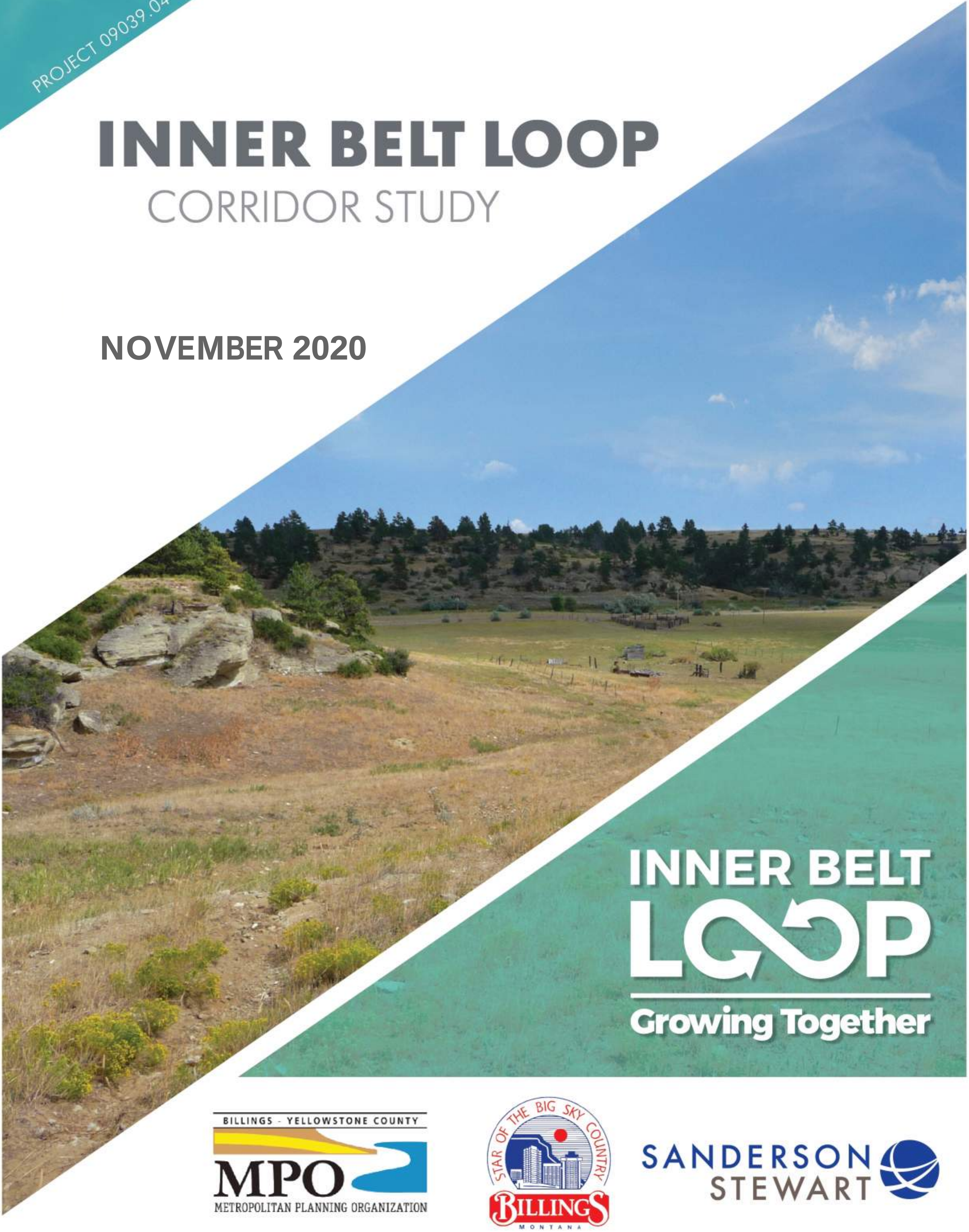
PROJECT 09039.04

INNER BELT LOOP

CORRIDOR STUDY

NOVEMBER 2020



BILLINGS - YELLOWSTONE COUNTY
MPO
METROPOLITAN PLANNING ORGANIZATION

STAR OF THE BIG SKY COUNTRY
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MONTANA

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STEWART

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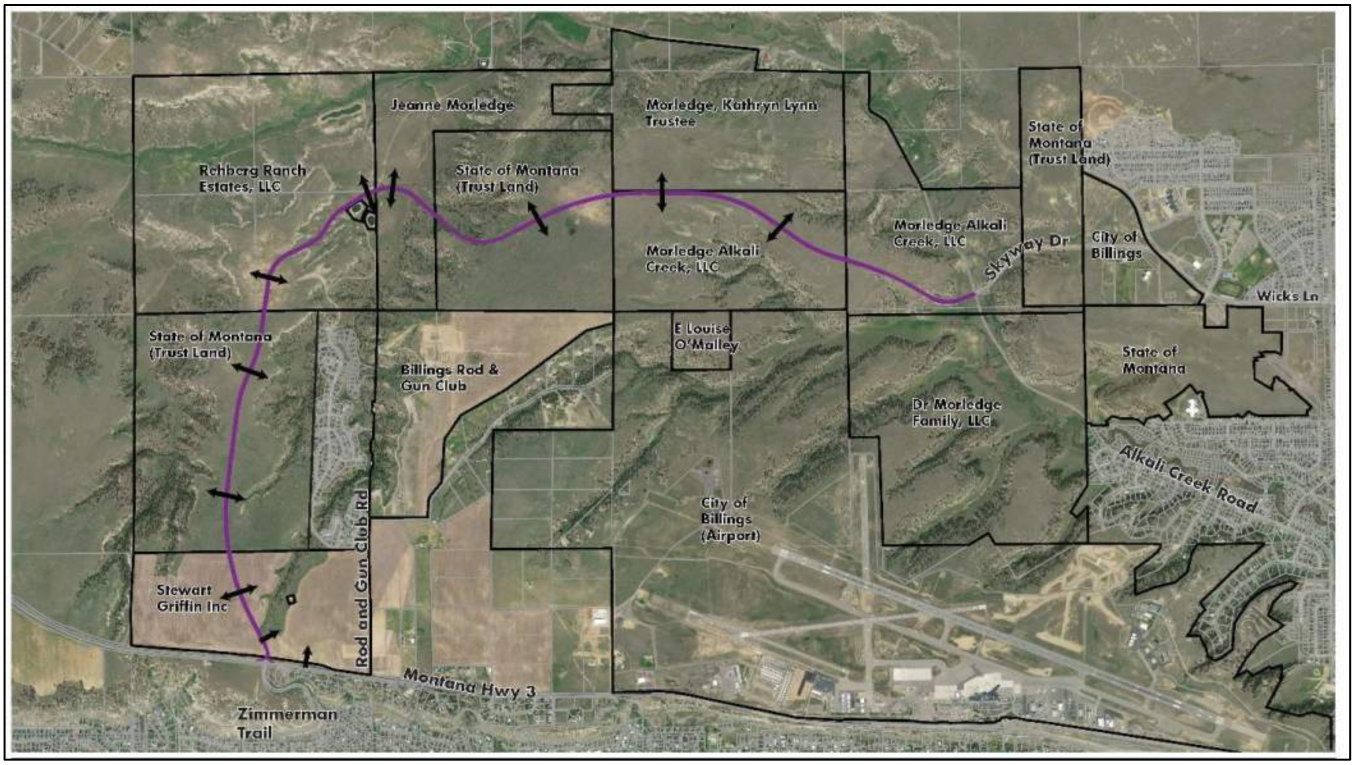
EXECUTIVE SUMMARY

The *Inner Belt Loop Corridor Study* provides a vision for the corridor that balances the need to plan for new development areas while ensuring a safe and well-connected city. The recommendations in this study are a result of extensive data collection and analysis, coupled with public and stakeholder engagement. The analysis and recommendations contained within this study will inform the final design and construction of the roadway and set the stage for land development to occur along the corridor in a way that is consistent with the principles outlined in the *2016 City of Billings Growth Policy*.

The Inner Belt Loop is a 7-mile roadway corridor that will connect the West End and Heights regions of Billings. The concept of an Inner Belt Loop roadway connection was first discussed approximately 30 years ago during the development of the 1990 update to Billings-Area Transportation Plan. In 2006, the City completed the *Inner Belt Loop Connection Planning Study*, which evaluated route alternatives and recommended the current alignment. Additional consideration of other possible routes was again reviewed in 2009, with the original alignment selected for design. Phase 1 of the project (Skyway Drive) was completed in 2014, providing a link from Wicks Lane to Alkali Creek Road.

The City of Billings has allocated funding within the current capital improvements plan to complete design and construction of the remainder of the corridor in two phases, targeted for fiscal year (FY) 2022 (funds available on July 1, 2021) and FY 2024 (funds available on July 1, 2023). Phasing of the project has yet to be determined. Figure 1 (below) depicts the designed route for the Inner Belt Loop from Montana Highway 3 to Skyway Drive/Alkali Creek Road.



Inner Belt Loop Alignment

Guidance for the vision development process for the Inner Belt Loop was provided by a Project Oversight Committee consisting of individuals from stakeholder groups including the City of Billings, Yellowstone County, Montana Department of Transportation, Federal Highway Administration, Department of Natural Resources and Conservation, Met Transit, and local neighborhood task force committees. Landowners with property fronting on the Inner Belt Loop provided input and guidance related to current and future land use and access needs. Additionally, two (2) public meetings were held to present preliminary and final findings of the study and to solicit feedback from the community on the project.

A key consideration for the Inner Belt Loop Study is to understand the land development feasibility for properties adjacent to the corridor. That in turn influences traffic demand and the corridor design. In order to understand the development feasibility, public service providers, including police, fire, public works and private utility companies were consulted regarding capacity to service the corridor. Their input, along with the evaluation of land topography, access standards, wetlands and floodplain impacts, airport influence, and City and County development standards, resulted in scenarios for future development. The scenarios represent approximately 2,300 acres of raw, developable land directly adjacent to the corridor, along with 975 single-family residential lots that are currently platted in the Rehberg Ranch and Skyview Ridge subdivisions.

With an understanding of development potential, existing and future traffic volumes and operations at key locations were evaluated. Combining the development scenarios with the future traffic operations, recommendations for the corridor were developed. The recommendations are intended to provide a framework for policy and decisions regarding future land use and corridor development.

Recommendations

Intergovernmental Coordination

Approach to Land Development - Because the majority of the land adjacent to the Inner Belt Loop is currently outside of the city limits and the construction of the road will be funded by the City of Billings, coordination between the City and the County relative to development approval is essential.

Intergovernmental Agreement - An intergovernmental agreement between the City of Billings and Yellowstone County would establish the roles and responsibilities of the County and City in the development review process.

Development Tools

Neighborhood Plan - a neighborhood plan of the area would articulate the goals of the Inner Belt Loop area.

Limits of Annexation Map - As the City looks to construct the Inner Belt Loop, consideration should be given to update the Limits of Annexation Map.

Development Standards - Expectations for future development, established through the zoning regulation, should be created prior the construction of the Inner Belt Loop.

Urban Density - Development of urban density will be dependent on the presence of utilities. Developing a plan for the extension of water and sewer to enable development at urban densities will be critical to fulfilling the development pattern envisioned.

Design Considerations

Roadway Right-Of-Way - The proposed right-of-way should be increased to at least 100 feet to provide flexibility for design.

Intersection Design - Major intersections may require future traffic signals or roundabouts and allocation of additional right-of-way at those intersection locations should be considered

Access Management - An access management strategy for the corridor should be developed, starting with an evaluation of the original planned access locations shown in the preliminary design with respect to spacing and configuration of access.

Bicycle and Pedestrian Facilities - The multi-use trail along the Inner Belt Loop will be developed and the City should identify locations along the route where stopping points with amenities as well as crossing locations of the roadway.

Phasing

Roadway Construction Phasing - Construction of the Inner Belt Loop will be funded through the City of Billings Capital Improvements Plan with half of the funding will be allocated in 2022 and the remaining funding to be allocated in 2024. Phasing the construction to align with the funding allocation should be considered.

Option 1 would focus on finalizing the road design, environmental assessments, permitting and initial site work within one phase. Completion of the road, including asphalt, signage, striping and trail work would occur with the final allocation of funding in 2024.

Option 2 would focus on completing one half of the roadway with the first allocation of funding and the second half with the remaining funding allocation. With this approach, the road design through the finish road section would be completed, with one section of the Inner Belt Loop completed with the 2022 funding allocation and the second section completed with the 2024 funding allocation.

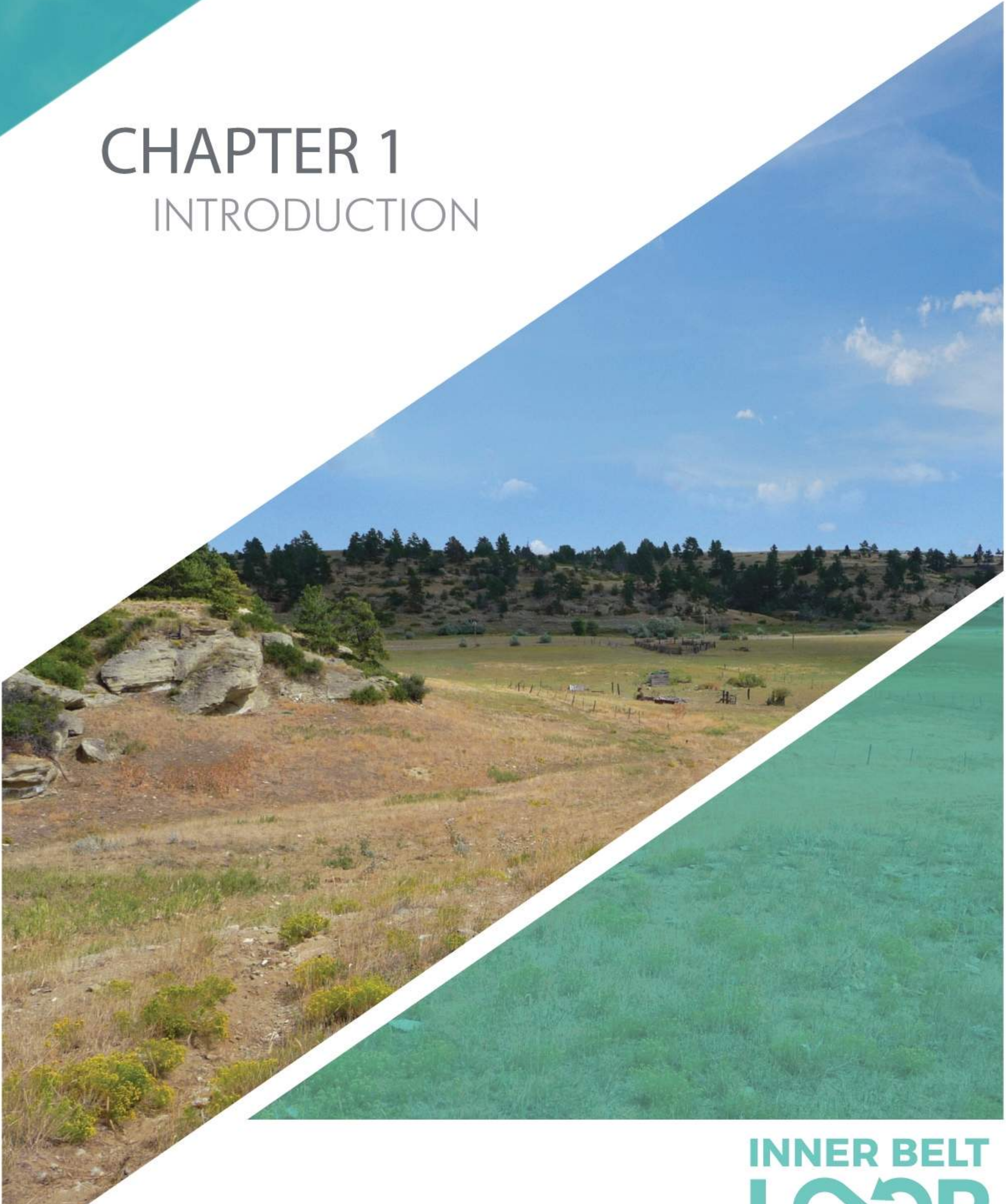
Infrastructure Development

Water and Sewer Infrastructure - To facilitate the infrastructure that will support development along the Inner Belt Loop, water and sewer infrastructure will need to be evaluated. The funding of these improvements will be critical and evaluation of tools available to finance the construction should be included.

- Private property owner agreements - The City and County could work to facilitate the property owners in establishing their own agreement to address utility provision.
- Reimbursement Agreements - If the City of Billings constructs the utilities along the corridor, developers would be required to pay reimbursement fees in order to connect to this infrastructure
- Special Improvement District or Rural Improvement District – A district can be created that would distribute the costs of infrastructure and maintenance across the properties that would benefit

CHAPTER 1

INTRODUCTION



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INTRODUCTION

Overview

The Billings Metropolitan Planning Organization (MPO) identified the need to conduct a corridor planning study of the future Inner Belt Loop corridor in Billings and Yellowstone County. The extents of the study area are from the Skyway Drive/West Wicks Avenue intersection on the northeast to the MT 3/Zimmerman Trail intersection on the southwest terminus of the future alignment.

This study provides a vision for the future corridor, including recommendations on land development, access management, multi-modal safety and operations, corridor aesthetics, stormwater management, and feasibility of public utilities service. In order to develop that vision, the project team performed extensive research, met with a variety of key project stakeholders (including adjacent property owners), held two public meetings to solicit input, and applied various of technical and planning-level analysis techniques prior to developing recommended steps for moving forward.

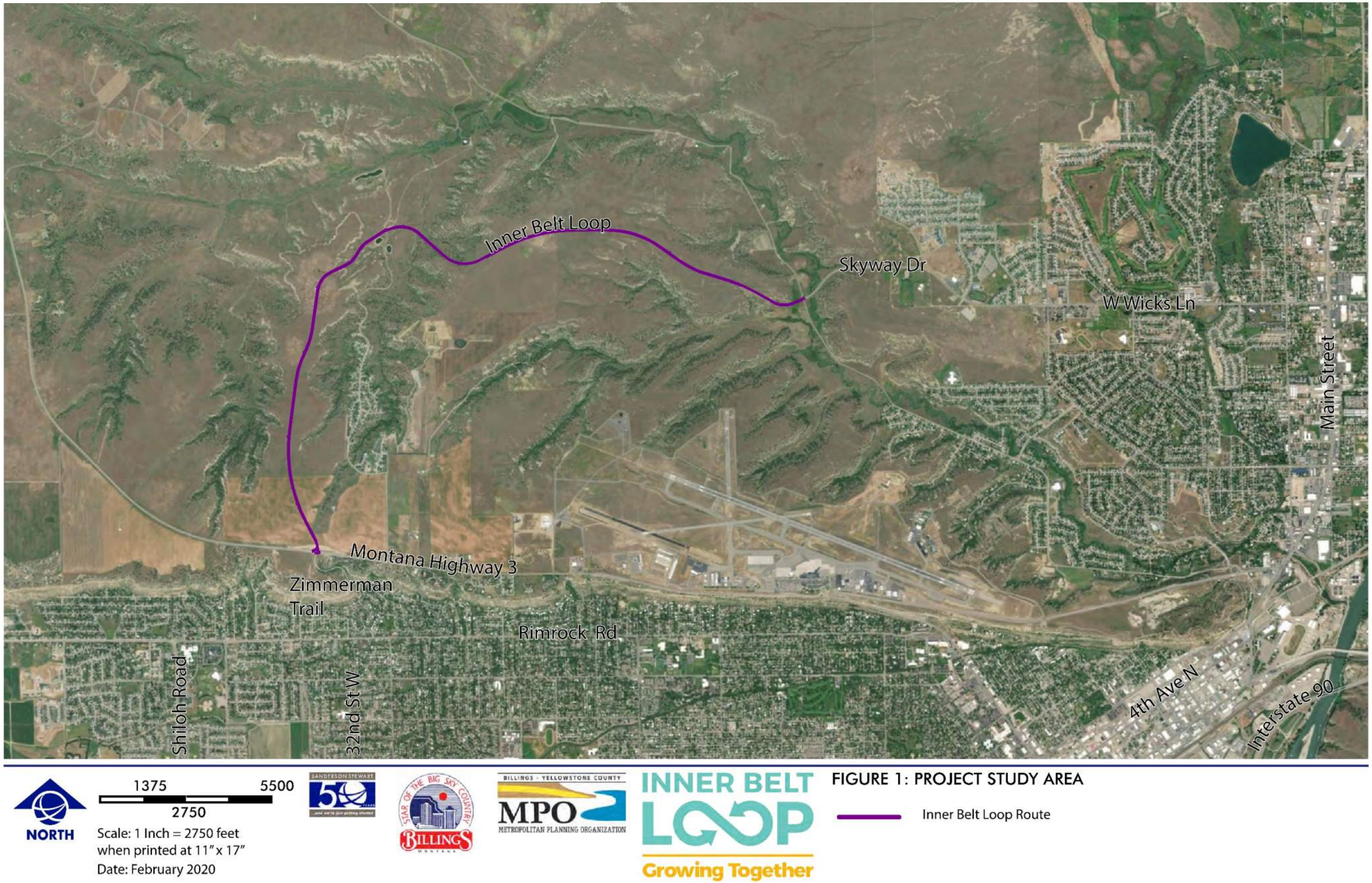
The Inner Belt Loop Corridor Study is generally broken into four parts, including Existing Conditions, Future Conditions, Corridor Vision, and Recommendations.

Study Area Description

The Inner Belt Loop is a proposed roadway that provides additional connectivity between the West End and Heights regions of Billings. The road has been in the planning stages for decades and previous work identified a specific alignment. The area considered for the corridor study consists of parcels adjacent to the future alignment. **Figure 1** (next page) illustrates the project study area.

The Roadway Functional Classification System in the Billings Urban Area Long Range Transportation Plan identifies the Inner Belt Loop as a proposed Principal Arterial. Roads that are classified as arterials represent the highest class of highways and roads within the transportation network. They are designed to service higher volumes of traffic, particularly through traffic, at higher speeds. The right-of-way for a Principal Arterial can be as wide as 120-feet, with roadway widths of 90 feet or greater. Right-of-way for the Inner Belt Loop has not been acquired from property owners affected by the alignment, so the final right-of-way may vary from the typical section described.

Figure 1: Project Study Area



Goals and Objectives

The Inner Belt Loop Corridor Study provides a vision for the corridor by considering physical design elements, projected land use buildout, and future traffic demand. The following objectives were outlined at the onset of the study.

- Maintain consistency with existing community plans.
- Identify and engage all relevant stakeholders.
- Appropriately consider all transportation modes.
- Identify elements of the corridor that will establish the design expectations as development occurs.

Skyway Drive (Phase 1 of the Inner Belt Loop) opened to traffic in 2014

Public Participation Process

A thorough public participation process was conducted for the Inner Belt Loop Corridor Study in conformance with the Yellowstone County Board of Planning Participation Plan.

The following meetings were conducted as part of the plan development:

- **Project Oversight Committee** meetings were held monthly to discuss the direction of the planning study.
- **Billings City Council** informational presentation was provided on September 16, 2019 to review the work completed to date and discuss key issues related to development in and near the Inner Belt Loop.
- **Public Meeting No. 1** was held on November 6, 2018 to introduce the corridor planning study to the public.
- **Public Meeting No. 2** was held on March 5, 2020 in order to present the draft corridor study.

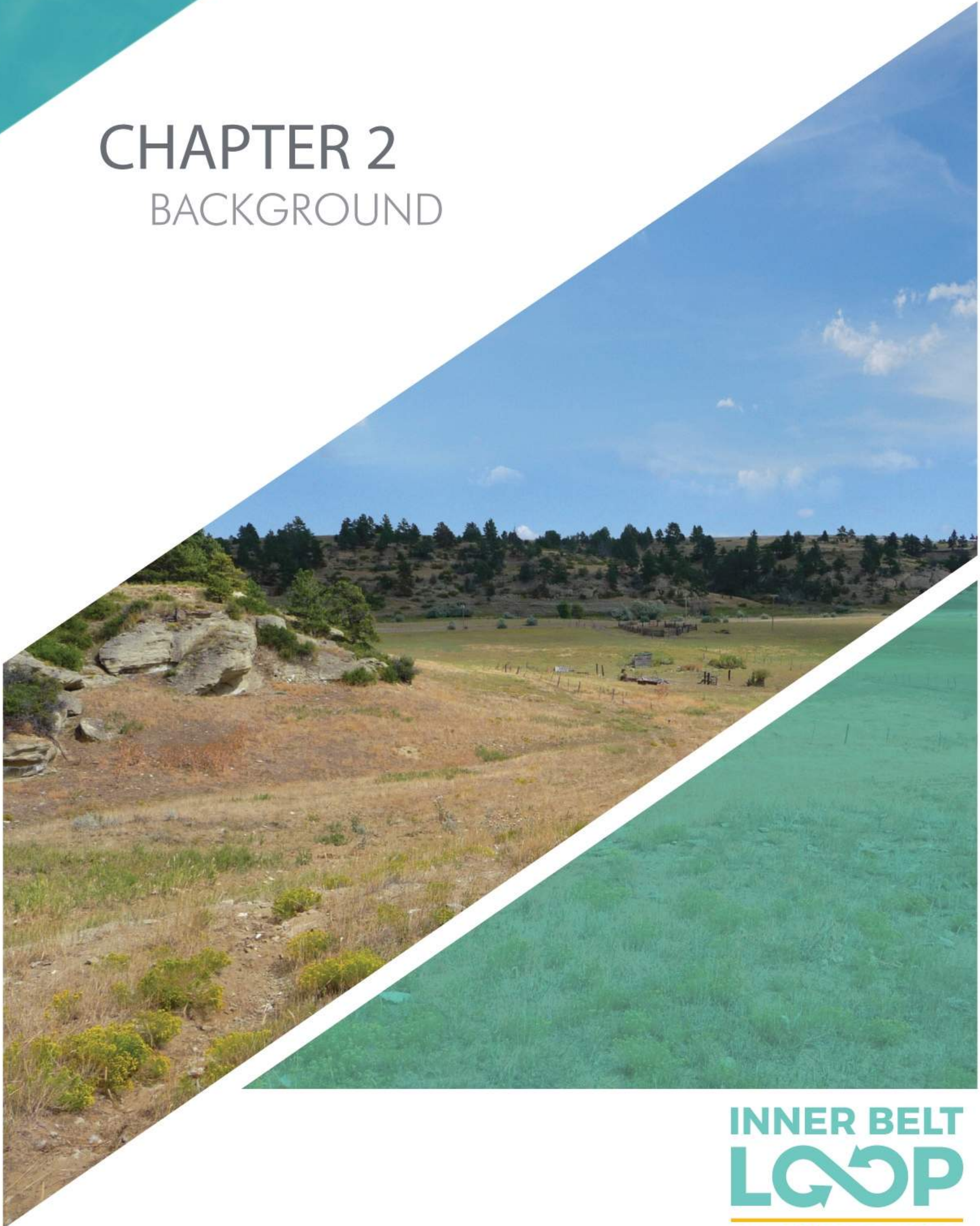
The following dates were scheduled for review and approval of the Inner Belt Loop Corridor Study:

- **Technical Advisory Committee** – Presentation and action on June 4, 2020.
- **Yellowstone County Planning Board** – Presentation on ___________ and public hearing/action on ____________
- **Billings City Council** – Presentation on __________ and public hearing/action on _______
- **Yellowstone County Commission** – Discussion on ______ and presentation/action on ________
- **Policy Coordinating Committee** – Final action on ___________

Weekly project updates were provided via email to the members of the Project Oversight Committee. Finally, a project website was developed as a location to post draft documents for review and as a tool to request additional public input. The web address is www.sandersonstewart.com/projects/innerbeltloop. The final document will be posted on the City of Billings website at ___________________________.

Attendees at Public Meeting #1 listen intently as the project team presents early findings

CHAPTER 2
BACKGROUND



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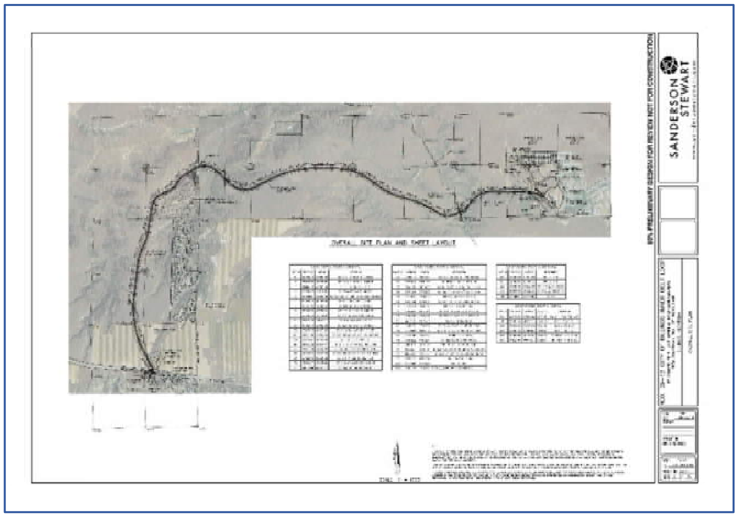
BACKGROUND

The Inner Belt Loop has been discussed as a potential solution for providing additional connectivity between the Heights and West End regions of the city for approximately 30 years. In 2005/2006, the Inner Belt Loop was more formally identified as a need for the Billings community via the *Inner Belt Loop Connection Planning Study*. That study recommended a preferred alignment for the Inner Belt Loop that was vetted further through additional studies supported by substantial public participation. Design of the roadway was initiated in 2009 and construction of Phase 1 was completed in 2014. The City of Billings has recently earmarked $7 million of their Capital Improvements Plan toward construction of the road, beginning in 2022. It is anticipated that the remaining $7 million needed to complete construction will be allocated for expenditure in 2024.

