

Summit County Safe Passages: A County-wide Connectivity Plan for Wildlife



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Dillon Ranger District

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Acknowledgements

In association with the Highway 9 Realignment Project near Frisco, Colorado, the Colorado Department of Transportation contributed funds to the National Forest Foundation (NFF) to support wildlife habitat improvement projects including landscape connectivity. The NFF is now using those funds and working with White River National Forest staff to support these projects.

Many stakeholders, agencies and community members have convened to make this project a successful collaboration. Those partners include USDA Forest Service, Colorado Department of Transportation, Colorado Parks and Wildlife, US Fish and Wildlife Service, Summit County, Town of Breckenridge, Town of Frisco, Town of Silverthorne, Vail Resorts, Arapahoe Basin, National Forest Foundation, Friends of the Lower Blue, Lower Blue Planning Commission, Friends of the Dillon Ranger District and local citizens.

Glossary and Acronyms

AADT: Average Annual Daily Traffic

CDOT: Colorado Department of Transportation

Connectivity: A conceptual measure of the degree that landscape elements facilitate or impede the movement of organisms and the flow of ecological processes, i.e., the degree to which the landscape is permeable to wildlife movement.

Core Habitat Areas: Contiguous patches of suitable, un-fragmented habitat for a species of interest.

CPW: Colorado Parks and Wildlife

Crossing Zone: Segments of roadway where wildlife preferentially attempt crossings.

FHWA: Federal Highway Administration

GIS: Geographic Information System

Habitat Fragmentation: The division of natural habitat blocks into smaller, discontinuous pieces. Habitat fragmentation has been identified as a major threat to biodiversity worldwide.

Habitat Linkages: Identified connections between core habitat areas that facilitate movement for a species or group of species. Linkages may be broad swaths of permeable habitat or they may be narrow chokepoints. Linkages may be intact or may require conservation actions to protect or restore the ability of wildlife to move through a linkage.

Habitat Permeability: Synonymous to ‘connectivity’. Habitat permeability refers to the ability of a species to move across the landscape. Habitat permeability varies across species depending on their movement capabilities and tolerances or sensitivities to features in the landscape (natural or human-made). Linkages provide permeability outside of core habitat areas.

Habitat Suitability: Refers to the habitat usage by a given species, ranging from preferred habitat types (high suitability), to suboptimal, to avoided (low suitability). Habitat suitability is species-specific and is used to inform model parameterization.

Highway Crossing Zone: Segment of highway where highway crossings by one or more species of wildlife tend to be concentrated.

Linkage Area: A large, regional connection between habitats that facilitates animal movements between different sections of a landscape. A linkage area may provide connectivity for daily movements within a seasonal range; migratory movements between seasonal ranges; or dispersal movements from an animal’s natal area to new territories.

Linkage Interference Zone (LIZ): A term developed by a group of interagency stakeholders along the I-70 Mountain Corridor (the ALIVE Committee) to denote highway segments of concern with regards to wildlife movement and wildlife-vehicle collisions on I-70. Later work to refine and revise these priority segments on I-70 continued the use of this term.

Lynx in Lieu Fee Mitigation: Mitigation process for transportation projects with impacts to Canada lynx whereby individual transportation projects may contribute to a fund supporting lynx conservation rather than restricting mitigation to on-site mitigation or to a lesser mitigation type while maintaining compliance with the requirements of the Endangered Species Act.

MP: Milepost

USFWS: United States Fish and Wildlife Service

West Slope Wildlife Prioritization: CDOT and CPW sponsored research study to identify and prioritize highway segments for wildlife-highway mitigation across Colorado's West Slope

Wildlife Corridor: A suitable habitat connection connecting two or more blocks of core wildlife habitat. Corridors are generally conceived as discrete, linear connections.

WVC: Wildlife-Vehicle Collision. Vehicular collisions with wildlife may be reported to law enforcement and compiled as accident reports, but many go unreported for a variety of reasons. WVCs typically result in wildlife mortality.

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Introduction

The Summit County Safe Passages Plan identifies areas for wildlife movement across Summit County and, specifically, the need for wildlife to move across highways. This plan was created by agencies, local governments, non-profits, community groups and other interested parties to provide a common vision and guidance for protecting wildlife movement corridors across jurisdictional boundaries. As such, it is a resource planning tool to support the integration of wildlife movement needs into transportation projects, land use and land management in Summit County. This plan identifies priorities and opportunities, and is designed to be a reference to help decision-makers identify tradeoffs for balanced decision making.

The plan documents the data- and stakeholder-driven process for identifying wildlife-highway mitigation priorities, and reflects current data and knowledge about wildlife movement. However, habitat and wildlife movements across the landscape are dynamic in response to land use change and environmental variables. Where possible, the plan reflects anticipated change such as future development areas or an increase in the moose population; however, the plan must also be fluid to reflect future changes in land use and wildlife movement patterns or shifting priorities and opportunities.

The Summit County Safe Passages for Wildlife Plan is not a decision document, nor does it replace any legal direction, or impose additional requirements to current planning processes. Instead, it is intended to provide guidance and recommendations to promote wildlife-highway mitigation and compatible land use activities in wildlife movement corridors. It may be used to attract additional partners, community support and funding to advance mitigation infrastructure projects. In addition, partner organization may draw from the plan to help inform land use decision making, including open space acquisitions or easements, habitat management or road decommissioning, recreation management, development permitting and other land use planning.

Summit County is known as a year-round recreation destination, including four ski/snowboard areas, and numerous motorized and non-motorized recreation trails. Recreation and tourism are a major industry here, along with ranching, mining and logging. Across the county, wildlife habitat and movement corridors are increasingly affected by population growth, increasing visitation, ski area expansion, and recreation growth. Substantial areas of wildlife habitat have been converted for housing and associated development, particularly in lower elevation valleys that also provide winter range for mule deer, elk and other wildlife. In addition, highways and roads travel through the county's major riparian valleys and bisect large expanses of forested habitat.

Landscape connectivity - the degree to which wildlife are able to move freely across the landscape (Bissonette and Cramer 2008) - is an essential component of healthy ecosystems and wildlife populations, allowing animals to disperse into new territories, access seasonal resources and breeding habitat, and maintain the flow of individuals and genes across the landscape (Rudnick et al. 2012). As development, roads and other human activities leave animals with smaller and more isolated pockets of intact habitat, active landscape planning and protection efforts are needed to allow wildlife continued access to seasonal habitats and the ability to disperse into new habitat areas. Landscape connectivity has been described as one of the most critical elements of biodiversity conservation planning, and is essential for allowing species to

move and adapt to shifting habitats and an altered climate (Heller and Zavaleta 2009). In addition, protecting wildlife movements across the landscape is anticipated to reduce the risk of negative impacts to wildlife populations, including threatened and endangered species, and is important for preserving habitat quality and biodiversity in general.

Several studies have demonstrated that wildlife do not cross roads randomly, and that highway crossing zones tend to be spatially and temporally clustered, influenced by habitat, terrain or road characteristics (Barnum 2003; Neumann et al. 2012). These findings underscore the value of focusing connectivity efforts in identified wildlife habitat linkages. While a road may present the most visible barrier to wildlife movement and directly contribute to wildlife mortality, other types of barriers may also constrain wildlife movements, including livestock fencing, residential development, commercial or industrial activities, recreational activities and other land uses.

Project Background

This assessment of wildlife habitat connectivity in Summit County originated from a highway mitigation agreement between the Colorado Department of Transportation (CDOT) and the Dillon Ranger District of the White River National Forest. Initially, the agencies considered options for mitigating impacts from a new alignment for a portion of State Highway 9 through National Forest lands. The site of the highway realignment, near the edge of Dillon Reservoir was determined to be a poor location for providing safe passages for wildlife in Summit County. Instead, the Dillon Ranger District requested that mitigation funds be used to compensate for the loss of wildlife habitat through on the ground habitat restoration projects and to conduct an analysis of state highways in southern Summit County to identify the best locations where wildlife crossings or other mitigation measures would maximize benefits to wildlife movement. Other partners then joined the effort such as the Breckenridge Ski Area, Colorado Parks and Wildlife (CPW) and Summit County.

As a result of these expanded partnerships, the original habitat connectivity assessment was expanded to an assessment of all lands and CDOT administered highways within Summit County. The Summit County Safe Passages for Wildlife Plan seeks to set the stage for collaborative work to protect and restore wildlife movement corridors across the county, including the Dillon Ranger District, CDOT, CPW, Summit County, towns, ski areas and other stakeholders.

Objectives

The primary objectives of this project are to:

- Provide a common vision for landscape connectivity in Summit County that accommodates the movement needs of diverse wildlife;
- Engage agency, local government, industry, non-profit and other community partners to identify wildlife-highway crossing zones on state-administered highways in Summit County;
- Recommend and prioritize highway mitigation projects to create safe passages for wildlife and reduce wildlife-vehicle collisions;
- Identify habitat linkages across highways that act as movement corridors for the target species and recommend habitat conservation and management projects that facilitate wildlife movement.

Methods: Identifying Wildlife Linkages and Highway Crossing Zones

Stakeholders

A stakeholder group composed of agencies, local governments, industry, non-governmental organizations, community groups and other interested citizens was convened to oversee the development of the safe passages plan and to contribute expert and local knowledge to the plan. See Appendix A for a complete list of stakeholder participants. Meetings were held at key points in the plan development process, each of which is described more fully in the following sections. Additional review and feedback was conducted over email.

Compilation of Existing Data and Habitat Linkage Analysis

Existing datasets were compiled to support this planning effort, including species habitat mapping and mortality from Colorado Parks and Wildlife (CPW); wildlife-vehicle collision (WVC) accidents reported to law enforcement; WVC carcass reports from the Colorado Department of Transportation (CDOT); a regional analysis of lynx highway crossing areas (Baigas et al 2017); lynx linkage areas, lynx landscape analysis units and Forest roads and trails from the Forest Service; and existing infrastructure (roads, bridges and culverts) from CDOT. In addition, a habitat linkage analysis across state highways was conducted for select target species to help identify portions of the landscape that support wildlife movement on either side of a highway crossing zone. The habitat linkage analysis was conducted for bighorn sheep, Canada lynx, elk and mule deer using the CorridorDesigner tool (Majka et al 2007) in ArcGIS. For a detailed, technical description of the habitat linkage analysis process, refer to Appendix B.

Stakeholder Identification of Highway Crossing Zones

The stakeholder group convened via a series of sub-groups based on geography to identify wildlife-highway crossing zones. In addition to bighorn sheep, Canada lynx, elk and mule deer, the stakeholder group also identified black bear, boreal toad and moose as target species. Both black bear and moose are frequent victims of WVC, and boreal toad is a state endangered species with known breeding areas in the county.

Stakeholders reviewed maps and information based on the compiled datasets and the habitat linkage analyses and brought local knowledge and expertise to delineate highway crossing zones. For each identified highway crossing zone, the stakeholder groups delineated the milepost extents of the zone; identified target species, habitat types, and land uses; defined the value of the linkage area to the target species (e.g., local, seasonal or dispersal movements); identified features that impede or facilitate wildlife movement through the linkage; and identified current or potential future threats to wildlife movement through the linkage area. The complete wildlife linkage form used for this process is available in Appendix C.

Field Assessment of Identified Highway Crossing Zones

The consultant team conducted a field verification of the identified highway crossing zones in the fall of 2016. As a result of the field review, revisions were made to the linkage extents, and two of the stakeholder-identified highway linkage areas were removed from further consideration: US 6 Keystone and I-70 Frisco-Silverthorne. While wildlife conflicts occur in both areas, neither

is needed to provide connectivity for wildlife for daily, seasonal or dispersal movements. During these site visits, the consultant team also began identifying potential highway mitigation opportunities to provide safe passages for wildlife, including wildlife underpasses, overpasses or improvements to existing bridges and culverts.

Prioritization of Highway Crossing Zones and Prioritization Criteria

The stakeholder group developed a set of scoring criteria to distinguish priorities among the identified highway crossing zones. Prioritization criteria were grouped into three categories wildlife/biological; safety; and urgency/opportunity (Table 1). The resulting prioritization provides guidance for strategically implementing the recommendations provided in this plan and highlights specific areas where investments in mitigation and other conservation actions are expected to provide the greatest returns for wildlife movement, reduce WVCs, and offer the greatest feasibility for implementing mitigation recommendations under current conditions.

Table 1. Prioritization criteria and scoring.

Criterion Description	Source	Scoring Scale
Wildlife/Biological Criteria		
Value of the linkage area to the population of the target species	Stakeholder and expert workshops	1-5, where: 1 = low value to target species 5 = high value to target species
Use of linkage area by federally or state threatened or endangered species	CPW and Forest Service habitat and species data	1 or 5, where: 1 = threatened or endangered species absent 5 = threatened or endangered species present
Safety Criteria		
Safety hazard to motorists	WVC crash reports and carcass records, and observations by local CPW staff	1-5, where: 1 = no or low WVC rates 5 = high WVC rates
Urgency, Opportunity and Feasibility Criteria		
Threat to wildlife movement through the linkage (e.g., from residential, commercial or industrial development, traffic, recreation activity)	Stakeholders	1-5, where: 1 = low threat urgency 5 = high threat urgency (i.e., linkage may be lost if no action is taken)
Presence of adjacent or nearby protected land	Land ownership data. Protected lands include public lands and private conservation lands.	1-5, where: 1 = no nearby protected lands 5 = protected lands on either side of highway and throughout linkage area
Feasibility of implementing mitigation, based on terrain and landscape features	Site visits, CDOT engineering staff	1-5, where: 1 = low feasibility 5 = high feasibility
Opportunity to implement mitigation, based on funding potential, willing private landowners and other situational considerations	Stakeholders	1-5, where: 1 = low feasibility 5 = high feasibility

Table 2 summarizes the scoring of prioritization criteria for each of the identified wildlife linkages. Prioritization scores may need to be revisited and adjusted in the future, as the landscape changes and as new areas become threatened or new opportunities emerge.

Table 2. Prioritization of wildlife linkages in Summit County.

Linkage Name	Primary Target Species	Wildlife/Biological Criteria			Safety Criterion		Urgency and Opportunity Criteria				Overall Score	
		Value to Target Species	Threatened or Endangered Species	Wildlife Score (Max = 10)	Safety Hazard	Safety Score (Max = 5)	Threat Urgency	Adjacent or Nearby Protected Land	Mitigation Feasibility	Mitigation Opportunity		Opportunity Score
I-70, Vail Pass	Elk, Lynx	5	5	10	4	4	3	5	5	3	16	30
I-70, Laskey Gulch	Elk, Lynx, Deer	4	5	9	4	4	4	5	3	1	13	26
I-70, Hamilton Gulch	Boreal Toad, Lynx	5	5	10	3	3	4	5	2	1	12	25
SH91, Copper Mountain	Lynx	5	5	10	1	1	3	5	3	3	14	25
SH9, Upper Blue River	Elk, Deer, Moose	4	5	9	5	5	5	2	3	1	11	25
SH9, Lower Blue River	Elk, Deer	5	1	6	4	4	3	4	5	3	15	25
SH9, Gold Hill	Elk, Lynx	4	5	9	5	5	5	2	2	1	10	24
SH9, Maryland/ Everist	Elk, Deer, Moose	4	1	5	5	5	5	3	3	3	14	24
SH9, Green Mountain Reservoir	Elk, Deer	5	1	6	5	5	3	5	2	2	12	23
I-70, Land Bridge	Bighorn	4	1	5	0	0	3	5	5	5	18	23
US6, Porcupine	Boreal Toad, Elk, Lynx	5	5	10	1	1	4	5	1	1	11	22

Linkage Name	Target Species	Wildlife/Biological Criteria			Safety Criterion		Urgency and Opportunity Criteria					Overall Score
		Population Value to Target Species	Threatened or Endangered Species	Wildlife Score (Max = 10)	Safety Hazard	Safety Score (Max = 5)	Threat Urgency	Adjacent or Nearby Protected Land	Mitigation Feasibility	Mitigation Opportunity	Opportunity Score	
US6, Loveland Pass	Bighorn, Lynx	4	5	9	2	2	3	5	1	1	10	21
SH91, Clinton Reservoir	Bighorn, Elk, Lynx, Deer	4	5	9	2	2	4	2	2	1	9	20
SH9, Iron Springs	Bear, Elk, Moose, Deer	3	1	4	1	1	4	5	3	3	15	20
I-70, Officer's Gulch	Bighorn, Lynx, Deer	4	5	9	1	1	3	4	1	1	9	19
US6, Soda Ridge	Elk, Deer	5	1	6	3	3	4	2	2	1	9	18
SH9, Hoosier Pass	Bighorn, Elk, Deer, Lynx, Moose, Bear	3	5	8	1	1	2	3	1	1	7	16

Stakeholder Review of Mitigation and Conservation Recommendations

Site visits were conducted with stakeholders early in the summer of 2017 to review recommendations for wildlife crossing structures, including underpasses, overpasses or improvements to existing infrastructure. During these site visits, stakeholders provided additional input on the preliminary highway mitigation recommendations developed by the consultant team. Specifically, the stakeholder group provided input on the engineering feasibility of constructing a wildlife crossing structure at specific locations; identifying additional land use challenges or management needs with regards to the proposed crossing structure locations; and highlighting the highest priority locations for wildlife-highway mitigation within a linkage area. Wildlife exclusion fencing is a critical component of highway-wildlife mitigation projects. The alignment and extent of wildlife exclusion fencing must be included as wildlife crossing projects are planned and designed, although it is not explicitly discussed in these recommendations.

Safe Passage Recommendations

Seventeen wildlife linkage areas were identified across state-administered highways in Summit County. Each linkage area is described in the following sections, with specific recommendations for highway mitigation and other conservation actions for improving opportunities for wildlife to move safely across a highway and through the linkage area. Wildlife linkage areas are presented by highway. Prioritization scores and ranks are presented at the beginning of each linkage description or, for the complete list of linkages and their prioritization scores, see Table 2.

Highway mitigation recommendations must consider the needs of all target species that move or potentially move through a linkage area. In most situations, multiple crossing structures are needed to accommodate wildlife movements through a linkage area. Redundancy is important to accommodate different types of wildlife and to provide multiple crossing opportunities across a longer road segment. Further assessment will be needed to determine how many crossing structures are needed in a given linkage area and the spacing between them.

Preliminary recommendations for structure types and, in some cases, minimum structure sizes are provided. More precise structure dimensions will need to be determined in conjunction with CDOT engineers as transportation projects are designed. Wildlife exclusion fencing is always recommended in conjunction with wildlife crossing structures to guide animals to a structure. Further assessment will be required during project development and design to refine these preliminary recommendations to determine the exact location, structure design, extent of wildlife exclusion fencing, and other complementary mitigation measures, such as escape ramps, wildlife guards at driveways and intersections, warning signage at fence ends, and other strategies.

State Highway 9

State Highway 9 (SH 9) extends north-south across Summit County. South of I-70, SH 9 connects the towns of Frisco and Breckenridge, and extends further south into Park County. The portions of SH 9 between Frisco and Breckenridge and south of Breckenridge around the town of Blue River are experiencing persistent development pressure, leaving few opportunities for maintaining and restoring wildlife connectivity across SH 9. Traffic volumes are high throughout this southern segment of SH 9.

North of I-70, SH 9 extends from Silverthorne towards Kremmling. The portion of SH 9 near Silverthorne is a combination of urban and suburban with heavy pressure for continued development. Traffic volume is highest near Silverthorne and decreases to the north. Terrain is gentle in the valleys making for both good building sites for humans and excellent habitat for many of the target species. Elevation decreases as the Blue River flows north, and this northern segment of SH 9 has a milder climate than the rest of the county, based on temperatures and snow depth. Habitat progresses from urban to suburban to ranchlands, then to open sagebrush hills near Green Mountain Reservoir. Winter range for mule deer and elk occurs throughout this area, with correspondingly high wildlife-vehicle collision rates with mule deer, elk and moose. New wildlife crossings have been implemented on SH 9 north of Green Mountain Reservoir, in Grand County.

SH 9, Hoosier Pass

Mileposts: 76.5 – 77.6

Land Ownership: Private, National Forest, County

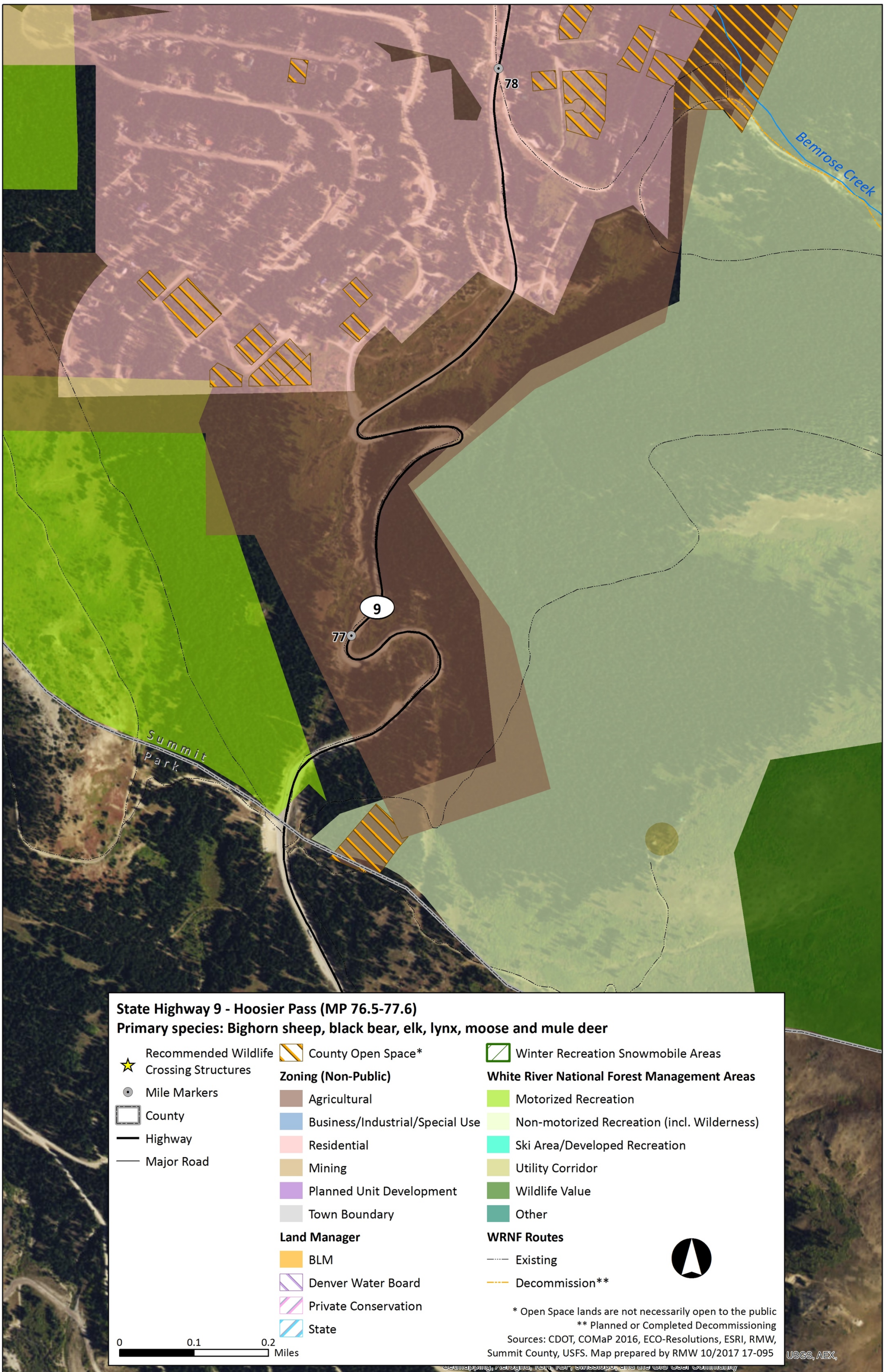
Road Type: Two-lane highway

Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
16 [Rank 11 out of 11]	8	1	7

Target Species	Movement Type	Population Value to Species	WVC Rate
Bighorn Sheep	Dispersal movements	Medium	Low
Black Bear	Local (within population)	Low	Low
Elk	Local movements in summer range; some migratory movements	Medium	Low
Lynx	Regional, dispersal movements	Medium	Low
Moose	Dispersal movements	Medium	Low
Mule Deer	Migration, summer range	Medium	Low

The Hoosier Pass linkage is a high elevation area composed primarily of spruce-fir forest and small headwater streams with associated riparian areas. The linkage provides a connection across SH 9 for a variety of wildlife between areas of rural residential development on either side of the pass. For bighorn sheep and mountain goat, the linkage is a natural pinch-point connecting high elevation habitat. Motorized and non-motorized recreation activities are common in the linkage. Current traffic volumes are moderate (3,800 AADT in 2015) and WVC are low through this segment.

