,795	$502,675
90	2108	$489,123	2198	$2,050	$491,173
100	2118	$481,237	2208	$1,489	$482,726

Figure 4: Estimated harvest revenues thru two 90-year rotations under various conservation license scenarios.



[15] The internal rate of return is calculated as DNRC's trust fund bond investment opportunity with a long-term average annual return of 5.4 percent. Including a 2 percent inflation premium brings the real rate to 3.4 percent. Inflation is accounted for using a real discount rate, rather than inflating future prices.

Recommended Term Length:

Based on the biological results presented above, the term length of a conservation license would preferably be 10 or 20 years. Stand MAI in the lodgepole pine stand reaches its peak (CMAI)between 10 and 20 years into the future before declining sharply. MAI in the Douglas-fir stands is already past maximum levels and without management would be expected to steadily decline. As previously explained, from the standpoint of long-term sustainable timber production, harvesting at CMAI represents the optimum age for harvesting, while delaying harvest past that point results in an inability to achieve sustainable yield targets over time because of the both the declining growth rate of the existing stand and delay in establishment and growth of future stands.

Based on the economic analysis, the best value for the Trust beneficiaries would be a 10-year conservation license term. Under a 10-year term length, discounted future timber sale revenues are limited while still realizing immediate income from conservation license revenues. A 10-year term would also limit potential asset loss to wildfire or insect and disease risks. No other term lengths generate as much revenue, yet longer term lengths present increased asset exposure and risk of loss to disturbance events thus making them a poor choice for instrument for Trust revenue generation.

Department of Natural Resources and Conservation
Bozeman Unit Office
2273 Boot Hill Court Suite 110
Bozeman, MT 59715-7249
(406) 586-5243

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