Design History

2009 Inner Belt Loop Design

Based on the recommendations from the 2006 planning study, the City of Billings contracted with Sanderson Stewart in 2009 to design the Inner Belt Loop as a two-lane rural highway with right-of-way that would accommodate future expansion to include an additional two lanes. The typical roadway section includes a 10-foot wide multi-use path. **Figure 2** (page 9) shows one version of the typical section. The preliminary design contemplated the management of stormwater using ditches, culverts, and retention areas. With the design completed to a 90% level in 2010, and lacking adequate funding for construction, the City made the decision to temporary suspend the project until funding for construction could be allocated.



2012 Skyway Drive Improvements

In 2012, the City of Billings completed design for an initial phase of the Inner Belt Loop project to build the first segment of the roadway from Wicks Lane to Alkali Creek Road.

Construction of Skyway Drive began in the early fall of 2013 and was completed the following spring with the roadway opening to traffic in mid-June of 2014.

In addition to the roadway, the section also includes a 10-foot wide multi-use path along the south side of the roadway.

2018 Zimmerman Trail Reconstruction Project

This project reconstructed Zimmerman Trail from Rimrock Road to MT 3, also constructing the roundabout at the MT 3/Zimmerman Trail intersection. The project included structural improvements to the rimrocks both above and below the road to improve the stability of the rock faces. Guardrail was replaced and signing updates were made to improve safety along the corridor. A pedestrian tunnel was constructed across Zimmerman Trail on the south leg of the roundabout for future connections to the Skyline Trail that will connect Zimmerman Park to Swords Park. The project was completed in late November of 2018.

Reference Documents/Projects

2006 Inner Beltloop Connection Planning Study

Alignment alternatives and intersection improvements were evaluated in the *2006 Inner Beltloop Connection Planning Study* by HKM Engineering. The study was prepared in 2005, with a series of public meetings, property owner meetings and neighborhood meetings. Additionally, the study was accepted by the Yellowstone County Planning Board (Nov 8, 2005), County Commissioners (Nov 28, 2005), Billings City Council (December 15, 2005), and Billings Policy Coordinating Committee (Dec 14, 2005).

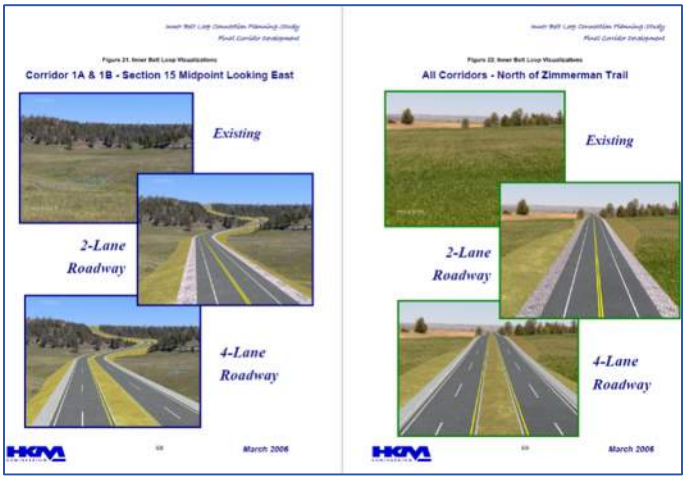


Figure 21. Inner Belt Loop Visualizations

Corridor 1A & 1B - Section 15 Midpoint Looking East

Existing

2-Lane Roadway

4-Lane Roadway

March 2006

Figure 22. Inner Belt Loop Visualizations

All Corridors - North of Zimmerman Trail

Existing

2-Lane Roadway

4-Lane Roadway

March 2006

2010 Billings Logan International Airport Master Plan

This master plan document provides an inventory of existing airport facilities, projects future airport demand, and evaluates alternatives for future improvements to the airport and surrounding areas. The master plan recommends future expansion of airport related land use to the west on MT 3, including additional hangars, an expanded rental car center and potential commercial development.

Billings Logan International Airport

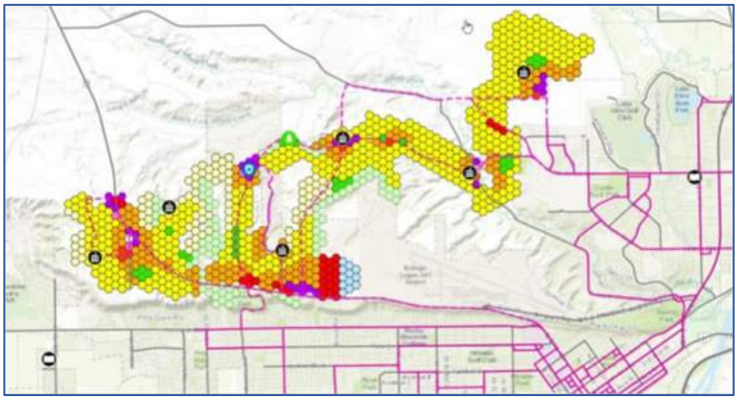
Billings, Montana

MASTER PLAN Executive Summary

March 2010

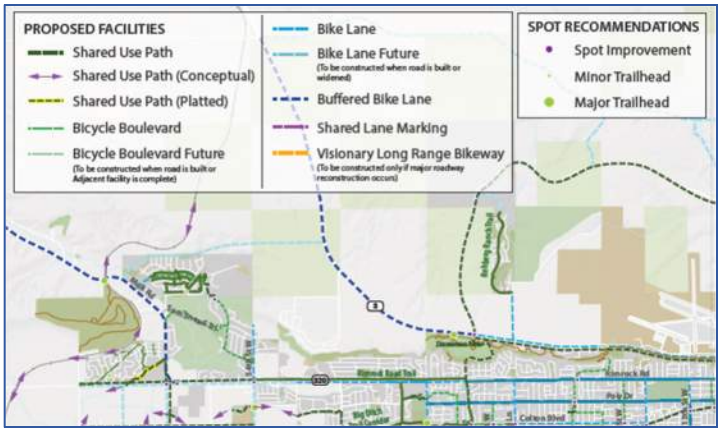
MEAD & HUNT

2016 City of Billings Growth Policy



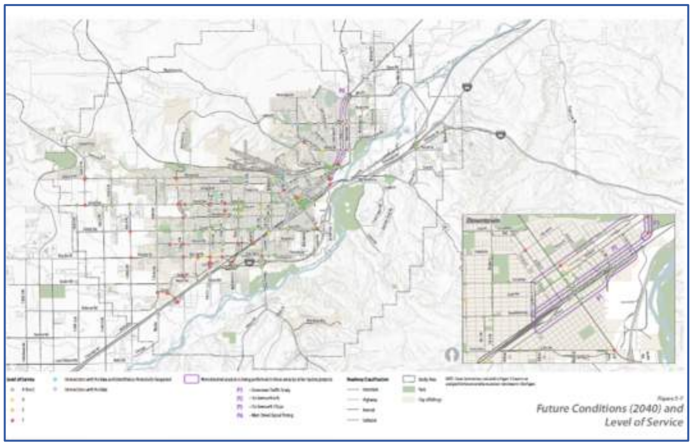
The *City of Billings Growth Policy* shows the land along the IBL corridor in the Long Range Urban Planning area, with the exception of the Rehberg Ranch property which has been annexed into the City. The growth scenarios included in the Growth Policy all suggest residential development adjacent to the corridor, with varying levels of density. The preferred scenario suggests most of the area be developed with medium density residential with nodes of high density residential and commercial development.

2017 Billings Area Bikeway & Trail Master Plan



This plan update provides short-term and long-term recommendations for improving mobility and recreational opportunities for bicyclists and other trail users in the Billings area. The list of recommended facility improvements includes a proposed multi-use trail along the Inner Belt Loop as well as various proposed and "future" bike lanes, buffered bike lanes, and multi-use trail facilities ("future" meaning that the facility is recommended at a point in time when the roadway is widened or reconstructed).

2018 Billings Urban Area Long Range Transportation Plan



The *Transportation Plan* identifies a variety of long-range, multi-modal transportation projects including and within the vicinity of the Inner Belt Loop. The Functional Classification Map (Figure 5-1 in that report) shows the Inner Belt Loop as a proposed principal arterial. Other anticipated future roadway connections in the vicinity of the Inner Belt Loop are also identified in the report. These proposed routes were considered through the travel demand modeling process for this study to evaluate their impacts on traffic demand along the Inner Belt Loop. Additionally, land development forecasting information from the *Transportation Plan* was utilized in the creation of land development forecast scenarios for this project.

Project ReCode, 2018-2020

Project ReCode is the City of Billings and Yellowstone County project to update the zoning regulations. The code updates will create changes to many aspects of the regulation. While the current draft of the updated zoning maps does not change the underlying zoning for the properties within the study area, it is likely that as development occurs near the Inner Belt Loop, City zoning will be applied. Evaluation of the code updates as it relates to development of the Inner Belt Loop will be important as the project continues and development becomes likely.

2018 Billings Fire Department Long Range Master Plan

The City of Billings contracted with Emergency Services Consulting International (ESCI) to complete this planning study intended to assist the City in future planning and provision of comprehensive emergency services to the citizens of the service area. The report evaluates current conditions within the agency (Billings Fire Department), projects future community growth and service demand, and provides recommendations to sustain or enhance current services over the next 10 to 15 years.

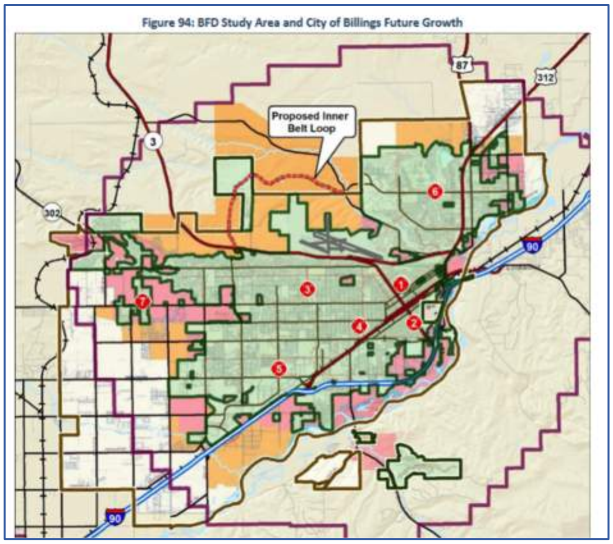
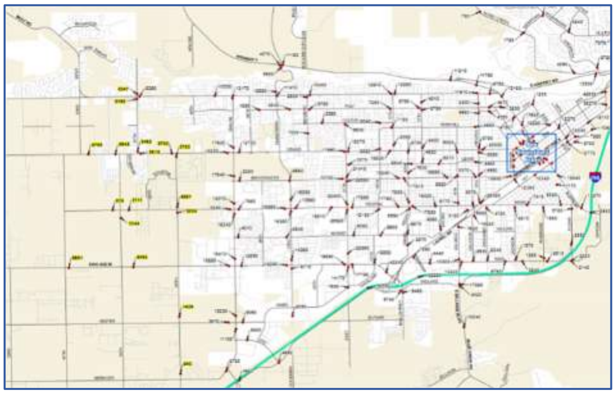


Figure 94: BFD Study Area and City of Billings Future Growth

Travel Demand Model

The Billings-Yellowstone County Metropolitan Planning Organization (MPO) contracted with Kittelson & Associates, Inc. in 2017 to develop and provide training for operation of a new travel demand model to help further community goals and improve transportation facilities and services in the Billings metropolitan area. The model has not yet been turned over to the MPO for operation but was available for use on this corridor study via coordination with Kittelson & Associates



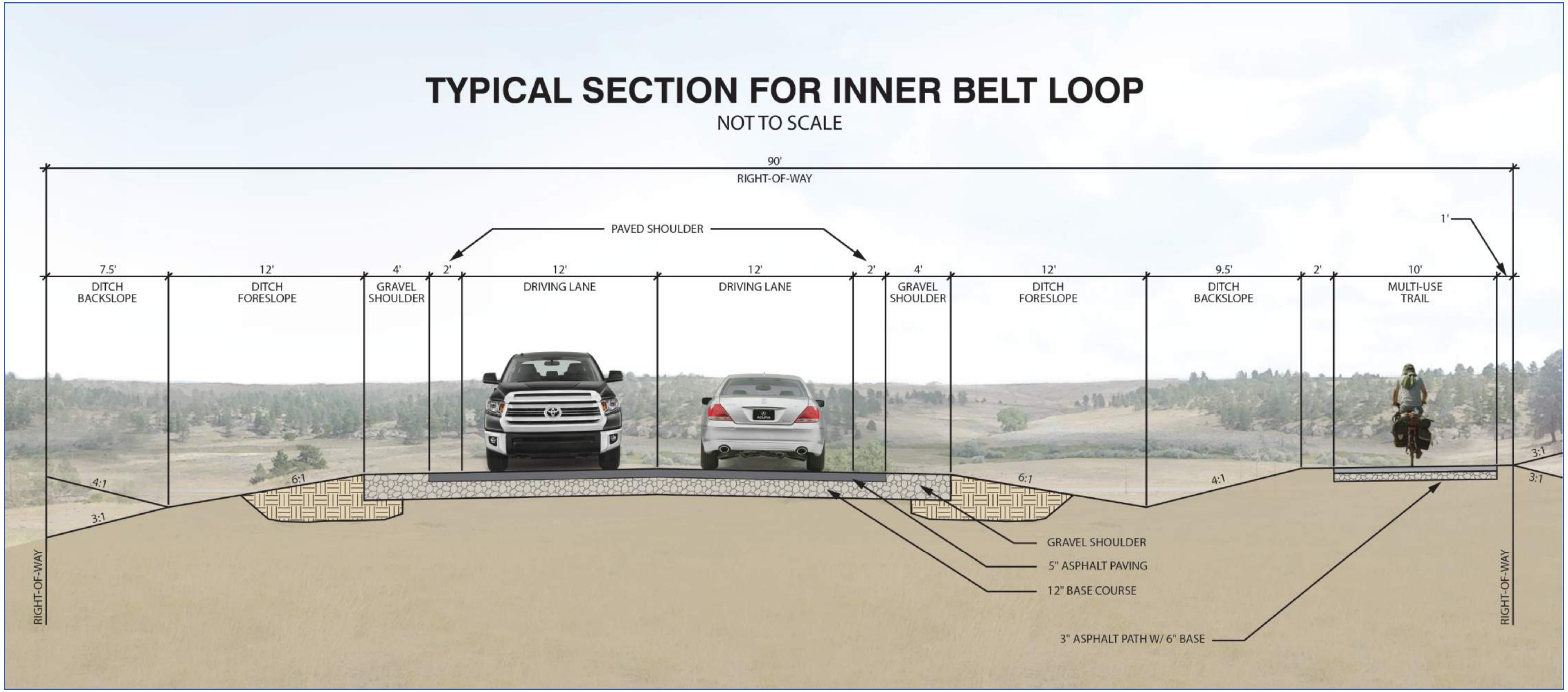
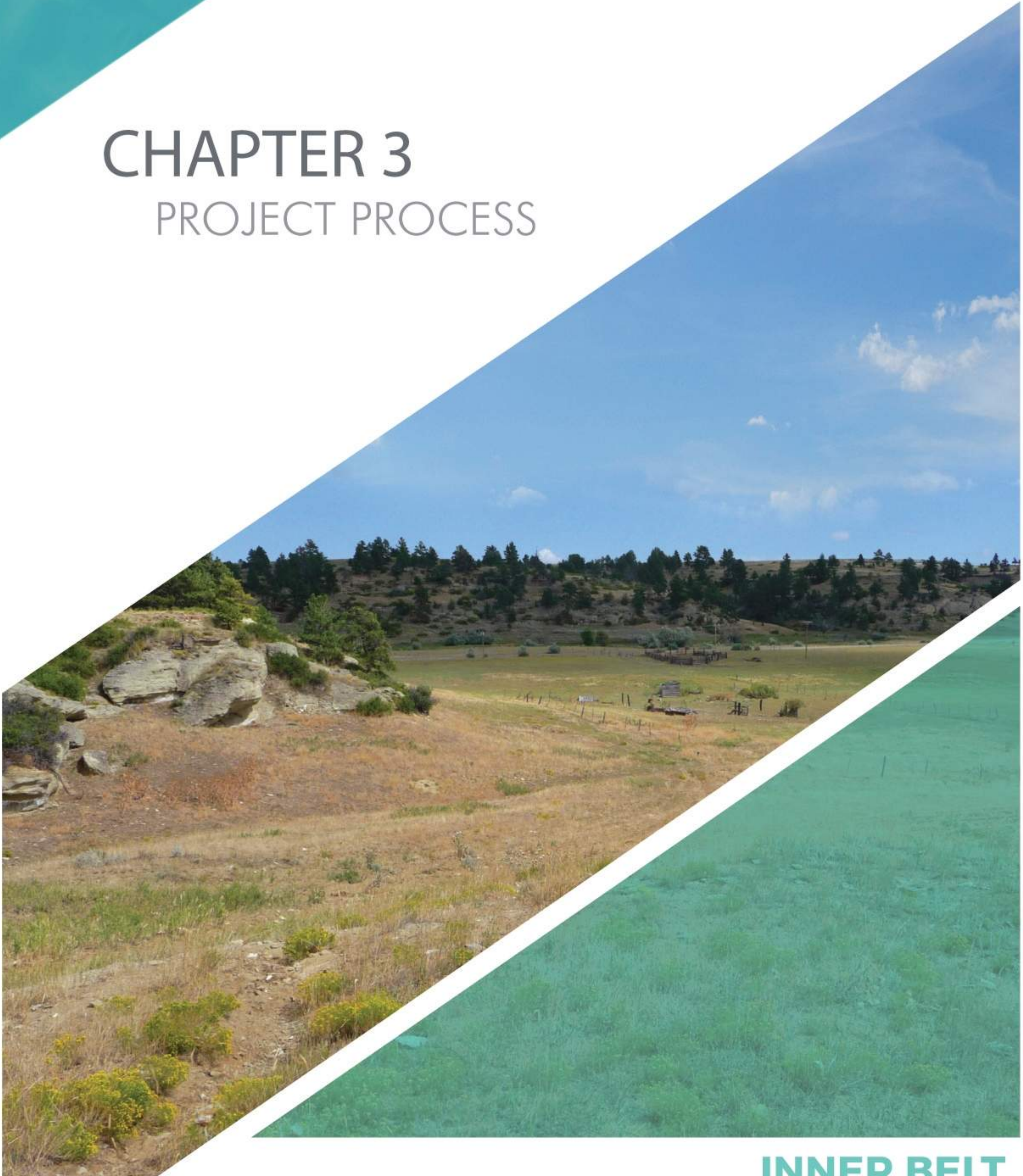


Figure 2: Preliminary Design Roadway Typical Section

CHAPTER 3

PROJECT PROCESS



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PROJECT PROCESS

The process to develop the vision for the future corridor included technical analysis, meetings to understand property owner and agency interests, projections of future development, visioning of land use and transportation, and recommendations. A summary of the project process is described below.

Technical Analysis

In this part of the process, an analysis of the existing conditions in and around the corridor, the suitability of the land for development, the locations of required utilities and infrastructure, current traffic conditions and a review of other pertinent planning documents was completed. The outcome of this analysis informed the remainder of the study.

Stakeholder Meetings

Early in the process, the consultant team and City staff met with the owners of the land adjacent to the Inner Belt Loop. The intent of these meetings was to understand the current use of the land, future plans that may include development of the property, and timing of any such development. There are eleven parcels with six distinct owners. See **Figure 3** (page 11) for parcel ownership information.

Input on the ability to expand public and private utilities was provided by the City of Billings Public Works Department, Montana Dakota Utilities, Northwestern Energy, Yellowstone Valley Electric Cooperative, Spectrum and Century Link.

The Project Oversight Committee (POC) was tasked with providing in-depth review and feedback on the study as it progressed. The Committee was made up of staff members from the City of Billings and Yellowstone County, elected and appointed officials, and community stakeholders. POC meetings were held monthly.

Projections of Future Development

Based on the technical analysis and meetings with landowners and agencies, areas for likely development were identified with consideration given for the likely timing of that development. From that, the consultant team generated two development forecast scenarios, a baseline and an aggressive, that included amount and type of development. These forecasts were then used in the traffic modeling and visioning.

Visioning for Traffic and Land Use

Based on the development projections and scenarios, the consultant team, staff and stakeholders suggested elements for the physical development of the corridor including land use, stormwater, and transportation. This vision lays out options for achieving the land use goals and addressing the traffic requirements.

Recommendations

Based on the goals of the project and for the corridor and the analysis, a set of recommendations were developed to anticipate and address future issues, generate the information needed for making future decisions including development feasibility and phasing.

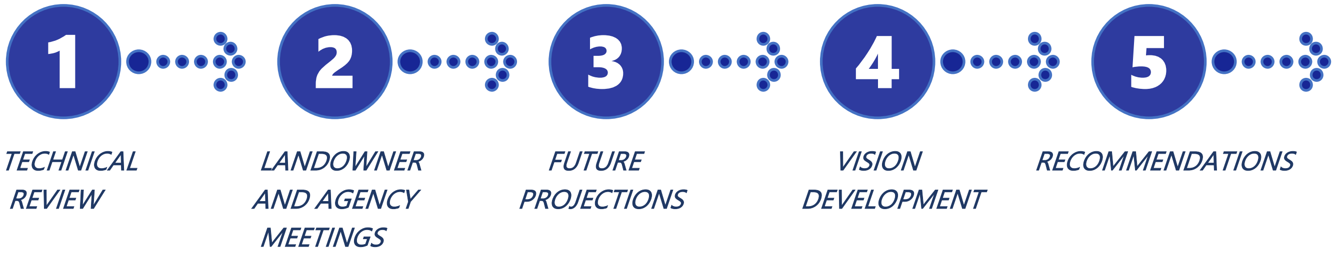
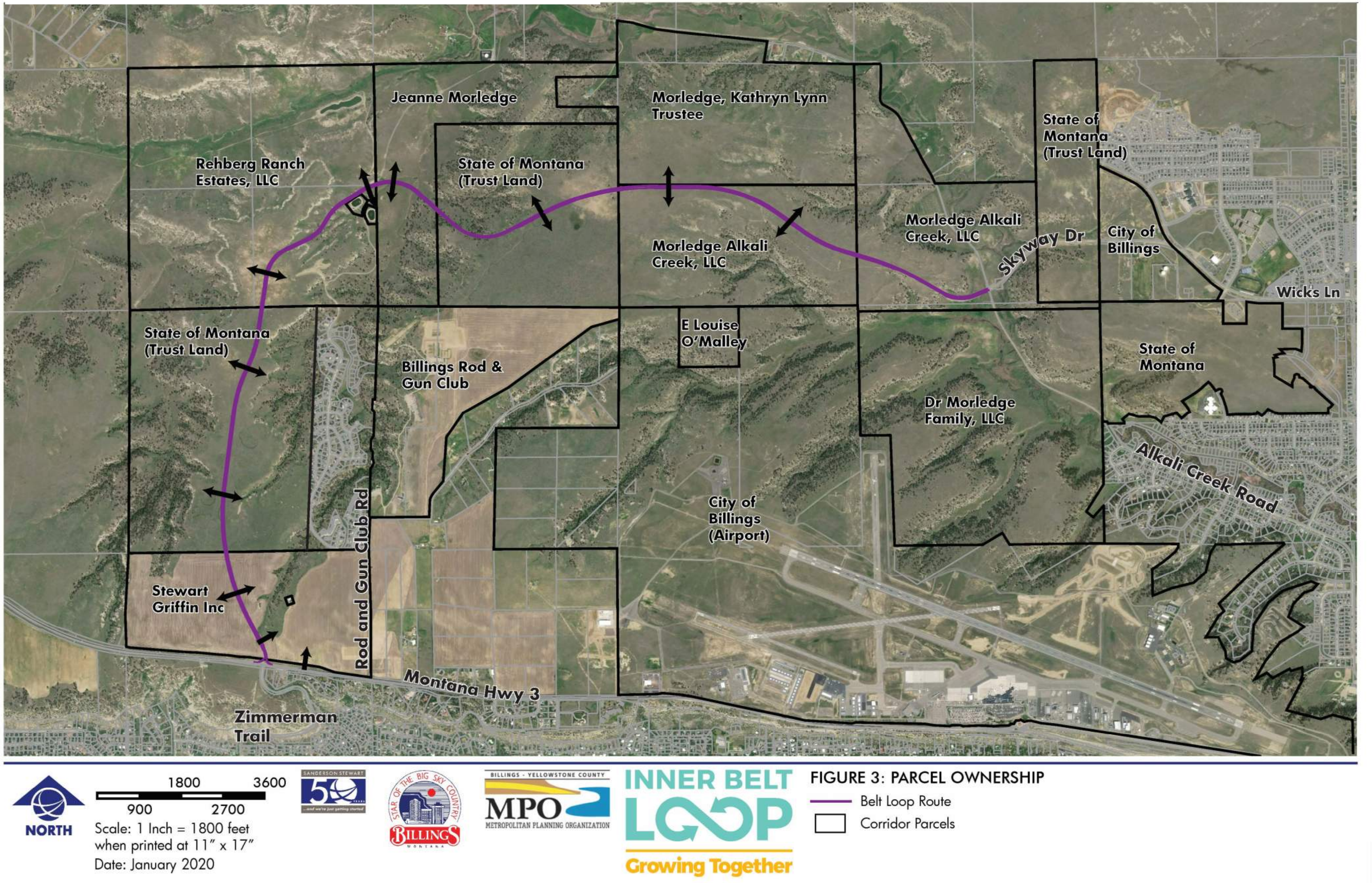
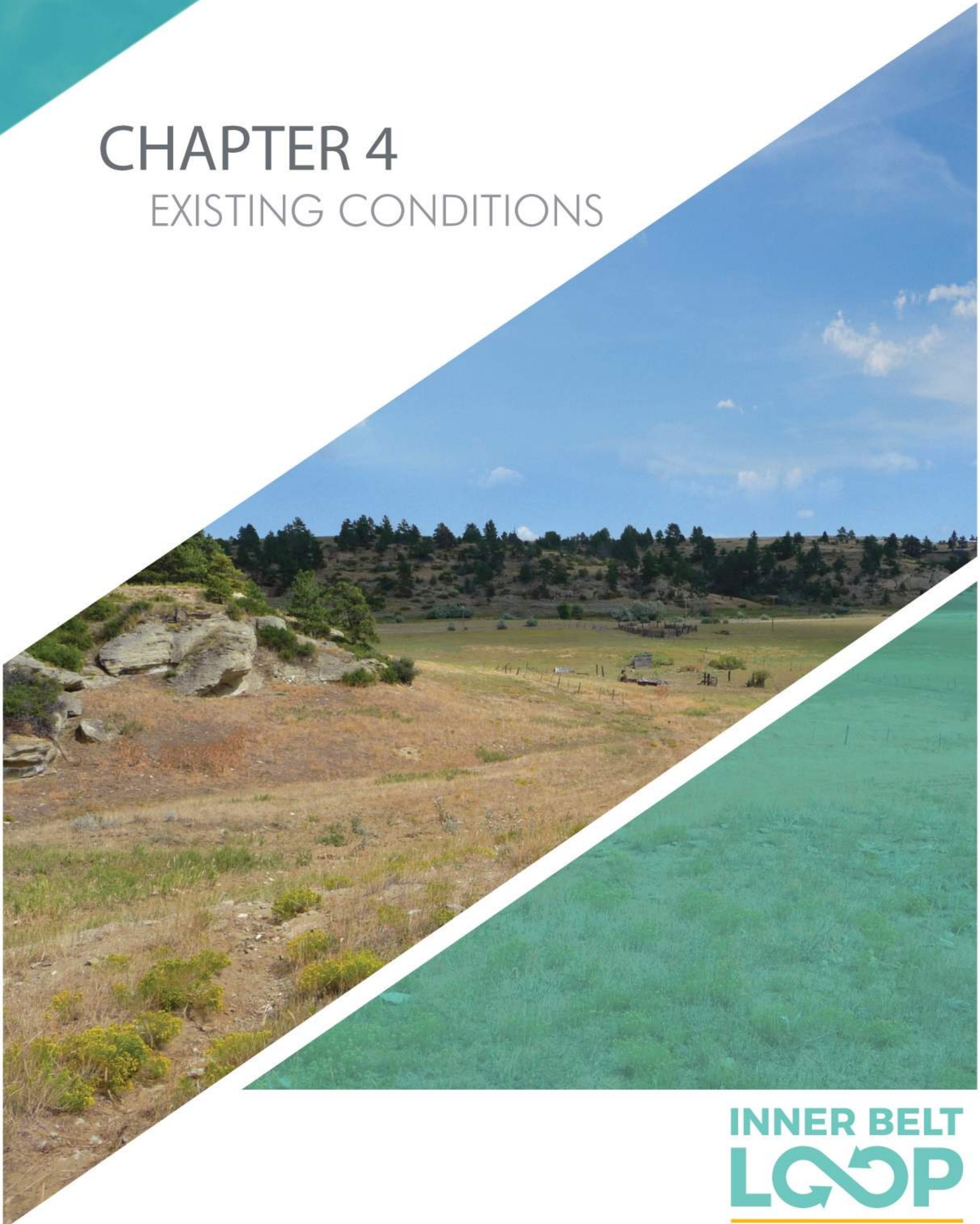


Figure 3: Parcel Ownership



CHAPTER 4

EXISTING CONDITIONS



INNER BELT LOOP

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EXISTING CONDITIONS

Land Use

Figure 4 (page 14) illustrates the current land uses near and along the corridor, which are primarily agricultural and grazing lands. While much of the land adjacent to the corridor is undeveloped and located within unincorporated Yellowstone County, there is some existing residential development in Rehberg Ranch. The Billings Logan International Airport is located just to the south of the corridor. At the eastern end of the corridor, there is significant existing and planned residential development.