The linkage offers no cost-effective opportunities for highway mitigation due to the mountainous terrain and curvy road. An overpass could be constructed at the summit ridge; however, this is not a favorable location. Given the low speed limit, low WVC rate and moderate traffic volumes, which currently do not threaten the dispersal function of this linkage for species such as bighorn sheep and lynx, no highway mitigation is recommended in this linkage at this time. It should be noted, however, that an empirical-based model by Baigas et al. (2017) found a very high probability of lynx crossing through much of this segment, and the Hoosier Pass linkage was ranked a #9 statewide priority for the lynx in-lieu fee mitigation fund based on an expert review process led by CDOT and involving CPW and USFS. This prioritization does not guarantee available mitigation funds; however, as these funds become available, they may be directed towards the highest priority areas in the state.



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SH 9, Upper Blue River

Mileposts: 80.1 – 85.6

Land Ownership: Private, National Forest

Road Type: Two-lane highway

Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
25 [Rank 3 out of 11]	9	5	11

Primary Target Species	Movement Type	Population Value to Species	WVC Rate
Elk	Migration, summer range	High	High
Moose	Local movements	High	High
Mule Deer	Migration	High	High
Secondary Target Species			
Black Bear	Local (within population)	Medium	Low
Lynx	Dispersal	Low	Low

The Upper Blue River linkage is a wide riparian valley with extensive willow complexes and riparian systems along the Blue River and forested habitat (spruce-fir, mixed conifer and aspen). Baigas et al. (2017) identified portions of this linkage as having a high or very high probability of lynx crossing, particularly around mileposts (MP) 82-83. Migratory deer and elk movements cross through this linkage and CPW mapping data show elk summer range on both sides of the highway corridor, but avoiding the developed areas on either side of the highway itself. Elk that summer in this area primarily winter in South Park, south of US 285, according to an elk collar study conducted by CPW in the 1990's. The wetland complexes throughout the linkage render much of it as primary habitat for moose. In addition, CPW identifies the entire Upper Blue River Valley around SH 9 as a human conflict area for bear.

There is extensive residential development immediately adjacent to the highway and, notably, CDOT has no right-of-way beyond the highway footprint through this segment. The highway runs straight through the valley and traffic speeds are high. This route experiences heavy commuter traffic into Breckenridge from Blue River and as far as Fairplay. Traffic volumes range from 4,800 AADT at the south end of the linkage to 7,000 AADT near Breckenridge, with an expected increase of up to 9,600 AADT by 2040, marking a significant increase in the barrier effect of this roadway. Wildlife-vehicle collisions are common in this linkage involving deer, elk, moose and bear, many of which are not reflected in accident reports. Seven moose-vehicle collisions were recorded by CPW in the area around Goose Pasture Tarn (~MP 84) from 2010-2016. Three moose-vehicle collisions have been recorded around MP 81 during this timeframe. Ongoing residential development and increasing recreation, including a potential paved recreation path running up the valley, will continue to limit wildlife movement through this linkage area.

Preliminary Connectivity Recommendations and Opportunities

Conservation Actions:

- Educate residents and business owners regarding living with wildlife and work with the community of Blue River to implement a bear-proof garbage program.

Highway Mitigation:

- The Blue River linkage was ranked a #13 statewide priority for the lynx in-lieu fee mitigation fund based on an expert review process led by CDOT and involving CPW and USFS. This prioritization does not guarantee available mitigation funds; however, as these funds become available, they may be directed towards the highest priority areas in the state.
- There are few opportunities for crossing structures in the southern portion of the linkage area, underscoring the value of crossing structures in the northern portion of the linkage where there are limited opportunities. See site-specific comments in table below.







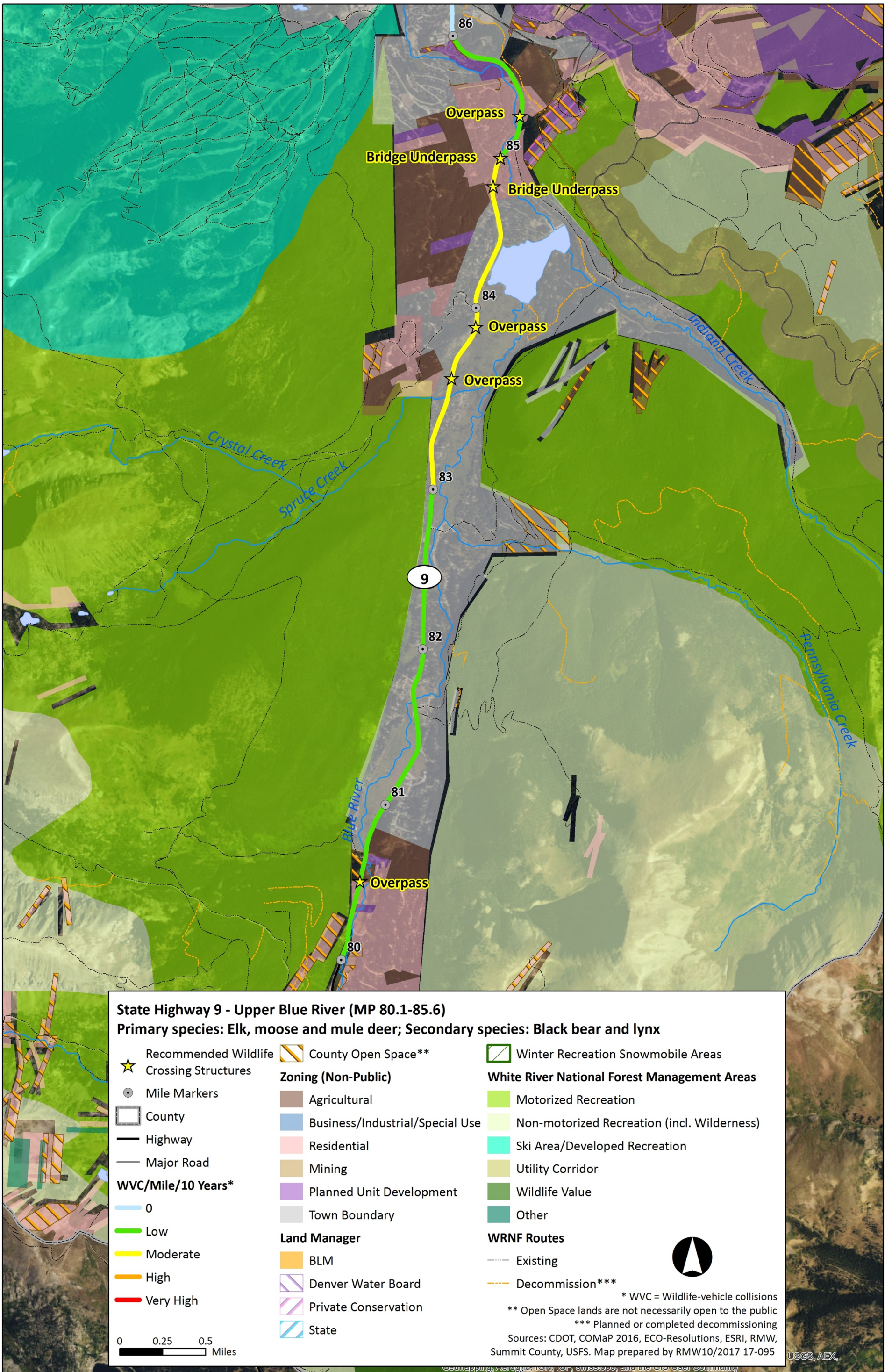
Milepost	Site Description	Recommendations
80.5	Small cut ridge south of Blue River Lodge. Small parcel of county land adjacent to National Forest on west side of SH9.	Potential overpass location. Not a preferred location for a wildlife crossing, but this section of the linkage offers few structure opportunities.
81.7	Blue River culvert (small pipe). Low roadbed and extensive wetlands on either side of highway. Nearby residences on either side of SH 9.	Difficult location to construct a wildlife crossing; however, reconnecting the wetland habitat is desirable. 

Figure 1 – Blue River culvert and wetlands.

<p>83.6</p>	<p>Forested habitat on either side of SH9. Extensive wetland complex through valley on east side.</p>	<p>Potential overpass location in area with high moose activity and moose-vehicle collisions.</p>  <p><i>Figure 2 – Location of proposed wildlife overpass.</i></p>
<p>83.9</p>	<p>South end of Goose Pasture Tarn.</p>	<p>Potential overpass location in area with high moose activity and moose-vehicle collisions. Overpass would connect from small cut slope on west side to a bench above the wetlands on the east side, adjacent to HOA tarn access road.</p>  <p><i>Figure 3 – Location of proposed wildlife overpass.</i></p>

<p>84.8</p>	<p>Large fill (20'H) in a forested draw. This location has a history of high collision rates.</p>	<p>Excellent location for constructing a bridge (preferred) or arch crossing structure. A wide arch may be preferred to minimize potential icing on bridge at a curve.</p>  <p><i>Figure 4 – Location of proposed wildlife underpass.</i></p>
<p>85.0</p>	<p>Blue River box culvert. Existing structure does not allow for terrestrial wildlife passage and is marginal for fish passage. Nearby residences on either side of SH 9.</p>	<p>Replace existing box culvert with a bridge spanning riparian banks.</p>  <p><i>Figure 5 – Blue River box culvert.</i></p>
<p>85.3</p>	<p>Cut ridge with dense forest on either side. Residential development to west. Moose observations common between here and Boreas Pass Rd.</p>	<p>Potential overpass location, minimum 50' wide with associated wildlife fencing.</p>  <p><i>Figure 6 – Proposed overpass location.</i></p>



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SH 9, Gold Hill

Mileposts: 90.5 – 92.2

Land Ownership: Mostly private with some county open space; National Forest beyond highway corridor

Road Type: Four-lane highway

Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
24 [Rank 4 out of 11]	9	5	10

Primary Target Species	Movement Type	Population Value to Species	WVC Rate
Elk	Winter range	High	High
Secondary Target Species			
Lynx	Regional, dispersal	Medium	High
Moose	Local movements	Medium-Low	Medium-Low
Mule Deer	Winter range	Medium	High

The Gold Hill linkage is situated between the towns of Frisco and Breckenridge, and is fragmented by commercial and rural residential development along either side of the highway. The linkage includes mixed conifer, sagebrush and riparian habitats that are important for local movements by deer, elk and moose, including wintering and resident elk and deer herds. The segment between MP 92-93 was identified by the project’s lynx linkage model and has a moderate probability of lynx highway crossing according to an empirical-based model by Baigas et al (2017). Wildlife-vehicle collisions are highest in the northern portions of the linkage (MP 91.7 – 92.0), and have involved a variety of species including a lynx that was killed near MP 91 in 2008.

Traffic volumes are very high in this linkage, with an AADT of 20,000 in 2015 that is expected to increase to 27,000 by 2040. Increased development, traffic volumes, high speed and recreation activity threaten to sever connectivity in this linkage. CDOT has already expanded the highway from two to four lanes. A bridge over the Blue River at MP 90.8 was enlarged at that time, in part, to accommodate wildlife movement; however, there is limited clearance under the structure, a limited dry pathway through the structure – particularly under high flow conditions – and no wildlife fencing associated with this structure. At the time of the highway widening, discussions were held to construct an arch underpass or a wildlife overpass to mitigate impacts to wildlife movement. However, neither structure was built due to cost, terrain considerations, and objections by the adjacent landowner.

The long-term value of this linkage to wildlife movement may be diminishing due to ongoing development, high levels of human activity. Year-round recreation activity is also expected to increase, for example, with a proposal to groom the bike path through the winter months. In recent year, beetle kill and associated forest harvesting have affected forest cover and the habitat quality of the linkage has diminished for forest-dependent species such as lynx, until such a time

that the forest regenerates. Provided these lands are protected from development, the habitat may be restored and the long-term value for wildlife movement preserved.

Preliminary Connectivity Recommendations and Opportunities

Conservation Actions:

- Increase and enhance forested habitat restoration on public and private lands in conjunction with highway mitigation.

Highway Mitigation:

- The Gold Hill linkage was ranked a #16 statewide priority for the lynx in-lieu fee mitigation fund based on an expert review process led by CDOT and involving CPW and USFS. This prioritization does not guarantee available mitigation funds; however, as these funds become available, they may be directed towards the highest priority areas in the state.
- Site-specific highway mitigation recommendations are detailed in the table below.


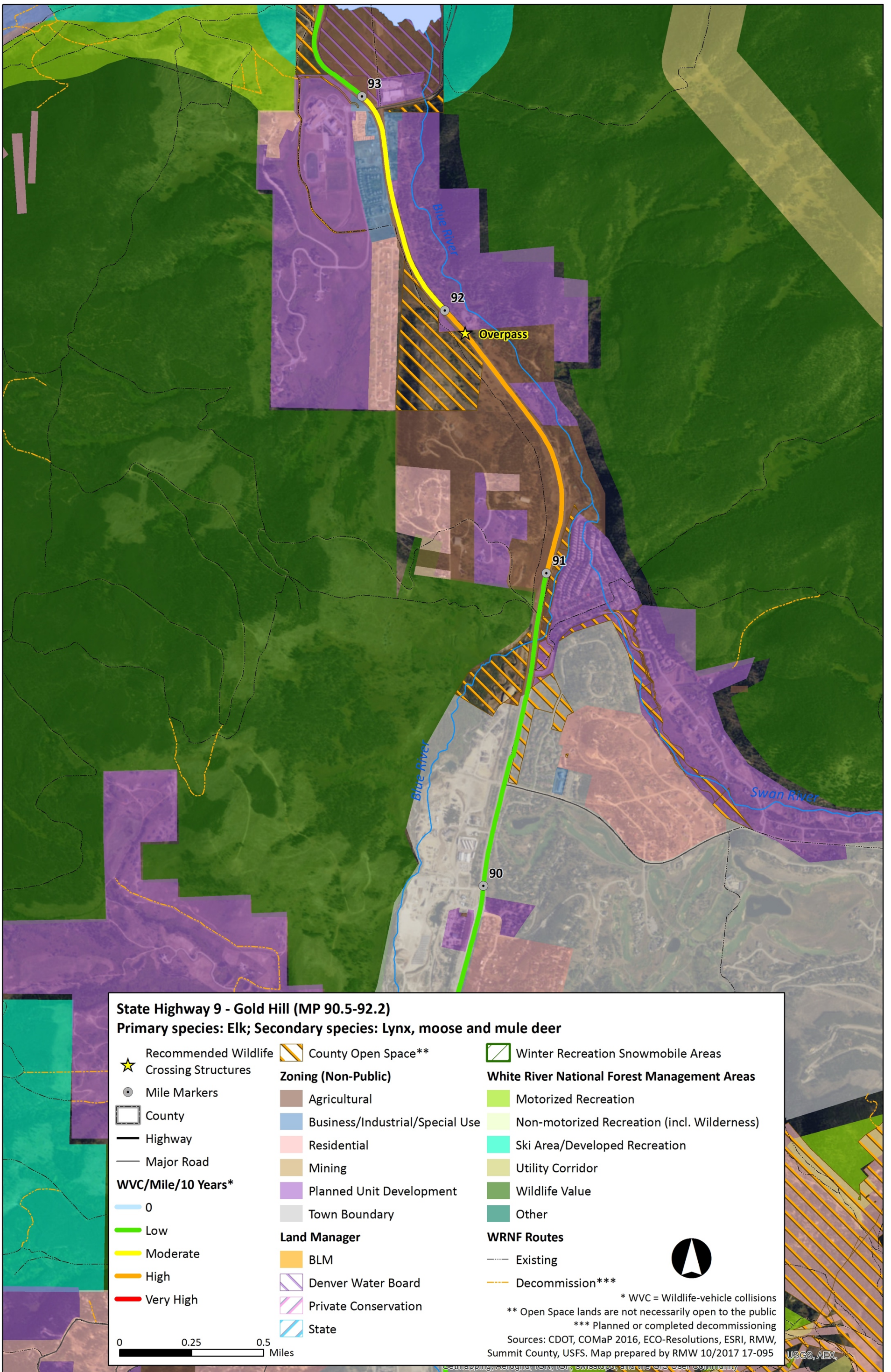
Milepost	Site Description	Recommendations
90.8	Blue River bridge replaced 3 culverts in the last highway widening project.	Limited wildlife potential due to low clearance, limited dry pathway and lack of wildlife fencing. Adjacent residential development and bike path on the west. No recommendation at this time.
91.8 – 92.1	Flat terrain and straight roadway; high WVC. Nearby residences on both side of SH 9; USFS lands lie beyond.	There are several possible locations for a wildlife overpass. Minimum 50’ wide. Stakeholders identified MP 91.9 (where county open space is present on either side of the highway) as the best location for a wildlife overpass. 

Figure 7 – MP 92.1 is another potential location for a wildlife overpass (looking north).



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SH 9, Iron Springs

Mileposts: 93.5 – 94.8

Land Ownership: National Forest

Road Type: Four-lane highway with median (upon completion of construction, Fall 2017)

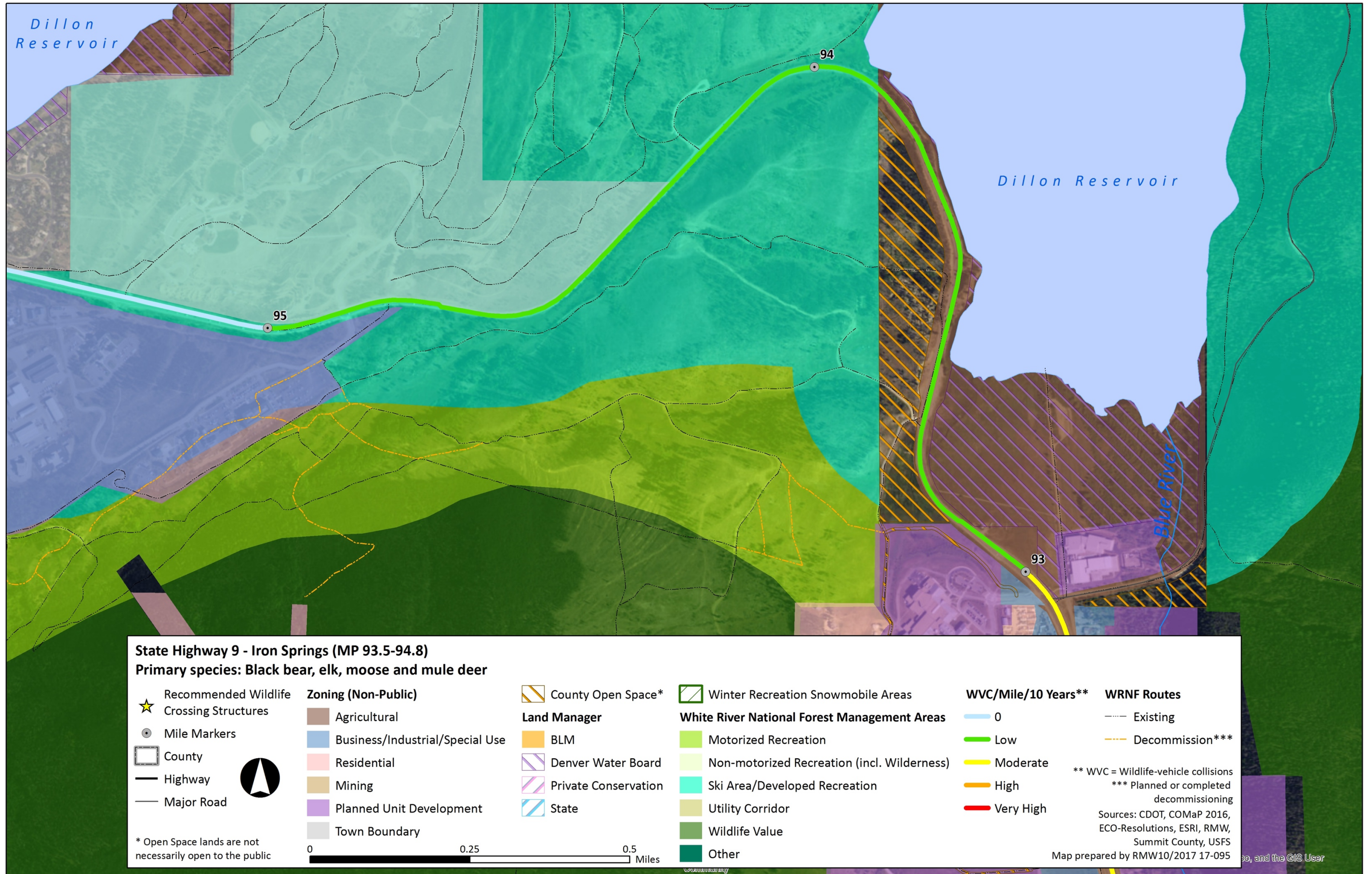
Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
20 [Rank 8 out of 11]	4	1	15

Primary Target Species	Movement Type	Population Value to Species	WVC Rate
Black Bear	Local (within population)	Low	Low
Elk	Local movements	Medium-Low	Medium
Moose	Local movements	Medium	Low
Mule Deer	Local movements	Medium-Low	Medium

The highway is currently being re-routed and widened through the Iron Springs linkage. To mitigate the project’s impacts on the forest and wildlife habitat, two underpass structures are being constructed for the bike path, and may also allow some wildlife movement under the highway. In addition, an oversized drainage culvert may provide passage for smaller fauna under the highway. Mixed conifer forested habitat on the east side of the highway has been heavily impacted by beetle kill in recent years and is limited by Dillon Reservoir.

As part of the design for this realignment, the majority of the old highway prism will be removed and narrowed down to the width of the bike path. Additionally, the wetlands that used to connect to the reservoir will be restored with the complete removal of the old highway prism. No additional mitigation actions are recommended in this linkage at this time.

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SH 9, Maryland/Everist

Mileposts: 107 – 109

Land Ownership: Private, National Forest

Road Type: Two-lane highway

Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
24 [Rank 4 out of 11]	5	5	14

Primary Target Species	Movement Type	Population Value to Species	WVC Rate
Elk	Local movements	High	High
Moose	Local and dispersal movements	High	High
Mule Deer	Local movements	High	High
Secondary Target Species			
Black Bear	Local (within population)	Medium	Medium

The Maryland/Everist linkage is characterized by increasing suburban and rural residential development immediately north of the town of Silverthorne. The linkage area originally identified by stakeholders extended south to MP 105, but due to extensive residential development and a gravel pit on the west side of the highway between MP 106-107, the linkage extent was later shortened to MP 107. Wildlife habitat in the linkage includes mixed conifer, aspen, sagebrush steppe, riparian and large riverine. The Blue River and associate riparian habitat, agricultural fields, and garbage all act as attractants for wildlife here.

Traffic volumes are moderately high through this segment, with an AADT of 6,400 that is expected to increase to 8,640 by 2040, becoming an ever-more substantial barrier to wildlife movement across the highway. Wildlife-vehicle collisions are correspondingly high – WVC rates in this linkage are among the highest in the county, including deer, elk, moose, mountain lion and bear. From 2012 through 2016, CPW recorded nine moose-vehicle collisions in this segment. Wildlife experts speculate that wildlife-human conflicts may increase in this linkage and ongoing development may push wildlife populations farther north.

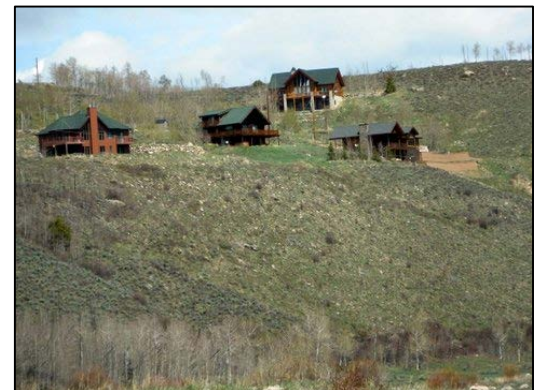


Figure 8 – Residential development in the Maryland/Everist linkage.