The City of Billings adopted the *Annexation Policy* (Resolution No. 17-10618) that establishes policies and procedures for annexing property into the City and includes a Limits of Annexation Map that shows limits of annexation in two time periods, a City Annexation Petition Area and a Long Range Urban Planning Area. The Petition Area is coordinated with the City's Capital Improvements Plan and is generally recognized as land that can be served with City services within that time frame. The Long Range Urban Planning Area shows properties that are not immediately ready for City services. See **Figure 5** (page 15) for Limits of Annexation Map designations for the area surrounding the Inner Belt Loop. Areas not currently within the City Limits are within the Long Range Planning Area.

Utilities

Public water and sewer availability along the Inner Belt Loop corridor alignment is limited to the systems that were installed to support Rehberg Ranch Subdivision. There is an existing, 16-inch water main that extends north from MT 3 along Rod and Gun Club Road to serve Rehberg Ranch. A branch of that same water main also extends west along MT 3 to terminate a few hundred feet east of the Zimmerman Trail roundabout.

Rehberg Ranch Subdivision is served by a low-pressure sanitary sewer system that pumps sewage effluent to a series of lagoons and surface application fields that are maintained by the City of Billings. The nearest available public sewer facilities at the south end of the corridor consist of low-pressure system that serves the residential area on top of the rims to the east of Zimmerman Trail and an existing 8-inch gravity main that begins at Masterson Circle and extends down the rims to tie into the overall network below. The nearest connection point to the gravity system is more than 6000 feet to the east of Zimmerman Trail.

At the east end of the Inner Belt Loop corridor there are sanitary sewer gravity mains located in Alkali Creek Road, approximately 7500 feet from the Skyway Drive intersection, and in Wicks Lane approximately 500 feet southeast of where Skyway Drive begins. Water main connection points are also available in the same approximate locations on Alkali Creek Road and Wicks Lane. **Figure 6** (page 16) shows the locations of the nearby public water mains and pressure zone boundaries and **Figure 7** (page 17) shows locations of sewer mains.

Emergency Services

Billings Fire Department

The Billings Fire Department (BFD) provides fire and emergency medical services (EMS) coverage for the City of Billings (approximately 44 square miles of coverage area), as well as the Billings Urban Fire Service Area (BUFSA) which contributes approximately 48 additional square miles of service area that lays outside of City limits. The BUFSA is an independent fire protection district that is served by BFD on a contract-basis with Yellowstone County. **Figure 8** (page 18) shows the relative coverage area limits overlaid with the Inner Belt Loop alignment. The majority of the study area falls outside of the BFD coverage area, and only the segment that bisects Rehberg Ranch Subdivision (including future phases) falls within the City limits coverage area. The portions of the Inner Belt Loop alignment and adjacent properties that don't currently fall under BFD jurisdiction are the responsibility of the Fuego Volunteer Fire Department (VFD), a non-profit, volunteer-based organization with fewer than 10 members and limited resources, particularly for responding to structural fires.

The Fire Department Long Range Master Plan completed in 2018 indicated that BFD is unable to meet National Fire Protection Association (NFPA) recommended standards for incident response times within the coverage area due primarily to not having fire stations located in close enough proximity to portions of the service area. Conversations with the BFD for this project confirmed that the biggest challenges related to meeting national standards are rooted in availability of manpower and infrastructure given the sprawling growth that is occurring in the outlying areas of Billings. It should be noted that the master plan gives the BFD high marks for administration and operations efficiency given the resources that are available to the department.

Billings Police Department

The Billings Police Department (BPD) also faces challenges with respect to providing desired patrol coverage, particularly during incidents that require emergency response from BPD. Based on discussions with BPD with respect to this study, the primary challenge in this case stems from a lack of dedicated manpower relative to the area of jurisdiction. For example, the "Heights" region of Billings, which was estimated to have a population of approximately 31,000 people by the United States Census Bureau *2017 American Community Survey*, typically has two or occasionally four officers patrolling that expansive area at any given time depending upon shift overlaps. When an incident occurs in another part of the urban area that requires response from those officers, patrol and emergency response coverage for the Heights may then be temporarily compromised further or negated entirely.

Figure 4: Zoning and Land Use

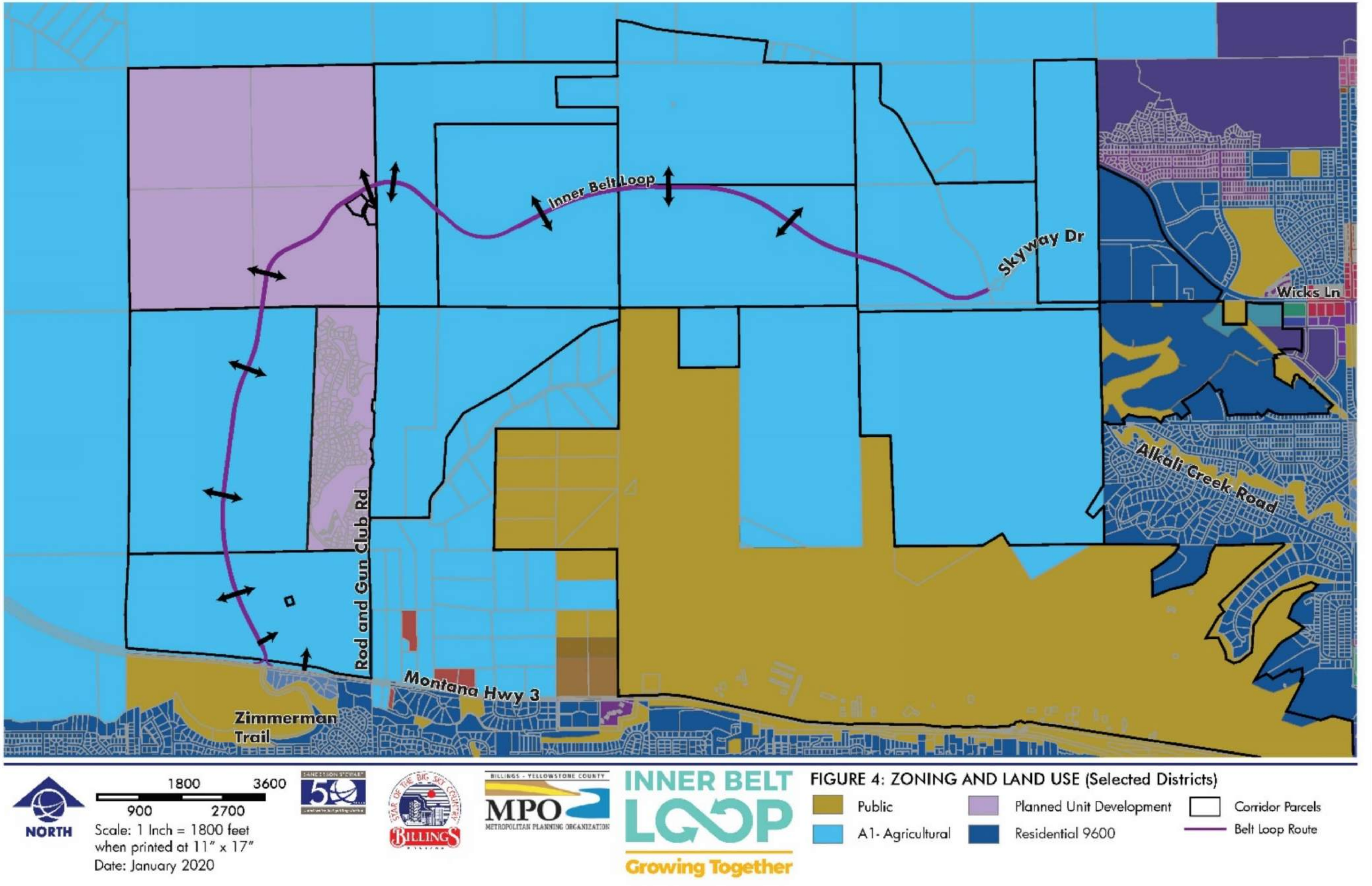


Figure 5: City Limits and Limits of Annexation Map

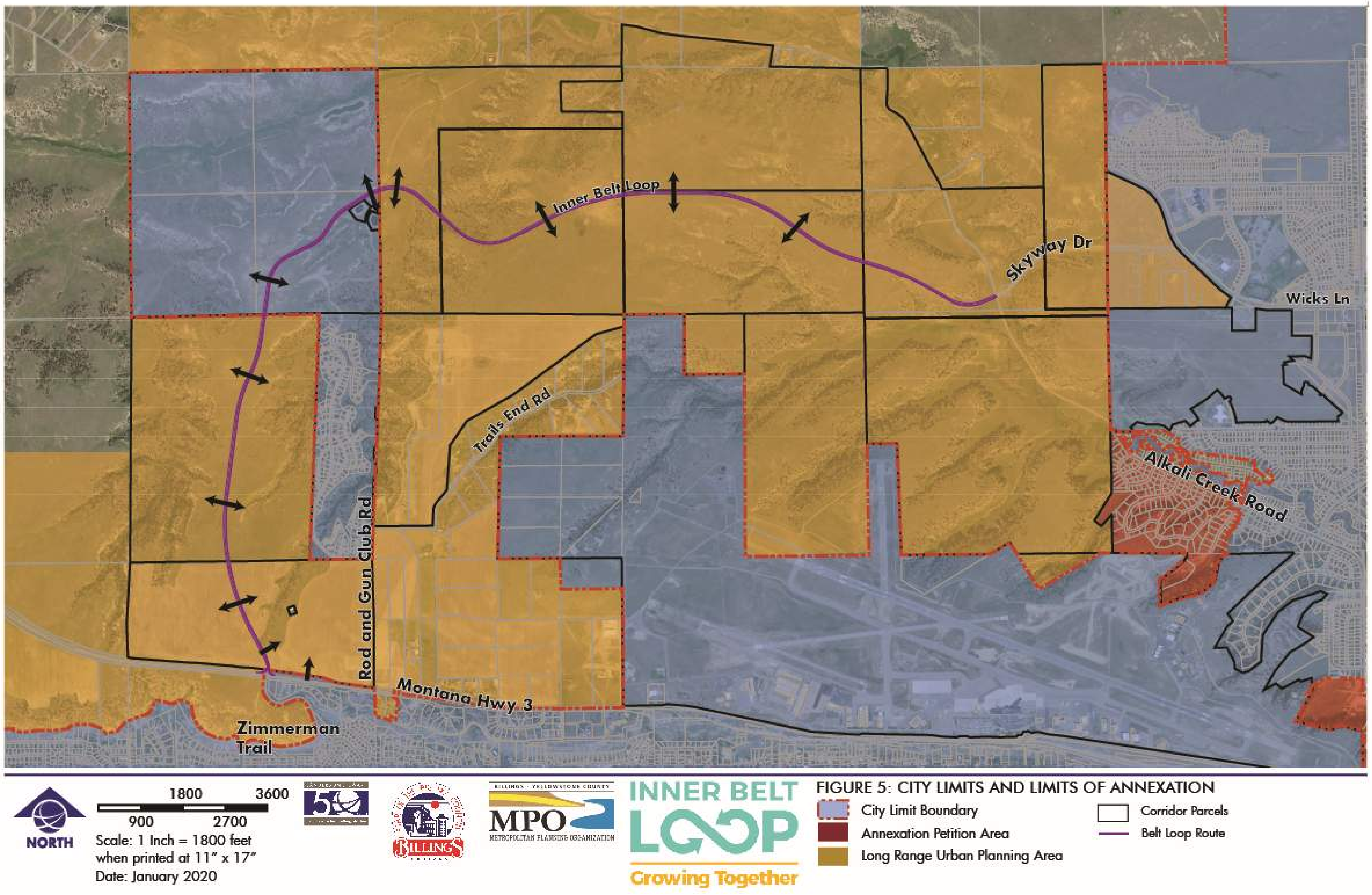


Figure 6: Existing Public Water Mains and Pressure Zones

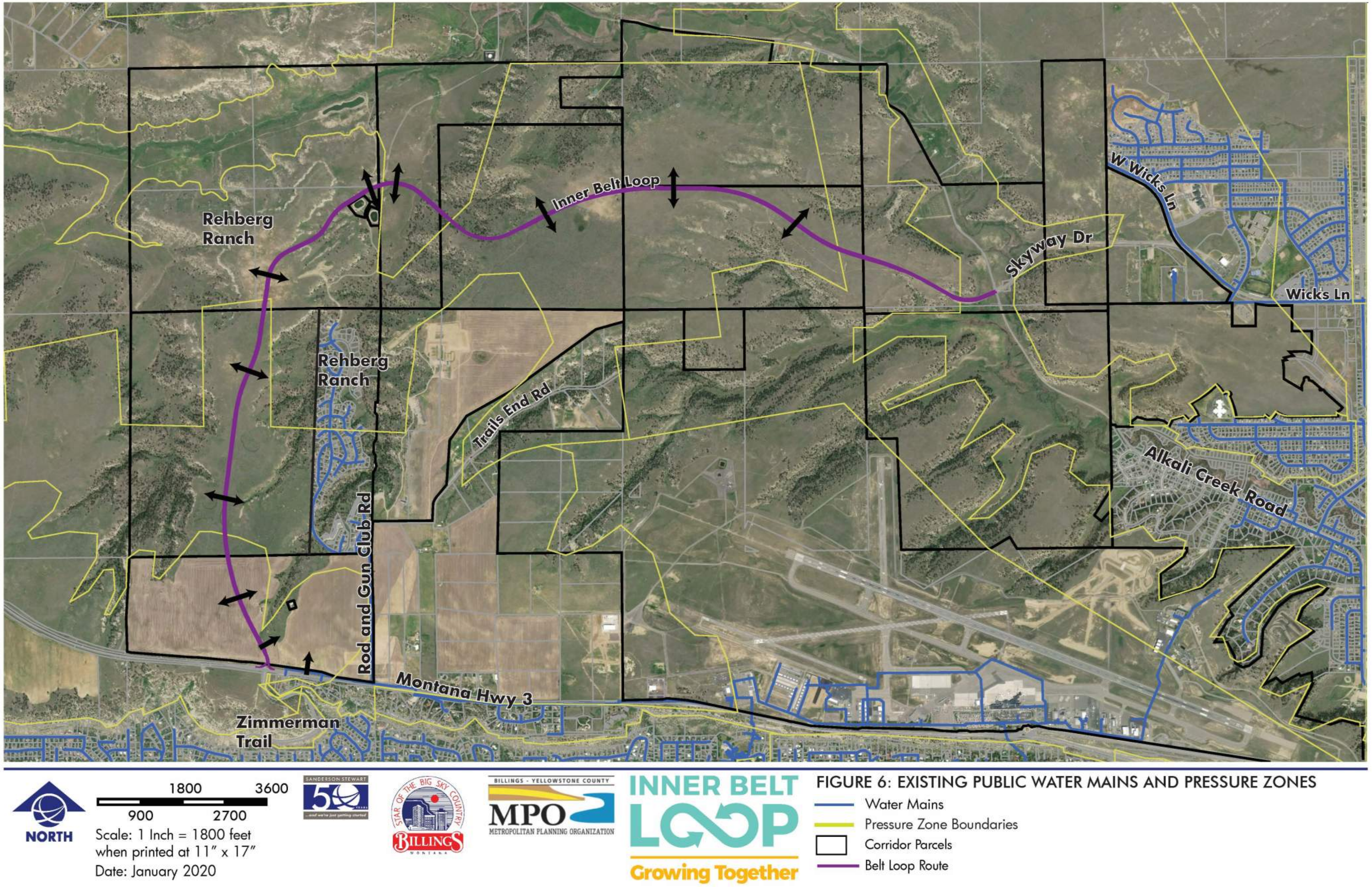


Figure 7: Existing Public Sanitary Sewer Mains

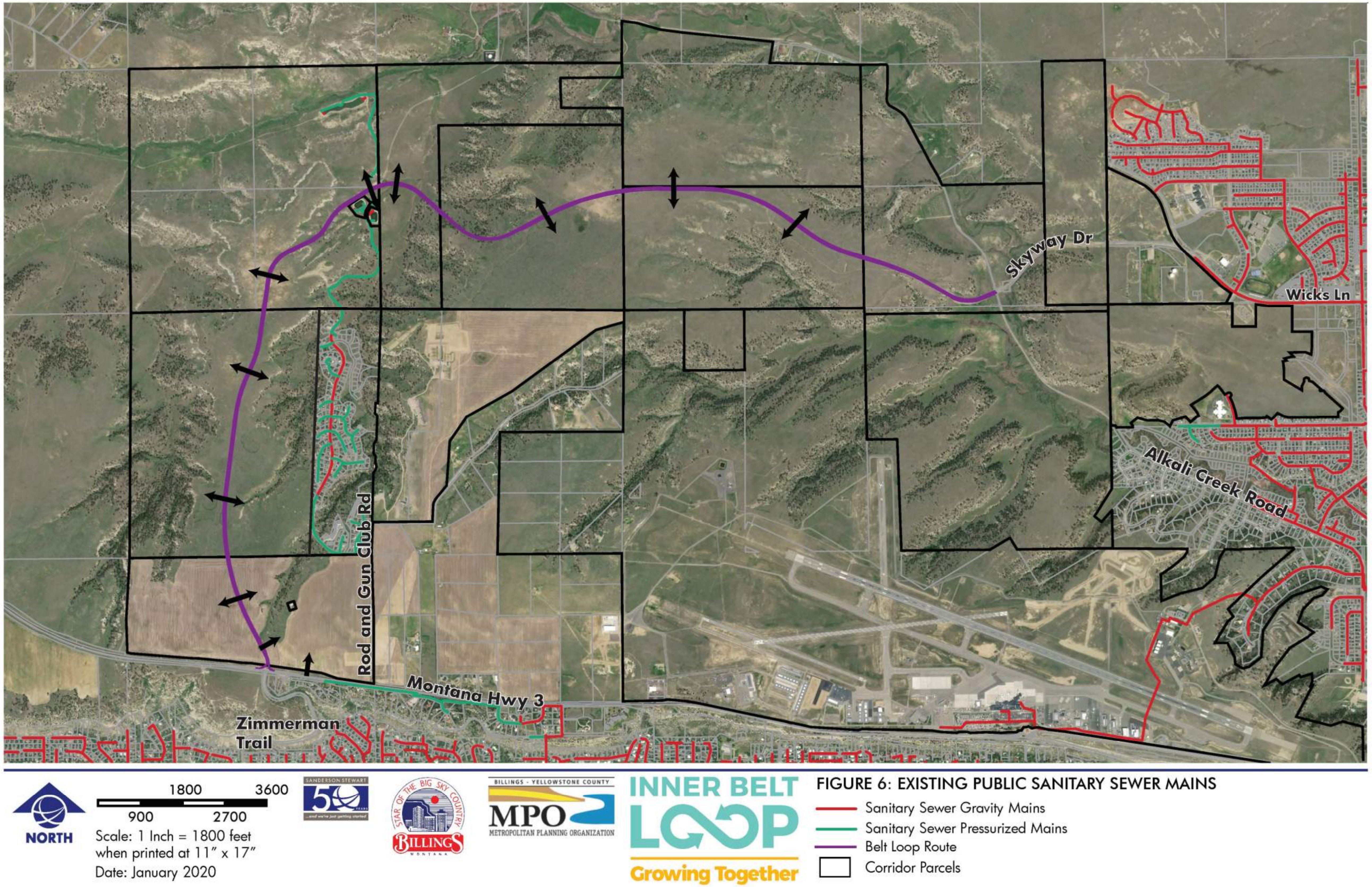
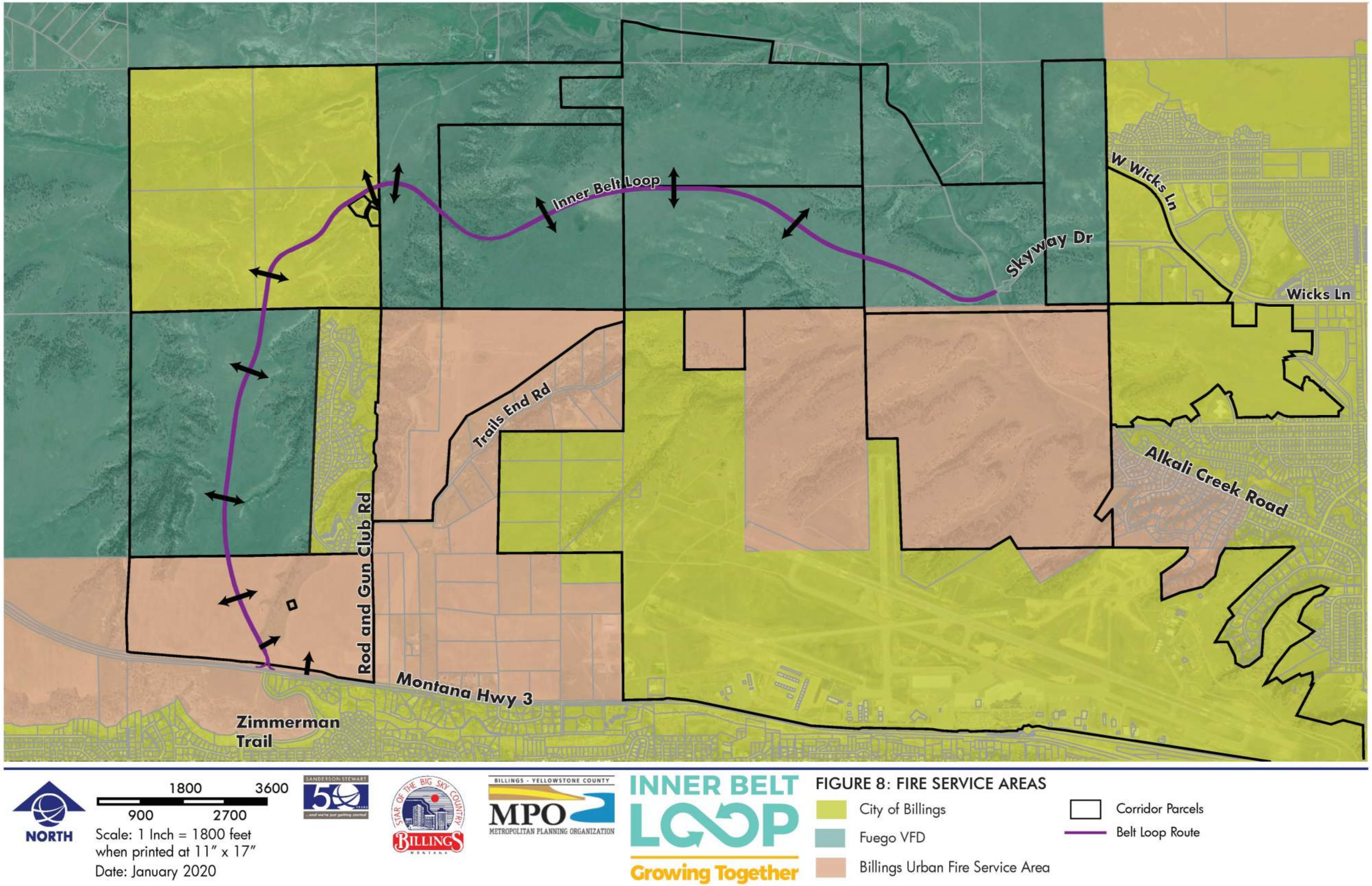


Figure 8: Fire Service Areas



Transportation

Roadway/Facilities Network

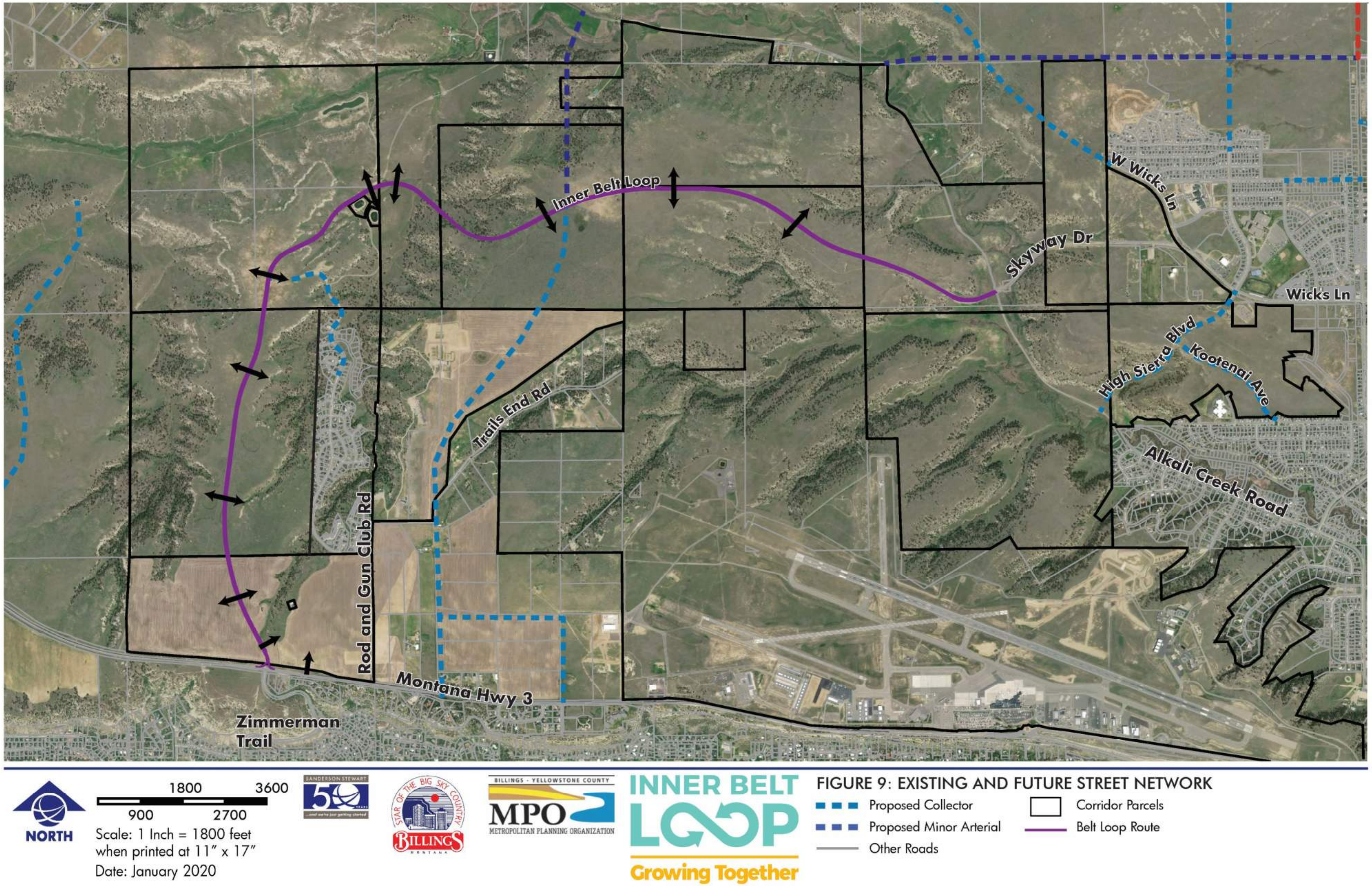
The area traversed by the Inner Belt Loop contains very few in the way of existing roads. **Figure 9** (next page) shows the existing street network, along with the proposed Inner Belt Loop alignment and future road network as described in the *2018 Billings Urban Area Long Range Transportation Plan*. There is an existing road network in the vicinity of the southwest end of the corridor that serves Rehberg Ranch Subdivision, the Billings Rod and Gun Club, and the rural residential neighborhood along Trails End Road. The south terminus of the Inner Belt Loop will tie into MT 3 (MT 3) at a roundabout that was recently constructed as part of the Zimmerman Trail Reconstruction project. The roundabout has a single-lane configuration supplemented with a northbound dedicated right-turn bay at the intersection.