Preliminary Connectivity Recommendations and Opportunities



Conservation Actions:

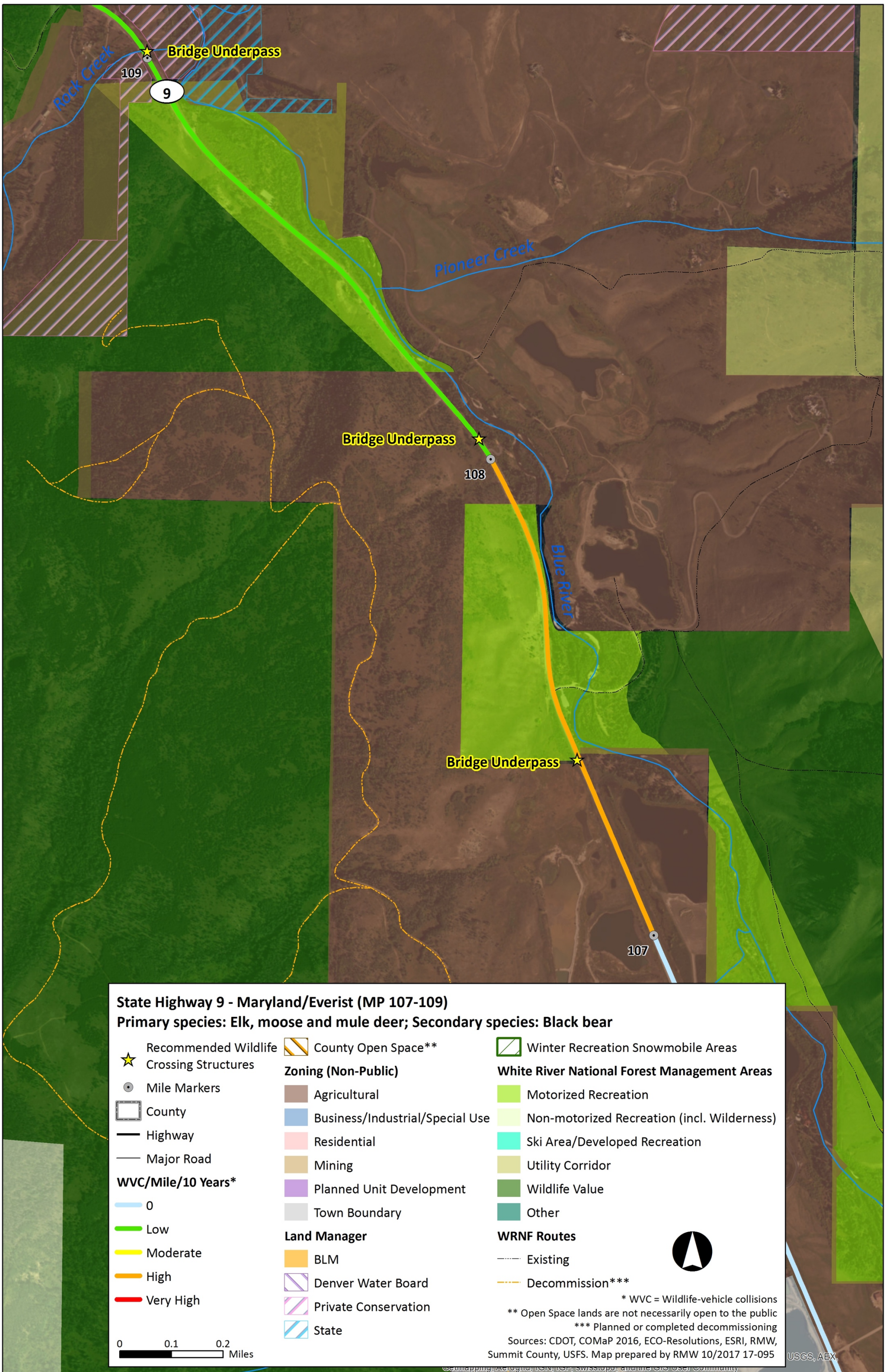
- Promote county planning and zoning consistent with wildlife movement needs, and direct compensation funds for development projects in areas outside of the linkage towards wildlife mitigation in the linkage.

- Reach out to local private landowners via Friends of the Lower Blue River. Engage and educate landowners about the value of this wildlife linkage.
- Increase and enhance forested habitat restoration on public and private lands in conjunction with residential and highway mitigation projects.

Highway Mitigation:

- Potential site-specific highway mitigation opportunities are detailed in the table below.

Milepost	Site Description	Recommendations
107.4	North of gravel pit at the east end of a broad, flat valley through which the Blue River winds. Low, raised roadbed through wetland area.	<p>Minimal fill height available – install a medium underpass suitable for deer and moose at least 12’H x 25’W with wildlife fencing. Wetland areas and a high water table will make construction in this area difficult. The best location here may be on the south side of the river bend next to a local access drive.</p>  <p><i>Figure 9</i> – Looking northeast at proposed underpass location.</p>
108.1	Small fill slope. Forested hillside to the west and the Blue River to the east.	<p>Construct low, wide bridge underpass. This is the most feasible location for constructing an underpass suitable for elk in this linkage.</p>  <p><i>Figure 10</i> – Looking north a proposed bridge location.</p>



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SH 9, Lower Blue

Mileposts: 109 – 118.8

Land Ownership: Private, National Forest, Private Conservation Easements

Road Type: Two-lane highway

Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
25 [Rank 3 out of 11]	6	4	15

Primary Target Species	Movement Type	Population Value to Species	WVC Rate
Elk	Local, winter range	High	High
Mule Deer	Migratory and winter range movements	High	Medium
Secondary Target Species			
Black Bear	Local (within population)	Medium	Medium
Moose	Dispersal	Medium	Medium

The Lower Blue linkage area is a broad, mostly flat valley composed of extensive agricultural fields, rural residential development, aspen and sagebrush steppe, through which the Blue River wends north. The linkage provides important winter range for elk as well as deer. Dispersing moose are also common in the linkage. Wildlife movements are dispersed throughout the linkage area, although several hotspots are reflected in the WVC crash and carcass datasets, particularly in the northern portions of the linkage.

The Lower Blue linkage is threatened by increasing residential development, but subdivision of larger lots is occurring to a smaller degree than in the Maryland/Everist linkage to the south. Traffic volumes are moderate, ranging from 2,800-3,500 AADT (2016), a likely contributor to the high WVC rates. There are multiple existing bridges and culverts under SH 9 in this linkage; however, they provide little opportunity for wildlife passage – the bridge support slopes are lined with large rip-rap and lack a pathway for wildlife, particularly hooved animals, while the culverts are too small for the target species.

Preliminary Connectivity Recommendations and Opportunities



Conservation Actions:




- Consider land exchanges or conservation purchase or easements to assure long-term protection of important wildlife habitat.
- Investigate opportunities to remove old fencing that may inhibit wildlife movements or, where fencing is needed, replace barbed wire fencing with a wildlife-friendly alternative.




Highway Mitigation:



- The segment of SH 9 north of Ute Pass may be scheduled for future transportation improvements. In addition, several of the bridges over the Blue River may be due for replacement, at which time considerations for terrestrial wildlife passage should be addressed.


- Site-specific highway mitigation recommendations are detailed in the table below. Install continuous wildlife fencing between wildlife crossings, provided the distance between crossing structures is less than 1.5 miles.

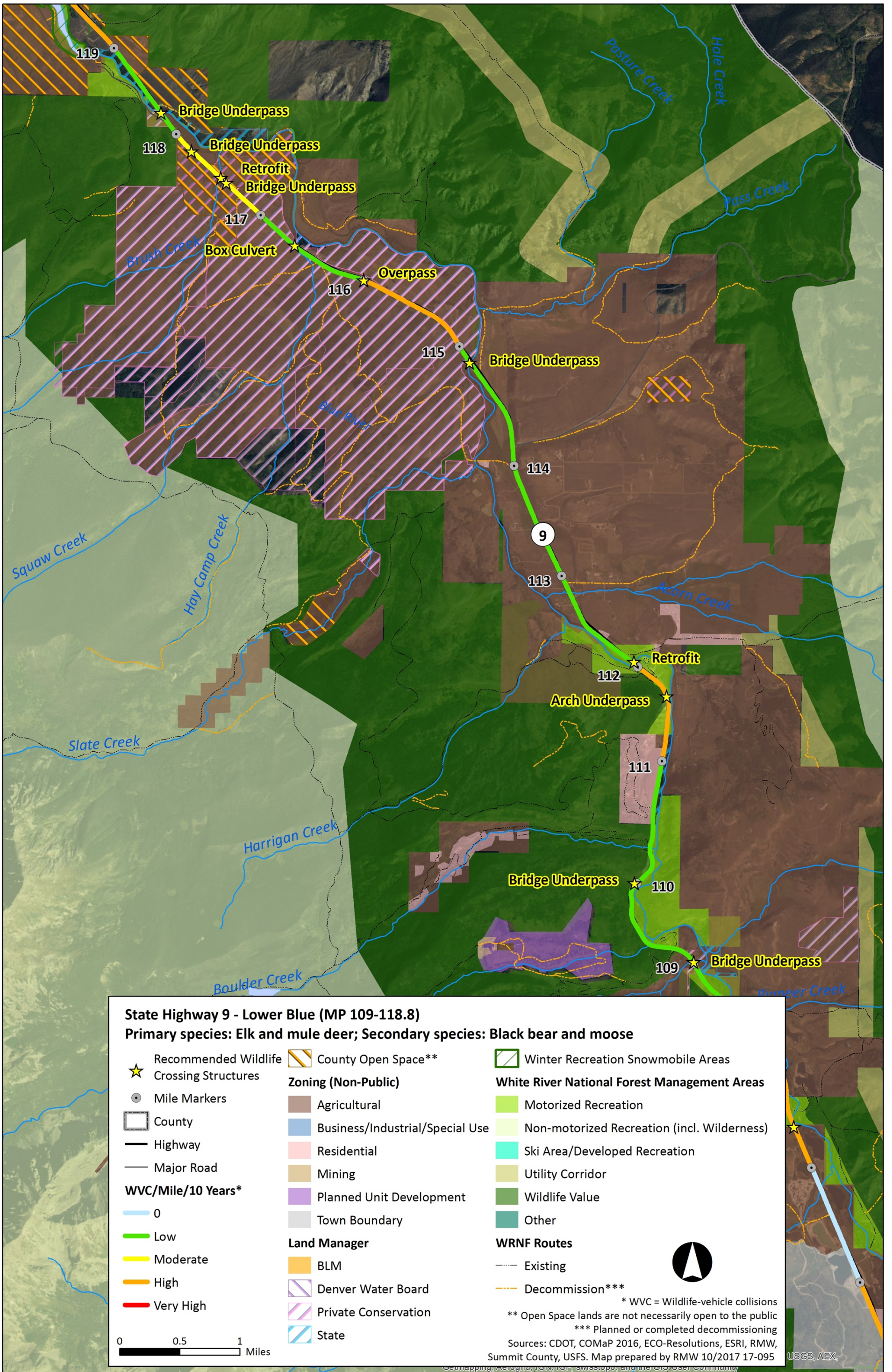
Milepost	Site Description	Recommendations
109	North Rock Creek tributary, double-pipe culvert inadequate for wildlife or fish passage. Low elevation mixed conifer and sagebrush habitat. Private land both sides of SH 9.	<p>Bridge underpass suitable for elk and other species, with associated wildlife fencing.</p>  <p><i>Figure 11</i> – Existing double-pipe culvert, looking east.</p>
110	Open drainage from west bisected by SH 9; Blue River to east. Existing 8'H x 8'W box culvert designated as a wildlife crossing structure. Limited wildlife guide fencing. Existing structure is undersized for elk and moose.	<p>Replace existing box culvert with a bridge underpass or large arch culvert, minimum 12'H x 44'W. Extend & improve wildlife fencing.</p>  <p><i>Figure 12</i> – Existing box culvert crossing structure.</p>

<p>111.6</p>	<p>Designated wildlife crossing 6'H x 6'W x 90'L box culvert, extends beyond the road prism on the east side. Rip-rap on the west end prevents most wildlife from using the structure, as does its small size and gravel bottom. Wildlife guide fence on west side of culvert only, extends ~50' in either direction.</p>	<p>Replace existing box culvert with a large arch or box culvert and extend existing wildlife fencing.</p>  <p><i>Figure 13 – Existing box culvert.</i></p>
<p>112.0</p>	<p>Blue River bridge (#1 in linkage). Sagebrush and mixed conifer habitat. Natural stream bottom, but heavily rip-rapped slopes prevent ungulate passage. Current use was assessed as good for small and mid-sized animals and fish and poor to none for deer, elk, moose and black bear.</p>	<p>Retrofit existing structure by providing 3'W dry, smooth pathways through the structure on either side of the river. Install wildlife fencing.</p>  <p><i>Figure 14 – Rip-rap slopes under existing bridge.</i></p>
<p>114.9</p>	<p>Blue River bridge (#2). Open pasture. Structure is marginally passable by target species, but access is confounded by existing sheep and cattle fence. Overall, the structure was rated as fair for deer, elk and black bear and good for smaller animals and fish.</p>	<p>The existing bridge may be considered for replacement. A new structure at this location should have a wider span to provide dry pathways for terrestrial wildlife on either side of the river. Replace existing fencing with wildlife fencing.</p>  <p><i>Figure 15 – West side of existing bridge.</i></p>

<p>116.0</p>	<p>Small road cut through sagebrush ridge at the top of a small hill.</p>	<p>Good location for wildlife overpass spanning between road cuts. Recommend overpass, minimum 50-80'W with wildlife fencing.</p>  <p><i>Figure 16 – Looking south towards road cuts.</i></p>
<p>116.6</p>	<p>Large graded hay field to west; steep, narrow, treed drainage to east. Small existing pipe drainage culvert.</p>	<p>Possible location for box culvert suitable for deer.</p>  <p><i>Figure 17 – Looking east towards drainage.</i></p>
<p>117.4</p>	<p>Fill slope ~20'H over flat meadow area. In riparian zone, a natural pathway for wildlife. Houses located to east.</p>	<p>Recommend bridge underpass or large arch culvert, minimum 14'H x 44'W with wildlife guide fencing.</p>  <p><i>Figure 18 – Looking south at proposed bridge location.</i></p>

<p>117.5</p>	<p>Existing cattle/ranch culvert 10'W x 10'H x60'L with gates and fencing. Culvert is immediately north of undersized Brush Creek pipe culvert.</p>	<p>Work with landowner to reconfigure fencing and add wildlife guide fencing to allow deer and bear passage through culvert.</p>  <p><i>Figure 19 – Looking west through culvert.</i></p>
<p>117.8</p>	<p>Small fill slope with raised roadbed (~10-15'H). High deer WVC.</p>	<p>Recommend bridge or large arch culvert. Location is suitable for mule deer, black bear mid-sized carnivore like bobcats and coyotes; marginal for elk due to height limitations.</p>  <p><i>Figure 20 – Proposed structure location.</i></p>

118.2	<p>Blue River bridge (#3). Located in a cottonwood river bottom with grassland and sagebrush surrounding hillsides. Steep rip-rap slopes under bridge prevent most wildlife passage.</p>	<p>The existing bridge has a structure sufficiency rating of 55.5 and planning for a replacement bridge may commence in the near-term. A new structure at this location should have a wider span to provide dry pathways for terrestrial wildlife on either side of the river. Replace existing fencing with wildlife fencing.</p>  <p><i>Figure 21 – Rip-rap slopes under bridge.</i></p>
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SH 9, Green Mountain Reservoir

Mileposts: 125 – 126.6

Land Ownership: National Forest, BLM, County Open Space, Private

Road Type: Two-lane highway

Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
23 [Rank 5 out of 11]	6	5	12

Primary Target Species	Movement Type	Population Value to Species	WVC Rate
Elk	Local winter movements	High	High
Mule Deer	Local winter movements	High	High
Secondary Target Species			
Black Bear	Local (within population)	Medium	Low

The Green Mountain Reservoir linkage is located between the north end of the reservoir, where most wildlife move around the reservoir, to the Grand County line. Rural residential development and recreation activities, including dispersed camping and lake access, occur within the linkage area. The majority of recreation activity occurs during the summer and early fall months and only limited recreation (ice fishing) occurs during the winter months. Traffic volumes are moderate (3,900 AADT in 2015) and expected to increase to 6,800 AADT by 2040, becoming an increasing barrier to wildlife movement. Wildlife-vehicle collisions are high, primarily involving deer and elk.

Habitat in this linkage area is primarily composed of sagebrush steppe with some aspen and riparian habitat along the Blue River. Wintering deer and elk come down to the reservoir to water. Increasingly, bighorn sheep have been observed in the linkage area. A historical sage-grouse lek is present adjacent to the highway. The SH 9 wildlife mitigation project in Grand County extends partially into this linkage – the southern extent of the wildlife exclusion fencing is at MP 126.6 and the closest wildlife underpass is at MP 127.7.



Preliminary Connectivity Recommendations and Opportunities

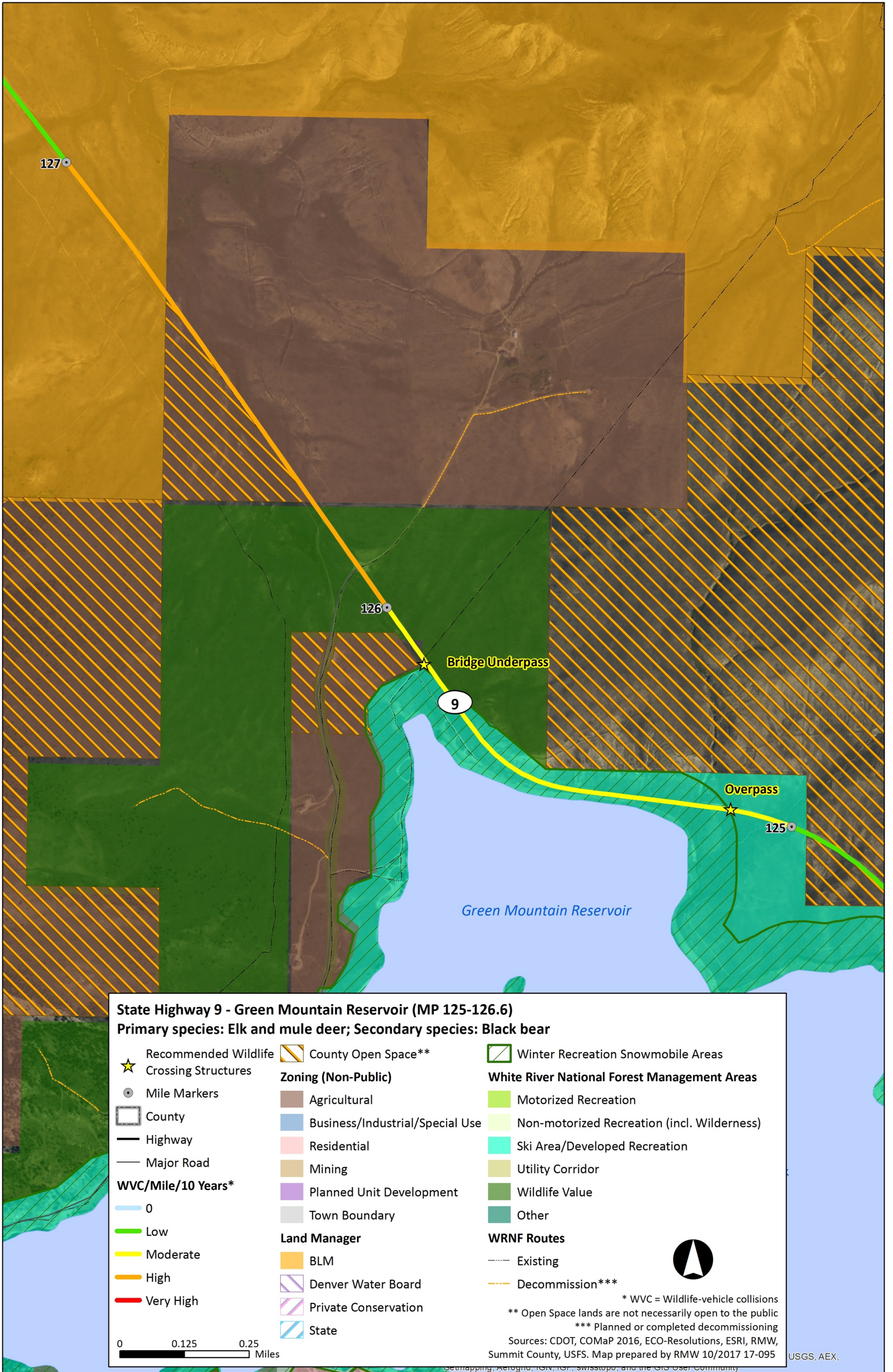
Conservation Actions:

- Maintain current camping closure dates and limited winter recreation use.
- Coordinate with Summit County Open Space and Trails to manage the Knorr property on the east side of the highway in a manner that supports wildlife movement, particularly during the winter months.
- Consider land exchanges or conservation purchase or easements to assure long-term protection of important wildlife habitat.

Highway Mitigation:

- Site-specific highway mitigation recommendations are detailed in the table below.

Milepost	Site Description	Recommendations
125.1	Small road cut.	<p>Marginal, but possible overpass location.</p>  <p><i>Figure 22 – From potential overpass location, looking north.</i></p>
125.9	Raised roadbed, small fill slop at north end of reservoir.	<p>Most suitable location for a wildlife crossing in this linkage. Recommend wide bridge underpass, at least 12'H and as wide as possible for both deer and elk passage. Install wildlife fencing, connecting to existing fence to north (MP 126.6).</p>  <p><i>Figure 23 – West side of proposed bridge location, looking south.</i></p>



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State Highway 91

SH 91, Copper Mountain

Mileposts: 18.5 – 21.5

Land Ownership: National Forest

Road Type: Two-lane highway

Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
25 [Rank 3 out of 11]	10	1	14

Primary Target Species	Movement Type	Population Value to Species	WVC Rate
Lynx	Local (within population)	Very High	Low
Secondary Target Species			
Black Bear	Local (within population)	Medium-Low	Low
Elk	Local summer movements	Medium	Medium
Moose	Local movements	Medium-Low	Medium-Low
Mule Deer	Migration and local summer movements	Medium	Medium

State Highway 91 (SH 91) through this linkage bisects the home range for an established, breeding population of lynx between the Vail Pass area and the Tenmile Range. Accordingly, this linkage is considered one of the most important areas for lynx in Summit County. An empirical-based model developed by Baigas et al. (2017) likewise found a very high probability of lynx crossing through this segment. The linkage also supports migratory and summer range movements for deer and elk that winter in South Park. Mountain lion and black bear are also known to use this linkage. Moose are currently uncommon, but increasing in the linkage.

Habitat in this linkage is composed of dense spruce-fir forest, with riparian vegetation along Tenmile Creek, which parallels SH 91 to the east throughout the linkage. Copper Mountain Resort is located immediately to the northwest and hosts both winter and summertime recreation activities. A paved bike path is being considered along the highway corridor and would likely be constructed on the east side of the creek, opposite the highway. Other backcountry trails are also located in the linkage area, including the Colorado Trail. A major utility corridor is present along the highway, bringing power to Climax Mine.



Figure 24 – Copper Mountain linkage from Tenmile Range looking west across SH 91.


Preliminary Connectivity Recommendations and Opportunities



Conservation Actions:




- Coordinate with Summit County Open Space and Trails and the Federal Highway Administration (FHWA) regarding the development and routing of the proposed bike path, the path’s impacts to wildlife and potential mitigation, which may include incorporating wildlife accommodations into the proposed pedestrian over- or underpass at Tenmile Creek, or funding contributions for other habitat or highway mitigation elsewhere in the linkage area. The stakeholder group is concerned about the area around Tenmile Creek becoming a de facto trailhead. Parking and trail access should be limited at this location. It is also recommended to permanently prohibit winter use and winter grooming of the recreation path, regulate potential increased use of the path, and prohibit commercial bike shuttling as well as other commercial uses on the proposed trail.

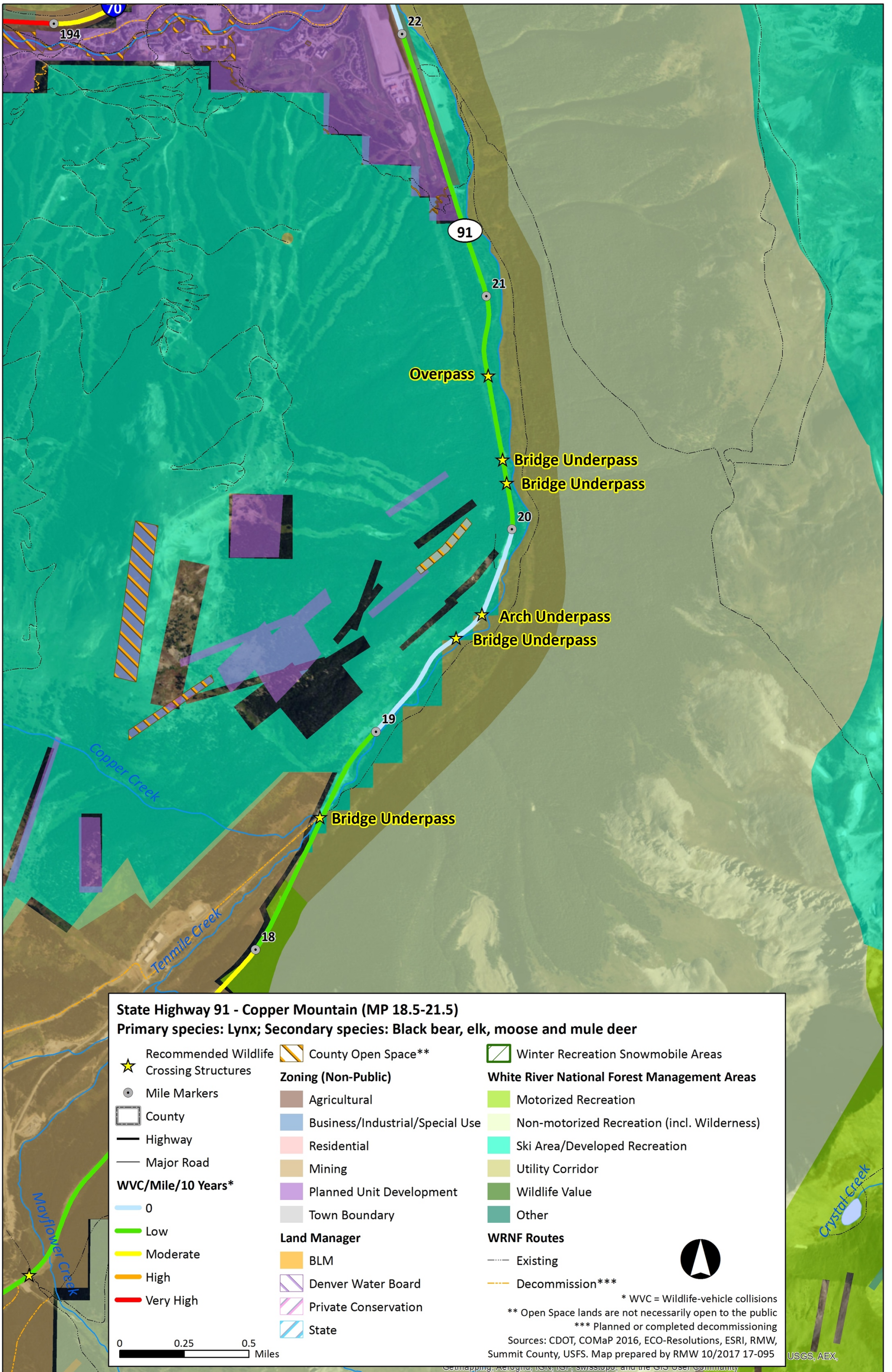
Highway Mitigation:

- The Copper Mountain linkage was ranked a #9 statewide priority for the lynx in-lieu fee mitigation fund based on an expert review process led by CDOT and involving CPW and USFS. This prioritization does not guarantee available mitigation funds; however, as these funds become available, they may be directed towards the highest priority areas.
- Potential mitigation locations in this linkage are limited by steep terrain and Tenmile Creek, which runs along the east side of the highway. Potential locations for wildlife overpasses are at bends in the creek where the creek meanders farther from the highway. These tend to be the only places where the highway corridor is wide enough for a pullout along the east side; however, these pullouts are also used for snow storage during the winter months. An overpass design at any of these locations may result in a steep approach slope on the east side due to limited space between the creek and the highway. In addition, Climax Mine may have concerns regarding the conveyance of large mine equipment under a wildlife overpass spanning the highway.
- Crossing structure mitigation should be coordinated with the bike path plan design. A preferred route and location for the path to cross over SH 91 is anticipated in late 2017.
- Preliminary site-specific highway-wildlife mitigation recommendations are provided in the table below.

Milepost	Site Description	Recommendations
18.6	Tenmile Creek. Pipe culvert is undersized and very skewed.	Replace culvert with low, shorter bridge underpass spanning riparian banks. Lower priority location. <div data-bbox="797 1423 1360 1797" style="text-align: center;">  </div> <p data-bbox="764 1801 1409 1869"><i>Figure 25 – From culvert outlet looking north into linkage area.</i></p>

<p>19.5</p>	<p>Bench on east side of highway, immediately south of large pullout.</p>	<p>Recommend low bridge underpass suitable for lynx and elk.</p>  <p><i>Figure 26 – Bench on east side of SH 91.</i></p>
<p>19.6</p>	<p>Spaulding Gulch is a small, very steep, ephemeral drainage into Tenmile Creek. There is an emergency access road for Copper Mountain that also crosses this drainage.</p>	<p>Replace existing 5' box culvert with a large arch culvert suitable for lynx, elk and other wildlife. However, steep terrain and a drop into Tenmile Creek may limit the feasibility of a crossing structure at this location.</p>  <p><i>Figure 27 – Box culvert inlet.</i></p>

<p>20.2</p>	<p>Raised roadbed, bench between highway and creek, immediately south of large pullout.</p>	<p>Recommend low bridge underpass suitable for lynx, elk and other wildlife.</p>  <p><i>Figure 28 – Bench on east side of highway.</i></p>
<p>20.3</p>	<p>Raised roadbed, bench between highway and creek, immediately north of large pullout.</p>	<p>Recommend low bridge underpass suitable for lynx, elk and other wildlife.</p>  <p><i>Figure 29 – Looking north.</i></p>
<p>20.6</p>	<p>Road cuts through ridgeline. Powerline corridor on west side. This is a possible location for the bike path to cross over SH91.</p>	<p>Possible overpass location, minimum 50' – 80' wide, with wildlife fencing.</p>  <p><i>Figure 30 – Looking south.</i></p>



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SH 91, Clinton Reservoir

Mileposts: 15 – 18.5

Land Ownership: Private, National Forest

Road Type: Three-lane highway

Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
20 [Rank 8 out of 11]	9	2	9

Target Species	Movement Type	Population Value to Species	WVC Rate
Bighorn Sheep	Local and seasonal movements. MP 13.5-16 identified as primary linkage area.	Medium	Low
Elk	Local summer movements	Medium	Medium
Lynx	Dispersal movements	Medium	Low
Mule Deer	Migration and local summer movements	Medium	Medium

State Highway 91 descends from the top of Fremont Pass, north, towards I-70. Climax molybdenum mine is located at the top of the pass and large tailings ponds on the west side of the highway and associated disturbed areas are located throughout the linkage area. Between the disturbed areas are spruce-fir forest, alpine meadows and riparian areas that support wildlife habitat and movement.



Much of the linkage area and highway frontage is privately owned by Climax Mine. Average traffic volume in 2015 was 4,300 AADT and is expected to increase to 6,020 by 2040. Increases in mining activity will result in greater traffic volumes, most notably, truck traffic. Forested habitat in Mayflower Gulch and Humbug Gulch are National Forest lands. Summer and winter non-motorized recreation activities are concentrated around Mayflower Gulch.

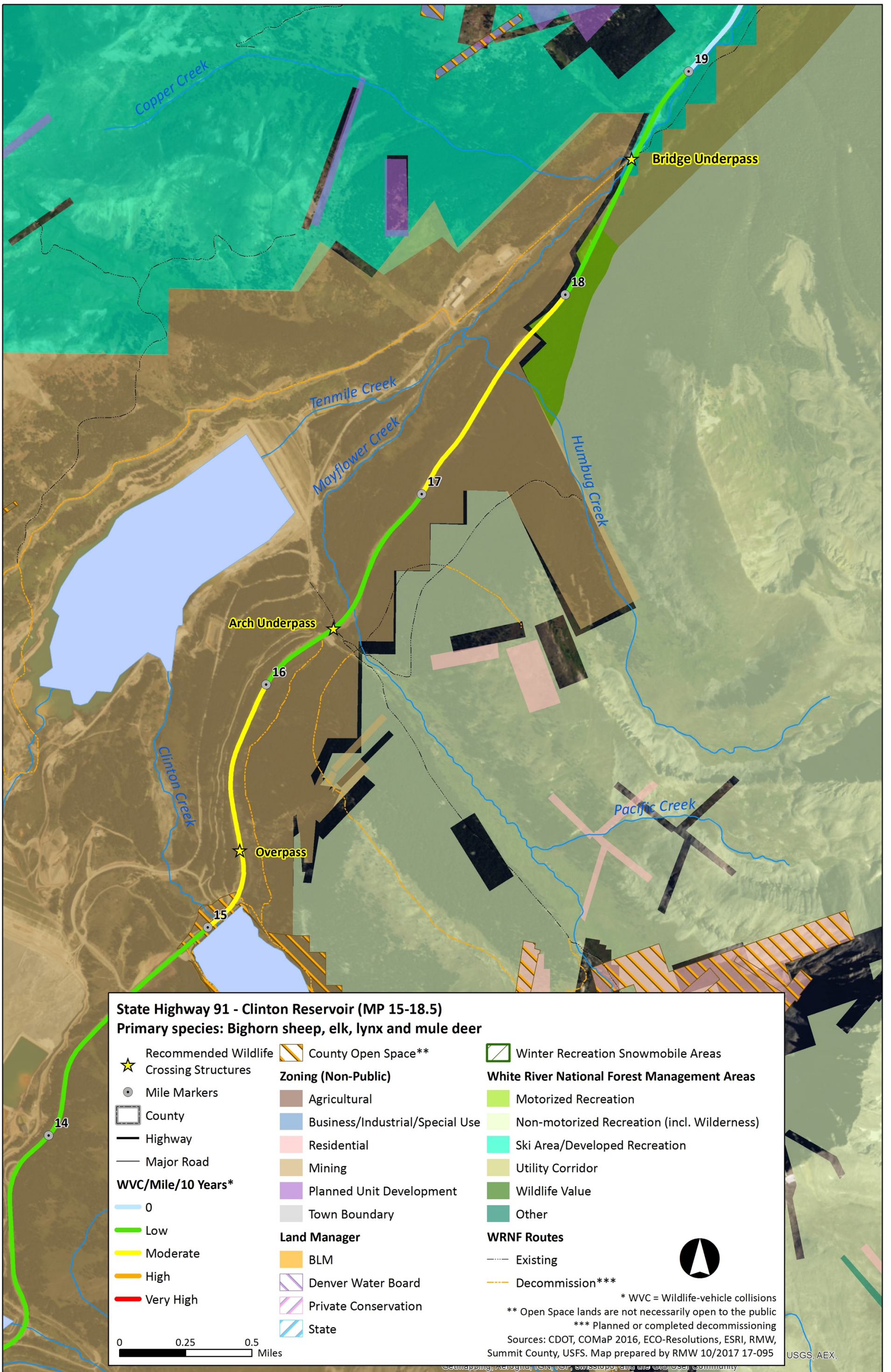
Wildlife activity is sandwiched between areas disturbed by mining and the heavy recreation use in Mayflower Gulch. In addition, elk are drawn into new meadows created by reclamation efforts. Both resident and migratory populations of elk and deer move through this linkage. The highest WVC rates in this segment are observed between MP 14.5–15.5 and have involved both deer and elk. Bighorn summer range crosses the highway near the pass and extends to the high peaks of the Tenmile range to the east. Mountain lion and black bear are known to inhabit this area, and a wolverine approaching from the south was also reported here.

Preliminary Connectivity Recommendations and Opportunities

Highway Mitigation:

- Site-specific highway mitigation recommendations are detailed in the table below.

Milepost	Site Description	Recommendations
15.3	Cut slopes in high WVC area in this segment.	<p>Potential overpass location (several possible sites) suitable for elk, deer, bighorn sheep, lynx and other carnivores.</p>  <p><i>Figure 31 – Looking south.</i></p>
16.3	Mayflower Gulch, large fill slope. Trailhead parking lot on southeast side.	<p>Potential large arch underpass location. Offset from deepest part of fill to north to shorten structure length. Alternatively, an overpass structure could span between the cut slopes immediately to the north of the trailhead.</p>  <p><i>Figure 32 – East side fill slope.</i></p>



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U.S. Highway 6

US 6, Loveland Pass

Mileposts: 222.5 – 225

Land Ownership: National Forest

Road Type: Two-lane highway

Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
21 [Rank 7 out of 11]	9	2	10

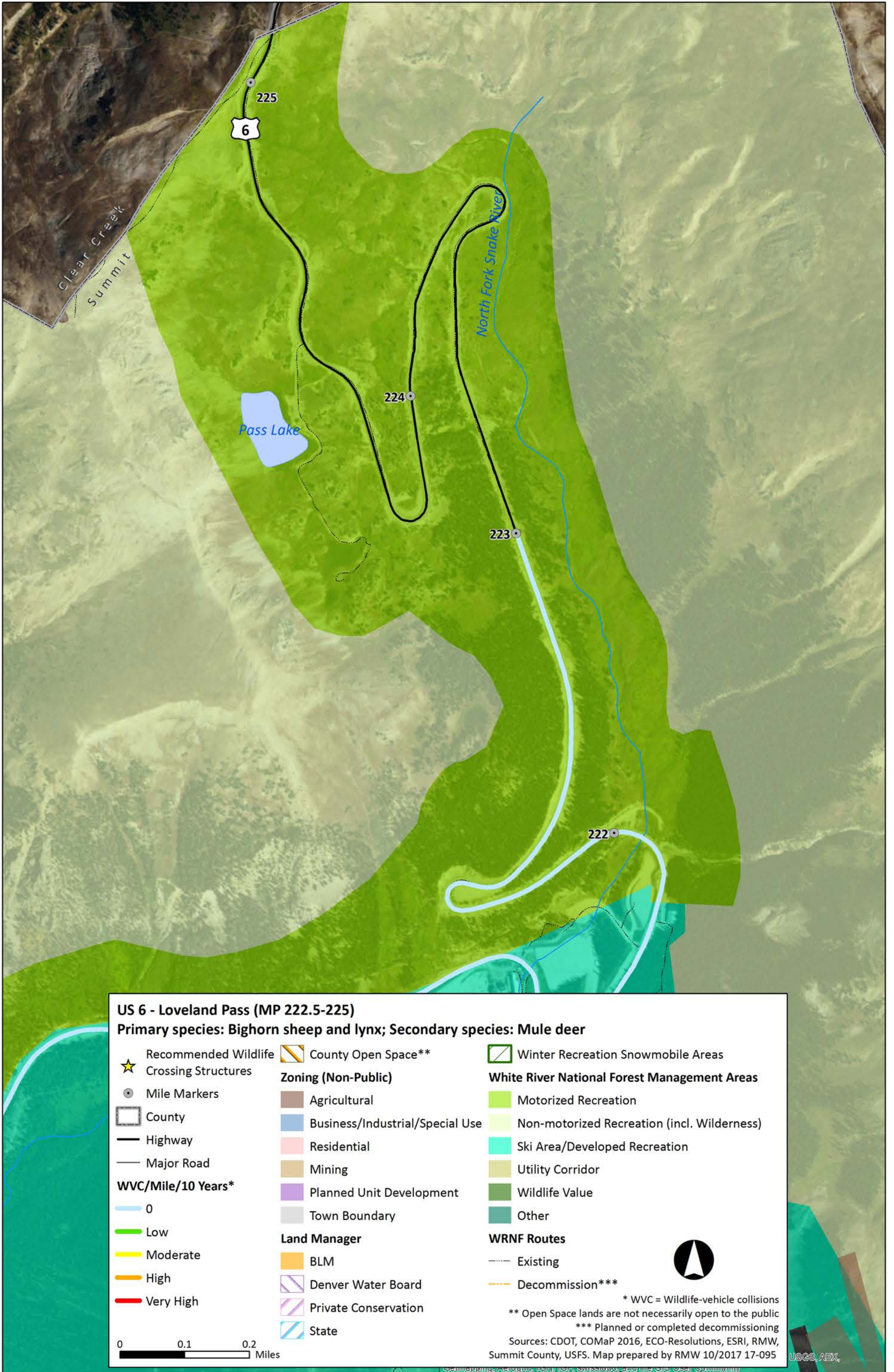
Primary Target Species	Movement Type	Population Value to Species	WVC Rate
Bighorn Sheep	Year-round movements both within and among populations	High	Medium
Lynx	Dispersal movements	High	Low
Secondary Target Species			
Mule Deer	Local and seasonal (summer) movements	Medium	Low

The Loveland Pass linkage area is noted primarily for bighorn sheep and lynx movements. The entire linkage area is identified as bighorn summer range and movements across the highway are relatively common. While the linkage itself is largely above tree line, it connects forested lynx habitat north and south of the I-70 land bridge. Notably, lynx movement through the linkage is largely via the large, open drainage, which, through much of the linkage runs parallel to the highway to the east; cross-highway movements, therefore, are primarily in the upper- and lower-most portions of the linkage. The linkage also provides summer habitat for migratory deer.

The linkage is characterized as high alpine tundra at and above tree line. The pass lies along the Continental Divide and connects to the land bridge over I-70 to the northwest. Highway 6 over Loveland Pass is a hazmat route, diverting trucks with hazardous material from the Eisenhower-Johnson Memorial Tunnels over the pass. Wildlife-vehicle collision rates are low compared to other highway segments due to low traffic volumes (1,600 AADT in 2015) and slower speeds due to the curvy road and steep climb. Weekend ski traffic results in pulses of high traffic volume during peak travel times. Regardless, even low WVC rates may have large consequences to small populations of lynx and bighorn sheep. Arapahoe Basin Ski Area is located at the bottom of the linkage area (~MP 221.5). Recreation activity at the ski area is primarily in the winter months, although the ski area is expanding its summertime activities. Recreation and visitation at the top of the pass occurs year-round.

Preliminary Connectivity Recommendations and Opportunities

There are few opportunities for improving wildlife passage across US 6 through this linkage. Given the mountainous terrain and overall low traffic volume and lower speeds, highway mitigation on this segment would be very costly and offer relatively little benefit.



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US 6, Porcupine

Mileposts: 216.8 – 221.2

Land Ownership: National Forest

Road Type: Two-lane highway with intermittent passing lane

Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
22 [Rank 6 out of 11]	10	1	11

Primary Target Species	Movement Type	Population Value to Species	WVC Rate
Bighorn Sheep	Local movements	Medium	Low
Boreal Toad (USFS sensitive species)	Local and seasonal movements	Very High	Low
Elk	Local, summer movements	High	Low
Lynx	Local, seasonal and dispersal movements	Very High	Low
Secondary Target Species			
Black Bear	Local and seasonal movements	Medium	Low
Moose	Seasonal movements	Medium	Low
Mule Deer	Local, summer movements	Low	Low

This segment of US 6 parallels the North Fork of the Snake River between Arapahoe Basin Ski Area to Keystone Ski Resort. Continuous spruce-fir and mixed conifer forest extends throughout the linkage. Riparian shrub habitat is present in the valley bottom along the river. This linkage is a USFS designated lynx linkage and is considered a very high value linkage for maintaining lynx populations through this part of the state. Specifically, the linkage over US 6 represents a pinch point for dispersing lynx moving north/south between the two ski areas. An empirical-based model developed by Baigas et al. (2017) found a very high probability of lynx crossing through much of this segment (MP 215-220).

Resident elk and deer are common in this linkage, primarily during the summer. Across all species, WVC rates are low, but even low WVC rates may have large consequences for boreal toad and lynx populations.

Preliminary Connectivity Recommendations and Opportunities

Conservation Actions:

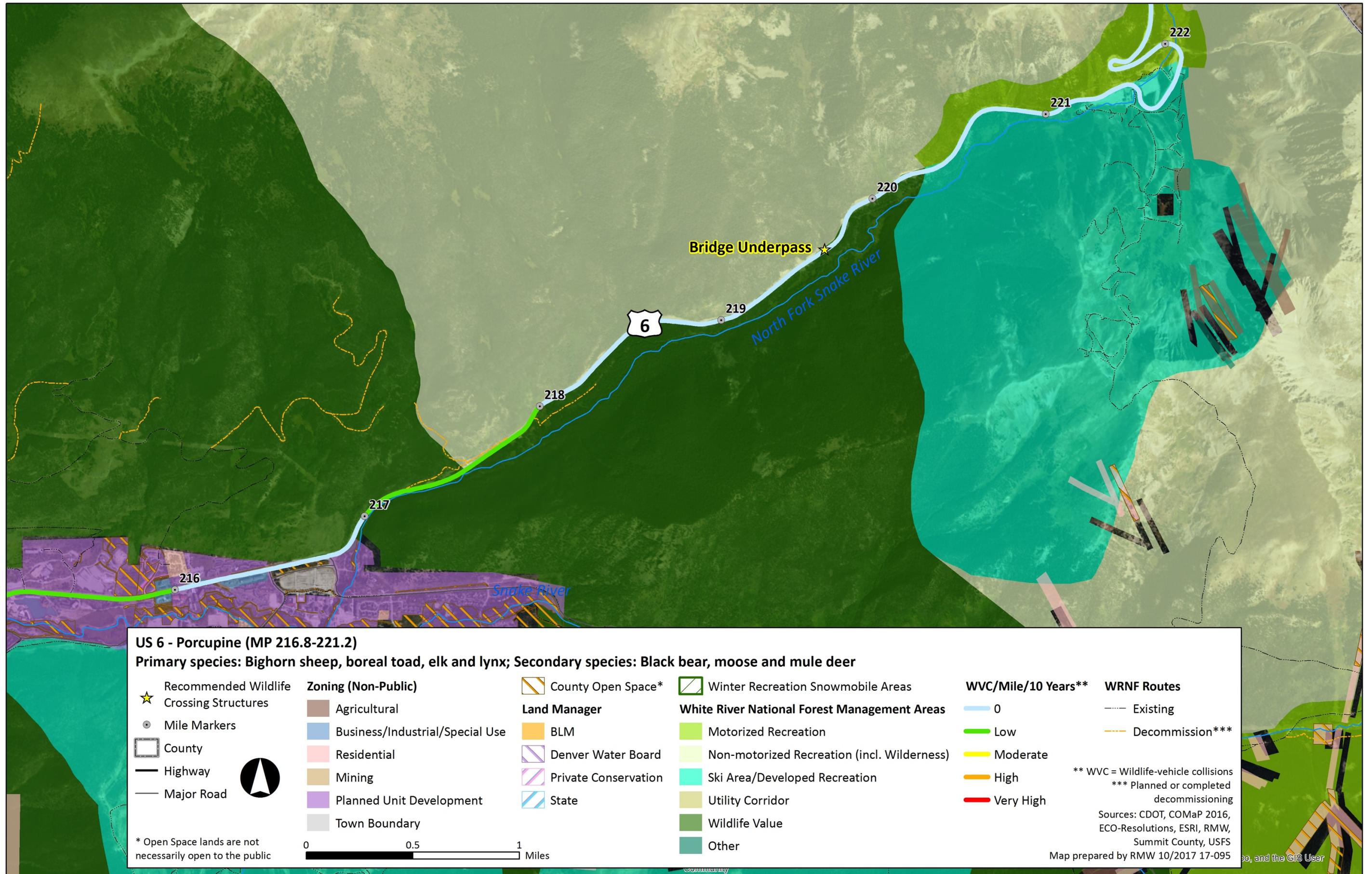
- Manage the habitat and recreation activity in this linkage in a manner that is compatible with wildlife use and movement over the long term. In particular, prohibit camping in the linkage area (including enforcement of illegal camping in or near highway pullouts), and limit dispersed recreation access and activity.
- Manage forest resources to maintain or improve forest cover and structural complexity.
- Work with Arapahoe Basin Ski Area to increase carpooling and shuttling to reduce increases in traffic volume. Currently, a temporary permit has been issued to allow the

pullouts along this segment of US 6 to be used for ski area parking, from which visitors are shuttled to the ski area. Future parking should be concentrated to prevent dispersed impacts throughout the linkage.