At the east end of the Inner Belt Loop corridor, Alkali Creek Road connects the Alkali Creek neighborhood to Skyway Drive (Phase 1 of the Inner Belt Loop) and to MT 3. Skyway Drive connects to Wicks Lane in the immediate vicinity of Skyview High School, Harvest Church, and High Sierra Subdivision in an area of Billings that has been growing steadily over the past couple decades. The Alkali Creek Road/Skyway Drive intersection is a stop-controlled “T” intersection (stop sign on westbound Skyway Drive approach) with no auxiliary turn lanes. The Wicks Lane/Skyway Drive/West Wicks Lane intersection is also a stop-controlled “T” intersection (stop sign on southbound West Wicks Lane approach). The intersection has a left-turn lane on the eastbound approach, a right-turn lane on the westbound approach, and separate left-turn and right-turn lanes on the stop-controlled southbound approach.

The MT 3/Zimmerman Trail roundabout

The Alkali Creek Road/Skyway Drive intersection

Figure 9: Existing and Future Street Network



Trail Facilities

In terms of dedicated pedestrian and bicycle facilities, the Zimmerman Trail Reconstruction project installed a multi-use path underpass on the south leg of the MT 3/Zimmerman Trail roundabout along with a 10-ft asphalt multi-use trail that extends east to Zimmerman Place (a local, residential street) and west to Zimmerman Park. The multi-use trail installation constitutes Phase 1 of the Skyline Trail project, which will ultimately construct a 10-foot multi-use trail all the way from Zimmerman Park to Swords Park along the rims. The MT 3/Zimmerman Trail roundabout has concrete boulevard sidewalk in all four quadrants with marked crosswalks on each leg of the intersection.

At the east end of the corridor, the Phase 1 Inner Belt Loop project constructed a 10-foot asphalt multi-use trail along the south side of Skyway Drive that ties into a recently constructed trail along the south side of Wicks Lane extending to the Wicks Lane/Governors Boulevard/Gleneagles Boulevard intersection. There is a marked crosswalk on the east leg of the Wicks Lane/Skyway Drive/West Wicks Lane intersection, though there is currently no sidewalk or trail facility on the north side of the road. There are no on-street bicycle lanes along any of the routes at either end of the Inner Belt Loop corridor.

The gravel multi-use trail that connects Zimmerman Trail to the MT 3/Zimmerman Trail roundabout

The asphalt multi-use trail on Skyway Drive

Traffic Volumes

Traffic data was collected at key locations at both ends of the Inner Belt Loop corridor for purposes of establishing typical daily and peak period traffic volumes for use in analysis and as a basis for projecting future traffic demand. Raw data was collected using Miovision Scout camera systems and then adjusted for daily and season variation using Montana Department of Transportation's (MDT) most current (2018) seasonal adjustment factors. Data was collected for intersections of Skyway Drive with Alkali Creek Road and Wicks Lane on Wednesday, April 24 and at the MT 3/Zimmerman Trail intersection on Wednesday, May 8. The morning peak period was found to occur from 7:15-8:15 AM for all three intersections. The evening peaks for the Skyway Drive intersections were from 5:00-6:00 PM, whereas for the MT 3/Zimmerman Trail intersection, the evening peak occurred from 4:45-5:45 PM. Figure 10 (next page) illustrates the Existing Conditions (2019) peak hour and annual average daily traffic (AADT) volumes that were calculated through this analysis.

Traffic Operations

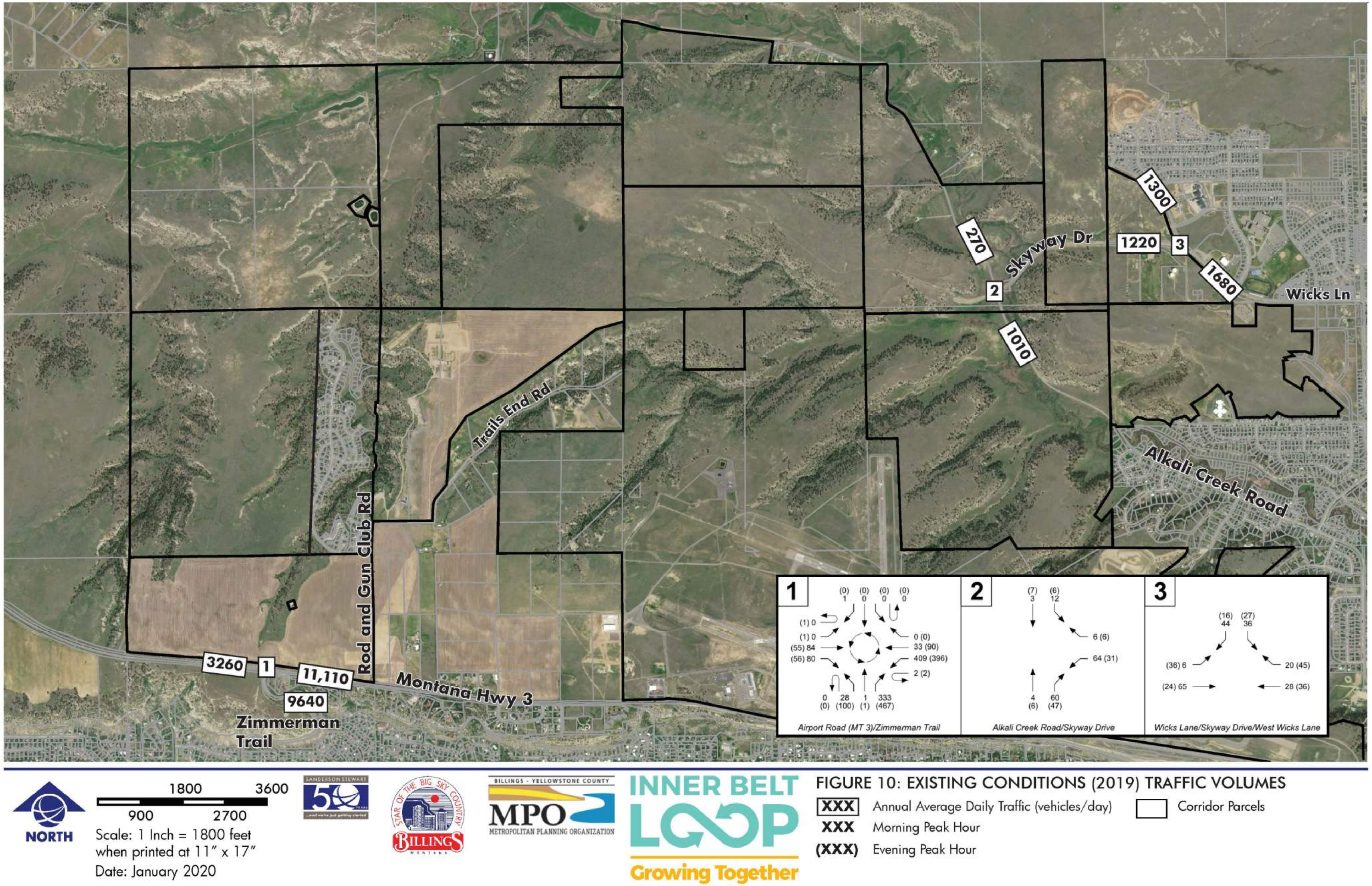
Existing Conditions (2019) intersection capacity calculations were performed for the study area intersections using Highway Capacity Software (HCS7) for the unsignalized intersections and SIDRA Intersection for the roundabout. Level of service (LOS) is defined as a quality measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience. LOS is a quantitative measure of the performance of an intersection with values ranging from LOS A, indicating good operation and low vehicle delays, to LOS F, which indicates congestion and longer vehicle delays. LOS C is typically considered a minimum acceptable threshold for operations in Billings, though exceptions are made in certain cases.

The results of the Existing Conditions (2019) intersection capacity calculations showed that all three of the study area intersections analyzed currently have all approaches operating at LOS A during typical morning and evening peak periods with virtually no problems related to queuing. Table 1 below displays the key metrics for the capacity calculations. Detailed capacity calculation worksheets for the Existing Conditions (2019) analysis are attached in Appendix C.

Table 1: Existing Conditions (2019) Peak Hour Intersection Capacity

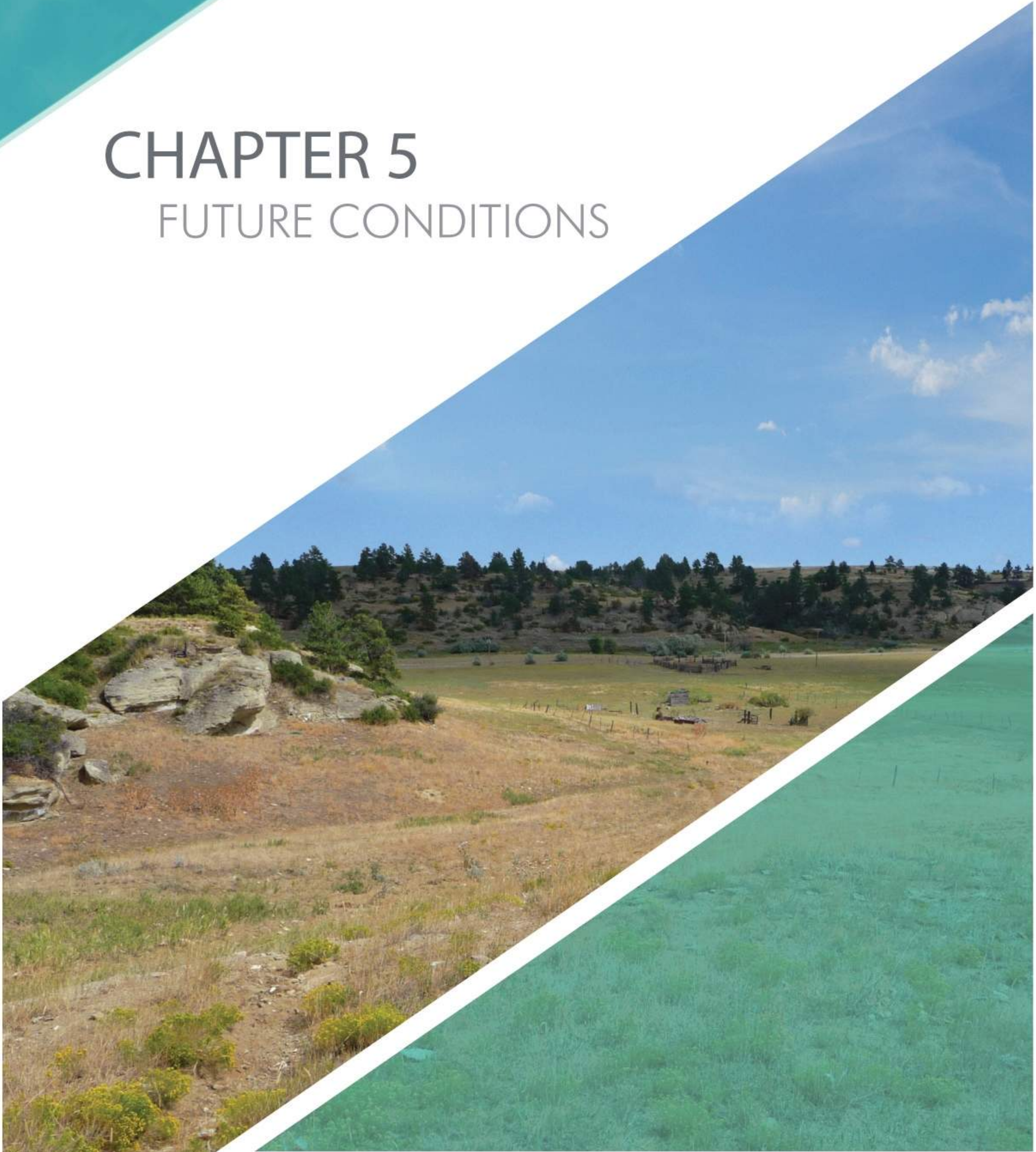
			AM PEAK			PM PEAK		
INTERSECTION	Intersection Control	Approach	Avg Delay (s/veh)	Level of Service	Max Queue (vehicles)	Avg Delay (s/veh)	Level of Service	Max Queue (vehicles)
MT 3 - Zimmerman Trail		NB	5.6	A	2	5.8	A	3
		SB	4.9	A	0	5.0	A	0
		EB	7.5	A	2	6.5	A	1
		WB	7.2	A	3	7.5	A	3
Alkali Creek Road - Skyway Drive	STOP	NB						
		SB	5.9	A	0	3.5	A	0
		WB	9.4	A	1	8.9	A	1
Wicks Lane/Skyway Drive - West Wicks Lane	STOP	SB	9.0	A	1	9.4	A	1
		EB	0.7	A	0	4.5	A	1
		WB		(NO DELAY)			(NO DELAY)	

Figure 10: Existing Conditions (2019) Traffic Volumes



CHAPTER 5

FUTURE CONDITIONS



INNER BELT LOOP

Growing Together

FUTURE CONDITIONS

Based on conversations with property owners and the Project Oversight Committee, the consultant team performed an analysis of potential land development along the Inner Belt Loop corridor. Ultimately two iterations of land use scenarios were chosen to analyze for development potential and traffic analysis. These land use projections were based on an analysis of the physical conditions, feasibility of infrastructure service, public services, and future land use potential. From this analysis, an identification of developable areas was created and assumptions regarding the type of land use were determined in order to evaluate future traffic conditions and transportation needs.

Development Areas

As a first step in determining potential development areas along the corridor, a series of physical site conditions were analyzed. A summary of the analysis is provided below.

Topography

The topography along the Inner Belt Loop corridor is varied. Generally, it consists of flat highlands crossed with steep drainages leading to low points at Alkali Creek to the north and east. Using a Digital Elevation Model sourced from the State of Montana, a slope map was created in GIS. For the purpose of analysis, areas with a slope of greater than 20 percent were excluded from the buildable areas. While it is possible to build on areas with greater slopes, and in fact permitted by Section 23-404. (b) of the *Billings Municipal Code,* 20 percent slopes, as calculated from aerial imagery, is a reasonable cut off to begin to establish development area. See **Figure 11** (page 27) for results of the slope analysis.

Wetlands and flood zones

Alkali Creek includes associated flood plain and wetlands. While some development could be permitted within these areas, for the purposes of estimated developable areas, land adjacent to Alkali Creek that is within flood zones or wetlands are excluded from the developable areas. There are likely additional wetlands located within the study area but are not necessarily mapped. Without a more detailed study, it is not possible to determine if these wetlands are able to be included within the developable areas. Generally, aside from the Alkali Creek area, the land within the study area is arid and therefore, large areas of wetlands are not likely to constrain future development. See **Figure 12** (page 28) for the Alkali Creek flood zones and wetland areas.

Access and Connecting Road Network

The Functional Classification Map from the most recent *Transportation Plan* shows proposed Principal and Minor Arterials and Collectors. As proposed, there will be limited connection between the Inner Belt Loop and the larger road network (**Figure 9**, page 20). In evaluating potential development area, access from the future street network was considered and will likely influence the location for future development.

Utilities

The consultant team solicited the expertise of the City of Billings Public Works Department, Engineering Division to assess the ability to extend public water and sewer services to serve future development areas. While limited development may be able to be served with private sewer and water systems, either by on-site services such as septic systems and/or wells/cisterns, or a private community system, development at urban densities will likely require the capacity of a municipal water and sewer system.

Water

The Existing Conditions chapter of this report provided a summary of the closest-proximity locations for existing public water system infrastructure that could serve as connection points to provide water service for users along the Inner Belt Loop. However, an additional consideration for providing water service to end users along the Inner Belt Loop is water pressure. The dramatic changes in elevation that occur along the Inner Belt Loop alignment would, without the benefit of additional infrastructure to increase or reduce water pressure, cause end user water pressures to be too high or too low at various points in the system. In support of this study, the City of Billings Public Works Department, Engineering Division performed an analysis of likely pressure zone locations. **Figure 13** (page 29) illustrates how many different pressure zones would be required to provide adequate end user water pressure. It also depicts estimated developable acres within each pressure zone (see discussion of developable area below). The additional infrastructure required to regulate pressure for a public water system along the Inner Belt Loop would most likely be very expensive depending upon the number of zones. At this time, detailed cost estimates for public water and sewer extensions along the Inner Belt Loop are not available.

The existing water main that serves Rehberg Ranch Subdivision is currently a dead-end line. The lack of redundancy in that system presents risk of widespread loss of service in the case of a water main break. As such, there is a desire by the City to "loop" that water main back to the main in MT 3 to provide redundancy in that system. This would represent an additional benefit of providing water main along the Inner Belt Loop between MT 3 and Rehberg Ranch Subdivision.

Property owners could also consider drilling wells to provide water service, but the geologic characteristics of that area (shallow bedrock) would make well service challenging. Furthermore, the allowable density of development would be reduced based on standard DEQ requirements for lot size for properties served by water wells. This would also not be desirable for the City of Billings, because properties with domestic water service by private well would not be allowed to annex into the City and thus would not contribute to the tax base.

Sewer

The existing public sanitary sewer system that serves Rehberg Ranch subdivision was designed with reserve capacity to serve future phases of that development. That system may also be able to support some additional areas of development in that vicinity, though doing so would likely require an expansion of the property available for surface application of the treated effluent. The City of Billings Public Works Department, Engineering Division considers this option to be an interim solution only. The long-term goal would still be to extend one or more sanitary sewer mains along the Inner Belt Loop alignment to provide gravity sewer connectivity (likely supplemented with one or more lift stations) for the bulk of the area. For approximately the east half of the corridor, a gravity main connecting to the existing system in Alkali Creek Road could serve properties along that stretch. However, the cost of extending the sanitary sewer gravity main would be substantial.

If public water and sewer systems are not extended to certain areas in the Inner Belt Loop corridor, the development potential in those areas will likely be dampened considerably. This would be due to both the density restrictions for development where public sewer and water is not available and given the relative difficultly of providing private sewer and water systems on a large scale.

Drainage

The current design for the Inner Belt Loop proposes that storm water and drainage would be managed via a system of roadside borrow ditches with culverts under cross-street, driveway, and farm field approaches and crossing culverts at key locations where runoff can be discharged from the borrow ditches. The conveyance system was designed to accommodate the 10-year, 24-hour design storm in accordance with City of Billings and Montana Department of Environmental Quality (DEQ) requirements from that timeframe. When the final design is completed, adjustments may be necessary to bring the design in compliance with current requirements in the City of Billings *Stormwater Management Manual* (February 2018).

Airport Influence Zone

The Billings Logan International Airport is located south of the corridor. Development in and around the airport was evaluated for compatibility with airports and aircraft noise. As shown on **Figure 14** (page 30), some properties within the study area are impacted. While this does not limit the ability to develop the property, it may affect the interest in people living and working in an area with aircraft noise.

Identification of Development Areas

An analysis of the preceding information resulted in the identification of potential development areas (**Figure 15**, page 31). A total of approximately 2,300 acres was identified as having development potential. The timing and viability of development in all of these areas was not evaluated as part of this study but were used as the basis of the development scenarios described below.

Figure 11: Topography and Slope Analysis

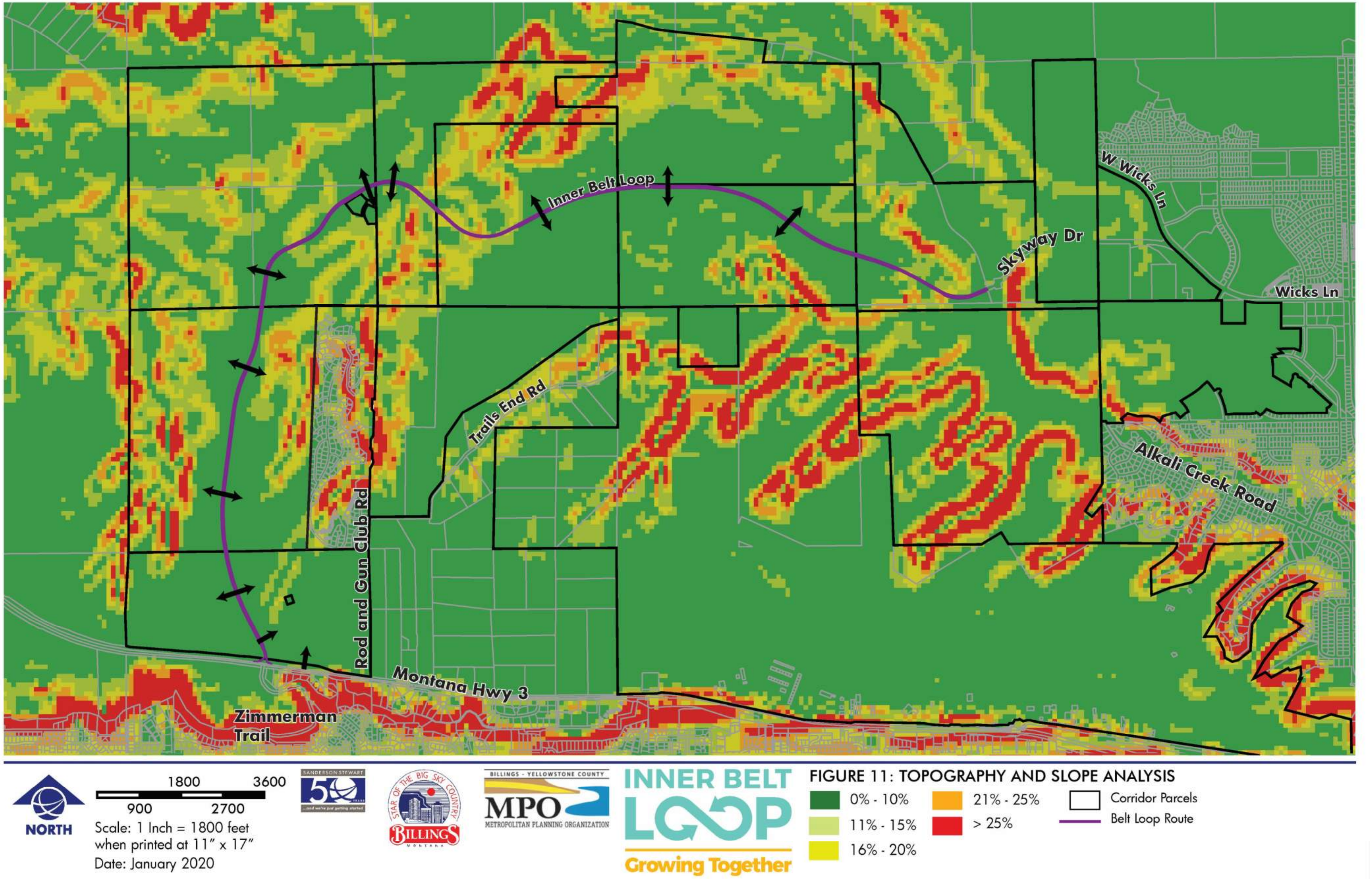


Figure 12: Alkali Creek Flood Zones and Wetlands

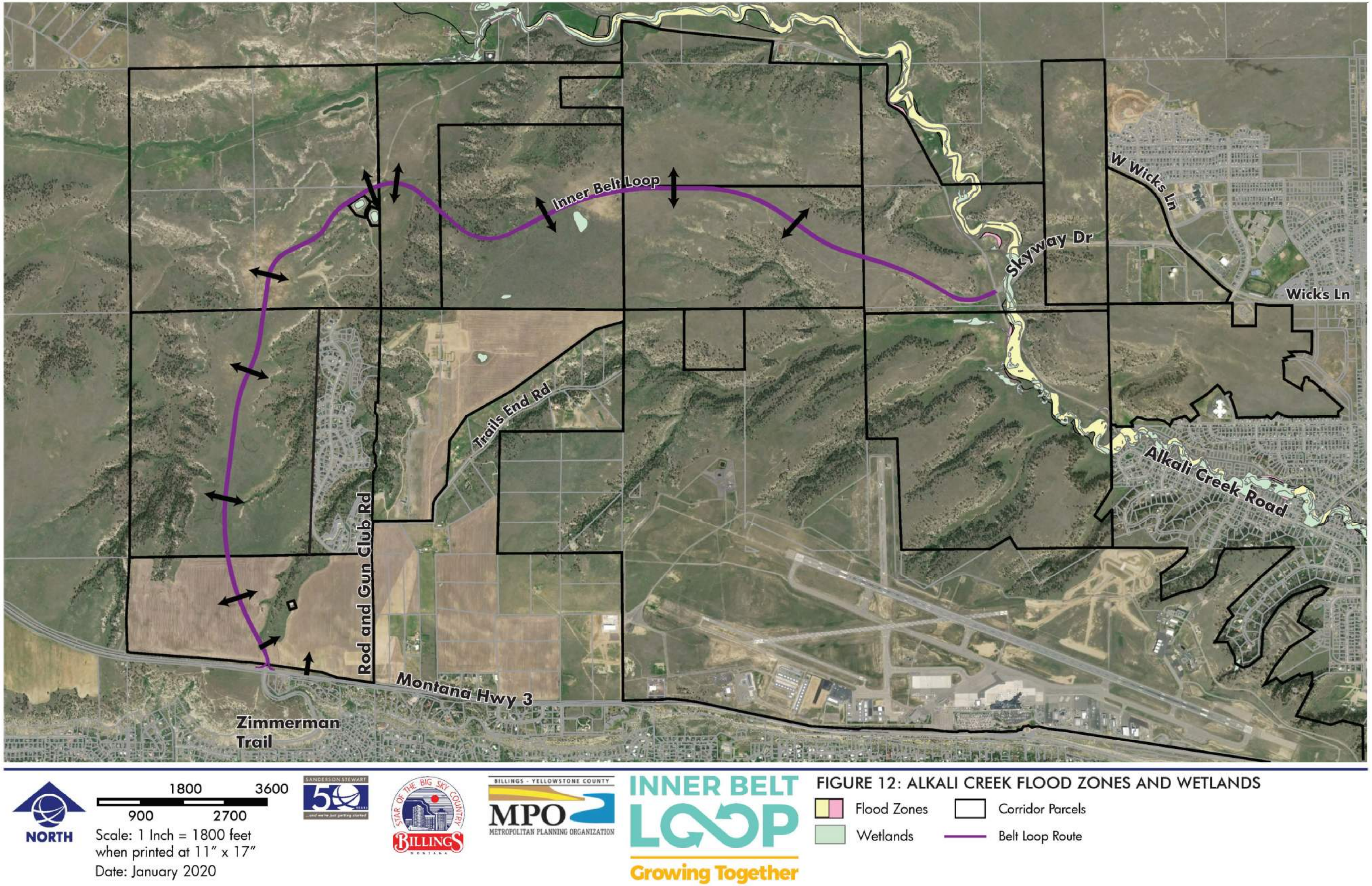


Figure 13: Projected Water System Pressure Zones (Developable Acres)