Highway Mitigation:

- The Porcupine linkage was ranked a #3 statewide priority for the lynx in-lieu fee mitigation fund based on an expert review process led by CDOT and involving CPW and USFS. This prioritization does not guarantee available mitigation funds; however, as these funds become available, they may be directed towards the highest priority areas in the state.
- Wildlife underpasses must be passable by lynx during the winter months; structure designs will need to ensure that the structure entrances do not become obscured by accumulating or plowed snow. In addition, heavy snow packs in this linkage area will render the effective height of any wildlife fencing shorter.
- Given the high value of connectivity through this linkage and the challenges to constructing wildlife crossing structures here, alternative mitigation measures to wildlife crossing structures may be considered for this linkage. However, mitigation measures such as an animal detection system must be able to reliably detect wildlife such as lynx even in heavy snowpack conditions.
- Much of the bighorn sheep crossing activity occurs immediately west of Arapahoe Basin. Target bighorn sheep crossing signage may be warranted here to warn drivers of the possibility of sheep on the roadway.
- Site-specific highway mitigation recommendations are detailed in the table below.

Milepost	Site Description	Recommendations
217-218	High priority segment for wildlife crossing	No specific wildlife crossing structures are recommended at this time, however this segment remains a high priority, and may require highway mitigation in the future if traffic volumes or other impacts begin to inhibit wildlife movements.
219.6	Small drainage (very small fill on north side; high fill on south side).	Install a low, wide bridge under the highway suitable for elk and other wildlife. <div data-bbox="813 1331 1377 1709" data-label="Image"> </div> <p data-bbox="764 1713 1393 1780"><i>Figure 33 – Looking north from proposed bridge underpass location.</i></p>



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US 6, Soda Ridge

Mileposts: 213.6 – 214.6

Land Ownership: Private, public (National Forest, Denver Water Board)

Road Type: Four-lane highway

Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
18 [Rank 10 out of 11]	6	3	9

Primary Target Species	Movement Type	Population Value to Species	WVC Rate
Elk	Winter range, migration	Very High	High
Mule Deer	Winter range, migration	High	Medium
Secondary Target Species			
Black Bear	Local movements	Medium	Medium
Moose	Summer seasonal	Low	Low

The Soda Ridge linkage is a high use pinch-point primarily for wintering elk, as well as deer, with limited use by moose and black bear. Much of this migration has already been lost, although smaller migratory groups and resident animals remain. While this connection continues to be important for the elk and deer herds that remain, it is of less value at the population level from a game management perspective.

The linkage area is composed of multiple habitat types (riparian, sagebrush, conifer and aspen forest) and multiple land uses (residential, recreational, and industrial). The River Course Golf Course is immediately south of US 6 through the linkage. Elk and deer are known to winter on the golf course grounds as well as around residences and on the forested hillsides to the south.



Preliminary Connectivity Recommendations and Opportunities

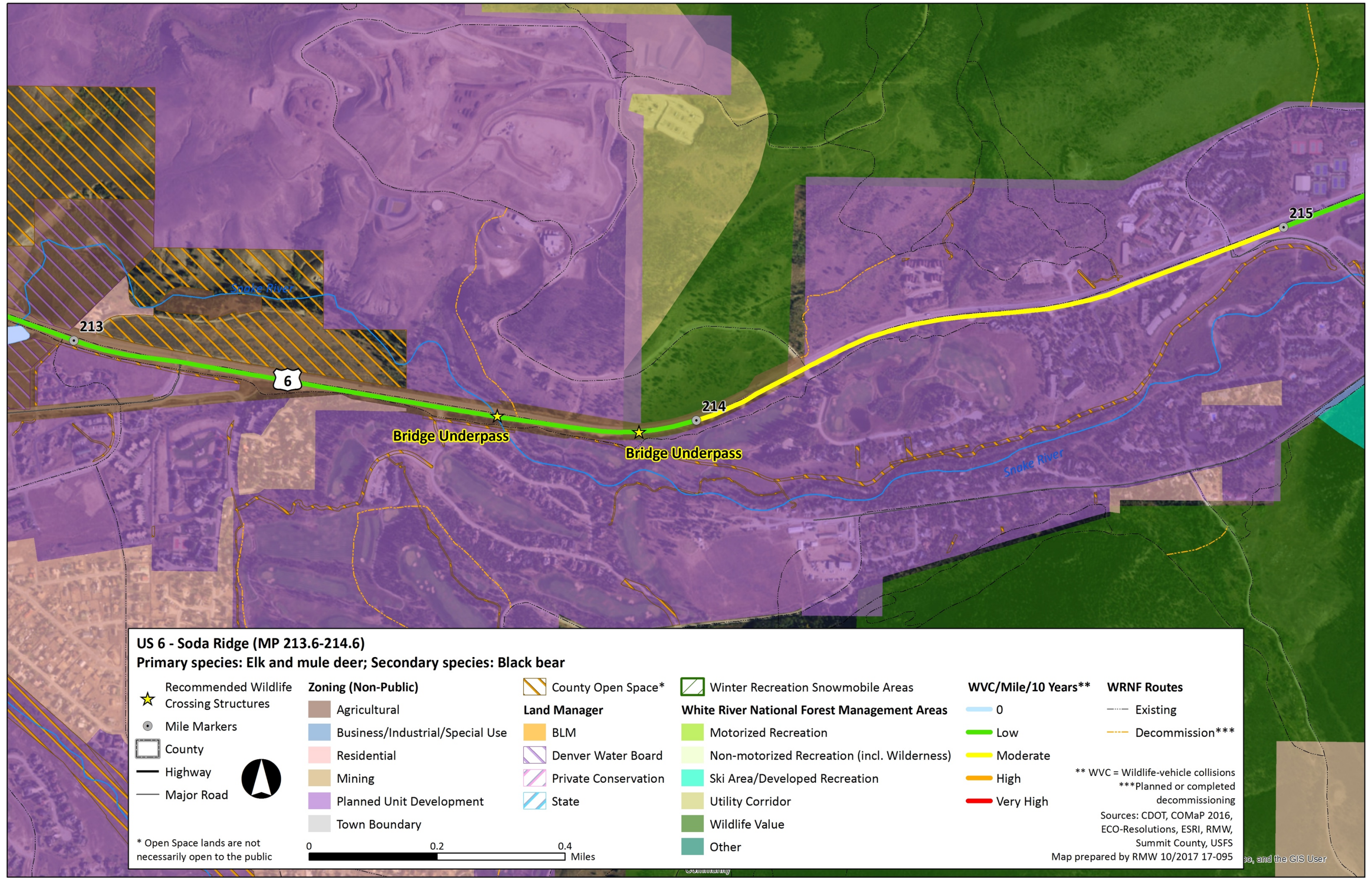
Conservation Actions:

- Retain lands in public ownership in this linkage and manage for wildlife so that future developments do not completely sever the wildlife corridor.

Highway Mitigation:

- Site-specific highway mitigation recommendations are detailed in the table below.

Milepost	Site Description	Recommendations
213.7	Snake River double box culvert. Culvert is long and askew relative to the highway. Bike path bridge is parallel along south side of culvert. Residential, golf course to south.	<p>Replace culvert with wide bridge underpass (at least 14'H) spanning natural riparian banks. Install wildlife exclusion fencing to guide animals to structure.</p>  <p><i>Figure 34 – Existing double box culvert channelizes river and precludes terrestrial wildlife movement.</i></p>
213.9	Forest lands adjacent on north side of road; golf course on south side. This site is the shortest connection between National Forest lands north and south of US 6.	<p>Recommend low and very wide bridge underpass suitable for elk to compensate for long structure length under four traffic lanes (minimum 12-14' H x 80' W).</p>  <p><i>Figure 35 – Looking west, with golf course to south and National Forest to north.</i></p>



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Interstate 70

I-70, Vail Pass

Mileposts: 190 – 194

Land Ownership: National Forest

Road Type: Four-lane interstate

Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
30 [Rank 1 out of 11]	10	4	16

Primary Target Species	Movement Type	Population Value to Species	WVC Rate
Elk	Summer seasonal	High	Medium
Lynx	Local (within population)	High	Low
Secondary Target Species			
Black Bear	Local (within population)	Medium	Medium
Moose	Summer seasonal	Low	Low
Mule Deer	Summer seasonal	Medium	Medium

Interstate 70 (I-70) through this linkage is a divided highway with a wide, natural, open median. West Tenmile Creek descends from the summit of Vail Pass through this median area. Five large open span bridges are present under the eastbound highway lanes (MP 190.9 Wilder Gulch; MP 191.9 Smith Gulch; MP 192.5 Stafford Creek; MP 193.3 Guller Creek; and MP 193.7 West Tenmile Creek). One large span bridge underpass is located under the westbound lanes at MP 191.4 over Corral Creek. However, there are no direct connections through these bridges beneath both the east and westbound lanes of the interstate.

Habitat through this linkage area is characterized as spruce/fir and mixed conifer, with some aspen and riparian components. The linkage area is almost entirely on National Forest land. The habitat is considered high quality and contiguous, although recreation activity is heavy around the top of the pass and along the paved bike path, which winds through the middle of the open median area between the eastbound and westbound lanes. Commercial bike shuttling drops visitors off at the rest area at the top of the pass between 9am-3pm through the summer months.



Figure 36 – Vail Pass linkage from Tenmile Range, looking west.

This linkage area connects high elevation elk and mule deer summer range. CPW identifies separate deer herds on the north and south sides of the interstate. A small breeding population of lynx is established on the south side of I-70 and is known to make regular movements across the interstate (USDA Forest Service, unpublished

data). Movement through the linkage area is very important to the continued success of this population. An empirical-based model developed by Baigas et al. (2017) found a high and very high probability of lynx crossing through this segment. The linkage also encompasses the East Vail Pass Linkage Interference Zone, previously identified as a priority for wildlife movement across the I-70 Mountain Corridor by Kintsch et al (2011). Specifically, MP 192.3 on the westbound lanes of I-70 has been identified as the best location for a wildlife overpass on the I-70 Mountain Corridor (Felsburg Holt & Ullevig and Wildlife Consulting Resources 2013). This location ranked high on multiple factors and is more feasible and less costly to construct because it would only have to cross the westbound lanes of I-70. While this location has received the most attention, multiple crossing structure over or under the westbound lanes are recommended in this linkage to complement the existing bridges under the eastbound lanes and to restore connectivity throughout this linkage.

Traffic flows are consistently high over the pass (22,000 AADT) with higher volumes experienced on weekends and holidays. Traffic volumes at this level present a serious barrier to wildlife movement. Correspondingly, reported WVCs with deer and elk are generally low along this segment of interstate, with the most collisions occurring between MP 192.2-193.8. Deer and elk are most commonly involved in WVC, although incidents involving bear and mountain lion are also reported by CPW. Wildlife regularly pass under the existing span bridges (Singer et al. 2011; SREP 2007), but also frequently cross at-grade.



Preliminary Connectivity Recommendations and Opportunities


Conservation Actions:

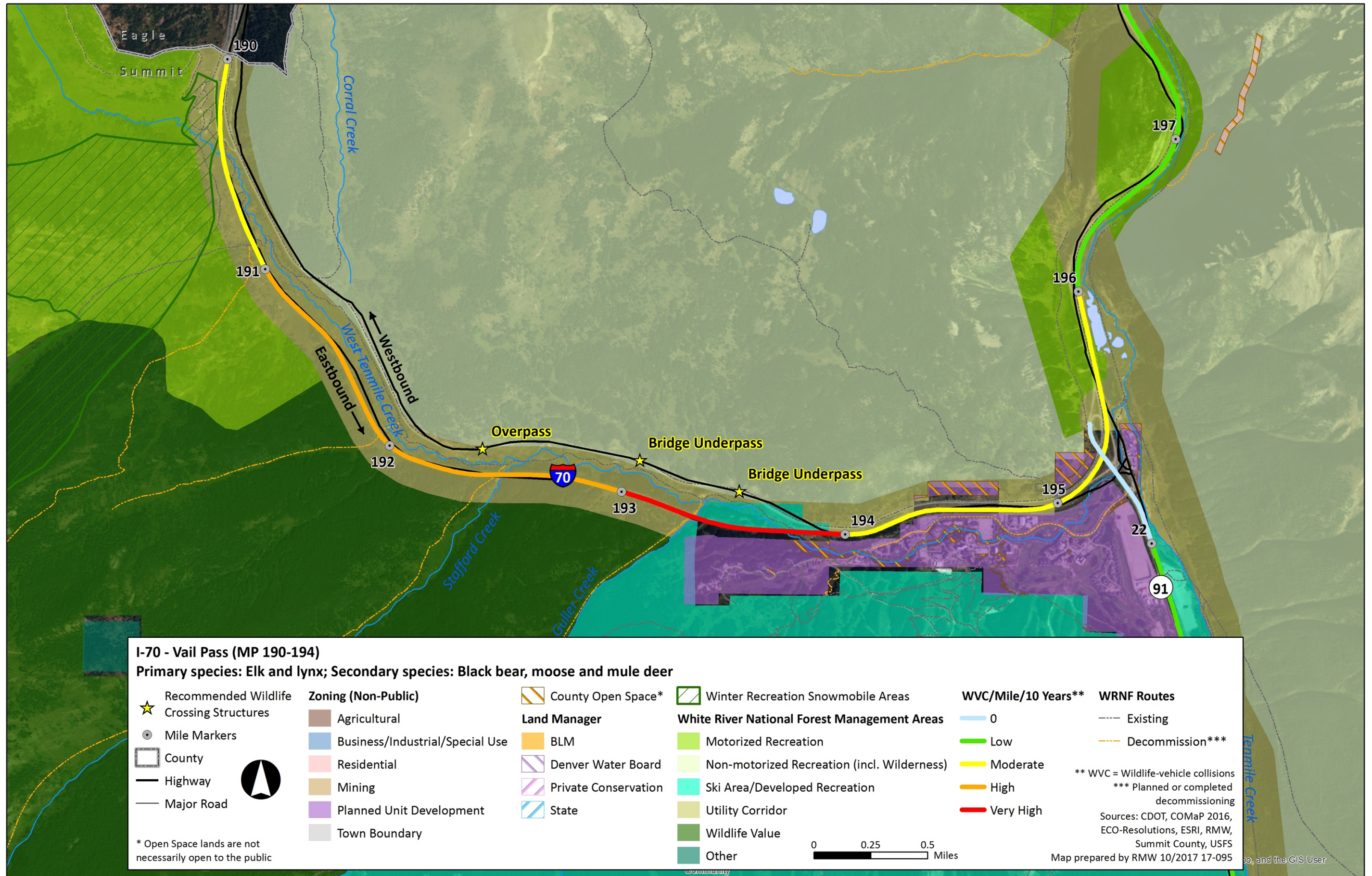
- Coordinate with CPW and the Forest Service to manage human activity (e.g., recreation, hunting) in a manner that is compatible with wildlife activity, particularly where recreation trails pass under the existing bridges.
- Limit winter recreation use and winter grooming/cross-country ski trails west of Copper Mountain Resort to minimize recreation impacts to wildlife.

Highway Mitigation:

- The Vail Pass linkage was ranked a #6 statewide priority for the lynx in-lieu fee mitigation fund based on an expert review process led by CDOT. This prioritization does not guarantee available mitigation funds; however, as these funds become available, they may be directed towards the highest priority areas in the state.
- Connect existing and proposed wildlife crossing structures with wildlife exclusion fencing to help guide wildlife to structures. Because of the wide, open median, wildlife fencing is also needed through the median (i.e., on both sides of the east- and westbound traffic lanes).
- Note, all of the site-specific mitigation recommendations in the table below relate to the westbound (WB) traffic lanes. Crossing structure designs may need to plan for a third traffic lane to accommodate future construction.

Milepost	Site Description	Recommendations
192.3 (WB)	<p>Low gradient, open area opposite Stafford Creek bridge under eastbound lanes. This site was determined to be the best location on I-70 for a wildlife overpass (Felsburg Holt & Ullevig and Wildlife Consulting Resources 2013).</p>	<p>Location of proposed Vail Pass Wildlife Overpass. A large bridge underpass may also be feasible.</p>  <p><i>Figure 37 – Proposed overpass location</i></p>
193.0 (WB)	<p>Natural draw, forested. Small bench above West Tenmile Creek on median side. Location is opposite the mineral lick on the south side of the eastbound lanes. Good elk habitat on both sides of the highway.</p>	<p>Construct bridge under westbound lanes suitable for elk and other target species (at least 14'H x 44'W – possibly larger to accommodate winter snow depths). Structure should be situated to connect from the bench on the south side to the forested area on the north side.</p>  <p><i>Figure 38 – Looking west towards proposed bridge location.</i></p>

<p>193.5 (WB)</p>	<p>Small drainage under WB lanes (pipe culvert), opposite span bridge under EB lanes. High WVC segment (within this linkage). Good elk habitat. Summer and winter recreation activities occur under eastbound bridge at Stafford Creek.</p>	<p>Construct bridge under westbound lanes suitable for elk and other target species (at least 14'H x 44'W – possibly larger to accommodate winter snow depths). To avoid situating a bridge at a curve, where there may be a greater likelihood of road icing and accidents, the bridge should extend from the west end of the curve, where the road begins to straighten; this would offset the structure from the drainage itself, and terrestrial wildlife would be guided to the crossing by fencing.</p>  <p><i>Figure 39</i> – Looking west towards proposed bridge location.</p>
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I-70, Officer’s Gulch

Mileposts: 195.3 – 201

Land Ownership: National Forest, Private

Road Type: Four-lane interstate

Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
19 [Rank 9 out of 11]	9	1	9

Target Species	Movement Type	Population Value to Species	WVC Rate
Bighorn Sheep	Dispersal	Medium	Low
Lynx	Dispersal	Medium	Low
Moose	Summer seasonal	Low	Low
Mule Deer	Summer seasonal	Low	Low

The Officer’s Gulch linkage connects the Gore Range to the north with the Tenmile Range to the south. The terrain on either side of the interstate is steep and rocky. This area was identified as having a high value for dispersing bighorn sheep, lynx and mountain goats, as well as deer. An empirical-based model developed by Baigas et al. (2017) found a high and very high probability of lynx crossing through much of this segment and lynx have recently been observed in this location near the interstate (pers. comm. Ashley Nettles). Wildlife-vehicle collisions are generally low throughout the linkage; however, collisions with moose and bighorn sheep have been reported.

Tenmile Creek parallels the interstate through the linkage. A paved bike path also parallels the interstate on the south side of the creek. The only existing structure in this linkage is a bridge at a highway interchange (MP 198). This structure is not suitable for wildlife passage and is not recommended for a retrofit due to its primary use as an interchange and heavy recreation use around the small lake directly adjacent on the north side.


Preliminary Connectivity Recommendations and Opportunities

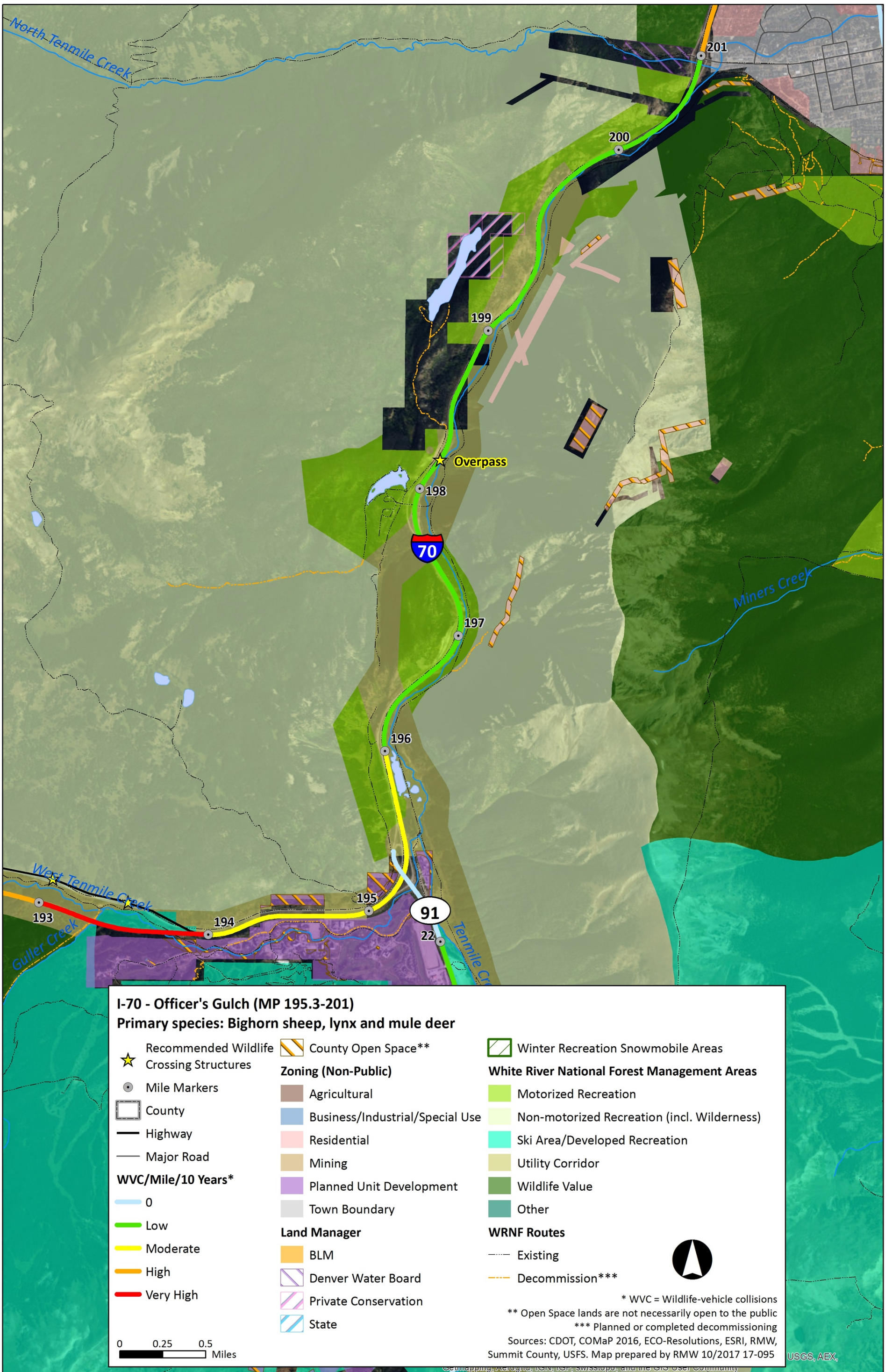
Conservation Actions:

- Limit recreation activities to day use (no overnight camping).
- Maintain forested cover for lynx to use when making dispersal movement through this area.

Highway Mitigation:

- Site-specific highway mitigation recommendations are detailed in the table below.

Milepost	Site Description	Recommendations
198.2	East of Officer's Gulch exit. National Forest on both sides of interstate.	<p>Perhaps the only possible location for a dedicated wildlife crossing structure in this linkage. Recommended structure is an overpass connecting cut slopes on the north side to a flat area on the south side.</p>  <p><i>Figure 40</i> – Looking east from access road towards proposed overpass location.</p>



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I-70, Laskey Gulch

Mileposts: 207.6 – 210

Land Ownership: National Forest, private and Denver Water Board at west extent of linkage.