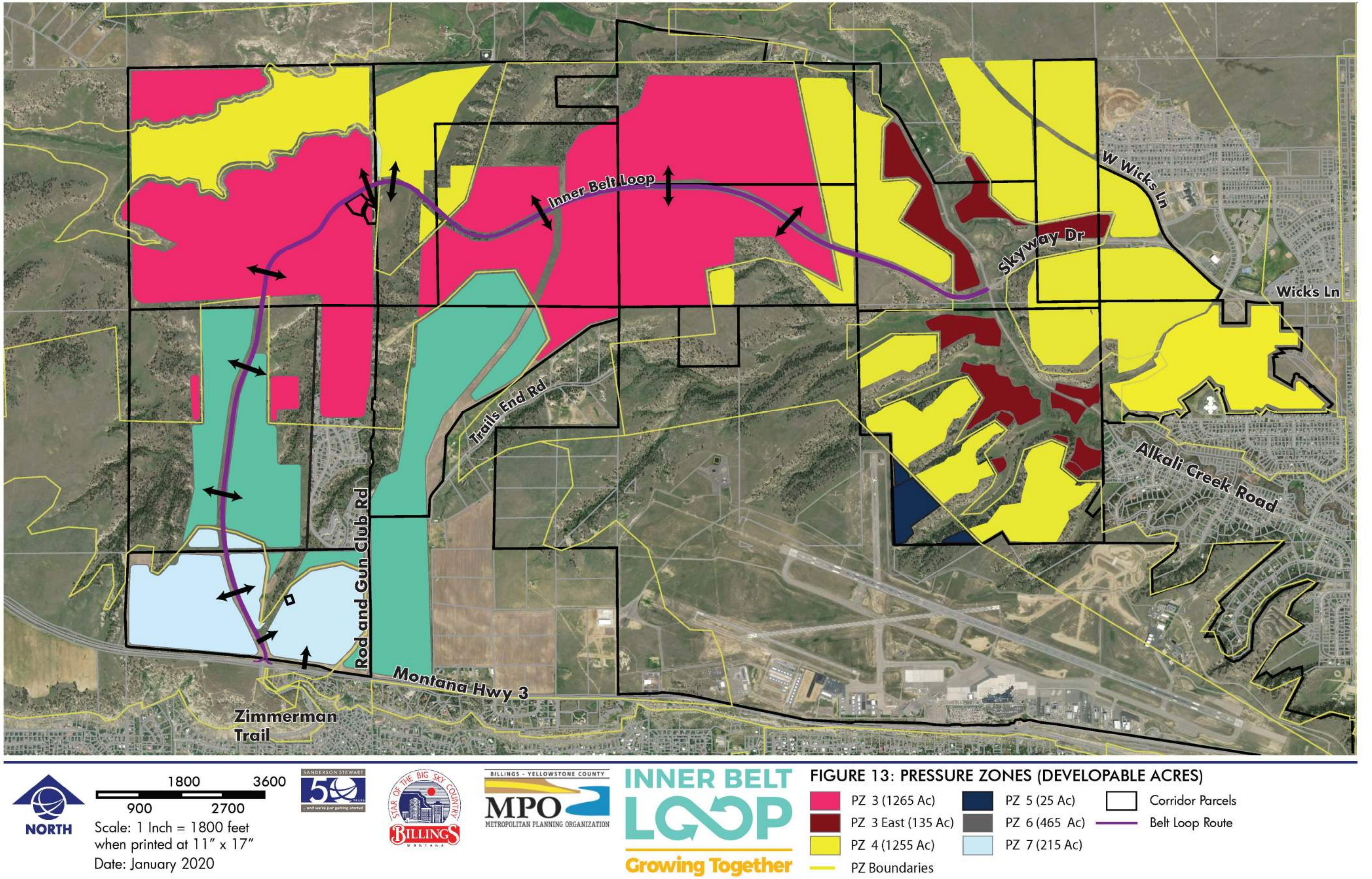


Figure 14: Billings Airport Noise Overlay Zones

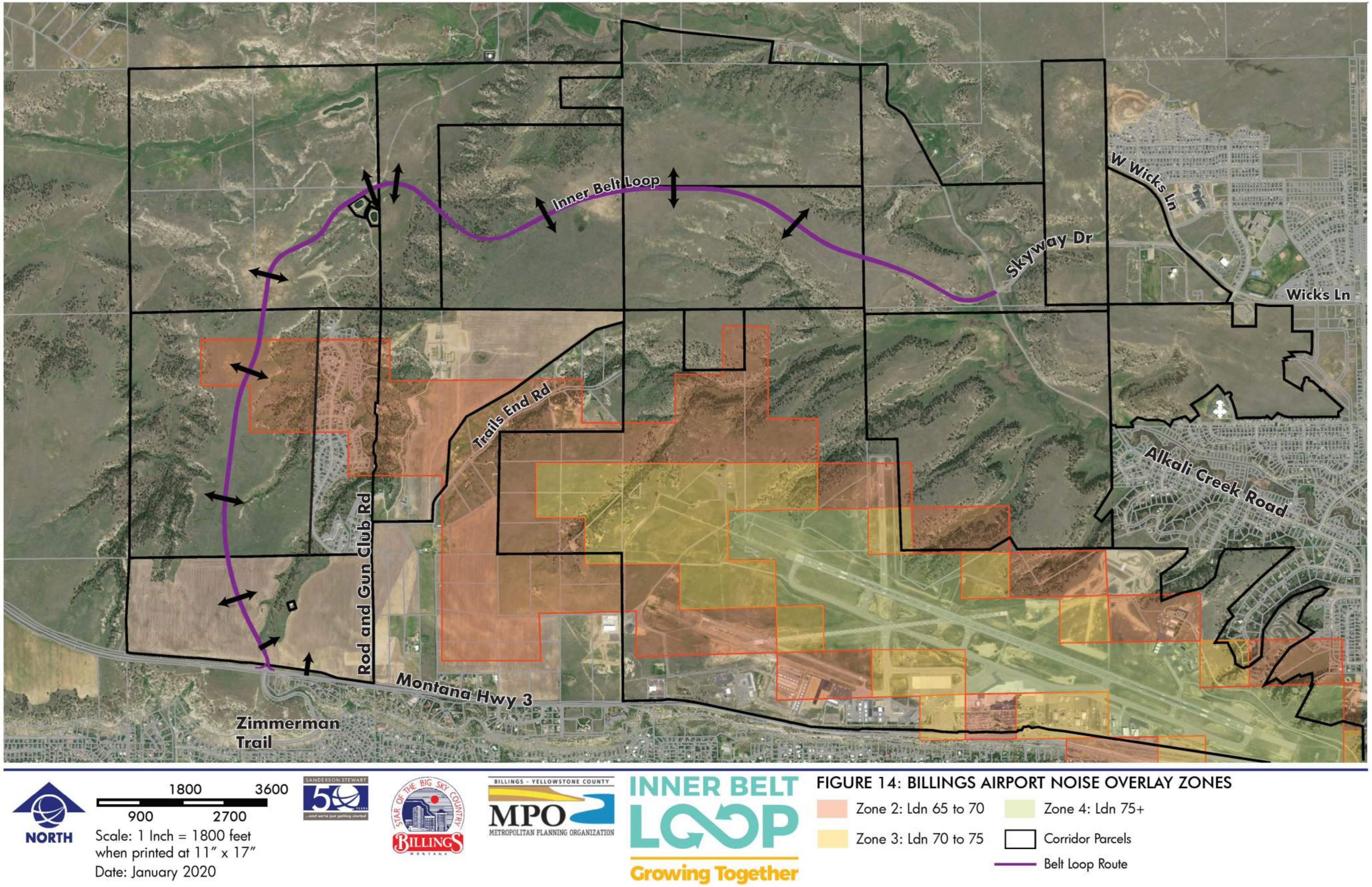
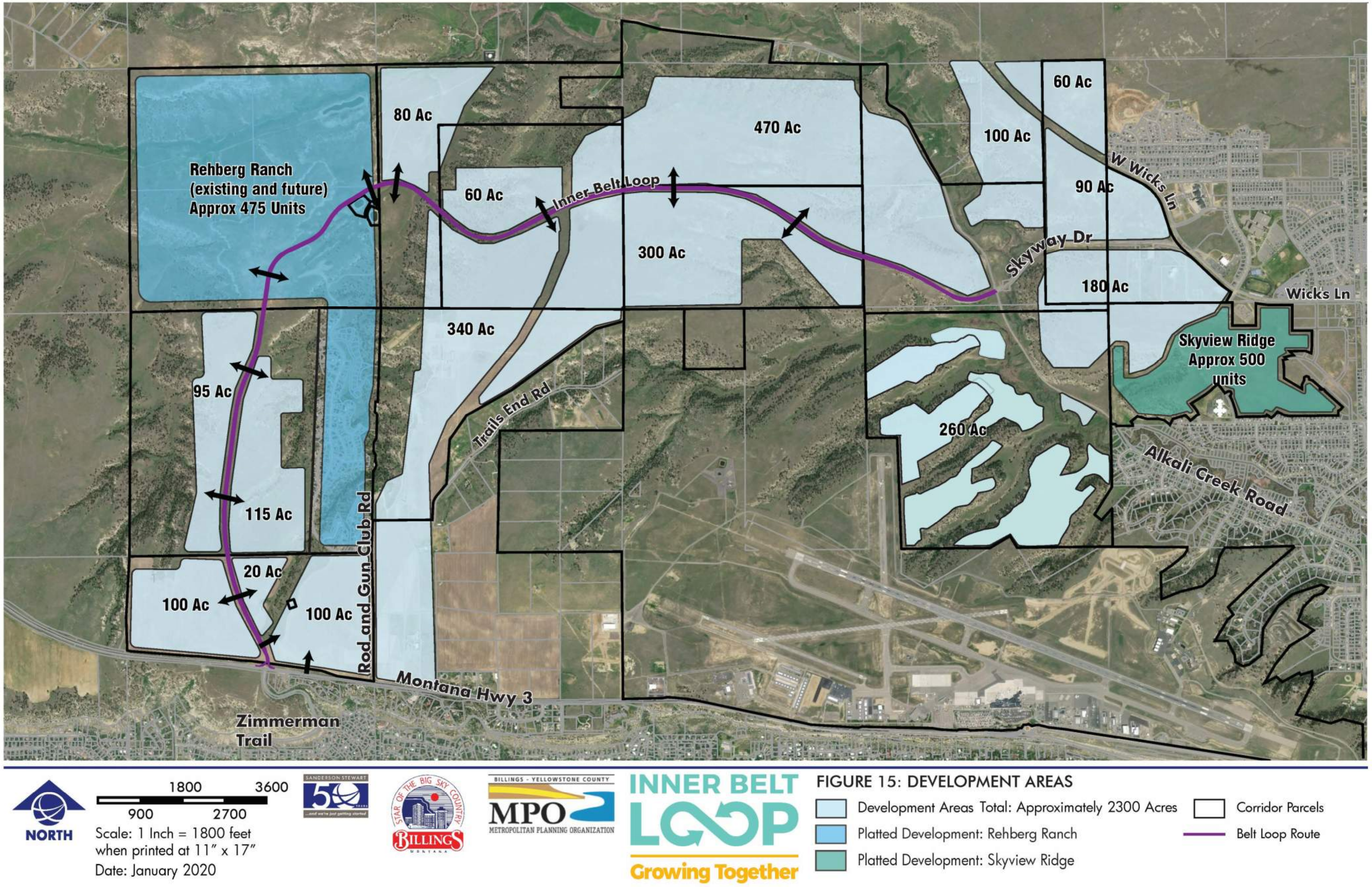


Figure 15: Development Areas



Development Scenarios

Type of Development

The development forecast for the corridor needed to consider the type of land use. Several factors were considered in this determination. The first factor considered the potential for commercial development. With the limited street network and close proximity to the well-established commercial center along Main Street, it is unlikely that the Inner Belt Loop will serve as a location for large areas of commercial development. Instead, some commercial development could be anticipated and planned for at major intersections within the corridor, such as MT 3 and Alkali Creek Road. The remaining development areas identified would be well positioned for future residential development. Small scale commercial development could occur within some of the residential development and therefore, should not be excluded from consideration. The resulting land use forecast identifies residential development as the bulk of potential development.

Development Projections

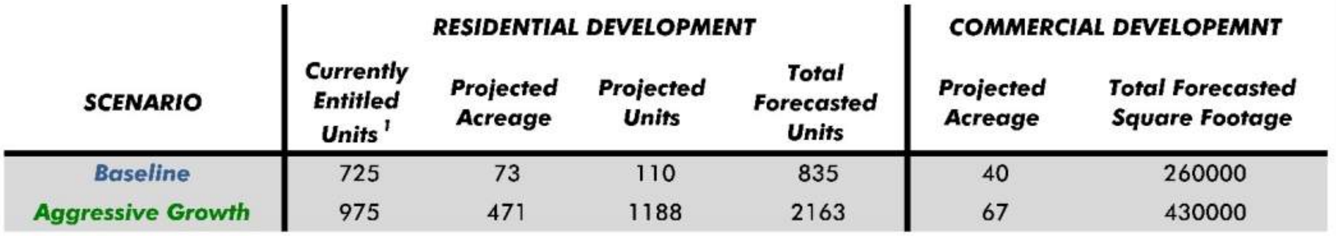
Once the development areas and types of development were defined, the next step of the land use forecast was to determine which of those areas and how much of them would be developed within a 20-year timeframe. There is a fair amount of subjectivity involved in this sort of analysis, however, the consultant team, along with City staff sought to make determinations based on location suitability for development and overall market absorption of new development based on the historic growth of Billings.

Two iterations of the land use projections were created, baseline and aggressive growth, varying the area of the corridor developed and the density of development (dwelling units per acre for residential and floor area ratio (FAR) for commercial). Note that the land development projections are based on the assumption that developing properties would annex into the City and develop at commensurate densities, that in turn assuming that public water and sewer service would be available. If it happens that public water and sewer extensions are not constructed to support development, the expected volume of residential and commercial development would likely be considerably less, although expected development progression for the Rehberg Ranch and Skyview Ridge subdivisions would not be impacted. In that scenario, future traffic volumes would also likely be somewhat lower, which would defer traffic operations impacts associated with development-based growth.

Baseline Scenario

The baseline scenario assumes a modest capture rate for development. The Billings residential market absorbs about 670 dwelling units a year, based on average growth since 2010. As momentum for development has focused on the western edge of the city, it may be some time before there is significant enough demand for housing along the corridor. Should this rate of development continue, in this scenario the study area would capture approximately 6% of all residential development. The baseline scenario includes the complete buildout of Rehberg Ranch and half of Skyview Ridge. Additionally, some commercial development is anticipated, primarily at the intersection of the Inner Belt Loop and MT 3.

Table 2: Development Scenario Land Use Forecasts



	RESIDENTIAL DEVELOPMENT				COMMERCIAL DEVELOPEMNT	
SCENARIO	**Currently Entitled Units [1]**	**Projected Acreage**	**Projected Units**	**Total Forecasted Units**	**Projected Acreage**	**Total Forecasted Square Footage**
Baseline	725	73	110	835	40	260000
Aggressive Growth	975	471	1188	2163	67	430000

Aggressive Growth Scenario

The aggressive scenario forecasts all of that development but also includes additional commercial and residential development along MT 3, residential and very limited commercial development along Alkali Creek Road and west on the Inner Belt Loop, and the buildout of the remainder of Skyview Ranch Subdivision. See **Figures 16 and 17** (pages 34-35) and **Table 2** (previous page).

A variety of residential densities are included in the forecasts, 1.5 dwelling units /acre, 3.0 dwelling units /acre, and 6.0 dwelling units /acre (all gross densities). These densities are derived from what is in existence: Rehberg Ranch is about 1.5 dwelling units per gross acre gross and the neighborhood surrounding Walsh Park is about 3.0 dwelling units/acre gross. The area forecast at 6.0 dwelling units/acre is meant to represent a development with multi-family, duplex, and small lot single family homes.

The commercial forecasts were created by converting the acres of development area to square feet of development using a floor area ratio of 0.15. This ratio was derived from an examination of other mixed commercial development areas in Billings.

The Travel Demand Model, which was utilized to project future traffic volume demand and traffic patterns for this study (see next report section), uses the number of residential dwelling units and square feet of different commercial development types (Retail, Light Industrial, Warehouse, Office) as its inputs. Therefore, it was necessary to further refine the previously summarized land development forecasts by making assumptions about the composition of the anticipated commercial development. For the commercial areas located along MT 3, 46 acres is forecast to have a use mix that is 20% retail, 30% light industrial, 30% warehouse, 20% office and 16 acres is forecast to have a mix that is 40% office, 30% light industrial, and 30% warehouse. The 6-acre commercial area at the intersection of Alkali Creek Road and the Inner Belt Loop is forecast to have a mix of 90% retail and 10% office. These percentages are based on the types of commercial development that are typically found at similar locations in the Billings area.

It's important to note that the land development and traffic projection scenarios for this study were developed based on an assumption that public sewer and water would be provided for at least portions of the Inner Belt Loop corridor. If no such facilities are extended, land development densities and traffic projections are likely to be considerably lower even relative to the Baseline Scenario.

Aerial images showing examples placed used to generate density and FAR assumptions. Rehberg Ranch, Gabel Road, and a Billings Heights neighborhood

Figure 16: Baseline Development Scenario

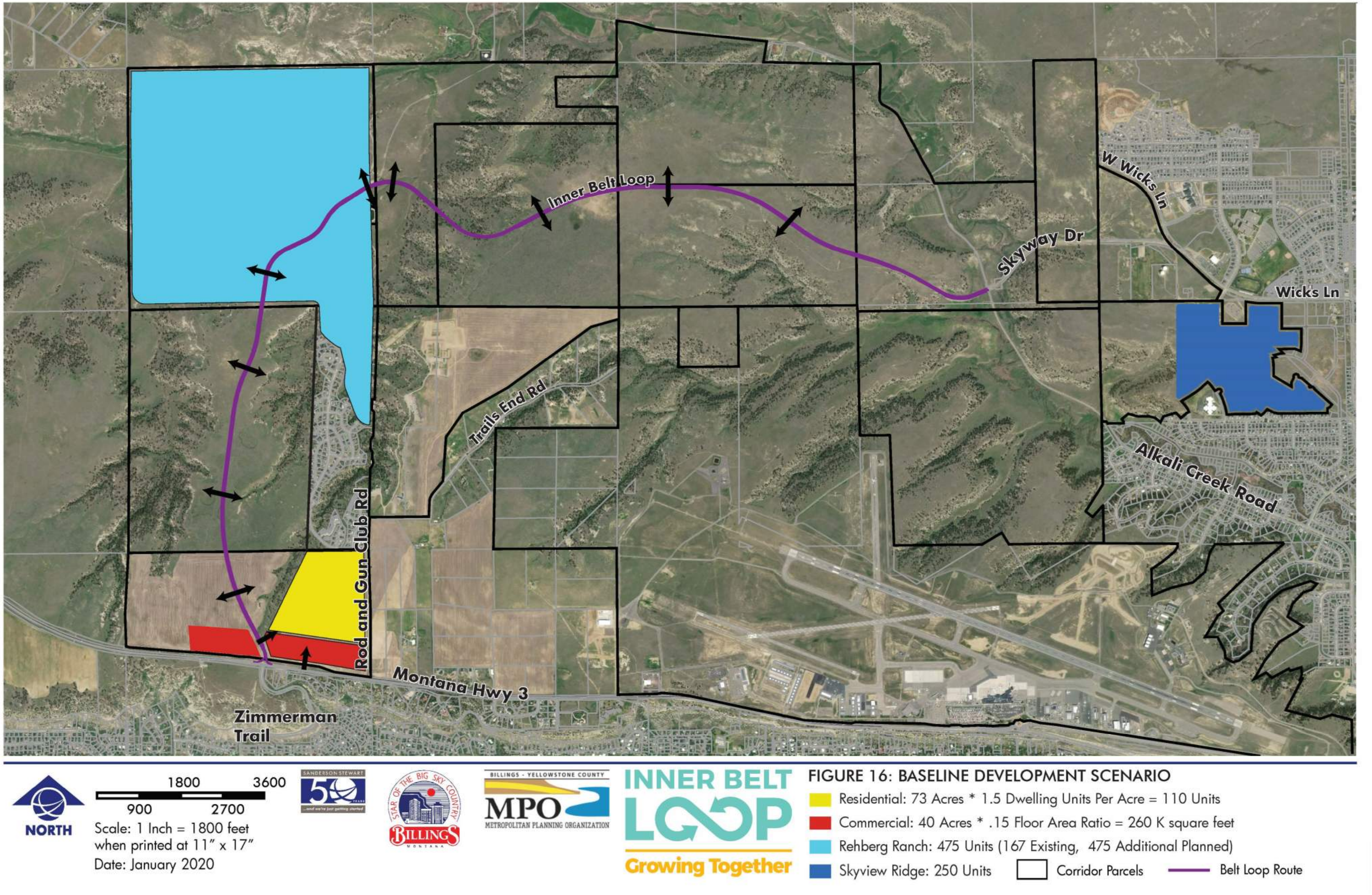
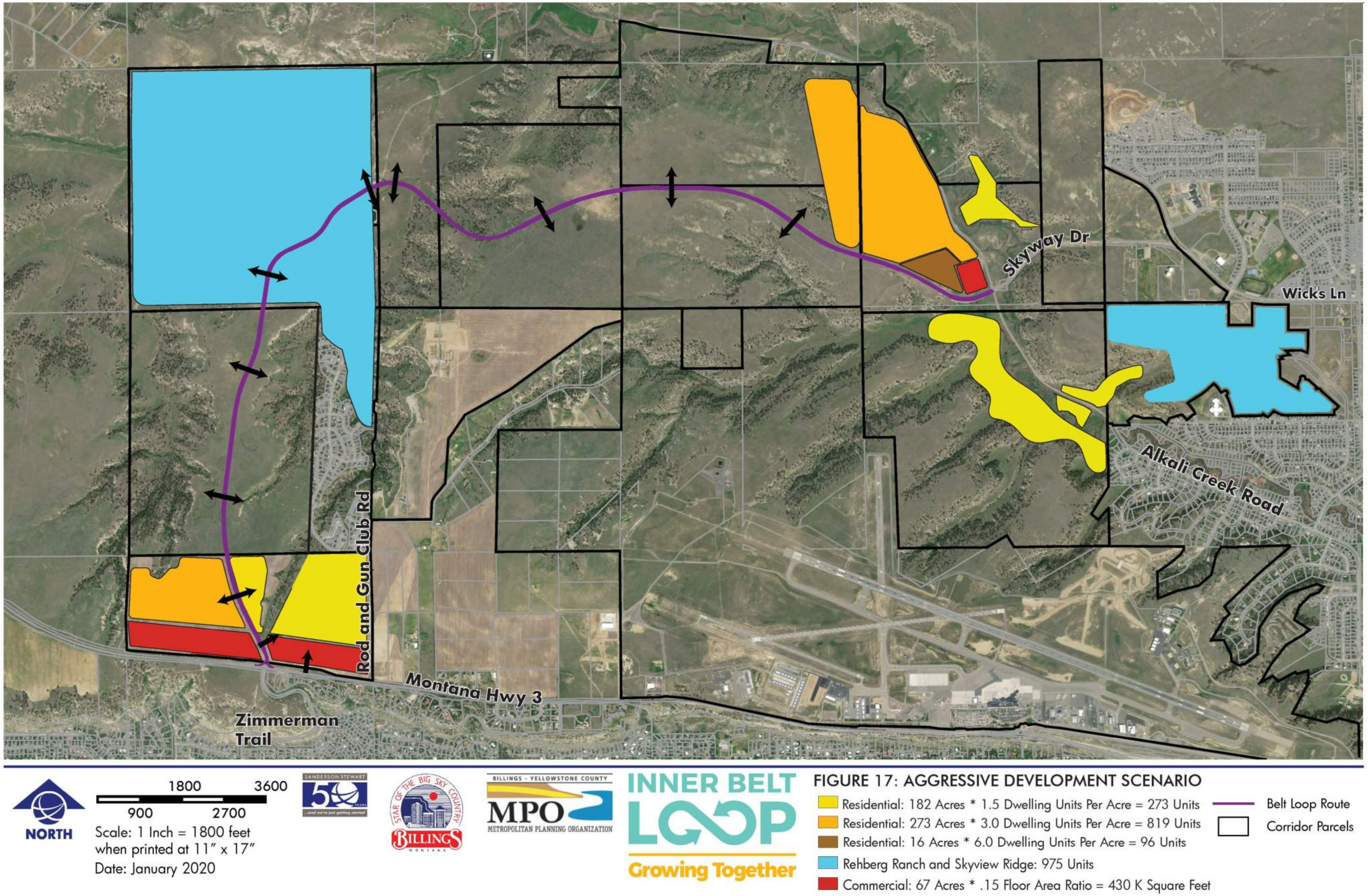


Figure 17: Aggressive Growth Development Scenario



Transportation

Roadway/Facilities Network

The primary roadway network improvements anticipated for the analysis horizon year of 2040 are the completion of the Inner Belt Loop roadway and the associated 10-foot multi-use trail, both of which would provide a continuous travel route between the MT 3/Zimmerman Trail intersection and the Alkali Creek Road/Skyway Drive intersection. However, as was discussed in the recap of information from the *2018 Billings Long Range Transportation Plan*, there are several future proposed roadways with connections to the Inner Belt Loop that would impact travel demand and operations in the corridor. The following is a list of the key future, proposed street connections that would likely have substantial impacts on the Inner Belt Loop:

- A proposed Minor Arterial that connects the Inner Belt Loop to Alkali Creek Road at approximately the midpoint of the alignment
- A Collector roadway that extends south from that same intersection to connect with MT 3 approximately ¼ mile east of Road and Gun Club Road
- An extension of Iron Horse Trail (as a proposed collector) to connect from the north end of the current development area for Rehberg Ranch Subdivision to the Inner Belt Loop
- A proposed Collector roadway extending from the Wicks Lane/High Sierra Boulevard intersection southwest to an intersection with Alkali Creek Road
- A proposed Collector roadway extending from Kootenai Avenue northwest through Skyview Ranch Subdivision to tie into the previously referenced High Sierra Boulevard extension

Likewise, the *Billings Area Bikeway + Trails Master Plan Update* proposes a variety of bicycle and pedestrian facilities that would connect to and augment use of the planned multi-use trail along the Inner Belt Loop. Below is a listing of the most significant of those proposed improvements:

- Shared-use path (Skyline Trail) along the south side of MT 3 from Zimmerman Trail to Billings-Logan International Airport (Swords Park Trail connection)
- Shared-use path along Zimmerman Trail from Poly Drive to MT 3
- Shared-use path along Alkali Creek from Senators Boulevard to the future intersection of Alkali Creek Road and High Sierra Boulevard
- Shared-use path along West Wicks Lane from Skyway Drive to future extension of Annandale Road
- Buffered bike lane along MT 3 west of Zimmerman Trail
- Bike lane(s) along MT 3 from Zimmerman Trail to North 27th Street roundabout (at Billings Logan International Airport)
- Bike lane(s) along Rod and Gun Club Road from MT 3 to Iron Horse Trail (south end of Rehberg Ranch Subdivision)
- Bike lane(s) along future extension of Iron Horse Trail from north end of currently developed Rehberg Ranch Subdivision to Inner Belt Loop
- Bike lane(s) from Inner Belt Loop to Alkali Creek Road along future, planned north-south minor arterial roadway
- Bike lane(s) along Alkali Creek Road from Skyway Drive/Inner Belt Loop to future extension of Annandale Road
- Bike lane(s) along future extension of High Sierra Boulevard from Wicks Lane to Alkali Creek Road

The recommendation to provide bike lanes and a shared-use path along MT 3 between Zimmerman Trail and the North 27th Street Roundabout at the airport may be redundant. However, in general, the above-listed roadway and multi-use facility improvements would greatly improve connectivity for all users in the vicinity of the Inner Belt Loop and future development along the corridor.

Right-Of-Way

Through the original design process for the Inner Belt Loop, it was determined that a standard right-of-way width for the corridor of 90 feet would be sufficient to accommodate a future 4-lane, urban roadway while still allowing for a 15-foot boulevard between the roadway and the multi-use path. It was anticipated that future water and sewer installations could be made in the boulevard area. The Phase 1 (Skyway Drive) segment was constructed in a 90-ft right-of-way dedication. Right-of-way has not yet been dedicated along any portion of the route from MT 3 to Alkali Creek Road. Although the 90-ft right-of-way allocation would generally be adequate based on the future proposed roadway template referenced above, the possible addition of features such as turn lanes, raised median to promote access control, sidewalk along the side of the road opposite the multi-use path, space for private utilities installations, and/or a boulevard area to allow for street lighting on that same side of the road would consume the small amount of extra space afforded by the 90-foot template. Although added cost for right-of-way acquisition would be a deterrent, it may be advisable to consider a wider right-of-way allocation. A five-lane urban roadway with 12-ft travel lanes, a 15-ft two-way left-turn lane (which could also allow for raised median with a narrower turn lane at major intersection locations), a 10-ft boulevard and 10-ft multi-use path on one side, and a 5-ft boulevard and 5-ft sidewalk on the opposite side, and one foot buffers to the right-of-way boundary would require 100 feet of right-of-way width. Depending on the anticipated intersection type and/or lane configurations for major intersections (such as at Alkali Creek Road), additional right-of-way width and/or intersection corner allocations may be needed in the future, as well.

Traffic Volume Projections

The Billings Metropolitan Planning Organization (MPO) recently developed a new travel demand model (TDM) intended to aid in the forecasting of future traffic demand and travel patterns in the greater Billings area. For this project, the TDM was utilized to project future traffic growth due to land development in the vicinity of the Inner Belt Loop corridor, but also to assess the impact of the Inner Belt Loop and other future, proposed roadway connections in the vicinity on traffic volume demands in and around the corridor.

The primary output metric from the TDM is traffic demand measured in vehicles/day by individual model link (roadway connection between intersection nodes). The project team and POC agreed upon a horizon year for future conditions analysis of 2040, which generally equates to a 20-year projection of land development and traffic growth. Travel demand model runs for the 2040 horizon year were processed both with and without the Inner Belt Loop for the Baseline and Aggressive Growth land development scenarios. Multiple runs were made to evaluate impacts of forecasted land development on the Inner Belt Loop and various other key transportation links in Billings.

Variations of the future model runs were processed with and without the additional future, proposed street connections, listed in the previous section of the report, to gauge their impacts on traffic demand and operations for the Inner Belt Loop. Table 3 on the following page provides a comparison of average daily traffic model projections for a handful of key streets based on the TDM configurations with and without the Inner Belt Loop in place for the Baseline and Aggressive Growth scenarios. The table also shows the most current available traffic data for each street to help illustrate the overall traffic growth that is expected over the 20-year forecast period.

Projections for the Inner Belt Loop itself vary from approximately 4,850 vehicles/day (vpd) to 9,760 vpd for the Baseline scenario and from 7,430 vpd to 13,300 vpd for the Aggressive Growth scenario. The modeling exercise showed moderate increases in traffic (approximately 5-6%) for Zimmerman Trail below MT 3 with the Inner Belt Loop in place, while demand on MT 3 to the east of Zimmerman Trail is projected to reduce by approximately 19-21%. Although not illustrated in Table 3, the projections from the model runs that included the future proposed street connections in the vicinity of the Inner Belt Loop indicated that north-south connector street from MT 3 to the Inner Belt Loop (and beyond to Alkali Creek Road) could carry as much as 2500 vpd for the Aggressive Growth scenario, thereby reducing traffic on the Inner Belt Loop itself by as much as 15%.

Using the average daily traffic forecasts from the Baseline and Aggressive Growth model runs (with the Inner Belt Loop) to approximate demand growth and traffic distribution, Sanderson Stewart calculated AM and PM peak hour turning movement projections for the two future analysis scenarios. The projections were calculated only for the three (3) intersections that were analyzed as part of the existing conditions analysis since precise turning movements would be difficult to predict for planned, future intersections where none of the intersecting roadways are currently in existence. **Figures 18 and 19** (pages 39-40) present the turning movement and average daily traffic projections for the study area, for the Baseline and Aggressive Growth analysis scenarios, respectively.

Table 3: Horizon Year (2040) Traffic Projections

STREET	**SEGMENT**		**Existing Traffic Volumes (veh/day)**	**FUTURE LAND DEVELOPMENT SCENARIO TRAFFIC VOLUME PROJECTIONS (VEH/DAY)**					
				Baseline			**Aggressive Growth**		
	From	**To**		Without IBL	With IBL	% Diff.	Without IBL	With IBL	% Diff.
Inner Belt Loop	MT 3	Iron Horse Tr.	-	-	**9,760**	N/A	-	**13,300**	N/A
Inner Belt Loop	Iron Horse Tr.	Alkali Creek Rd.	-	-	**4,850**	N/A	-	**7,430**	N/A
Skyway Dr.	Alkali Creek Rd.	Wicks Ln.	1,220	1,810	**4,020**	122.1%	2,000	**5,210**	160.5%
Wicks Ln.	Skyway Dr.	High Sierra Blvd.	1,680	3,720	**5,290**	42.2%	3,850	**6,370**	65.5%
Alkali Creek Rd.	Foothill Dr.	Skyway Dr.	1,010	1,500	**1,980**	32.0%	1,660	**3,160**	90.4%
Zimmerman Tr.	Rimrock Rd.	MT 3	9,640	14,830	**15,720**	6.0%	15,540	**16,350**	5.2%
MT 3	Apache Tr.	Zimmerman Tr.	3,260	7,630	**5,070**	-33.6%	8,730	**5,060**	-42.0%
MT 3	Zimmerman Tr.	Rod and Gun Club Rd.	11,110	17,410	**14,070**	-19.2%	18,500	**14,630**	-20.9%
Main St.	MT 3	Lake Elmo Dr.	40,450	44,760	**43,350**	-3.2%	44,450	**43,160**	-2.9%

Figure 18: Baseline Scenario (2040) Traffic Volume Projections

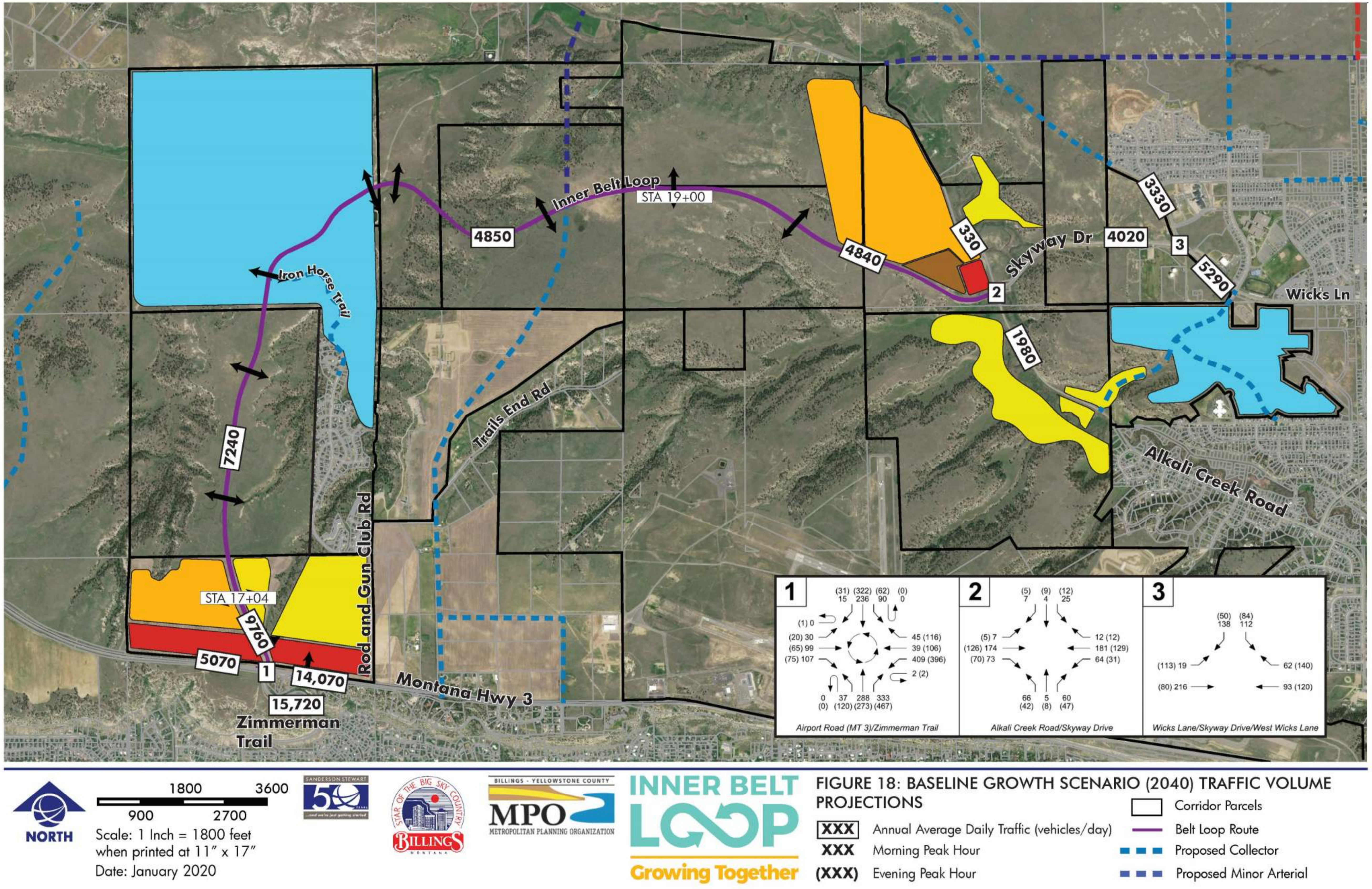
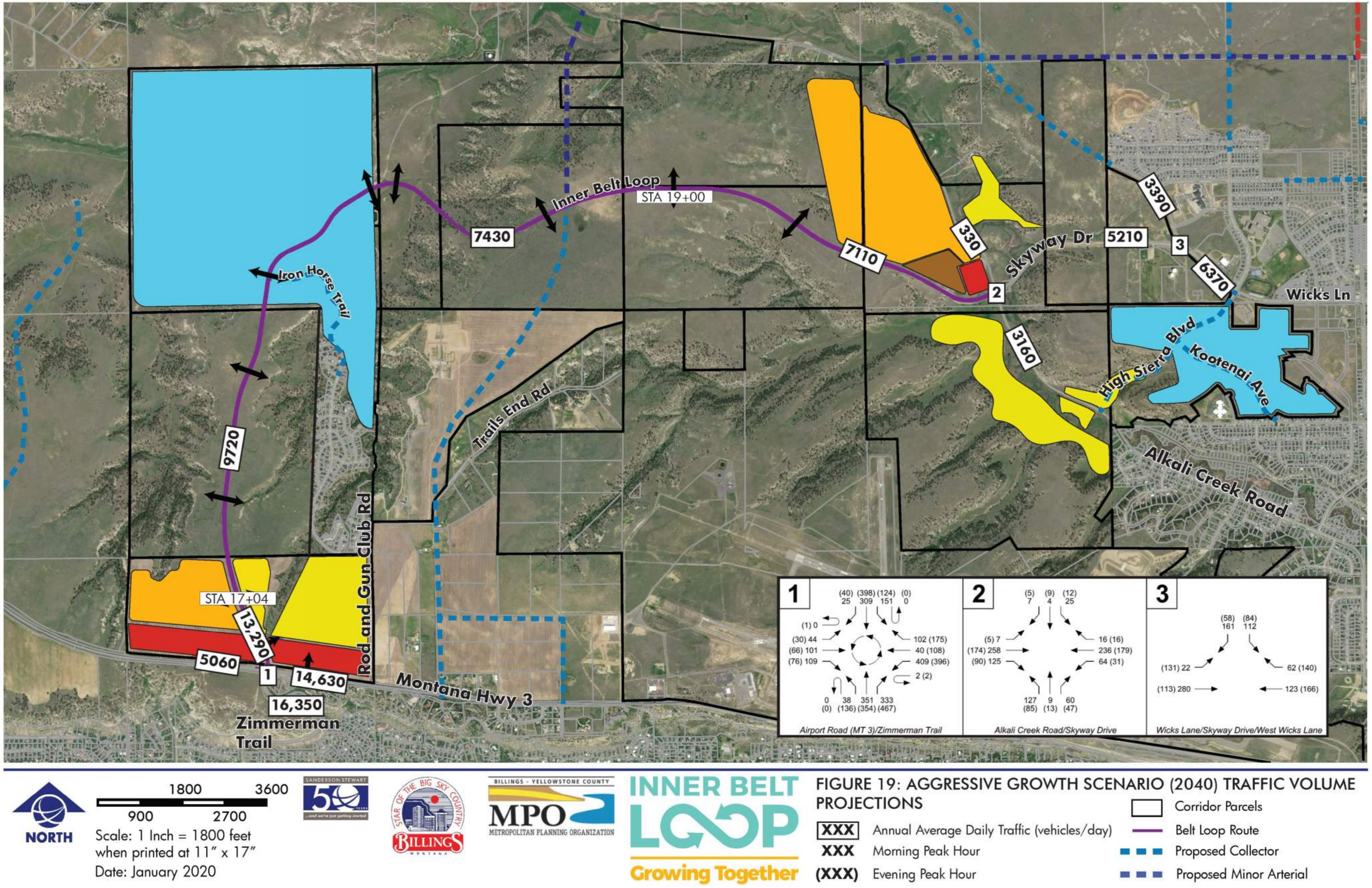


Figure 19: Aggressive Growth Scenario (2040) Traffic Volume Projections



Traffic Operations

Future (Baseline and Aggressive Growth) scenario capacity calculations were performed for study area intersections as well as for four distinct segments of the roadway as defined by anticipated locations of major intersections. Intersection geometry and traffic control for the MT 3/Zimmerman Trail roundabout and for the Wicks Lane/Skyway Drive/West Wicks Lane intersections were initially assumed to be the same as existing. For the Alkali Creek Road/Skyway Drive intersection, it was assumed that the intersection would remain two-way stop-controlled, but that the Alkali Creek Road approaches would have stop control, and that the Skyway Drive approaches would be uncontrolled. Auxiliary turn lanes were not modeled for the intersections initially since the preliminary design did not include any such improvements.

The begin and end points for the four highway segments that were analyzed are summarized below:

Segment #1 – MT 3 to private access approaches at STA 17+04

Segment #2 – Private access approaches at STA 17+04 to Iron Horse Trail

Segment #3 – Iron Horse Trail to private approaches at STA 190+00

Segment #4 – Private approaches at STA 190+00 to Alkali Creek Road

Capacity analysis for two-lane highway segments requires a classification of the roadway into one of three categories (Class I, Class II or Class III). The Class I designation is generally intended for rural, high-speed highways (speed limits of 55 mph or greater). For this and other reasons, the Inner Belt Loop does not qualify as a Class I facility.

A Class II highway is defined as a facility where motorists do not necessarily expect to travel at relatively high speeds, that serve as scenic or recreational routes, or that pass through rugged terrain such that high-speed operation would be impossible. The definition for a Class III two-lane highway discusses roadways that pass through small towns or developed recreational areas; that in general sever moderately developed areas. Such facilities are often accompanied by reduced speed limits that reflect higher activity levels.

For the Inner Belt Loop, initial operations are likely to fit most closely with the Class II category. In the future when adjacent development is denser, the Class III highway or an urban street designation may be more appropriate, depending upon the level of urbanization along the corridor. For the purposes of this study, highway segment capacity was evaluated for both classifications to show relative performance.

Table 4 (next page) summarizes the results of the future condition (2040) peak hour intersection capacity calculation for the Baseline scenario. **Table 5** (next page) summarizes the intersection capacity calculations results for the Aggressive Growth scenario. **Table 6** (next page) presents the results of the highway segment capacity analysis.

The three intersections evaluated through this study are projected to operate reasonably well based on analysis of Baseline scenario traffic. For the Aggressive Growth scenario, however, traffic operations degrade substantially for two of the three intersections. At the MT 3/Zimmerman Trail roundabout, the southbound approach is projected to operate at LOS E with a lengthy vehicle queue. The westbound approach is projected to operate at LOS F during the PM peak hour with an even longer queue. All other approaches at the roundabout are projected to operate at LOS C or better during both peak periods.

For the Alkali Creek Road/Skyway Drive intersection, the northbound approach is projected to operate at LOS D during AM peak hour (Aggressive Growth scenario). All other approaches at that intersection, as well as at the Wicks Lane/Skyway Drive/West Wicks Lane intersection are shown to operate at LOS C or better during both peak periods. Detailed intersection capacity calculation worksheets for the future year (2040) analysis scenarios are attached in Appendix C.

Table 4: Baseline Scenario (2040) Peak Hour Intersection Capacity Calculations

			AM PEAK			PM PEAK		
INTERSECTION	Intersection Control	Approach	Avg Delay (s/veh)	Level of Service	Max Queue (vehicles)	Avg Delay (s/veh)	Level of Service	Max Queue (vehicles)
MT 3 - Zimmerman Trail	↻	NB	6.1	A	2	6.8	A	3
		SB	11.0	B	4	18.5	C	6
		EB	12.8	B	3	12.0	B	2
		WB	12.9	B	6	22.4	C	14
Alkali Creek Road - Skyway Drive	STOP	NB	14.8	B	2	11.6	B	1
		SB	15.2	C	1	12.1	B	1
		EB	0.3	A	0	0.2	A	0
		WB	2.4	A	1	1.6	A	1
Wicks Lane/Skyway Drive - West Wicks Lane	STOP	SB	10.7	B	1	12.0	B	1
		EB	0.6	A	0	4.7	A	1
		WB		(NO DELAY)			(NO DELAY)	

Table 5: Aggressive Growth Scenario (2040) Peak Hour Intersection Capacity Calculations

			AM PEAK			PM PEAK		
INTERSECTION	Intersection Control	Approach	Avg Delay (s/veh)	Level of Service	Max Queue (vehicles)	Avg Delay (s/veh)	Level of Service	Max Queue (vehicles)
MT 3 - Zimmerman Trail	↻	NB	7.2	A	3	8.1	A	3
		SB	16.8	C	8	42.5	E	18
		EB	17.6	C	4	15.6	C	2
		WB	18.8	C	10	50.7	F	29
Alkali Creek Road - Skyway Drive	STOP	NB	31.4	D	5	15.1	C	2
		SB	19.8	C	1	13.8	B	1
		EB	0.2	A	0	0.2	A	0
		WB	2.2	A	1	1.3	A	1
Wicks Lane/Skyway Drive - West Wicks Lane	STOP	SB	11.4	B	1	13.3	B	1
		EB	0.6	A	1	4.4	A	1
		WB		(NO DELAY)			(NO DELAY)	

Table 6: Future Conditions (2040) Corridor Capacity Calculations

		BASELINE				AGGRESSIVE GROWTH			
Segment	Travel Direction	PTSF ^{1} (%)	PFFS ^{2} (%)	Class II LOS ^{4}	Class III LOS ^{4}	PTSF ^{1} (%)	PFFS ^{2} (%)	Class II LOS ^{4}	Class III LOS ^{4}
1	NB	74.3	76.6	D	C	72.4	73.8	D	D
	SB	74.3	76.6	D	C	80.0	71.7	D	D
2	NB	57.4	82.9	C	C	64.3	79.8	C	C
	SB	67.4	81.8	C	C	72.3	78.8	D	C
3	EB	62.7	81.9	C	C	69.3	79.2	C	C
	WB	62.7	81.9	C	C	69.3	79.2	C	C
4	EB	62.7	82.0	C	C	69.6	79.7	C	C
	WB	62.7	82.0	C	C	69.6	79.7	C	C

[1] (PTSF) Percent Time Spent Following

[2] (PFFS) Percent of Free-Flow Speed

[3] (LOS) Level of Service based on Class II two-lane highway classification

[4] (LOS) Level of Service based on Class III two-lane highway classification

The highway segment capacity calcs showed then when analyzed as a Class II facility, LOS metrics are C or D for all segments, under both scenarios, with the LOS D levels in primarily in Segments 1 and 2 where the higher traffic demands are projected to occur as a result of increased land development. For the Class III designation, LOS is projected at C for all segments in both directions for the Baseline scenario. Only Segment 1 projects at LOS D (both directions) for the Aggressive Growth scenario.

The City of Billings does not have a published standard for highway segment LOS, but the LOS criteria presented in the MDT Traffic Engineering Manual (Figure 30.2B) shows a minimum LOS C for Urban Principal Arterials. As such, the LOS D metrics projected for the future scenarios should be considered as sub-standard. Detailed highway segment capacity calculation worksheets for the future year (2040) analysis scenarios are attached in Appendix

Mitigation Analysis

Based on the results of the future conditions traffic operations analysis, Sanderson Stewart investigated potential mitigation alternatives for addressing the substandard LOS conditions that are projected to occur on both an intersection and corridor basis. For the MT 3 /Zimmerman Trail roundabout, the heavy demand for westbound and southbound left-turns is such that exclusive lanes would be necessary to improve the poor PM peak period LOS for the Aggressive Growth (2040) scenario. The addition of those lanes would improve the westbound approach from LOS F to LOS C, but would only improve the southbound approach from LOS E to LOS D. The resulting change in circulating operations would actually cause the eastbound approach to degrade to LOS D. Additional modifications to the intersection would likely be necessary in order to achieve a minimum LOS C for all approaches, but the LOS D may be considered acceptable in this case given the downstream constraints (to the south) for this intersection.

With respect to the LOS deficiencies projected for the Alkali Creek Road/Skyway Drive intersection for the Aggressive Growth (2040) scenario, Sanderson Stewart evaluated auxiliary turn lane warrant criteria for that intersection as presented in the MDT *Traffic Engineering Manual*. The analysis showed that an eastbound right-turn lane and a westbound left-turn lane may be warranted based on the AM peak hour traffic projections. The addition of those auxiliary lanes was shown through intersection capacity analyses to reduce average delay for the northbound approach by approximately six seconds/vehicle, although the approach would still project to operate at LOS D during AM peak period. A traffic signal warrant analysis was also performed for the Alkali Creek Road/Skyway Drive intersection based on Aggressive Growth (2040) scenario traffic projections. The analysis indicated that a traffic signal would be warranted within minimum thresholds being met for all three volume-based traffic signal warrants (warrants 1, 2, and 3), with 70% criteria applied since major street speeds would be expected to exceed 40 mph (with a 45 mph speed limit on all roadways). If the 100% criteria was to be applied, no traffic signal warrants would be met.

Relative to the roadway corridor level of service concerns (LOS D), given the traffic demand levels projected for the Baseline (2040) and Aggressive Growth (2040) scenarios, the only way to provide for LOS C operations for Segment 1 would be to provide additional lanes (travel lanes or passing lanes). Ultimately, it is expected that the Inner Belt Loop, or at least portions of the roadway, may need to be widened to four or more lanes at some point in the future. This analysis confirms the legitimacy of that consideration, although the timing for when that modification might be justifiable from a cost/benefit standpoint will likely depend upon the progression of development in the corridor. Given the expense of providing four lanes vs. two lanes, a LOS D condition for a segment of the corridor may be acceptable as long as there are no significant associated safety concerns.

Emergency Services

The City of Billings has been developing a plan for a public safety mill levy proposal that would be on the ballot in the spring of 2020. The mill levy would provide for additional funding for fire, police, and municipal courts facilities, personnel, and operations. The BFD long-range master plan proposes construction of two new fire stations, if and when funding is available. Those fire stations would conceptually be located in the vicinity of the Hilltop Road/Topaz Avenue intersection in the southwest part of the Heights and in the vicinity of the 48th Street West/Hesper Road intersection in the southern part of the "West End" region of Billings. The addition of these fire stations would greatly improve emergency services coverage for key areas of the city. However, the Inner Belt Loop corridor from MT 3 to Alkali Creek Road and the adjacent private property that is anticipated to be developed at some point in the future would still fall outside of the area that would be expected to meet NFPA-recommended response time criterion. The master plan also discusses a strategy whereby a fire station would be implemented in the vicinity of the MT 3/Zimmerman Trail intersection (i.e., at the south end of the Inner Belt Loop). Even with that station in place, the projections estimate that only the south/west half of the Inner Belt Loop corridor would meet the recommended response time coverage standards

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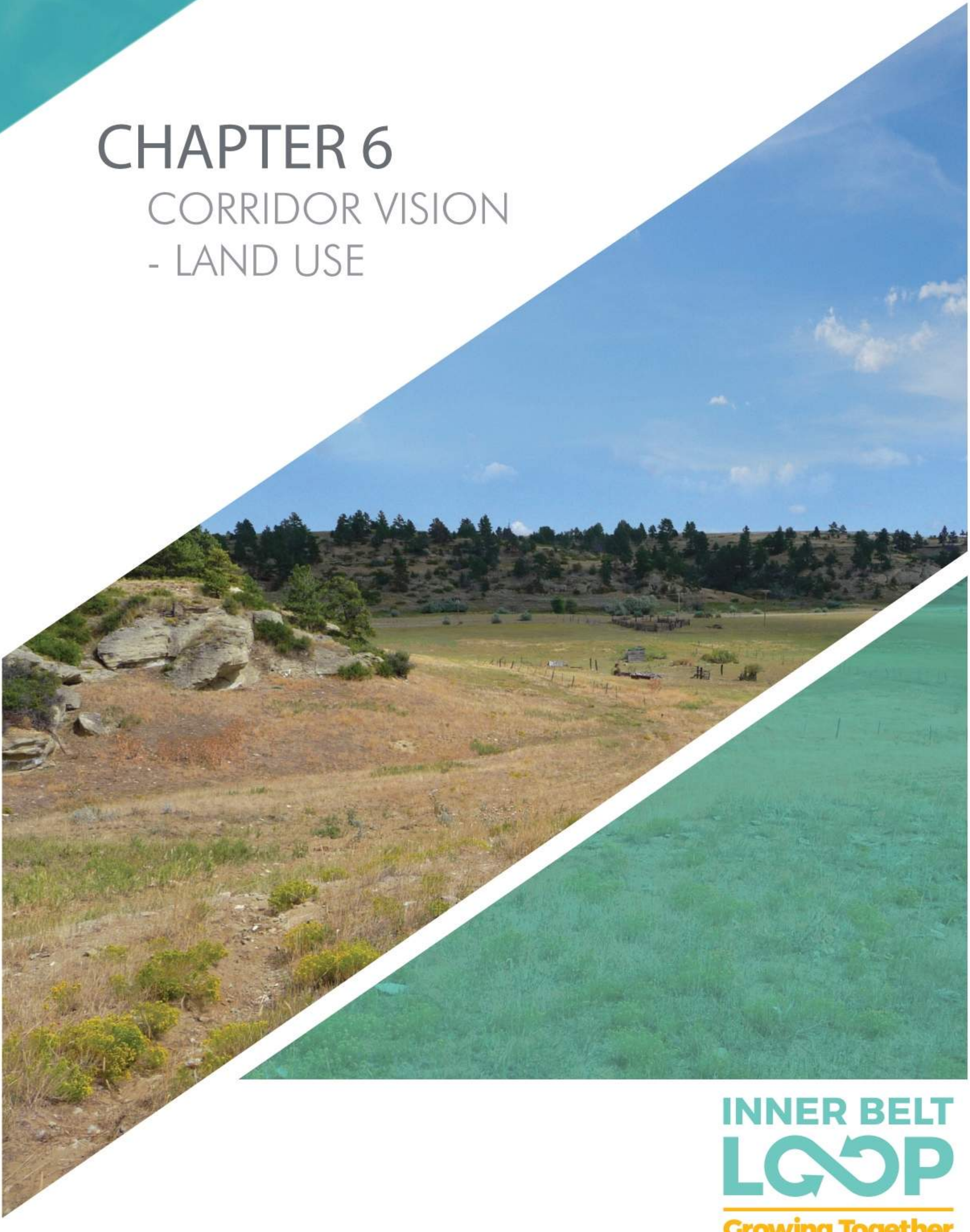
CHAPTER 6

CORRIDOR VISION - LAND USE



INNER BELT LOOP

Growing Together

CORRIDOR VISION – LAND USE

The coordination of the transportation facilities and land use will be vital to the function and success of the corridor. This will ensure that the transportation network is sufficient to serve future development and investment in the area. To create a vision for the physical development of the corridor, potential elements were identified and analyzed for impact on the corridor development. Options for each were developed and a preferred standard was developed and is described below. Additionally, for each element, a list of considerations and tools for implementation are identified.

Residential Land Use

Elements of land use that affect the character of the corridor include building location and orientation, mix of uses and activities, physical improvements, and access to and from adjoining properties. As noted above, the design speed for the Inner Belt Loop is 45 mph. Characteristics of the land use should be compatible with that design speed.

Location

Development of residential neighborhoods can influence the character of the corridor. Buildings are close to the road can provide visual interest and appeal. Whereas, when buildings separated by a greenspace buffer, it can create an environment of openness. As regulated through site setbacks, building locations can also establish the viewshed to and from the roadway and improve circulation between sites.

Two options for setback are shown. Option 1 indicates a development pattern with a shallow setback, 25-feet from the property line. This option can ensure consistency throughout the corridor and still maintain transportation function. Option 2 shows a development pattern with a wider setback with a greenspace separating the buildings from the roadway.

Implementation of either option can be achieved with the application of an appropriate zoning district to adjacent properties. The City of Billings currently requires setbacks along arterials streets to be a minimum of 80-feet from the centerline of a principal arterial street. As proposed, the 90-foot right-of-way for the Inner Belt Loop would require a minimum of a 35-foot setback from the edge of that right-of way. Option 1 would require a change to Article 26-602 – Arterial Setback of the Billings City Code.

Option 1: Development along Monad Road in Billings shows a shallow setback with apartments close to the right-of-way

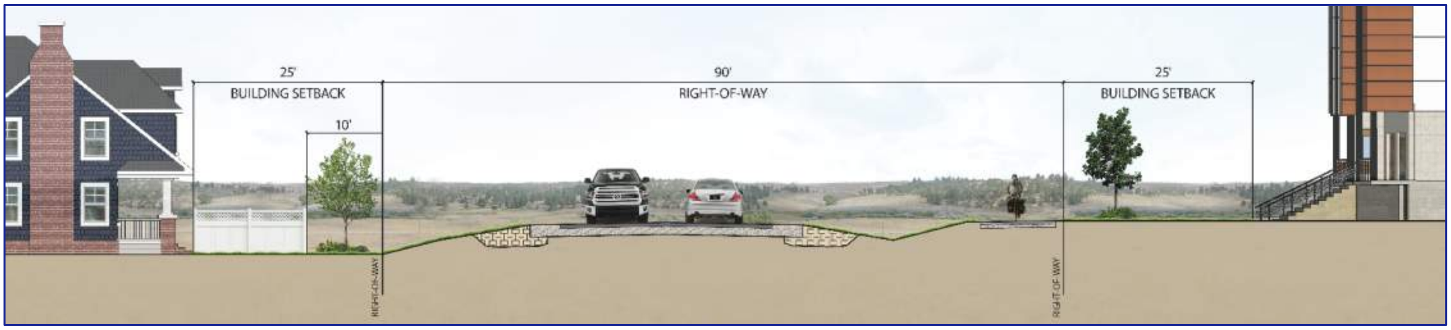
Option 2: Development along Shiloh Corridor shows a wide setback with greenspace separating the residential uses from the road

Residential Building Orientation

The relationship that buildings have to the street contributes to the overall character of the corridor. Buildings that face the corridor can contribute to a welcoming and safe image of the roadway and neighborhood. Building orientation also creates a comfortable pedestrian environment along the roadway. With limited access from the corridor, most building sites will be accessed from internal street connections. That can make building orientation towards the corridor a challenge, particularly for single family residential development. Balancing the welcoming character desired for the corridor with the need for functional subdivisions will need to be thoroughly evaluated.