Road Type: Six-lane interstate

Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
26 [Rank 2 out of 11]	9	4	13

Primary Target Species	Movement Type	Population Value to Species	WVC Rate
Elk	Local, winter range and seasonal migration	Medium	High
Lynx	Dispersal	High	Low
Mule Deer	Local and seasonal migration	Medium	High
Secondary Target Species			
Black Bear	Local movements	Medium	Medium
Moose	Local, summer range	Medium	Medium

The interstate parallels the Straight Creek drainage and crosses smaller drainages feeding into Straight Creek from the north. The south side of the interstate is a steep, continuous fill slope through this segment. The linkage is composed primarily of spruce-fir forest, which has been extensively impacted by spruce beetle kill. This landscape linkage extends to the south over Tenderfoot Mountain and Loveland Pass, also crossing over US 6.

The linkage provides a dispersal corridor for lynx and other carnivores, as well as seasonal habitat for ungulates, including elk, moose and mule deer. An empirical-based model developed by Baigas et al. (2017) found a very high probability of lynx crossing through this segment. Breeding ponds for boreal toad are present in the Straight Creek drainage, on the south side of I-70; however, no known movements by toads have occurred across I-70. The highway infrastructure (six traffic lanes with a concrete median barrier) and heavy traffic volumes are a major threat to movement through the linkage. Traffic volume in 2015 was 32,000 AADT and is projected to increase to 41,200 by 2040. Wildlife-vehicle collisions are generally moderate to high. Collisions with moose may be increasing, with two moose-vehicle collisions reported from 2012-2015. Hunters and backcountry recreationists are common in Laskey Gulch, although their numbers are low.

Preliminary Connectivity Recommendations and Opportunities

Conservation Actions:



- Increase and enhance forested habitat restoration in area heavily impacted by beetle kill.

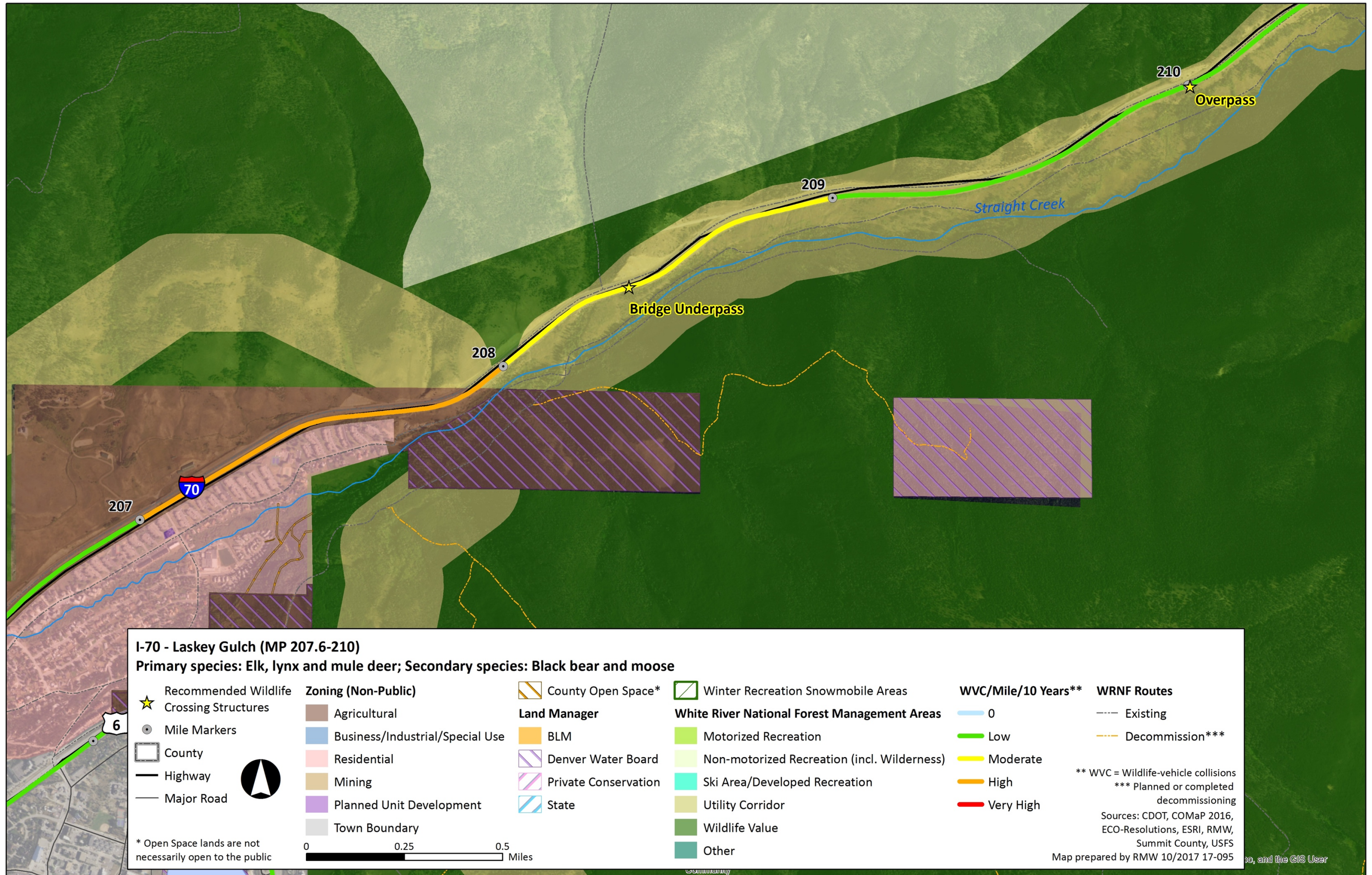
Highway Mitigation:

- The Laskey Gulch Linkage (along with Herman Gulch) was ranked a #4 statewide priority for the lynx in-lieu fee mitigation fund based on an expert review process led by CDOT and involving CPW and USFS. This prioritization does not guarantee available

mitigation funds; however, as these funds become available, they may be directed towards the highest priority areas in the state.

- Highway mitigation in this linkage will be very costly and challenging: wildlife crossings must span six traffic lanes; construction detours and delays are particularly difficult on interstate highway; and steep, mountainous terrain offers few feasible crossing structure locations. Opportunities for site-specific highway mitigation recommendations are listed in the table below.

Milepost	Site Description	Recommendations
208.4	Laskey Gulch. Drainage bisected by a large fill slope supporting the interstate. Steep fill slope on the south side drops onto a flat bench.	<p>Remove fill and construct a large divided bridge underpass to accommodate elk, lynx and other wildlife. Restore the natural hydrologic flow regime under the interstate. Install wildlife exclusion fencing to guide animals to the structure.</p>  <p><i>Figure 41 – North side fill slope, looking east.</i></p>
210	Potential location for wildlife overpass.	 <p><i>Figure 42 – Potential overpass location connecting uphill slope on north side of I-70 to a bench on the south side.</i></p>



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I-70, Hamilton Gulch

Mileposts: 211.6 – 213

Land Ownership: National Forest

Road Type: Six-lane interstate

Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
25 [Rank 3 out of 11]	10	3	12

Primary Target Species	Movement Type	Population Value to Species	WVC Rate
Boreal Toad (USFS sensitive species)	Local, seasonal movements	Very High	Low
Lynx	Dispersal movements	High	Low
Secondary Target Species			
Black Bear	Summer, local movements	Medium	Low
Elk	Summer, local movements	Medium	Medium
Moose	Dispersal movements	Medium	Medium
Mule Deer	Summer, local movements	Medium	Medium

The interstate parallels the Straight Creek drainage and crosses smaller drainages feeding into Straight Creek from the north. The linkage is characterized by high cut slopes, sharp narrow drainages, and a steep continuous fill slope on the south side of the interstate. Habitat in the linkage is primarily spruce-fir forest, which has been extensively impacted by spruce beetle kill. The linkage provides a dispersal corridor for lynx and seasonal habitat for ungulates, including elk, moose and mule deer. Other carnivores and mountain goats are also likely to use this linkage. Of note, CPW wishes to maintain instream barriers to fish movement between Hamilton Gulch and Straight Creek.

The highway infrastructure (six traffic lanes with a concrete median barrier and a runaway truck ramp) and heavy traffic volumes are a major threat to movement through the linkage. Traffic volume in 2015 was 32,000 AADT and is projected to increase to 41,200 by 2040.

Preliminary Connectivity Recommendations and Opportunities



Conservation Actions:

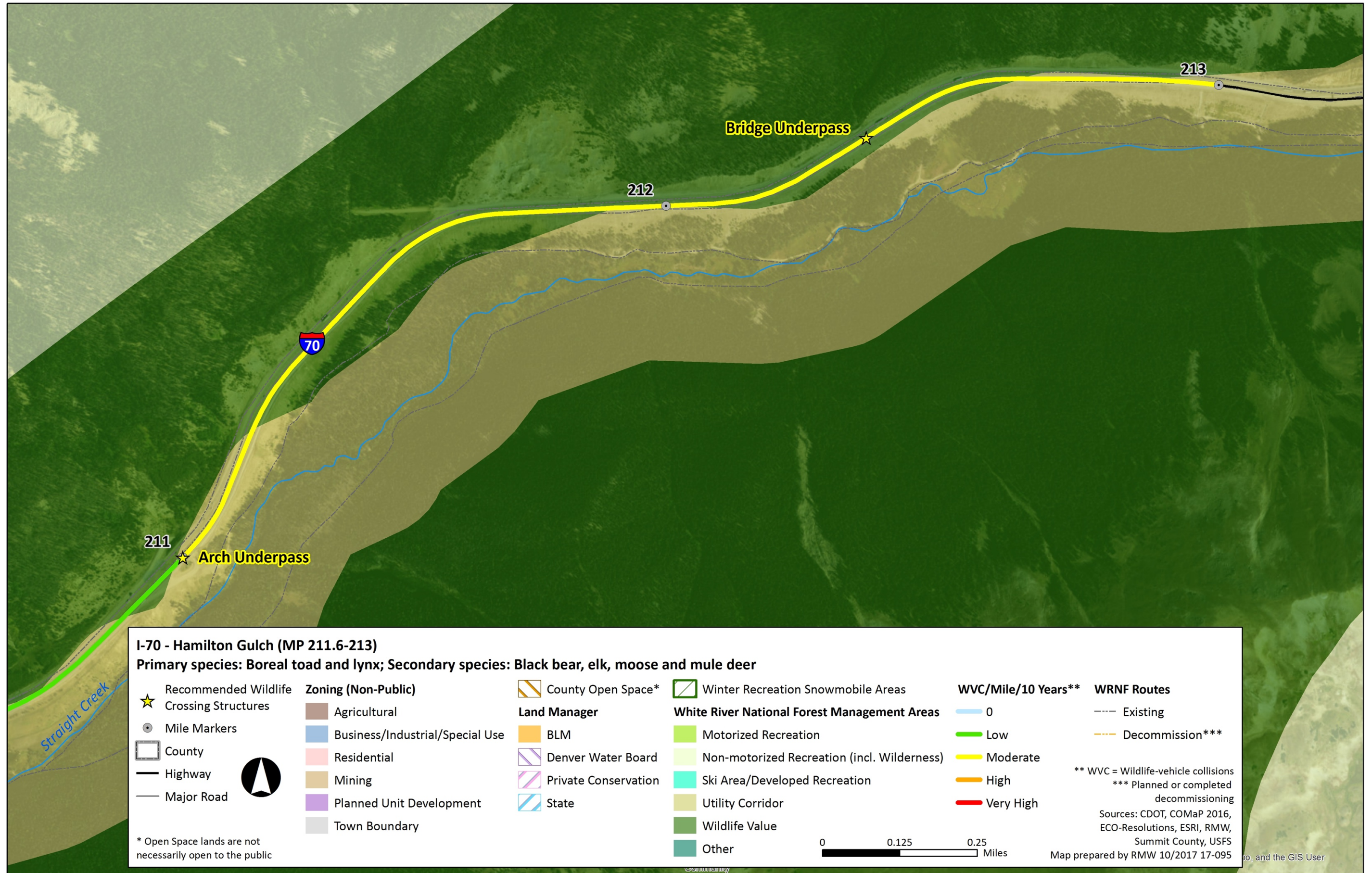
- Continue implementing BMPs to reduce sediment loading into Straight Creek, which may impacts boreal toad and other wildlife habitat in the Straight Creek drainage.

Highway Mitigation:

- The Hamilton Gulch Linkage (along with Laskey Gulch) was ranked a #4 statewide priority for the lynx in-lieu fee mitigation fund based on an expert review process led by CDOT and involving CPW and USFS. This prioritization does not guarantee available mitigation funds; however, as these funds become available, they may be directed towards the highest priority areas in the state.
- Highway mitigation in this linkage will be very costly and challenging: wildlife crossings must span six traffic lanes; construction detours and delays are particularly difficult on

interstate highway; and steep, mountainous terrain offers few feasible crossing structure locations. Opportunities for site-specific highway mitigation recommendations are listed in the table below.

Milepost	Site Description	Recommendations
211.7	Hamilton Gulch. Steep narrow drainage bisected by I-70 and runaway truck ramp.	No recommended mitigation at this location.
212.4	Steep, narrow drainage bisected by I-70.	<p>Recommend bridge underpass suitable for lynx and elk; however, the necessary structure length and grade at this location will make designing a suitable structure very challenging.</p>  <p><i>Figure 43 – Fill slope under I-70 at drainage.</i></p>
211.0	CDOT service road box culvert. The existing box culvert was built in 1966 and may need to be replaced. This location is outside of the linkage area, but may offer an opportunity to improve wildlife passage under I-70. It is unknown whether wildlife are currently using the structure to cross under I-70	<p>This culvert has a structure sufficiency rating of 55, indicating that a replacement structure may be needed. Given the challenges associated with constructing wildlife crossing structures along this segment of I-70, every opportunity to improve wildlife passage should be maximized. Recommend incorporating wildlife considerations when replacing this culvert, i.e., replace with a wider box or arch culvert.</p>  <p><i>Figure 44 – Service road culvert, looking south.</i></p>



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I-70, Land Bridge

Mileposts: 213.6-215.3

Land Ownership: National Forest

Road Type: Four-lane interstate

Overall Priority Score	Wildlife Score (Max = 10)	Safety Score (Max = 5)	Opportunity Score (Max = 20)
23 [Rank 5 out of 11]	5	0	18

Primary Target Species	Movement Type	Population Value to Species	WVC Rate
Bighorn Sheep	Dispersal, seasonal movements	High	n/a
Secondary Target Species			
Elk	Dispersal movements	Medium	n/a
Mule Deer	Dispersal movements	Medium	n/a

The land bridge over the Eisenhower-Johnson Tunnels is a mile-long natural connection across I-70. Habitat on the land bridge is high elevation alpine tundra. Loveland Ski Area, located on the east side of the tunnels, has lifts and ski runs on the land bridge, extending up to the Continental Divide.

The land bridge provides an important connection for bighorn sheep. Elk, mule deer and mountain goats also make use of this natural corridor. This linkage scored the highest opportunity score of all of the Summit County linkages because it provides an existing natural connection and no further highway mitigation is needed to maintain it.

Preliminary Connectivity Recommendations and Opportunities

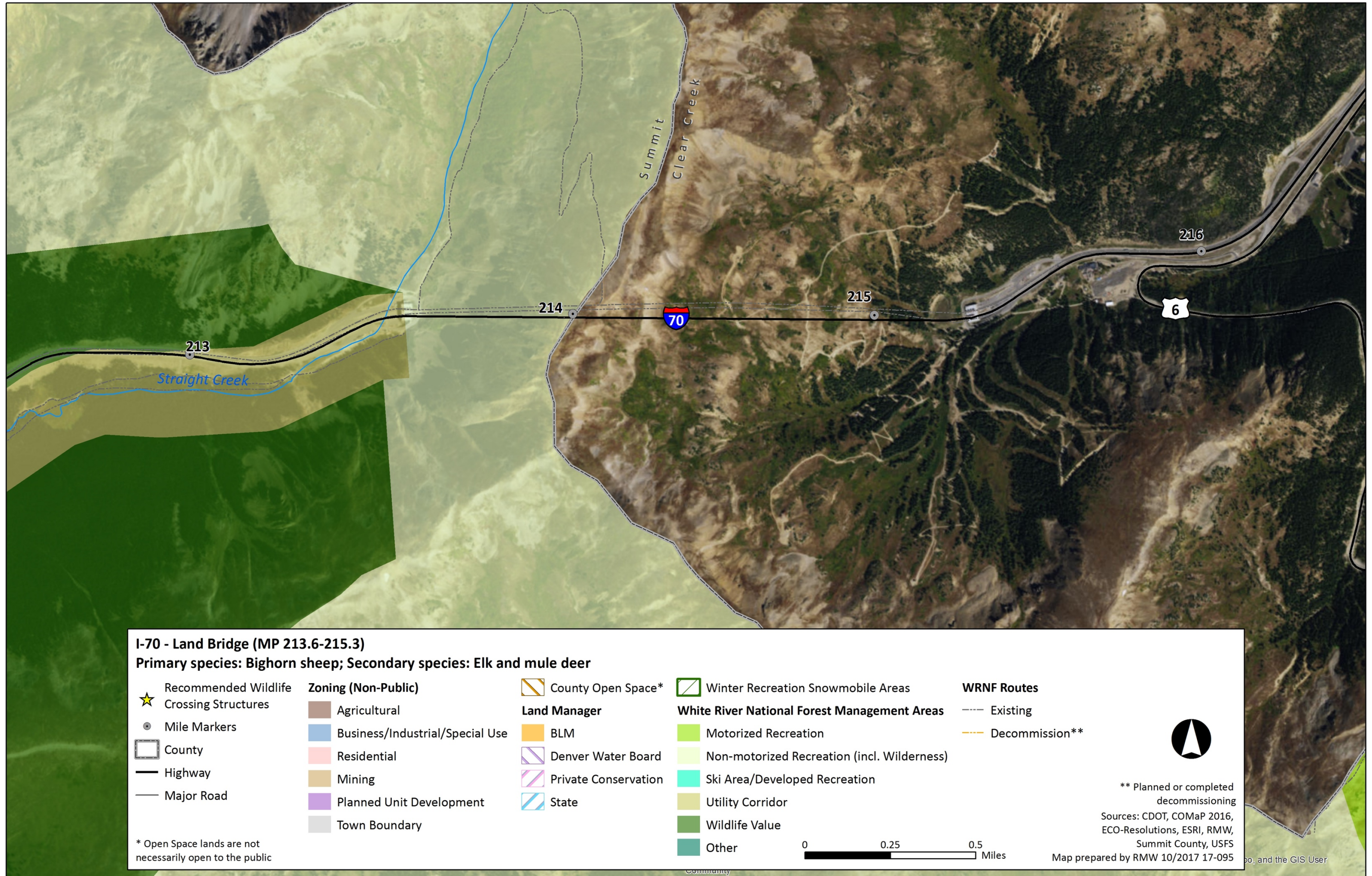
Conservation Actions:

- Manage for continued wildlife use and direct new trail proposals and uses outside of the linkage area.

Highway Mitigation:

- Not applicable.

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Implementation

A key component of the Summit County Safe Passages for Wildlife Plan is to build on the momentum generated by the development of this plan and the partnerships that are forming. Implementing the highest priority recommendations identified in this plan will require raising funds for the design and environmental review process through the construction phase. On August 9, 2017 the stakeholder group held a meeting to discuss how to implement this plan, where to focus efforts initially, how each partner can contribute, and to develop some preliminary fundraising ideas. The outcomes of that discussion are presented here.

The first task for the stakeholder group was to determine where to focus initial implementation efforts. Using the prioritization matrix and resulting priority ranks developed earlier in this planning process as a guide, the group decided on three linkage areas that present the greatest need for wildlife and safety, and offer the best opportunities and partnerships for pursuing funding to construct wildlife crossing structures. It was determined that working in several linkages simultaneously was preferable to putting all the effort into just one linkage. In the interest of pursuing the most feasible linkages first, both Laskey Gulch and Hamilton Gulch were deemed unsuitable for these initial efforts due to challenging terrain and a wide highway footprint. Other considerations the group discussed included, linkages where mitigation would bring the greatest improvements to the traveling public; the role of partners in each linkage landscape; land use and terrain considerations that influence the feasibility of a wildlife crossing structure; alignment with other priorities or projects; fundraising opportunities; relative cost; visibility to the public; existing infrastructure; and existing community support. Ultimately, the group identified I-70 Vail Pass, SH 9 Lower Blue River, and SH 9 Upper Blue River as the three areas in which to initially focus efforts to implement wildlife crossings. These may change as circumstances change.

In addition, the stakeholder group identified several smaller scale and lower cost mitigation actions as immediate and feasible. These actions are listed in Table 3. In addition, where existing culverts are bridges are to be replaced within any of the linkage areas, these locations should be targeted for wildlife accommodations.

Table 3. Low cost mitigation actions recommended in near term outside of priority linkage focus areas.

Linkage Name	Location	Mitigation Action	Partner Roles & Potential Funding Sources
Land Bridge	I-70	Protect wildlife values on the only habitat connection over the I-70 Mountain Corridor; Restrict new trail development.	Forest Service, CPW and USFWS
Loveland Pass	US 6	Install bighorn sheep warning signs.	CDOT, Arapahoe Basin
Frisco-Silverthorne	I-70	Install wildlife barrier fence along I-70 from Silverthorne to Frisco Main Street Exit to reduce WVCs. This segment does not have a connectivity value for wildlife due to its adjacency to the Town of Frisco.	CDOT FASTER/Safety funds

Next Steps

The stakeholder group identified the following next steps for implementing the priorities outlined in this plan, specifically organizing a local steering committee to continue to coordinate efforts across the county, and individual linkage teams to develop and pursue fundraising and implementation action plans in each of the three priority linkage areas (Fig 45). Each of these teams will be composed of partners that have been participating in the development of the Summit County Safe Passages for Wildlife Plan or new partners, as appropriate, that can assist in promoting, fundraising and implementing the top priorities identified in this plan.

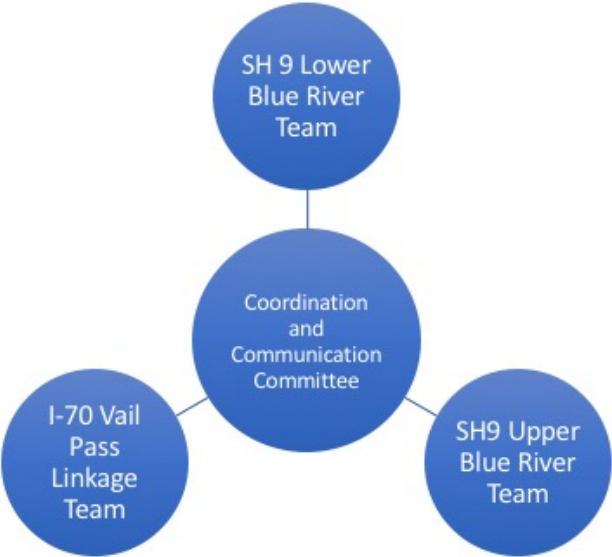


Figure 45. Relationships among committees working together towards implementation of the Summit County Safe Passages for Wildlife Plan.

Convene a Safe Passages Communication and Coordination Committee

The stakeholder group agreed on the need for a local steering committee to continue to oversee and coordinate implementation efforts across the county. The steering committee would consist of select members of the current stakeholder/partner group who would build on the momentum created via the development of the Summit County Safe Passages Plan. It is anticipated that Ashley Nettles, who as acted as the project lead and Forest Service coordinator for this plan would continue in this role to organize both the steering committee and the individual linkage teams, discussed below. A follow-up meeting will be scheduled this fall (Oct 2017) to convene the Summit County Safe Passages Committee, confirm funding and support for the committee and linkage teams to operate, and develop a detailed action plan.

In addition to supporting and coordinating efforts among the linkage teams, next steps for the steering committee may include:

- Coordinate efforts with the Wildlife and Transportation Steering Committee that formed as a result of the CDOT and CPW sponsored Wildlife and Transportation Summit held in

July 2017 in Silverthorne to establish partnerships and share ideas and expertise around improving highway safety and protecting wildlife populations and movement corridors.