As the frontage of a corridor cannot be used exclusively for retail and commercial purposes, the general appearance and image of the residential neighborhoods from the corridor will need to be considered. The backing of lots onto streets can produce unsightly appearances since rear yards are generally fenced but not usually maintained in a uniform fashion. There are several options to address residential building orientation along the Inner Belt Loop. One option is for lots located along arterials to “side face” the street. This allows an open appearance of the neighborhood with views of home fronts, landscaped yards, etc., such as exist in older areas. A second option is to permit lots to back onto the corridor but require greater setbacks in order to increase separation and add a landscaping buffer. A third option would be to require standard fencing along the corridor right-of-way, thereby allowing for a shallow setback with some privacy for those lots adjacent to the corridor. A final option would be to permit local streets or a trail corridor to parallel the corridor, thus allowing access to residential lots with a front facing orientation. Example photos are shown below. Given the length of the corridor, it may be appropriate to use more than one of these options, as the site conditions warrant.

Aerial images from Google Earth illustrating the four possible approaches to residential building orientation along the Inner Belt Loop.



Visual representation of recommended building setbacks along corridor

Landscaping

Landscaping plays a significant role in the creation of a comfortable street environment. Trees and shrubs filter sunlight and wind, providing a comfortable pedestrian environment and moderating the microclimate. The textures and colors soften the hard surfaces of the built environment, connecting people to nature and reinforcing the character of place. Landscaping along the Inner Belt Loop will be either within the public right-of-way or on private land in association with new development. The City of Billings Zoning Code will provide standards for landscaping associated with private development. Landscaping within the corridor right-of-way should take into consideration availability of water for irrigation, adjacent land use, topography and visibility constraints. One option for landscaping along the corridor is a formal approach with native vegetation. This approach would focus on spacing of trees, shrubs and ground cover, within focused areas. Those areas could include intersections or areas of particular natural beauty. Additionally, landscaping could be used as a buffer adjacent to residential areas. A second option would encourage landscaping be integrated in a more informal way along the corridor. Using this approach, specifications would outline tree, shrub and ground cover types and encourage the landscaping to blend into the native vegetation and topography. Unlike the formal approach, intersections and other areas of interest would not receive special landscape treatment.

Commercial Land Use

As the Inner Belt Loop is completed, it is anticipated that commercial development will occur within the corridor. As with residential development, there are several design factors that will influence how that commercial activity is developed. Future planning along the Inner Belt Loop should encourage the clustering of commercial development by the development of commercial nodes and disincentivize commercial strip development.

Commercial areas should be designed with and thoughtfully connected to vehicle, pedestrian and bicycle connections, and adjacent residential areas. This would encourage the creation of a neighborhood center, allowing a variety of commercial activity to develop. To further support this type of development, the following elements can be evaluated.

Location

Development should reinforce the edge of the corridor, while providing views to parking and other development beyond. As well, parking lots should be located and configured so as to easily allow the introduction of additional development over time. The arrangement and design of parking lots and the overall arrangement of buildings can ensure that further intensification of development over time is not precluded. While the market may dictate an auto-oriented form as first phase development, the adaptability of the site to accommodate growth and pedestrian improvements over time should be considered.

Application of this approach would encourage buildings to be located no further than 20 feet from the right-of-way, with parking located to the side or rear of the building. The location of buildings in relation to the roadway is often a defining element in the character of the corridor. It creates a focal point of activity convenient to the corridor and nearby residential areas. It also promotes efficient use of the land around the roadway and can encourage multi-modal connections.

Building Orientation

The spatial relationship between the road corridor and building entrances provide safety for pedestrians and bicyclists and can assist in wayfinding for all modes of transportation. In coordination with locating the buildings near the front property line, commercial sites that would be developed along the Inner Belt should be oriented to face the corridor, even if the site access is from a collector or local street.

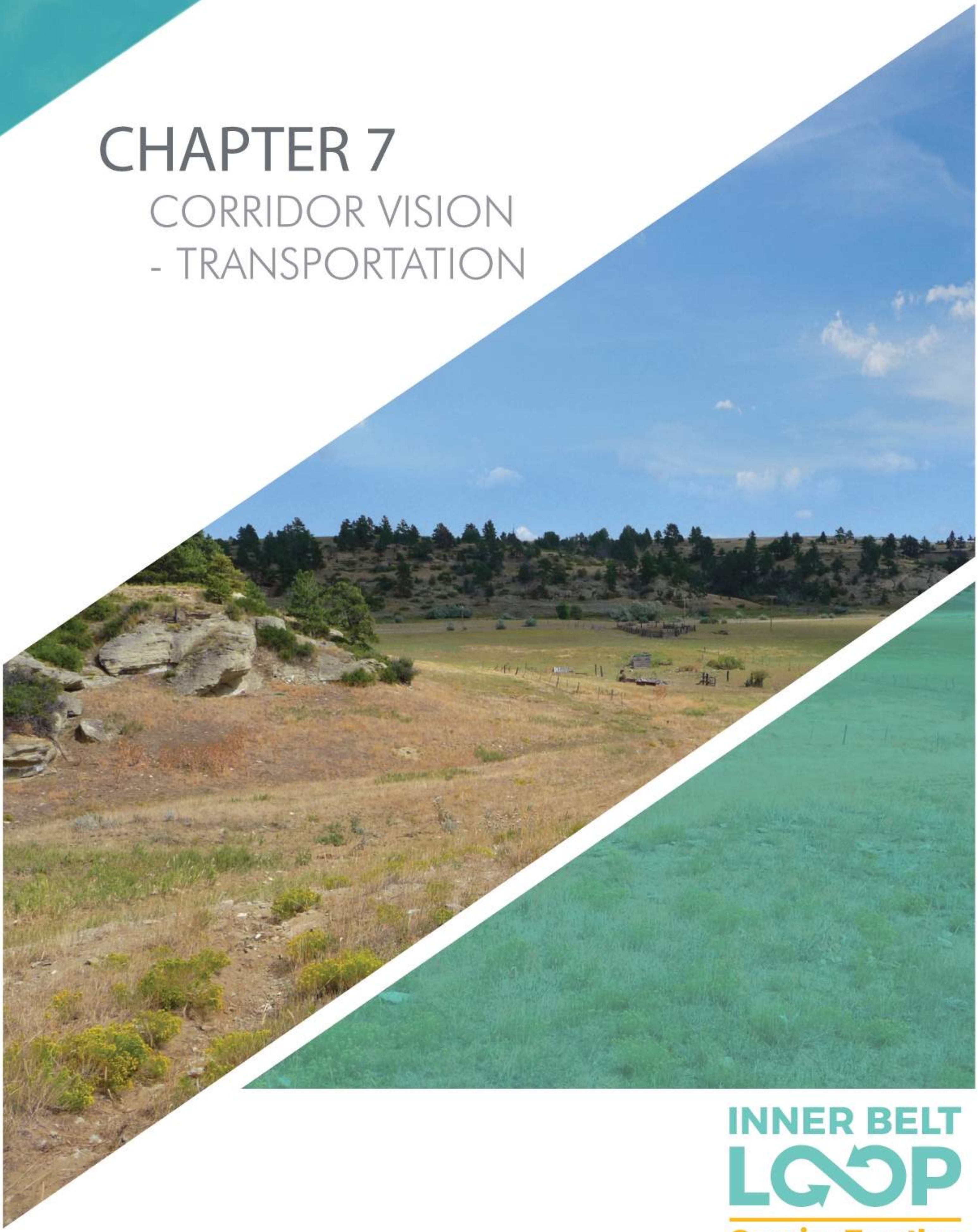
Images from Bozeman and Billings, Montana showing commercial buildings oriented toward an arterial street.

Landscaping

As with the residential development, landscaping for commercial land uses will be regulated through the City of Billings Zoning Code. Many of the same principles apply to landscaping of the right-of-way adjacent to commercial development. Consideration for availability of water for irrigation, topography and visibility will need to be factored into the landscape design.

CHAPTER 7

CORRIDOR VISION - TRANSPORTATION



INNER BELT LOOP

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CORRIDOR VISION – TRANSPORTATION

Functional Classification

Functional classification is a system that categorizes segments of streets or roadways on the basis of if those roadway segments are primarily intended to provide local property access vs. mobility for users (primarily vehicles) or some combination of those functions. The *2018 Billings Urban Area Long Range Transportation Plan* classifies the Inner Belt Loop (from MT 3 to Alkali Creek Road) as a Proposed Principal Arterial. Skyway Drive (Phase 1 of the Inner Belt Loop) is classified as a Principal Arterial. The Principal Arterial classification implies that the Inner Belt Loop is intended to provide a high degree of mobility while access to adjacent properties should be configured to minimize impacts to mobility in the corridor. Given the generally agreed upon purpose for the Inner Belt Loop and with consideration given to limitations to both accessibility and land development caused by the terrain in the area around the corridor, the Principal Arterial designation is appropriate for the facility. The following sections of this report discuss how functional classification relates to speed, access management, and other aspects of corridor vision.

Speed Profile

In order to deliver on the promise of prioritized mobility for the Inner Belt Loop (as consistent with the Principal Arterial classification), the speed profile for the corridor is a very important consideration. The roadway design that was completed in 2010 was based on a 45 mph design speed, as was originally referenced in the *Inner Beltloop Connection Planning Study* (HKM, 2006). The design speed is relatively low for what will at least initially function primarily as a rural highway. However, the 45 mph design speed was the maximum for which the roadway could be designed using AASHTO's Low-Speed Urban Street design criteria. The 45 mph design speed (and speed limit) allows the Inner Belt Loop to function as an urban principal arterial as we expect this area to eventually be developed. As development progresses in the future, there may be valid reasons to consider lowering the speed limit in certain areas of the corridor where development and traffic demand is more highly concentrated. The potential expansion of the roadway from two lanes to four should also be considered when and if that question arises.

Access Management

Access management is a proactive strategy for configuring vehicular access points along a roadway for the purpose of promoting traffic safety and efficiency along that roadway corridor. Access management is typically achieved through the application of one or more of the following techniques:

- Regulation of Intersection/Driveway Spacing – a lesser number of or further spaced vehicular access points improves traffic flow and safety by limiting vehicle conflicts.
- Movement Restriction – the restriction of certain movements at key access locations can augment intersection/driveway spacing regulations by further eliminating vehicle conflicts that are known to increase crash risk and/or stopped-time delay for drivers.
- Auxiliary Lanes – the provision of auxiliary or continuous turn lanes where turning movement volumes justify such improvements can greatly improve intersection capacity and general corridor efficiency
- Intersection Control Improvements – the implementation of all-way stop control, traffic signals, or roundabouts can substantially improve intersection operations and safety for locations where the minor approach (side-street) traffic demands require interruption of flow in order to access the mainline roadway. However, those mechanisms also introduce delay for mainline roadway vehicles that would otherwise

operate under free flow conditions, so it is important to carefully weigh the benefits of the improvements vs. the impacts.

- Right-Of-Way Management – the technique involves reserving right-of-way where it is anticipated to be necessary for future access locations, widening, and/or the provision of good sight distance.

The level of access management for a given roadway facility should be directly tied to its functional classification (i.e., its intended function relative to prioritizing mobility vs. access). It has been established that the Inner Belt Loop will be classified as a Principal Arterial meaning that its primary function is to provide efficient mobility. In order to maximize efficiency of mobility, a well-thought-out access management strategy will be of vital importance. Although there is not a formal access management requirement in the Subdivision Regulations or City Code, the City does follow an informal standard for arterial streets whereby the following general pattern is followed for a ½-mile segment (repeated thereafter):

- **Begin Segment (0 feet) –** full-access intersection with traffic signal or roundabout allowed if warranted
- **1/16 Mile Point (330 feet)** - right-in/right-out approach(es)
- **1/8 Mile Point (660 feet) –** 3/4 access approach(es)
- **3/16 Mile Point (990 feet)** - right-in/right-out approach(es)
- **1/4 Mile Point (1320 feet) –** full (unsignalized) access
- **5/16 Mile Point (1650 feet)** - right-in/right-out approach(es)
- **3/8 Mile Point (1980 feet) –** 3/4 access approach(es)
- **7/16 Mile Point (2310 feet)** - right-in/right-out approach(es)
- **1/2 Mile Point (2640 feet) –** full-access intersection with a roundabout allowed (but no traffic signal)

This level of access management would seem to be generally appropriate for the Inner Belt Loop given its functional classification. However, a standardized access control plan may not be realistic for this corridor considering the variability of terrain, which directly impacts location of access through both limitations to sight distance and effects on private property land development feasibility. It is also important to note that effective access restriction at approach locations (right-in/right-out or three-quarter access) typically requires raised center median on the mainline route in order to physically prohibit drivers from making the restricted movements. The use of signage, even in combination with channelizing islands on a restricted-access approach, has been largely ineffective in Billings and would likely be even less effective in what will be a mostly rural environment, unless a targeted enforcement effort was employed.

The initial design configuration as a rural, two-lane highway is not particularly conducive to the implementation of access restriction via raised median, though such improvements could be installed in spot locations to provide for access control. Raised median installations also would require street/intersection lighting in those locations. The current proposed design includes full-movement access approaches at 15 locations along the corridor with spacing between successive access intersections ranging from approximately 400 feet at the lower end to approximately 4740 feet and the upper end. There are six approach spacings of less than a quarter-mile, with three of those six spacings being less than an eighth-mile. In those locations, access restriction should be strongly considered if and when development of the corresponding properties occurs in order to promote safety and high mobility in the corridor.

Access locations were carefully evaluated during the initial design process for the Inner Belt Loop. However, prior to the acquisition of right-of-way, it would be beneficial to review proposed approach locations with respect to a high-level access management strategy for the corridor and with input from impacted property owners. Furthermore, the private properties to be bisected by the Inner Belt Loop are currently undeveloped and several are in use for farming and/or grazing. Those agricultural types of uses must also be considered relative to location and type of access to the adjacent properties. As a result, the access control strategy for the corridor may need to be phased with pre- and post-development stipulations that differ relative to location and type of access based on the particular use of the land at the time of plat approval.

Roadway/Intersection Environment

As has previously been established, the planned initial build for the Inner Belt Loop consists of a two-way, rural highway facility with at-grade intersections and private property access. An evaluation of corridor and intersection capacity based on two future land development scenarios for the year 2040 identified some potential deficiencies on both accounts relative to typical minimum LOS standards. The potential shortfalls in corridor capacity are directly proportional to the level of traffic demand given the number of travel lanes and availability of passing zones. As such, if the projected level of development is achieved at some point in the future, additional lanes may be necessary in order to achieve desired LOS metrics. It is not expected that the two-lane configuration will be at or near capacity for the opening year.

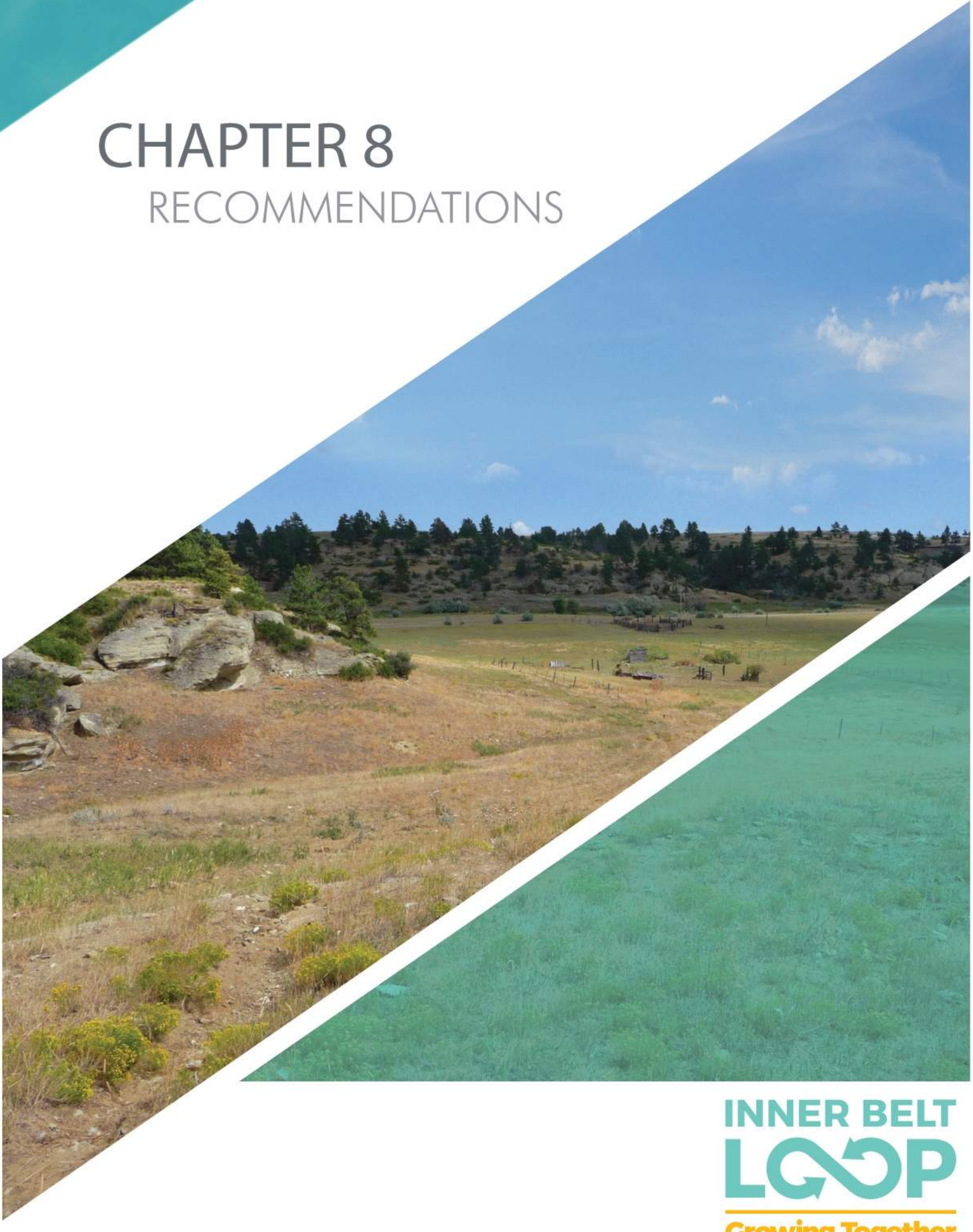
Likewise, based on the results of the future conditions traffic analyses for the Inner Belt Loop, it is likely that one or more current or future intersections along the route may require traffic control beyond the standard two-way stop control that would be minimally required for public or private street approaches intersecting with a principal arterial. The intent of this section of the report is to discuss how various intersection and pedestrian crossing configurations would fit within the roadway environment both initially and longer-term as density of development progresses.

Traffic signals and roundabouts have relative advantages and disadvantages, particularly when evaluated on higher-speed, rural highways with agricultural land use vs. lower-speed, densely developed urban streets. The level of demand for pedestrian and bicycle traffic is also a key consideration. For the Inner Belt Loop, the expectation is that the higher-speed, rural setting will be prominent throughout much of the corridor for many years with pedestrian and bicycle traffic demands trending more toward long-distance, recreational usage rather than for localized traffic. From a safety perspective, properly designed urban roundabouts have been proven to be a much safer alternative to conventional traffic signals, at least relative to frequency and severity of vehicle crashes. This is particularly true in higher-speed environments where roundabouts virtually eliminate the occurrence of often-severe, right-angle crashes. Opinions vary on relative safety between roundabouts and traffic signals for pedestrians and bicycles, but drivers in the Billings area are generally poor when it comes to compliance with the Montana Code Annotated statute [61-8-502-1(a)] which requires that "the operator of a vehicle shall yield the right-of-way, slowing down or stopping if necessary, to a pedestrian crossing the roadway within a marked crosswalk or within an unmarked crosswalk at an intersection." This may be in part due to a lack of knowledge that the statute even exists but is likely also caused by a relative lack of exposure to pedestrian and bicycle traffic when compared with more urbanized areas around the country. As a result, the level of comfort (at a minimum) and to some extent safety may be lesser for pedestrians at roundabouts than at intersections with signalized crosswalks. That said, crosswalks at roundabouts can be signalized and, in fact, it is now a requirement in the draft Public Right-of-Way Accessibility Guidelines (PROWAG) that crosswalks at roundabouts have pedestrian-activated signals for any crosswalk that traverses more than one travel lane. The addition of signals for the crosswalks at a roundabout typically adds anywhere from $80,000 to $250,000 to the construction cost for the intersection. Both types of intersections would require lighting for safety purposes. A roundabout may or may not require more right-of-way than a signalized intersection depending on the required lane configurations of each intersection. In general, a roundabout is likely to be more expensive than a traffic signal in a rural or semi-rural environment. Yet the safety attributes and the added benefit of inherent traffic calming (slowing of traffic) that roundabouts provide would seem to make them attractive for intersections along the Inner Belt Loop.

In support of pedestrian and bicycle safety and traffic efficiency, it may also be worthwhile to consider installation of one or more grade-separated pedestrian crossings if there are locations where frequent crossings are expected to occur. For example, where the Inner Belt Loop bisects the Rehberg Ranch Subdivision, the planned facilities to the northwest of the roadway may at some point in the future generate a high demand for pedestrian and bike crossings. A grade-separated crossing (most likely a tunnel in this case) would virtually eliminate potential conflicts between vehicles and bicycles/pedestrians, while also reducing delay for vehicles that might otherwise have to stop or yield to crossing users at those locations. These types of facilities, if strategically located, may also be beneficial in the short-term for crossing livestock without impacting traffic on the roadway.

CHAPTER 8

RECOMMENDATIONS



INNER BELT LOOP

Growing Together

RECOMMENDATIONS

Intergovernmental Coordination

Approach to Land Development

Because the Inner Belt Loop construction will be funded by the City of Billings, it is anticipated that development that is accessed from the roadway will ultimately be annexed into the City and developed at urban densities. This development pattern would provide tax revenue and a return on investment to the City. However, because the majority of the land adjacent to the Inner Belt Loop is currently outside of the city limits, it's not a given that land will be annexed and developed to City standards. Because the City and County have different design standards and goals for land development, setting a coordinated approach will establish priorities for development along the Inner Belt Loop. Establishing this coordinated approach should be completed prior to the construction of the roadway. One method for such coordination is an intergovernmental agreement. It would articulate commitment from each party and inform the community of a comprehensive approach to development in the area.

Intergovernmental agreement

An intergovernmental agreement (IGA) between the City of Billings and Yellowstone County would establish the roles and responsibilities of the County and City in the development review process. It would also identify conditions when development would be appropriate within the City or the County. Specific considerations should be given to:

1. Appropriate timing and location for land annexation into the City.
2. Comprehensive approach to zoning within for land adjacent to the Inner Belt Loop. Consideration should be given to allowing properties to remain in current zoning until development is desired. At that time, annexation and application for City zoning would be expected.
3. In certain circumstances, land could be developed within the County. In these situations, the agreement could stipulate how that development would conforms to City standards, in case of future annexation. This is applicable in a situation where utilities to support that development are available, but annexation is not possible.
4. In cases of low intensity development, as may be permitted with current zoning, the agreement could articulate that specific site planning would not preclude future development of the property at a higher density and intensity when utilities are present.

Development Tools

Neighborhood Plans

To further articulate the goals of the Inner Belt Loop, the City should development a neighborhood plan of the area. A neighborhood plan may be adopted as part of the City of Billings Growth Policy and as such, can further articulate a development pattern that matches the vision for the corridor and guide development towards that vision.

Limits of Annexation Map

As the City looks to construct the Inner Belt Loop, consideration should be given to update the Limits of Annexation Map. As part of the update, consideration will need to be given as to the availability to extend water and sewer services, resulting in potentially only a few properties being designation within the Petition Area.

Development Standards

Ensuring the vision of the corridor is fulfilled, standards for future development will need to be established prior the construction of the Inner Belt Loop. Standards would be established through the zoning regulation. Project ReCode will create new zoning districts and an evaluation of appropriate zoning within the study area should be completed.

Urban Density

Development of urban density will be dependent on the presence of utilities. Given the anticipated costs of extending public utilities along the corridor, utilities will likely be installed with development and not at the time of construction of the roadway. When utilities are extended with development, it can result in a pattern of development that extends from currently developed areas to undeveloped areas in a linear fashion. This means that property owners who are further from existing development are unable to economically develop until their neighbors located closer to existing utilities develop. While there are a number of positive outcomes from not having "leapfrog" development, property owners may want to develop before utilities are adjacent to their site and may therefore have no viable economic choice but to develop in the County.

Developing a plan for the extension of water and sewer to enable development at urban densities will be critical to fulfilling the development pattern envisioned. As the City updates these infrastructure master plan, this Inner Belt Loop area should be included and coordinated with other planning documents, including the Growth Policy and a future neighborhood plan.

Design Considerations

Roadway Typical Section/Right-Of-Way

Based on the land development projections and future traffic projections completed for this study, it seems likely that the Inner Belt Loop roadway may need to be expanded to a 4-lane or 5-lane section at some point in the future. However, if land development does not occur at urban densities due to a lack of public water and sewer or other contributing circumstances, the proposed initial design of a 2-lane section may adequately serve traffic in the corridor for an extended period of time beyond the 20-year outlook for this analysis.

In order to ensure that adequate right-of-way is available to accommodate a 5-lane roadway typical section along with the multi-use path, a corridor for utilities, drainage, and roadway lighting, boulevard sidewalk, and the potential need for raised median for access control, the proposed right-of-way should be increased from 90 feet to at least 100 feet. The additional right-of-way width would provide flexibility with regard to design, even for the initial 2-lane roadway section, and would also help to solve concerns about arterial vs. building setbacks for the corridor, though it would also increase costs associated with right-of-way acquisition.

Intersection Design/Right-Of-Way

Major intersections such as with Alkali Creek Road, the proposed extension of Iron Horse Trail, or with the future planned north-south collector roadway between the Inner Belt Loop and the airport may require traffic signals or roundabouts in order to maintain acceptable LOS in the long-term future. Allocation of additional right-of-way at those intersection locations should be considered through the final design and right-of-way acquisition process.

For any intersection where a traffic signal becomes warranted in the future, a roundabout should be strongly considered in place of a traffic signal given the associated safety benefits, particularly with regard to reduction of high-speed, right-angle crashes at rural intersections.

Access Management

Access management is an important aspect of maintaining efficiency of mobility and safety for any arterial roadway. As a new roadway through largely undeveloped property, the Inner Belt Loop is an ideal candidate for implementing a strict access control plan that would define the allowable frequency, spacing, and configuration of access along the corridor. However, the variation in topography and the way in which the topographic features relate to property boundaries make it difficult to uniformly apply an access control mandate without the possibility of negative impacts to land development potential. It would also be difficult to effectively restrict access (such as to right-in/right-out or three-quarter access operation) without a raised center median, which would not fit well with the planned initial roadway template (2-lane, rural highway). Another important factor is the type and use of each access approach. Many of the approaches would initially be utilized for agricultural purposes with very different needs from a future developed condition. Given all of these considerations, an access management strategy for the corridor should be developed, starting with an evaluation of the original planned access locations shown in the preliminary design with respect to spacing and configuration of access. The City should consider stipulations within the right-of-way purchase agreements with property owners that allow for approach locations and configurations to be reviewed and modified at the time when land development proposals are brought forward.

Bicycle/Pedestrian Facilities

The multi-use trail along the Inner Belt Loop will initially be utilized primarily by recreational runners and bicyclists. In order to augment the aesthetic and functional qualities of that facility, the City should consider identifying locations along the route where stopping points with amenities such as picnic tables, trash receptacles, shaded areas and restrooms could be installed.

Consideration should also be given to bicycle and pedestrian crossing locations of the roadway. Given the relatively high design speed of the roadway, at-grade crossings may need to be designed with higher-level signage and or pedestrian-activated traffic control such as rectangular rapid-flash beacon (RRFB) systems or pedestrian hybrid beacon (HAWK) signals to ensure safety for users. Below grade crossing should also be considered. As there is topographic variation along the corridor, tunnel crossings may be feasible in certain locations.