- Coordinate with CDOT and CPW on the West Slope Wildlife Prioritization Study.
- Support Summit County with integrating information and recommendations from the Safe Passages for Wildlife Plan into the upcoming county master plan and basin plan updates.
- Coordinate with Summit County on land use policy and regulations that support the goals of the Safe Passages Plan.
- Present the Safe Passages Plan and next steps to the Transportation Environmental Resource Council (TERC) and the Intermountain Transportation Planning Region.
- Communicate with county commissioners and mayors on the progress of the Summit County Safe Passages Plan.

This represents a partial list; additional items will be identified as the steering committee develops its strategy and timeline.

Convene Linkage Sub-Committees in Three Priority Areas: I-70 Vail Pass, SH 9 Upper Blue River, and SH 9 Lower Blue River

Individual teams will convene for each of the three priority areas to focus on specific funding and implementation strategies for that linkage. Each team will convene this fall (Oct 2017) to begin developing detailed action and fundraising plans.

Next steps for the linkage teams may include:

- Develop an action plan and strategy detailing which wildlife crossings recommendations listed in this plan (see Recommendations Section) will be pursued first. Multiple crossing structure connected with wildlife fencing may be needed to achieve connectivity goals in each wildlife linkage area. Each linkage strategy should specify how many crossing structures are needed and the intervals between crossing structures.
- Identify non-structural mitigation needs to complement wildlife crossings and fencing, such as dynamic signage or vegetation treatments, where appropriate.
- Coordinate with CDOT to create cross-sections for each wildlife crossing structure identified in the action plan and develop cost estimates.
- Coordinate with CDOT to calculate the benefit-cost for each linkage area based on a revised formula currently under development as a part of the West Slope Wildlife Prioritization Study.
- For each linkage area, integrate the priority linkage recommendations with other priorities, such as CDOT's lynx in-lieu fee program, the Lower Blue River master plan update, and Forest Service lynx linkage areas.
- Identify additional partners to engage and potential funding sources and develop a funding action plan.
- Share the action plan for the linkage area with CDOT and identify potential opportunities to integrate wildlife mitigation into upcoming projects.
- Develop detailed community outreach plans.

This represents a partial list; additional items will be identified as the sub-committees develop detailed strategies and timelines.

Partner Roles

Participants at the final stakeholder meeting for the development of the Summit County Safe Passages Plan were asked to share what they foresee as their individual/organization’s role as the group works towards the funding, design and construction of wildlife crossing structures. These roles are summarized in Table 4, and may be amended as appropriate or as new partners become engaged.

Table 4. Potential partner roles for implementing wildlife crossing structure recommendations.

Agency or Organization	Representatives	Role
USDA Forest Service	Rick Truex, Natasha Goedert, Bill Jackson, Ashley Nettles, other WRNF staff	Champion wildlife connectivity at regional and national levels; Tie wildlife connectivity objectives into the bigger picture of the Forest Service’s mission and priorities (e.g., landscape resilience); Support staff to work on wildlife connectivity at district level; Engage community partners; Manage habitat for wildlife movement in wildlife corridors.
CDOT	Grant Anderson, Catherine Ventling, Cinnamon Levi-Flinn, Jeff Peterson, Tracy Trulove	Fund and construct wildlife crossings; Align wildlife crossing priorities with safety needs; Identify partnership programs as potential funding sources; Integrate wildlife crossings mitigation and best management practices into upcoming projects; Conduct scoping and coordinate with project engineers
CPW Commission	Michelle Zimmerman	Funding support for wildlife crossings (e.g., the Commission voted on 8/11/17 to use \$1 million of Habitat Stamp funds for wildlife crossings in 2018); Champion wildlife connectivity in guidance to agency.
CPW Staff	Elissa Slezak, Tom Davies, Michelle Cowardin, Kirk Oldham	Wildlife management and coordination with landowners; Wildlife movement research; WVC data not captured in accident reports; Coordinate with local landowners; Share lessons learned about partnerships, design, construction and maintenance.
US Fish and Wildlife Service	Alison Michael, Allison Jehly	ESA Section 7 consultation and possible ESA funding.
Summit County	Jim Curnutte, Kate Berg, Don Reimer	Integrate Safe Passages Plan (data, maps, recommendations) into upcoming master plan update and basin plans, as well as land use policy and regulations, and best management practices; Coordinate open space acquisitions or easements with wildlife connectivity objectives.
Town of Breckenridge	Anne Murphy, Chapin LaChance	Funding and community support for projects local to Breckenridge; Coordinate open space acquisitions or easements with wildlife connectivity objectives.

Friends of the Lower Blue River	Jim Donlon, John Longhill	Champion this Safe Passages Plan to homeowners in the Lower Blue River; Engage in the Lower Blue River Sub-Committee to implement wildlife crossings in this landscape; Assist with fundraising and coordination with private landowners.
National Forest Foundation	Rebecca Davidson, Emily Olson	Manage remaining funds from SH 9 realignment and Vail Resorts lynx mitigation for priority habitat improvement projects on the Dillon Ranger District; coordination and technical expertise to support implementation of this plan.
Ski Resorts	Rick Cables, Gary Shimanowitz, Jeff Zimmerman, Patrick O’Sullivan, Alan Henceroth, Copper Mountain representative	Funding and support for wildlife crossings.
Insurance Companies	-	Invite Carole Walker, Rocky Mountain Insurance Information Association and Insurance Companies to engage in wildlife crossings implementation.

Transportation Project Development

Mike Vanderhoof, now former CDOT Region 3 Planning and Environmental Manager, gave a presentation to the stakeholder group on the processes involved in developing and funding a highway project, including wildlife crossing structures. Figure 46 depicts the project development process CDOT must undertake for every transportation project. The planning phase includes a preliminary assessment of need and conceptual planning (e.g., this study), coordination, and, to launch the design phase, initial funding. For projects with funding partners, at the outset of a project, CDOT and other government agencies (e.g., local jurisdictions or land management agencies) must sign an intergovernmental agreement outlining the funding partnership. The design phase then commences with land surveys and right of way (ROW) mapping, as well as scoping and the establishment of project need; the environmental review process, as required by the National Environmental Policy Act (NEPA); and engineering design, including Field Inspection Review (FIR, 30% design) and Final Office Review (FOR, 80-90% design). The design phase also includes ROW acquisition, which must be purchased at fair market value, and the development of Plans, Specifications and Estimates (PS&E) for construction contracts. Provided funding is available, the project then proceeds to construction. Upon completion, all projects require ongoing maintenance for the life of the infrastructure.

Motorist safety is a primary concern for CDOT and projects that substantially reduce the risk of WVCs will receive a higher priority from CDOT. However, partners can influence project priorities, for example for wildlife crossing structures, by bringing funding to the table that leverages CDOT and the transportation commission. This was the case for the wildlife crossings project on SH 9 in Grand County, where roughly 20% of the \$50 million project was raised by sources outside of CDOT, thereby qualifying the project for a partnership funding program.

Transportation Project Development Process

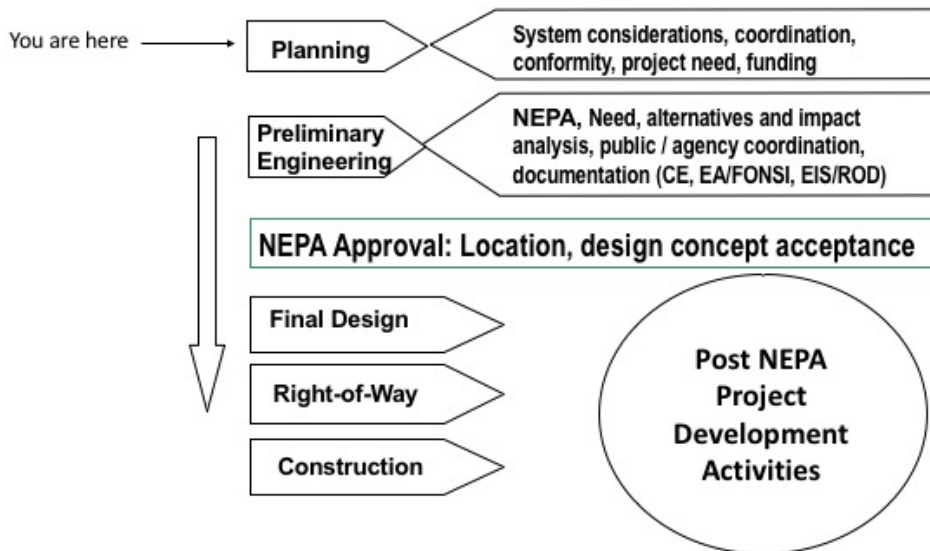


Figure 46. CDOT transportation project development process. The Summit County Safe Passages for Wildlife Plan and the recommendation herein represent an initial phase of planning.

Funding Ideas for Design and Construction

Usually the greatest constraint on building wildlife crossings and other mitigation measures to benefit wildlife is funding. Since wildlife crossings can cost over \$300,000 – sometimes millions of dollars apiece – and multiple crossing structures are often recommended along a given highway segment, cost becomes the limiting factor. The usual funding is from highway projects, but state Departments of Transportation have many priorities and there may not be adequate funding to include the necessary wildlife crossings. Hopefully, using innovative funding approaches will result in more projects being built and implemented. Additionally, this approach can be used by other states and communities to increase funding for their priority wildlife projects. Some of these funding sources and options are traditional, but many have not been tried or implemented. A list of potential funding sources is presented in Table 5. This is not a complete list; nor are all funding sources appropriate for every situation. It will be the role of the Safe Passages Steering Committee and the individual linkage sub-committees to determine which funding alternatives to pursue.

Media and conservation shows (TV or You Tube videos) that highlight early success to continue building momentum for additional crossing structures.

Table 5. Partial list of potential funding sources for wildlife crossing design and construction.

Funding Source	Details
Colorado Department of Transportation	State DOTs have traditionally been the primary funding source for most wildlife crossing and mitigation projects. Funding programs within CDOT that may be used for wildlife mitigation include the Regional Priority Program and the FASTER Safety Program, which may be appropriate for wildlife fencing or reconstruction projects.
Federal Lands Access Program/Federal Lands Transportation Program	Qualifying projects include environmental mitigation in or adjacent to federal lands to improve public safety and reduce WVCs while maintaining habitat connectivity.
Transportation Alternatives Program (TAP)	Typically funds bike and pedestrian facilities, however may also fund smaller environmental mitigation projects. https://www.codot.gov/programs/planning/tap-cfp
Farm Bill	NRCS Colorado (funding for non-federal entities) EQUIP program/wildlife
State Discretionary Grant Programs	CPW Habitat Partnership Program (e.g., install wildlife friendly fencing on private lands)
State Transportation Bill	Legislature may fund a transportation bill in the next session, including money for the West Vail Pass climbing lanes project and associated mitigation; Increase gas tax for wildlife mitigation.
Resource Agencies (CPW, USDA Forest Service, BLM)	May provide direct contributions, land exchanges or purchases in wildlife corridors, or compatible habitat management in wildlife corridors.
County Open Space	Coordinate conservation easements or land purchases in wildlife corridors.
Land Trusts (Colorado Open Lands, The Nature Conservancy)	Coordinate conservation easements or land purchases in wildlife corridors.
Great Outdoors Colorado (GOCO)	Potential state funding option.
Department of Local Affairs (DOLA)	Potential state funding option.
Ballot initiative to renew open space sales tax	Include wildlife crossing structures as a possible use of open space sales tax in the next initiative renewal (examples include Pima County, AZ and Teton County, WY).
Non-governmental Organizations (e.g., Rocky Mountain Elk Foundation, Mule Fanatics, Mule Deer Foundation, Humane Society, Theodore Roosevelt Conservation Partnership, Summit Foundation, Rocky Mountain Wild)	Depending on the organization, NGOs may make direct funding contributions, coordinate private fundraising efforts for wildlife crossings, including fundraising events, or conduct public outreach and education campaigns.
Insurance Companies	Direct contributions; public outreach and education.
Foundation Grants	E.g., Gates Foundation, Doris Duke, others.
Private Donations	Private donations from conservation-minded citizens.
Endowments	Bequests and donations from estates by conservation-minded citizens.

Wildlife Crossing Foundation	Set up a foundation to collect monies (local or national) for wildlife crossings. Elicit help from existing foundations like the National Forest Foundation, Fish and Wildlife Foundation, National Park Foundation, etc.
Impact Fees	Development fees to offset impacts of development.
User Fees	For example, \$1 add-on to ski tickets and passes.
Events	Brew festivals, community fundraisers or concerts, Wildlife Crossings Ski Day, etc.
Product Sponsorship	Find product sponsors who will donate a portion of the product sales to wildlife crossings.
License Plate	Wildlife crossings plate
Adopt-an-Overpass	Develop a program to raise funds while engaging local citizens and businesses. Such a program may include signage or an ad campaign, and may need to be coordinated with FHWA.

References

- Baigas, P. E., J. R. Squires, L. E. Olson, J. S. Ivan, and E. K. Roberts. 2017. Using environmental features to model highway crossing behavior of Canada lynx in the Southern Rocky Mountains. *Landscape and Urban Planning* 157:200-213.
- Barnum, S.A. 2003. Identifying the best locations along highways to provide safe crossing opportunities for wildlife. Report No. CDOT-DTD-UCD-2003-9. Colorado Department of Transportation Research Branch. Denver, CO.
- Bissonette, J. A. and P. C. Cramer. 2008. Evaluation of the use and effectiveness of wildlife crossings. NCHRP Report 615. National Cooperative Highway Research Program, Transportation Research Board, National Academies, Washington, D.C., USA.
- Felsburg Holt & Ullevig and Wildlife Consulting Resources. 2013. Interstate 70 wildlife overpass screening documentation, CDOT Region 1. Report to the Colorado Department of Transportation. Denver, CO.
- Kintsch, J., P. Singer, M. Huijser, J. Crane, and A. Huyett. 2011. A regional ecosystem framework for terrestrial and aquatic wildlife along the I-70 Mountain Corridor in Colorado: An EcoLogical field test. Federal Highway Administration and Colorado Department of Transportation, Denver, CO.
- Majka, D., J. Jenness, and P. Beier. 2007. CorridorDesigner: ArcGIS tools for designing and evaluating corridors. Available at <http://corridordesign.org>.
- Neumann, W., G. Ericsson, H. Dettki, N. Bunnefeld, N.S. Kueler, D.P. Helmers, and V.C. Radeloff. 2012. Difference in spatiotemporal patterns of wildlife road-crossings and wildlife vehicle collisions. *Biological Conservation* 145, 70–78.
- Rudnick D. A., P. Beier, S. Cushman, F. Dieffenbach, C. W. Epps, L. Gerber, J. Hartter, J. Jenness, J. Kintsch, A. M. Merenlender, R. M. Perkl, D. V. Preziosi, S. J. Ryan, and S. C. Trombulak. 2012. The Role of Landscape Connectivity in Planning and Implementing Conservation and Restoration Priorities. *Issues in Ecology*, 16.
- Singer, P., A. Huyett, J. Kintsch and M. Huijser. 2011. Interstate 70 Eco-Logical Monitoring and I-70 Wildlife Watch Report. Final Report to the Colorado Department of Transportation, Denver, CO.
- SREP. 2007. Citizen science wildlife Monitoring on Vail Pass. Unpublished Data. Southern Rockies Ecosystem Project, Denver, CO.

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Appendices

Appendix A: Stakeholders List

Name	Affiliation	Kickoff Meeting	Expert Workshops	Prioritization Meeting	Site Visits	Implementation Meeting
Grant Anderson	Colorado Department of Transportation	X	X	X	X	
Anna Bengtson	USDA Forest Service					X
Kate Berg	Summit County Planning Department					X
Norman Bowles	Citizen					X
Rick Cables	Vail Resorts	X	X		X	
Mike Connolly	Friends of the Dillon Ranger District					X
Michelle Cowardin	Colorado Parks and Wildlife	X	X	X	X	X
Jim Curnutte	Summit County Community Development Department			X		X
Rebecca Davidson	National Forest Foundation				X	
Tom Davies	Colorado Parks and Wildlife	X	X	X	X	
Jim Donlon	Friends of the Lower Blue River					X
Natasha Goedert	USDA Forest Service	X				X
Bill Jackson	USDA Forest Service	X				X
Chapin LaChance	Town of Breckenridge			X		X
Susan Lee	Town of Silverthorne	X				
Mark Leidal	Town of Silverthorne	X				
Cinnamon Levi-Flinn	Colorado Department of Transportation	X		X		X
John Longhill	Lower Blue Planning Commission; Friends of the Lower Blue River			X	X	
Brian Lorch	Summit County Open Space and Trails	X				
Sam Massman	USDA Forest Service	X				
Alison Michael	US Fish and Wildlife Service			X		X
Ann Murphy	Town of Breckenridge			X		X
Ashley Nettles	USDA Forest Service	X	X	X	X	X
Kirk Oldham	Colorado Parks and Wildlife	X	X	X		
Emily Olsen	National Forest Foundation				X	

Jeff Peterson	Colorado Department of Transportation			X		X
Scott Reid	Town of Breckenridge	X				
Patrick O'Sullivan	Arapahoe Basin	X	X	X		X
Marcus Selig	National Forest Foundation	X				
Gary Shimanowitz	Vail Resorts	X		X	X	
Elissa Slezak	Colorado Parks and Wildlife	X	X	X	X	X
Karn Stiegelmeier	Summit County Commissioner					X
Mark Truckey	Town of Breckenridge	X				
Rick Truex	USDA Forest Service					X
Mike Vanderhoof	Colorado Department of Transportation				X	X
Catherine Ventling	Colorado Department of Transportation	X	X	X		X
Bob Warner	Citizen					X
Jeff Zimmerman	Vail Resorts			X	X	
Michelle Zimmerman	Colorado Parks and Wildlife Commission					X

Appendix B: Wildlife Habitat Linkage Modeling – Technical Methods Description

Habitat suitability models had been previously created for the target species bighorn sheep, Canada lynx, elk and mule deer (SREP 2008) whose habitat preferences and movement needs encompass a range of ecological systems and capture the needs of other mammalian species in Summit County. The parameters for the habitat suitability models were derived from extensive review of the published literature and a number of wildlife experts across the state. They include four primary factors, depending on the species: land cover, elevation, topographic position and distance to roads. As no changes in our understanding of these factors have emerged since the initial development of the habitat suitability models, the researchers retain confidence in the habitat suitability models as the basis for the linkage analysis in Summit County. Notably, habitat suitability is only a partial predictor of wildlife movements, which may also be influenced by finer-scale landscape features (Nogeire et al. 2015) or non-habitat drivers, such as human activity. In addition, dispersing individuals may be more tolerant of unsuitable habitat types than individuals that are established within a home range, and many species show little aversion to moderately unsuitable habitat conditions within a home range (Keeley et al. 2015). To the extent possible, these nuances were captured through extensive expert review of the original model parameters for each focal species.

Additional parameters were used to define core habitat areas on either side of each of the individual study roads. These core areas serve as the endpoints between which the linkage analysis model runs. Core habitats were defined as contiguous patches of preferred or usable suboptimal habitat that are, at a minimum, large enough to support one breeding event (i.e., the minimum home range size of the focal species). Defining suitable core habitat patches is preferred to defining endpoints for the linkage analysis based on protected area boundaries, which may or may not contain sufficient suitable habitat for a given focal species. Each road in the study was then buffered by a static distance of 500 meters, and the buffered roads layer was then clipped from the suitable habitat patches layer for each focal species to define species-specific core habitat areas. Once the core habitat areas were defined, the researchers employed the Corridor Designer toolbox to conduct the linkage analysis across each of the roads included in the study. The GIS-based linkage analysis offered a consistent methodology for identifying spatially defined linkages across the entire county.

Data Sources

Type	Source
Summit County Boundary	CDOT
Highways	CDOT
Habitat Suitability Models (bighorn sheep, elk, lynx and mule deer)	Rocky Mountain Wild

GIS Methodology

1. The analysis area was created by buffering the Summit County boundary layer by 5 miles to account for edge effects. The boundary layer was first re-projected into NAD 1983 UTM Zone 13N as specified by the Corridor Designer manual.
2. Only state and federal highways (I-70, US 6, SH 9 and SH 91) were included in the analysis.
 - a. The CDOT Highway layer was clipped to the analysis area and I70, US 6, SH 9, and SH 91 were selected out.
 - b. Railroads were not included in the analysis because there are too many variables with them (i.e. inactive vs. active, degree of activeness for the active ones).
3. Buffering the road layer: The roads layer from above was buffered using a static distance of 500 m across species. Based on the parameters for the distance from roads used to create the habitat suitability model for each species, this distance roughly clips out the most strongly avoided and occasionally used habitat, thus creating cores from the most strongly preferred and usable but suboptimal habitat which is the most ideal to connect. The final buffered layer was dissolved to create a single polygon layer, affectively combining all roads into one layer. This roads layer was later clipped/erased out of all core areas despite what road is being analyzed (i.e. SH 9 and 91 are erased out of the core areas used for the I-70 analysis).
4. The habitat suitability models used for this project were created in 2008 for the project Making Connections for Wildlife: Aligning Transportation Planning with State Wildlife Action Plans (SREP 2008). The parameters for the habitat suitability models were derived from the published literature and expert opinion and include four primary factors: land cover (SWreGAP - reclassified to a smaller number of habitat groupings), elevation (30m resolution NED), topographic position (created from 30-m NED) and distance from roads (buffered by species from highways, major roads, local roads, and FS roads). Each parameter was weighted 0-100% depending on the degree of influence for a given target species' habitat use, with all the factors adding up to 100%. For these target species (bighorn sheep, elk, lynx and mule deer), elevation was not an individually weighted factor because these species are not sensitive to elevation to an extent greater than what is already captured by the land cover variable. Topographic position (i.e., canyon bottom, flat or gentle slope, steep slope, ridgetop) was weighted for bighorn sheep and mule deer, but was not weighted for elk or lynx. Within any one 30m pixel, this variable is not presumed to be influential for these species. For each focal species, these factors were then combined to create the habitat suitability model, where every pixel is assigned a value relating to the habitat value of the combined factors for that species. For each factor with a weight greater than zero, the weighted geometric mean was calculated by raising each factor by its weight and by multiplying the factors.

5. In ArcCatalog, the statewide habitat suitability model for each target species was clipped to the analysis area using the “Clip layers to analysis area” tool within the CorridorDesigner toolbox (first tool under “I. Layer Preparation”).
6. Core habitat areas for each focal species were defined to serve as the endpoints, or areas, between which the linkage model was run. Corridor Designer derives these patches from the habitat suitability model by weighting the land cover data layer based on habitat preferences as defined by species experts, 1-3 (strongly preferred, 1 is best), 4-5 (usable but suboptimal habitat), 6-7 (not breeding habitat, but occasionally used), 8-10 (strongly avoided, 10 is worst). Potential core habitat patches were derived from the habitat suitability model and based on expert identified parameters for minimum potential habitat core sizes (i.e. support core population for at least 10 years) and/or potential breeding habitat (home range or enough to support one breeding event) and were used to define the endpoints (actual areas) for the linkage analysis model.
7. Run habitat patch analysis for each species using the “Create habitat patch map” tool in ArcCatalog (last tool under “II. Habitat Modeling”)
 - a. Parameters for Bighorn Sheep –
 - i. Moving window radius (based on Daily Dispersal Distance (the distance a species might move between patches within the same home range)) - Circle 33 CELL (1 km)
 - ii. Threshold 70
 - iii. Breeding (home range or enough to support one breeding event) = 2500 ha
 - iv. Minimum potential habitat core size (i.e. support core pop for at least 10 years) = 10000 ha
 - b. Parameters for Elk –
 - i. Moving window radius (based on Daily Dispersal Distance (the distance a species might move between patches within the same home range)) - Circle 33 CELL
 - ii. Threshold 70
 - iii. Breeding (home range or enough to support one breeding event) = 1500 ha
 - iv. Minimum potential habitat core size (i.e. support core pop for at least 10 years) = 7500 ha
 - c. Parameters for Lynx –
 - i. Moving window radius (based on Daily Dispersal Distance (the distance a species might move between patches within the same home range)) = Circle 100 CELL
 - ii. Threshold = 70
 - iii. Breeding (home range or enough to support one breeding event) = 7200 ha
 - iv. Minimum potential habitat core size (i.e. support core pop for at least 10 years) = 75500 ha
 - d. Parameters for Mule Deer -

- i. Moving window radius (based on Daily Dispersal Distance (the distance a species might move between patches within the same home range)) = Circle 24 CELL
 - ii. Threshold = 70
 - iii. Breeding (home range or enough to support one breeding event) = 1295 ha
 - iv. Minimum potential habitat core size (i.e. support core pop for at least 10 years) = 6475 ha
 - e. Naming convention – SPECIES_PatchTHRESHOLD
 - f. Threshold (% good quality habitat) = 70 (or 70 to 100 best habitat) used for MCW in most cases, used for this project although can potentially use other thresholds if not enough good habitat to do analysis
 - g. NOTE: The text files will have information on what inputs were used for any of the Corridor Design tools.
8. Output patch shapefile should include:
 GRIDCODE 3 = Potential Population Patch
 GRIDCODE 2 = Potential Breeding Patch
 GRIDCODE 1 = Smaller than Potential Breeding Patch
 Preferably want GRIDCODE 3 and at least GRIDCODE 2 to run corridor model
9. Create core areas
- a. Clip patch shapefile to analysis area again (polygons overflow after patch analysis) (SPECIES_patchTHRESHOLD_clip)
 - b. Select out only GRIDCODE 3 and 2, eliminating any GRIDCODE 1, from patch shapefile (SPECIES_patchTHRESHOLD_clip_GD2_3)
 - c. Dissolve patch polygons into one layer (SPECIES_patchTHRESHOLD_clip_GD2_3_dslv)
 - d. Erase buffered road layer out of patch shapefile (SPECIES_patchTHRESHOLD_clip_GD2_3_dslv_erase)
 - i. Note that this may leave core habitat areas that are smaller than expected because the original core area crossed the highway and got split.
 - e. Explode Multipart feature to create separate polygons on either side of each highway
 - i. Merge any smaller polygons with their larger corresponding polygons
 - ii. Delete any disconnected slivers (very small polygons)
 - iii. Done during editing so naming convention remains the same as the last step
 - f. Export areas on either side of focus roadway as core 1 and core 2. Only include cores near the road segment that is being analyzed.
 - i. Naming convention: HWY_SpeciesTHRESHOLD_Block1;
HWY_SpeciesTHRESHOLD_Block2
 - ii. Divide I70 into two segments, east and west of where SH 9 heads south including the areas between SH 9 and SH 91 and west of SH 91 in the

southern block. I considered A third segment between highways 9 and 91 was considered but not included because there were already so many analyses.

- iii. Divide SH 9 into two segments, north and south of I70.
10. Create slices using “Create corridor model” tool in ArcCatalog (first tool under “III. Corridor Modeling”)
 - a. Creates slices .1%, 1-9%
 - b. Use same inputs as number 7 above.
 11. If necessary, create additional slices using “Create corridor slices” tool in ArcCatalog (second tool under ‘III. Corridor Modeling’)
 - a. Input = 1, 10, 41 (if enter 40, only makes slices up to 39).
 12. Union all highway desired display % slices by species using “Create union of all corridors” in ArcCatalog. Naming convention = SPECIESTHRESHOLD_%SLICE_corridor_allhighways (i.e. elk70_0_6_percent_corridor_allhighways where _0_6_percent = .6%)
 13. If desired, clip cst raster file to the desired display slice for each highway in order to display the various raster values. Naming convention = SPECIES_HWY_cstc
 14. The final display linkage shapefiles were unioned (using the “Union” tool in ArcGIS).
 - a. Used unioned allhighways shapefiles created for each species
 - b. Added column in each shapefile for chosen display slice %, highway and species.
 - c. Once unioned, began editing and used “Explode multipart feature” tool to separate the linkages into individual features.
 - d. While still editing, selected and merged separated individual polygons to create final discrete linkages.
 - i. All touching polygons were considered in the same linkage even if just touching by a corner.
 - e. Any cross highway unions were removed.

Appendix C: Wildlife-Highway Linkage Form

1. Linkage Area Number (Format = Hwy#-StartMP):

2. Linkage Name:

3. Mile Posts:

4. **General Habitat.** Indicate all major habitat types that apply to linkage area:

- Spruce/Fir Mixed Conifer Aspen
 Sagebrush Steppe Riparian Large Riverine

5. **Land Uses** (estimate in increments of 10%):

- _____ Natural _____ Agricultural _____ Developed Recreation
_____ Other Recreation _____ Urban _____ Suburban
_____ Commercial/Industrial _____ Rural

Describe:

6. **Target Species:**

- Lynx Elk Mule Deer Moose Bighorn Sheep
 Boreal Toad

Other Mammals:

Reptiles:

Amphibians:

Other:

7. **Significance of Linkage Area**

- Local (e.g., daily movements within a seasonal range)

Explain local movements:

- Regional (e.g., migratory movements between seasonal ranges)

Explain regional movements:

- Ecosystem (e.g., dispersal movements or movement between major mtn. ranges)

Explain ecosystem movements:

8. **What existing features facilitate animal movement through the linkage area** (check all that apply):

- Waterway Riparian Habitat Continuous Habitat Cover
 Existing Bridges/Culverts Other (specify):

9. Is the linkage biological pinch-point? Yes No
If Yes, Describe:

10. Migratory Herds (Ungulates)
 Yes No Species and Numbers:

11. Is there a significant number of highway mortality? High Mod. Low
Species:

Are there specific mileposts/locations of concern for WVC? Specify:

12. Attractants
 Water Riparian Ag Fields Cover
 Forage/Prey Garbage/Human
Describe:

13. What current threats or barriers to wildlife movement occur within the linkage area? Indicate current (C) or future (F).
C F Residential Development C F Other Roads
C F Habitat Management C F Fencing
C F Developed Recreation C F Motorized Recreation
C F Non-motorized Recreation C F Natural Barriers
C F Other (specify):

14. Score the overall threat to connectivity in this linkage. Circle one. (Scale 1-5, where 1 = no threat/secure; 3 = moderate threat; 5 = severe threat/imminent loss)
1 2 3 4 5

12. Land Ownership/Management
 Forest Service BLM State _____
 Private
Describe any lands with protected status in linkage area:

Appendix D: Community Open House Posters

The following posters were presented at a community open house to share the project with the public on July 26, 2017 in Frisco, and to the Friends of the Lower Blue River on July 30, 2017 in Silverthorne.

Why Do Wildlife Need

Safe Passages?

ECOLOGICAL BENEFITS:

Wildlife need to move across the landscape to find food and water, to hunt for prey, to find safe places to rear their young, to disperse into new habitats, or to access seasonally-available resources.

SOCIAL BENEFITS:

Summit County's majestic landscapes and wildlife are a major reason why people choose to visit and live in Summit County, and contribute to our quality of life.

ECONOMIC BENEFITS:

Healthy wildlife populations are important to Summit County's economy, providing opportunities for wildlife viewing and hunting, and creating associated jobs and revenue. Each year, Colorado's economy receives \$919 million from hunting related activities, and another \$2.3 billion from wildlife viewing (CPW 2017).

Threats to Connectivity

and Wildlife Movement

ROADS AND TRAFFIC:

Individual animals may die when they are hit by vehicles, affecting population health. Collisions with wildlife are also a human safety problem. Each year, over 3,600 wildlife-vehicle accidents are reported to law enforcement across the state, resulting in property damage, injuries and fatalities, at a cost to society of \$53.7 million per year. Roads and traffic also create barriers to wildlife movement, and may prevent animals from accessing the resources they need to survive or dispersing into new areas.

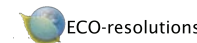
HUMAN RECREATION:

The White River National Forest has the highest levels of recreation of any Forest in the nation. Wildlife may be disturbed by human recreation, and avoid areas with high levels of activity.

RESIDENTIAL, COMMERCIAL, AND INDUSTRIAL DEVELOPMENTS:

Because of the draw to Summit County, expanding development may degrade wildlife habitat, displace animals, restrict wildlife movements, or create wildlife conflicts with homeowners and their pets.

Summit County Safe Passages for Wildlife



Background

Identifying Safe Passages for Wildlife in Summit County

GOALS:

-  Create a common vision for multi-species landscape connectivity in Summit County based on existing data and expertise.
-  Recommend the best locations for crossing structures for different types of wildlife. Also recommend compatible land management actions in wildlife movement areas.
-  Bring together stakeholders from state and federal agencies, the county, towns, ski areas, recreation interests, private landowners and other parties to work together towards a collaborative vision for achieving safe passages for wildlife.



CURRENT PARTNERS:

USDA Forest Service, Colorado Department of Transportation, Colorado Parks and Wildlife, US Fish and Wildlife Service, Summit County, Town of Breckenridge, Town of Dillon, Town of Frisco, Town of Silverthorne, Vail Resorts, Arapahoe Basin, National Forest Foundation, Friends of the Lower Blue, Lower Blue Planning Commission, Friends of the Dillon Ranger District, and You!



HOW DID WE GET HERE?

Over the past year, the Dillon Ranger District of the White River National Forest (WRNF) has convened stakeholders from across the county to create a science-based process for identifying important areas for wildlife movement. This study combined two approaches:

1. Habitat analysis of landscape connectivity to map corridors across the landscape for select target species.
2. Stakeholder and expert workshops to define discrete highway crossing zones and review the corridor models.

Once highway crossing zones were identified, the stakeholder group created criteria for prioritizing the linkages.

The stakeholder group will convene in August to review the final plan and recommendations and discuss next steps for implementing the highest priority wildlife crossing structures.

Your comments and feedback are important to us! Please let us know your thoughts on this study.

Summit County Safe Passages for Wildlife

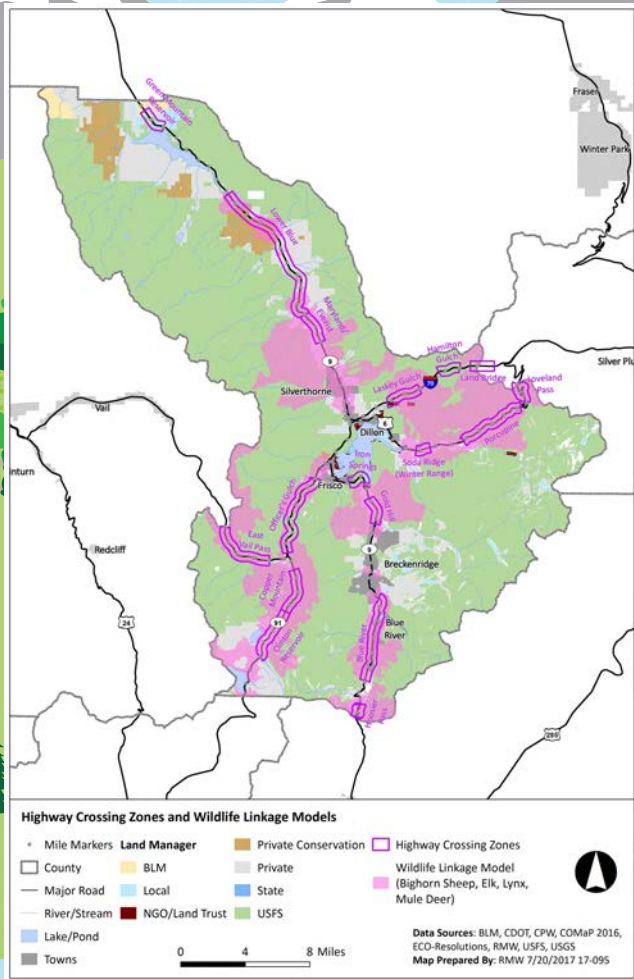


ECO-resolutions



Wildlife
Consulting
Resources

Wildlife Connections Across Highways in Summit County



Prioritizing Safe Passages

WILDLIFE AND BIOLOGICAL VALUES:

How important is this connection to the health of the species population?

Are the species that would use this connection Threatened or Endangered?



SAFETY HAZARD:

What is the level of risk for drivers of a wildlife-vehicle collision?



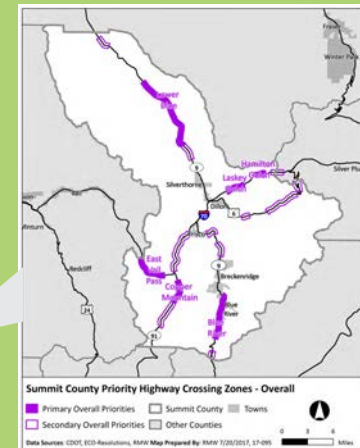
URGENCY AND OPPORTUNITY:

How threatened is this connection?

Are there protected lands nearby?

How feasible will it be to construct a wildlife crossing, based on the terrain and other landscape features?

Are there unique opportunities that will facilitate funding and constructing a wildlife crossing?



Summit County Safe Passages for Wildlife

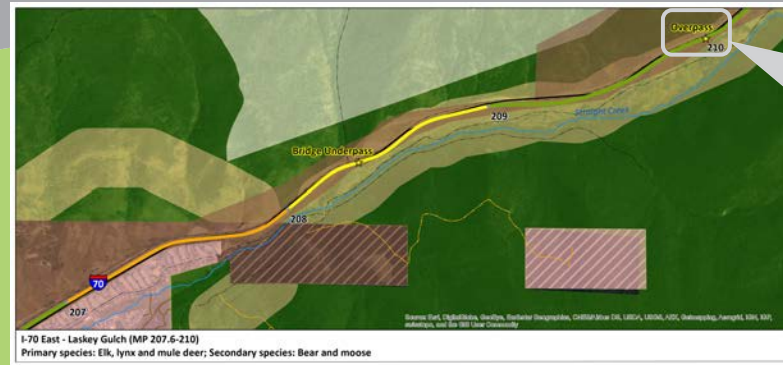
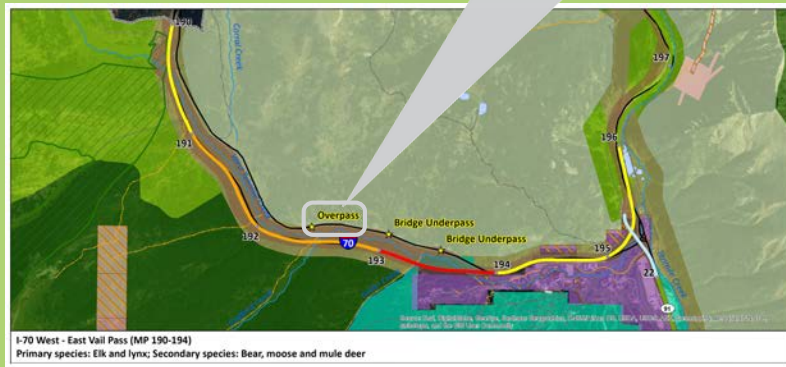
Restoring Safe Passages on Interstate 70

EAST VAIL PASS:

Because there are existing bridges suitable for wildlife passage under the eastbound lanes, new crossing structures only need to help wildlife cross the westbound lanes. However, construction detours and delays on an interstate highway will make building a structure here expensive.



Highway 9 Colorado, Credit: J. Richert

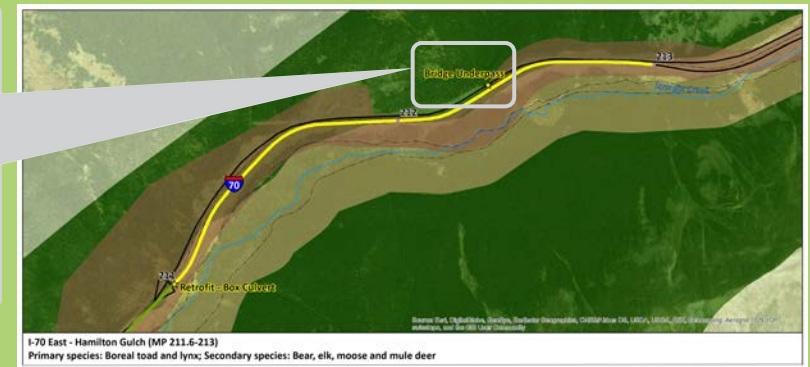


LASKEY GULCH & HAMILTON GULCH:

The Laskey Gulch and Hamilton Gulch portions of I-70 have a wide footprint (6 traffic lanes) and travel through steep mountainous terrain. People and groups from across the county will need to work together to build crossing structures in this challenging environment.



I-70 Colorado, Credit: Rocky Mountain Wild, ECO-resolutions, CDOT



I-90 Washington, Credit: WSDOT

Summit County Safe Passages for Wildlife



Restoring Safe Passages on State Highways 9 & 91

SH 91, COPPER MOUNTAIN:

The Copper Mountain Linkage currently supports a breeding population of Canada lynx. Maintaining the forested habitat on either side of the highway in addition to crossing structures spanning the highway are important for this population, but will be difficult to construct in this steep, narrow canyon.



At Switzerland, Credit: J. Kintsch



I-90 Washington, Credit: Cramer, Kintsch & WSDOT



Highway 9, Colorado, Credit: J. Richert



I-90 Washington, Credit: Cramer, Kintsch & WSDOT



SH 91 - Copper Mountain (MP 18.5-21.5)
Primary species: Lynx; Secondary species: Bear, elk, moose and mule deer

SH 9, UPPER BLUE RIVER:

This portion of SH 9, south of Breckenridge, has many residences along the highway and high levels of commuter traffic. Building wildlife crossing structures in this area will be challenging, and will require the support of local residents.



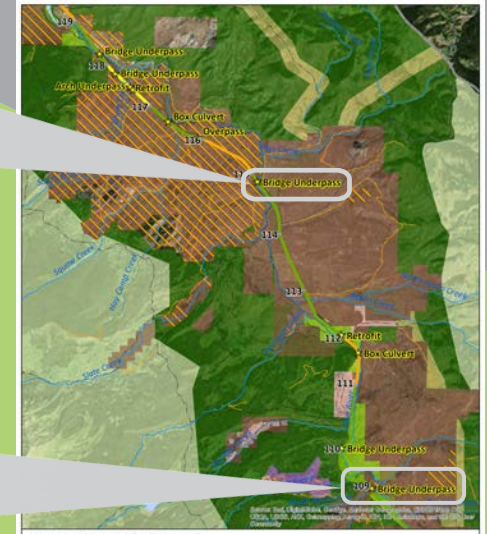
SH 9 South - Blue River (MP 80.1-85.6)
Primary species: Elk, moose and mule deer; Secondary species: Bear and lynx

SH 9, LOWER BLUE RIVER:

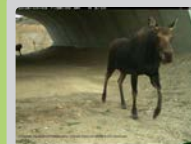
There are multiple opportunities to replace or improve existing bridges and culverts for wildlife passage along this section of SH 9. Restoring safe passages for wildlife here will require working closely with public and private landowners.



US 93 Montana, Credit: P. Cramer



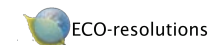
SH9 North - Lower Blue (MP 109-118.8)
Primary species: Elk and mule deer; Secondary species: Bear and moose



Highway 9, Colorado, Credit: CDOT, CPW & ECO-resolutions



Summit County Safe Passages for Wildlife



Working Together to Create Safe Passages Solutions

WILDLIFE OVERPASSES:

Wildlife overpasses create habitat connections over a roadway allowing wildlife to cross a highway safely, out of the line of traffic. Some species like elk and bighorn sheep generally prefer overpasses to underpasses.

HABITAT RESTORATION:

Work together across jurisdictional boundaries to coordinate public land management and restore wildlife habitat.

INCREASE COLLABORATION:

Increase collaboration with ski areas, mountain biking and hiking groups to minimize impacts to wildlife movement.

WILDLIFE UNDERPASSES:

Many animals will use wildlife underpasses to cross under a road.

BRIDGES AND CULVERTS:

Improve existing bridges and culverts to accommodate wildlife passage for deer and other animals

LAND-USE PLANNING:

Support land use planning that protects wildlife movement corridors.

WORK WITH PRIVATE LANDOWNERS:

Engage private landowners and citizens' groups in efforts to conserve and restore wildlife movement corridors in ways that are compatible with ranching and farming.

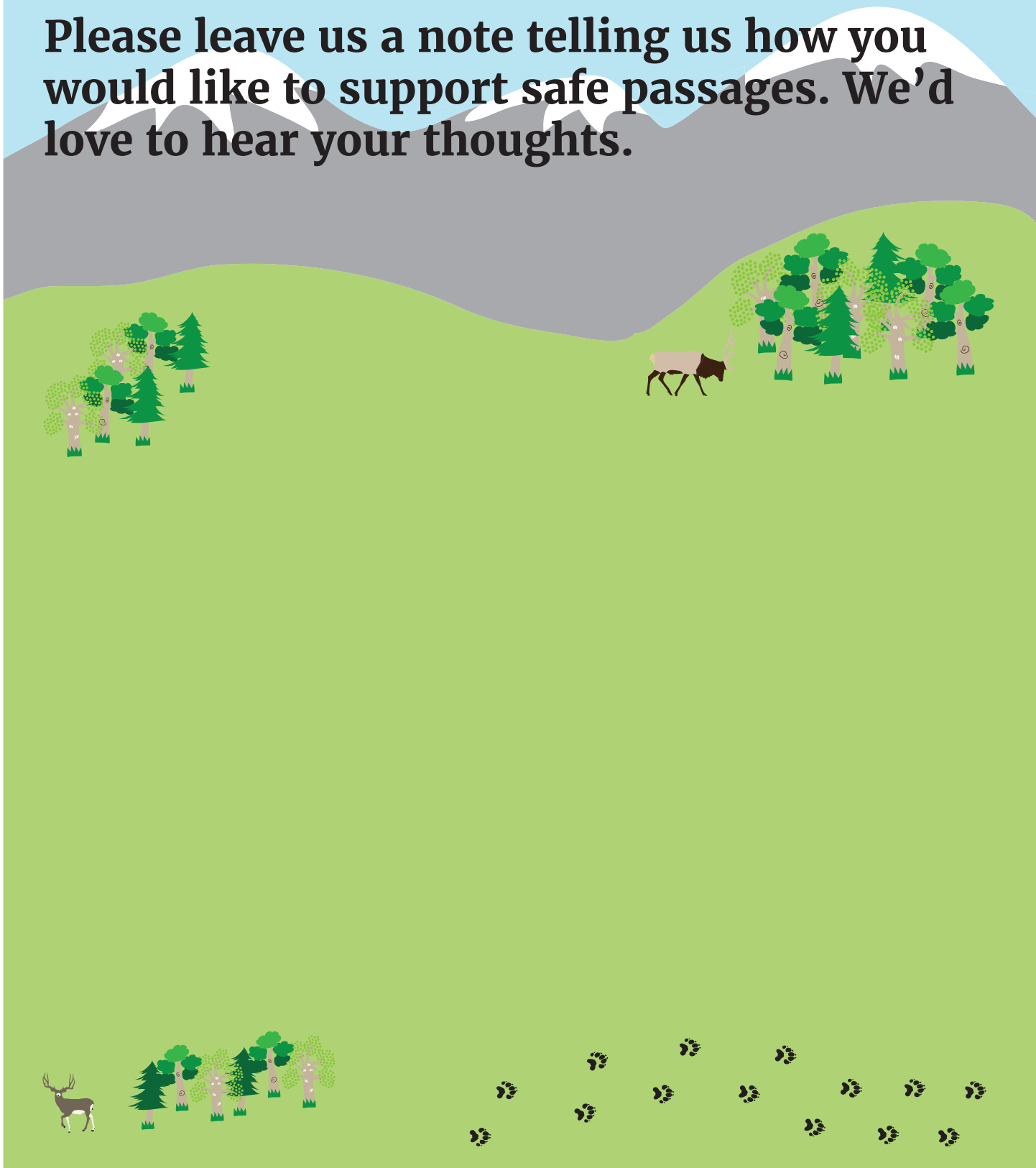
Your community support is needed to help fundraise and build partnerships that will lead to the construction of wildlife crossing structures.

Summit County Safe Passages for Wildlife



Express Your Ideas Here!

Please leave us a note telling us how you would like to support safe passages. We'd love to hear your thoughts.



Summit County Safe Passages for Wildlife



ECO-resolutions



Wildlife Consulting Resources