Water and Sewer Infrastructure

To facilitate the infrastructure that will support development along the Inner Belt Loop, there are tools available to finance the construction.

Private property owner agreements

The City and County could work to facilitate the property owners in establishing their own agreement to address utility provision. The agreement could establish private reimbursement and cost share agreements. For instance, a property owner closer to exiting utilities could participate in the extension of utilities through their site to an adjacent site that wishes to develop. Agreements such as this require a fairly high level of sophistication and trust among property owners.

Reimbursement Agreements

Similar to reimbursement agreements that can be in place between private developers, a reimbursement agreement could be established if the City of Billings constructs the utilities along the corridor so that landowners are not dependent on others adjacent to existing utilities developing first. Developers would be required to pay reimbursement fees in order to connect to this infrastructure.

Fees for connection should be fixed or based on land area so that developers face incentives to develop at the highest and best use possible. However, fees must not be so high that development cannot carry the cost. There is a risk that the appropriate fee and the cost of the infrastructure become “detached” in that there is not an economic relationship between the two.

For developers, the advantages are not having to carry the cost of the utility installation through their project financing, not being exposed to construction and financing / interest rate risk, and the certainty of the fee amount.

For the City, the advantages are that they get control over the process, have more leverage regarding development and may also be able to finance the construction more cheaply than a private developer could. Conversely, it is risky to extend utilities for development that does not, and may not, exist.

Special Improvement District or Rural Improvement District

A special improvement district (SID), used by cities, or a rural improvement district, used outside of incorporated cities, can be created that would distribute the costs of infrastructure and maintenance across the properties that would benefit. State law allows the distribution on the basis of the area of each parcel in the district, the assessed value of each parcel, the number of parcels, the front footage of each parcel bordering a street, or a combination of these. Establishing and SID would allow for infrastructure to be constructed using bond funds with a pay off period of up to 20 years.

Further analysis should be performed to examine the relationship between the ultimate cost of the infrastructure and the amount of development that can be expected with the goal of determining whether development along the corridor is financially feasible from both a public and private perspective. The cost of the infrastructure should be compared with the expected amount of development to determine a cost of infrastructure / unit of development ratio. This ratio should be compared to other area developments to evaluate the competitive position of Inner Belt Loop development. If the ratio is not competitive, we can expect that development along the IBL will lag or not come to fruition.

Phasing

Roadway Construction Phasing

Construction of the Inner Belt Loop will be funded through the City of Billings Capital Improvements Plan (CIP). As indicated in the most current plan, half of the funding will be allocated in 2022 and the remaining funding to be allocated in 2024. Phasing the construction to align with the funding allocation should be considered. There are three likely options for construction phasing.

Option 1 would focus on finalizing the road design, environmental assessments, permitting and initial site work within one phase. This would enable the entire road alignment to be graded, erosion control installed and the road bed seeded. Completion of the road, including asphalt, signage, striping and trail work would occur with the final allocation of funding in 2024. Based on construction estimates of the road design, this option spends approximately 25 percent of the budget on the earthwork phase and 75 percent for the completion phase.

Option 2 would focus on completing one half of the roadway with the first allocation of funding and the second half with the remaining funding allocation. With this approach, the road design through the finish road section would be completed, with one section of the Inner Belt Loop completed with the 2022 funding allocation and the second section completed with the 2024 funding allocation. Splitting the road approximately halfway, this option would spend approximately 45 percent for the first phase and 55 percent for the second phase. Completing the road using this phasing strategy would allow for development of the adjacent land to the completed section prior to full build out of the roadway. Given the adjacency of City water and the capacity within the Rehberg Ranch lagoon system to serve additional property, completing the western half of the roadway would create development opportunity more immediately than other areas of the corridor.

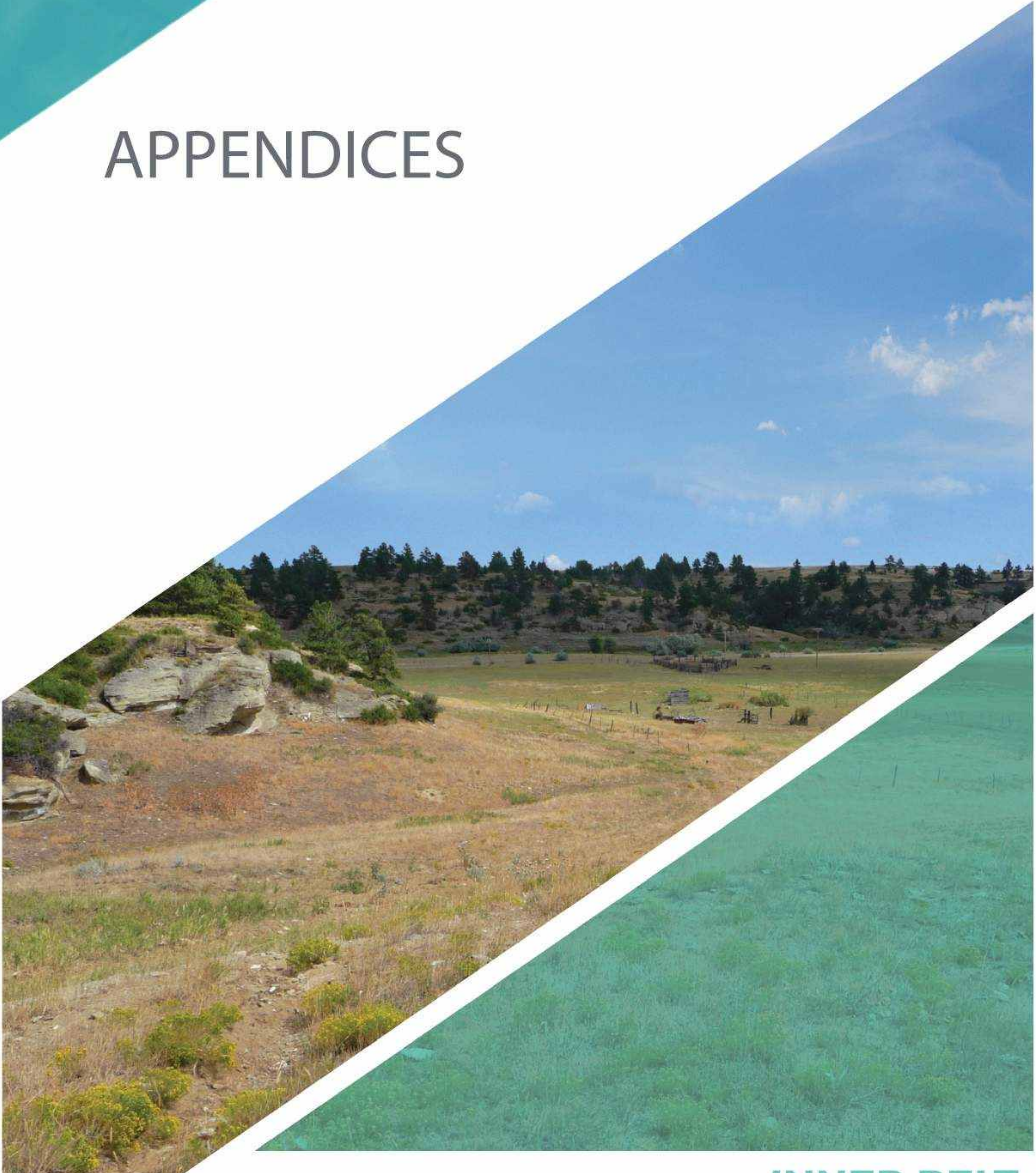
Either of the above options could be combined with a third option, that would link portions of the construction of the Inner Belt Loop to land development within the study area. This option would likely use the funding allocated within the CIP and additional funding from private development to complete the construction of the roadway. If there is development awaiting the construction of the roadway, this option would enable a faster completion. While this enables faster construction, it is also costly to a developer. To offset some of that cost, a reimbursement agreement could be pursued. This type of reimbursement would pay proportionally for the road capacity that is required to serve the traffic generated by the development. Using this approach, developers would fund the required portion of the Inner Belt Loop and then be eligible for reimbursement by future development.

Summary of Next Steps

It will be important that as the City moves towards undertaking the construction of the Inner Belt Loop in 2022 that the issues and recommendation identified in this study are evaluated and acted upon. The following list is drawn from the recommendations above.

1. **Intergovernmental Agreement**. As these documents can take time to develop and approve, initial work on an intergovernmental agreement between the City and the County should begin immediately.
2. **Limits of Annexation Map.** As the City reviews and updates the Limit of Annexation Map in 2020, consideration for including some property within the Inner Belt Loop corridor should be given some consideration.
3. **Right of Way Acquisition.** Developing a plan to secure the necessary right-of-way for the entire corridor should be completed.
4. **Planning Tools.** Ensuring the tools are in place for landowners to begin to conceptualize development project will help facilitate the type of development that fulfills the vision of the corridor. The City should consider a neighborhood plan and appropriate zoning for the area.
5. **Phasing.** The approach to phasing the construction will influence the availability of land for development, use of available funds, the approach to acquiring right-of-way and other facets of the project. Selecting a phasing approach will help facilitate and direct other decisions related to the project.
6. **Water and Sewer Infrastructure.** Developing an approach to providing water and sewer infrastructure to the corridor will be instrumental in determining how the corridor will be development and how this area fits into the City's overall infrastructure management. Included in this should be an evaluation of the funding mechanisms mentioned above.

APPENDICES



INNER BELT LOOP
Growing Together

SUMMARY OF PUBLIC MEETINGS

APPENDIX A

ENDURING COMMUNITY DESIGN

SANDERSON STEWART

Two (2) public meetings were held through the course of the Inner Belt Loop Corridor Study project. The first public meeting was held on the evening of November 6, 2019 at 6 PM at the Billings Community Center. The meeting was well-attended (see attached attendance log). Sanderson Stewart opened the meeting by presenting an update on the status and to-date completed work for the study, which at that point had focused primarily on background research and meetings with key project stakeholders, an analysis of existing conditions traffic operations and safety, and a land development feasibility evaluation for the properties along the Inner Belt Loop corridor. At the conclusion of the presentation, the project team opened the meeting to public feedback/questions, the intent being to solicit valuable input on developing a well-thought-out vision for the corridor to help guide not only the design and construction of the roadway, but also future development of the properties along the corridor. It was stated specifically that the alignment and connection points (the location) of the Inner Belt Loop had long ago been decided and that possible changes to those aspects were not part of the scope of the study. Even so, the question and answer period was dominated by questions and comments primarily about the connection point at the south end of the Inner Belt Loop corridor and its anticipated impacts for traffic and safety on Zimmerman Trail. A number of residents from that general area below the rims along Zimmerman Trail voiced concerns about traffic demand, speed, and safety should traffic increase a result of the construction of the Inner Belt Loop. Several comments referenced the potential for alternate connection points and the additional evaluation of such options. The project team did its best to answer the questions that were asked and to re-direct the conversation toward input on how the established corridor would be designed and constructed and how land development potential along the corridor could be maximized. However, in the end, there was very little discussion or feedback that did not revolve around concerns over the location of the south end connection. The meeting ended at approximately 7:30 PM after an hour or so of public comment period.

The second public meeting was held on March 5, 2020 at 6 PM at the Billings Parmly Library. Once again, the meeting was well attended (see attached attendance log). At this stage in the project, the draft summary report had been completed and initially reviewed by the MPO. Sanderson Stewart opened the meeting by presenting the analyses, results, and recommendations from the draft report. The presentation lasted approximately 30 minutes and was followed by about 30 minutes of a question and answer period. This time around, the questions and comments from the public centered much more around the overall vision for the corridor. There were questions about right-of-way for the road, physical design characteristics as related to travel speeds and safety, the disposition of both public and private lands along the corridor with respect to likely future development, and area growth with respect to that development potential. There was some discussion about upstream and downstream impacts to traffic demand, which is a key discussion point in the study. The meeting ended at approximately 7:00 PM.

PUBLIC MEETING #1
ATTENDANCE SIGN-IN SHEET

MEETING DATE: November 6, 2019 **TIME:** 6:00 PM

LOCATION: Billings Community Center – 360 N. 23rd St.

NAME	ADDRESS	PHONE	E-MAIL
Scott Walker	C/C Plng		
Chuck & Georgia Walter	4309 Smokehawk Trl	702-3287	
Jeff Kanning	2280 Grant Rd	248-2443	
Andrew Wolff		818-383-3650	
WYETH FRIDAY	PCSD		
Larry Seekins	380 Camel Pl	671-8886	
Chuck & Jolynn Summers	3410 Flagstone Dr	406-697-1359	Jolynnsummers@gmail.com
Dave Kinnard	106 Sky Ranch Dr		kinnlaw@bresnan.net
PHIL BELL	3426 TIMBERLINE		philbell@charter.net
Jacob Cote	15½ Alderson Avenue		jacobscote@live.com
TERRY SMITH			inxring@gmail.com.
Cheryl Lenhardt	3209 Rimrock	652-2247	
DANNY CHORIKI		406 748 6116	danny@chorikiformontana.com
MARC OSBORN		406-672-4554	MARC OSBORN Realestate@gmail.com

PUBLIC MEETING #1
ATTENDANCE SIGN-IN SHEET

MEETING DATE: November 6, 2019 **TIME:** 6:00 PM

LOCATION: Billings Community Center – 360 N. 23rd St.

NAME	ADDRESS	PHONE	E-MAIL
Steve Swanson	5342 Cabernet	827-2469	SSwanson@beartooth.org
Tony Nave	1518 Alkali	252-1761	sand.tony@bresnan.net
Katie Barry	3633 Glantz Dr	690-8279	kbarry@m-m.net
Heather Mosser	237 Quiet Water	697-8893	hmosser@m-m.net
Marcia Hurlburt	5550 Walter Hagen Dr	696-1999	darchitex@bresnan.net
JIM DECKER	112 SKY RANCH DR	200-7012	DJNJDECKER@CHARTER.NET
Elaine Kinnard	106 Sky Ranch Dr.	672-5556	eekinnard@gmail.com
ED ARNOLD	1323 PAUL REVERE ST	252-0507	
MARLENE CARSTENS	3444 Tilson D.	656-4295	marlene3444@gmail.com
Dennis Gaub	6007 Catherine Ct.	690-5444	dennis.w.gaub@gmail.com
Gordon Olson	5919 Ironwood Drive	307-461-0397	wjodrivermts@yahoo.com
Tom Zurbuchen	1747 W. Dr	252-2270	
BARBARA RAMLOW	3450 Masterson Circle	534-2102	crkside100@gmail.com

PUBLIC MEETING #1
ATTENDANCE SIGN-IN SHEET

MEETING DATE: November 6, 2019 **TIME:** 6:00 PM

LOCATION: Billings Community Center – 360 N. 23rd St.

NAME	ADDRESS	PHONE	E-MAIL
Kevin Nelson	4255 Bruce Ave		geos59101@gmail.com
Pam Ellis	2008 Outlook Dr		pamellis50@gmail.com
Carolyn Kennedy	3224 Zimmerman Pl		cmk2jak1@aol.com
Valerie [illegible]	3142 Zimmerman Pl.		
Lyle Gabrian	3142 Zimmerman Pl.		lgabrian@bresnan.net
DAVID F Schwarz	P.O. BOX 31956 BLGS		
NICK REICHARD	3056 RIMROCK ROAD		reichard.nf@gmail.com
Roy Neese	2323 Constellation Ter		NA
CHUCK BARTHULY	300 Fairway Cr		chuck@betterbillings.com
DAN BROOKS	2724 TERRACE CIR		daniel@billingschamber.com
Kevin Ploehn	1901 Terminal Circle	657-8484	Ploehnk@ci.billings.MT.gov
Jennifer Owen	906 Royal Ave 59105		jowen76@gmail.com
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Lloyd Swords	2940 Rimrock Rd Unit 1		applesos@icloud.com
Brad Tecca	5544 Vitero Trail SD, CA		brad.tecca@cushwake.com
Greg Hubbs	4516 Grans CT		g.hubbs@hotmail.com
Barb Herda	3447 Timberline Dr	698-7996	bherda@bresnan.net
Denise Joy	djoy@ci.Billings.Mt.gov		
Howard + Carol Holz	1120 Blackberry Way	612-759-6138	hcholzper@gmail.com
DAN BRADBURY	2223 8 Ave N		
Bill Cole	3733 Tommy Armour		coleb@billingsmt.gov
Denis Pitman	726 Arguello Pl.		dpitman@co.yellowstone.mt.gov
SHARON FLETCHER	2740 ZIMMERMAN TR		smfiors@bresnan.net
Bill Schultz	2740 Zimmerman Tr		altmail@bresnan.net
Dennis McKnire	3905 Rimrock		
Terry Odegaard	2101 Lake Hills		[illegible]@Bresnan.net
Sandra Hubbs	4516 Grans CT		Zleeb[illegible]hotmail.com

PUBLIC MEETING #~~1~~ 2
ATTENDANCE SIGN-IN SHEET

MEETING DATE: March 5, 2020 **TIME:** 6:00 PM

LOCATION: Community Room – Parmly Library

NAME	ADDRESS	PHONE	E-MAIL
Lisa Chapel			lisakchapel@gmail.com
Jennifer Owen			jowen2k@gmail.com
Dennis McKnire	3905 Rimrock		
Leslie Cooke	3251 Rimrock		ldmcooke@hotmail.com
Clifford Cooke	3251 Rimrock		CliffordCCooke@Gmail.com
DAN BROOKS	815 S. 27TH		DANIEL@BILLINGSCHAMBER.COM
Tory MING CABRERA	1734 POLY DT		mingformontana@gmail.com
MIKE ORMSBY	2930 WALDEN PL		MIKE@MONTANAPROPERTY.COM
ED GULICK	3015 10th AVE. N.		egulick@bresnan.net
JAN Rehberg	4401 Highway 3		jan@rehbergranch.com
Michael Tuss	1046 N. 31st & 2835 Hwy 3		miketuss@cushingterrell.com

PUBLIC MEETING #2
ATTENDANCE SIGN-IN SHEET

MEETING DATE: March 5, 2020 **TIME:** 6:00 PM

LOCATION: Community Room – Parmly Library

NAME	ADDRESS	PHONE	E-MAIL
Alice Gabrian	108 Sky Ranch	850-8017	agabrian@bresnan.net
JIM KOHTLES	17 STANFORD CT	671-4664	JAMESKOSUP@MSN, COM
MARILY KOHTLE	17 STANFORD CT	671-7998	
Steve Simonson	5340 Cabernet	962-3914	ssimonson@beartooth.org
Justin Biehl	1180 Centennial St	855-0171	biehljustin@yahoo.com
Lukas Marthson	509 4th Ave N	8613603	lukas@theonemt.com
Darell Tunnicliff	2314 Queen Cir	4066681920	[illegible]
Jack Nickels		406-672-6936	
Lyle Gabrian	3142 Zimmerman Pl.	259-1823	lgabrian@bresnan.net
Pam Purinton	CM Ward 4		
Chadwick Trandahl	1032 N 26th St.	(406)5466677	mrresp@hotmail.com
SIMON HARPER	4156 BLACKPOOL TR. 59106	8608912	SIMON@BRESNAN, NET.
Howard & Carol Holz	1120 Black Berry Wy 59106	534-4340	
Denis Pitman	726 Aquarius Pl. 59105		
mark Boyd	1925 Lake Elmo	248-5510	
SAM Boyd			
Joanie Tuss	1046 N 31st	2529364	joantuss@gmail.com

PUBLIC MEETING #~~1~~ 2
ATTENDANCE SIGN-IN SHEET

MEETING DATE: March 5, 2020 **TIME:** 6:00 PM

LOCATION: Community Room – Parmly Library

NAME	ADDRESS	PHONE	E-MAIL
Scott Walker	c/c Plng.		
T Ryan	Alkali Cr. Rd.		dantryan@MSN.com
Pam Ellis			
Brad Tecca			brad.tecca@CUSquake-c.c
ERNIE SZILLAT			creativevinyl@live.com
John Felton	1614 Morocco Dr	Blgs 19102	johnfelton1958@gmail.cm
Kendra Shaw	934 N. 31st	670-7772	shawk@billingsmt.gov
LARRY BREWSTER	1216 BABCOCK	670 0929	
Curtis Haney	2405 Granite Ave	656-1569	
Mike YAKAWICH	206 S. 32	647-6391	yak-mike@gmail.com
Lora Mattox	c/c Planning		
Jeff Bollman	1371 Rimtop	247-4404	jbollman@mt.gov
Jerry Dennis	1918 Barrett	8602160	Terdenz1@icloud.com
Deanna Dennis	"	665-5569	crowmex@hotmail.com
Melissa Henderson	825 Parkhill		melissa.hend@gmail.com
Roy Neese			
Frank Ewald			
Susan Jordan	2108 Yellowstone Ave		Dogsong1@msn.com

INTERSECTION/CORRIDOR CAPACITY CALCULATIONS

APPENDIX B

ENDURING
COMMUNITY
DESIGN

SANDERSON
STEWART

INTERSECTION CAPACITY CALCULATIONS – EXISTING CONDITIONS

SANDERSON
STEWART

MOVEMENT SUMMARY

Site: 101 [MT 3 & Zimmerman AM]

AM Peak
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
South: Zimmerman Trail												
3	L2	35	0.0	0.028	3.0	LOS A	0.1	2.8	0.22	0.09	0.22	33.6
8	T1	1	0.0	0.028	3.0	LOS A	0.1	2.8	0.22	0.09	0.22	33.5
18	R2	416	0.3	0.325	5.8	LOS A	1.7	43.8	0.30	0.16	0.30	33.8
Approach		453	0.3	0.325	5.6	LOS A	1.7	43.8	0.29	0.16	0.29	33.8
East: MT 3												
1	L2	514	1.2	0.436	7.1	LOS A	2.9	75.5	0.20	0.08	0.20	31.7
6	T1	41	45.5	0.436	8.3	LOS A	2.9	75.5	0.20	0.08	0.20	31.0
16	R2	0	0.0	0.436	7.1	LOS A	2.9	75.5	0.20	0.08	0.20	30.8
Approach		555	4.5	0.436	7.2	LOS A	2.9	75.5	0.20	0.08	0.20	31.6
North: Zimmerman Trail												
7	L2	0	0.0	0.002	4.9	LOS A	0.0	0.2	0.54	0.34	0.54	35.1
4	T1	0	0.0	0.002	4.9	LOS A	0.0	0.2	0.54	0.34	0.54	35.0
14	R2	1	0.0	0.002	4.9	LOS A	0.0	0.2	0.54	0.34	0.54	34.0
Approach		2	0.0	0.002	4.9	LOS A	0.0	0.2	0.54	0.34	0.54	34.2
West: MT 3												
5	L2	0	0.0	0.260	7.3	LOS A	1.1	29.4	0.60	0.57	0.60	34.0
2	T1	105	6.0	0.260	7.6	LOS A	1.1	29.4	0.60	0.57	0.60	33.8
12	R2	100	0.0	0.260	7.3	LOS A	1.1	29.4	0.60	0.57	0.60	33.0
Approach		205	3.1	0.260	7.5	LOS A	1.1	29.4	0.60	0.57	0.60	33.4
All Vehicles		1214	2.7	0.436	6.6	LOS A	2.9	75.5	0.30	0.19	0.30	32.7

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6).
Roundabout Capacity Model: US HCM 6.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [MT 3 & Zimmerman PM]

PM Peak
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows		Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed
		Total veh/h	HV %	v/c	sec		Vehicles veh	Distance ft				mph
South: Zimmerman Trail												
3	L2	106	1.0	0.082	3.4	LOS A	0.3	8.5	0.18	0.08	0.18	33.3
8	T1	1	0.0	0.082	3.4	LOS A	0.3	8.5	0.18	0.08	0.18	33.3
18	R2	497	0.9	0.378	6.3	LOS A	2.2	55.5	0.26	0.12	0.26	33.5
Approach		604	0.9	0.378	5.8	LOS A	2.2	55.5	0.25	0.11	0.25	33.5
East: MT 3												
1	L2	423	1.0	0.435	7.4	LOS A	2.8	71.5	0.37	0.21	0.37	31.9
6	T1	96	13.3	0.435	7.8	LOS A	2.8	71.5	0.37	0.21	0.37	31.6
16	R2	0	0.0	0.435	7.4	LOS A	2.8	71.5	0.37	0.21	0.37	31.0
Approach		519	3.3	0.435	7.5	LOS A	2.8	71.5	0.37	0.21	0.37	31.8
North: Zimmerman Trail												
7	L2	0	0.0	0.000	5.0	LOS A	0.0	0.0	0.55	0.30	0.55	34.4
4	T1	0	0.0	0.000	5.0	LOS A	0.0	0.0	0.55	0.30	0.55	34.2
14	R2	0	0.0	0.000	5.0	LOS A	0.0	0.0	0.55	0.30	0.55	33.3
Approach		0	0.0	0.000	5.0	LOS A	0.0	0.0	0.55	0.30	0.55	33.9
West: MT 3												
5	L2	2	0.0	0.155	5.7	LOS A	0.6	16.3	0.51	0.43	0.51	34.6
2	T1	59	27.3	0.155	6.8	LOS A	0.6	16.3	0.51	0.43	0.51	34.0
12	R2	60	3.6	0.155	5.8	LOS A	0.6	16.3	0.51	0.43	0.51	33.4
Approach		120	15.1	0.155	6.3	LOS A	0.6	16.3	0.51	0.43	0.51	33.7
All Vehicles		1244	3.3	0.435	6.5	LOS A	2.8	71.5	0.32	0.19	0.32	32.8

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6).
Roundabout Capacity Model: US HCM 6.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

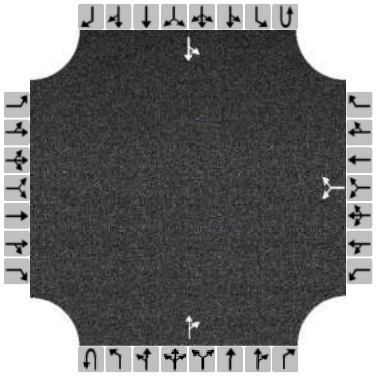
HCS7 Two-Way Stop-Control Report

General Information

Site Information

Analyst	Audrey Stoltzfus	Intersection	Alkali Cr & Skyway Dr
Agency/Co.	Sanderson Stewart	Jurisdiction	City of Billings/MDT
Date Performed	6/6/2019	East/West Street	Skyway Drive
Analysis Year	2019	North/South Street	Alkali Creek Road
Time Analyzed	AM Peak	Peak Hour Factor	0.75
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Inner Belt Loop Corridor Study		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	1	0	0	0	1	0
Configuration							LR					TR		LT		
Volume, V (veh/h)						64		6			4	60		12	3	
Percent Heavy Vehicles (%)						4		0						0		
Proportion Time Blocked																
Percent Grade (%)					0											
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)						7.1		6.2						4.1		
Critical Headway (sec)						6.44		6.20						4.10		
Base Follow-Up Headway (sec)						3.5		3.3						2.2		
Follow-Up Headway (sec)						3.54		3.30						2.20		

Delay, Queue Length, and Level of Service

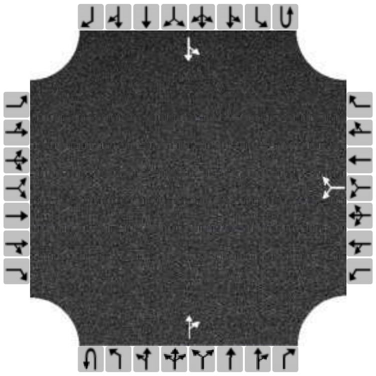
Flow Rate, v (veh/h)							93							16		
Capacity, c (veh/h)							915							1524		
v/c Ratio							0.10							0.01		
95% Queue Length, Q_{95} (veh)							0.3							0.0		
Control Delay (s/veh)							9.4							7.4		
Level of Service, LOS							A							A		
Approach Delay (s/veh)					9.4								5.9			
Approach LOS					A											

HCS7 Two-Way Stop-Control Report

General Information / Site Information

Analyst	Audrey Stoltzfus	Intersection	Alkali Cr & Skyway Dr
Agency/Co.	Sanderson Stewart	Jurisdiction	City of Billings/MDT
Date Performed	6/6/2019	East/West Street	Skyway Drive
Analysis Year	2019	North/South Street	Alkali Creek Road
Time Analyzed	PM Peak	Peak Hour Factor	0.80
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Inner Belt Loop Corridor Study		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	1	0	0	0	1	0
Configuration							LR					TR		LT		
Volume, V (veh/h)						31		6			6	47		6	7	
Percent Heavy Vehicles (%)						0		0						0		
Proportion Time Blocked																
Percent Grade (%)					0											
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)						7.1		6.2						4.1		
Critical Headway (sec)						6.40		6.20						4.10		
Base Follow-Up Headway (sec)						3.5		3.3						2.2		
Follow-Up Headway (sec)						3.50		3.30						2.20		

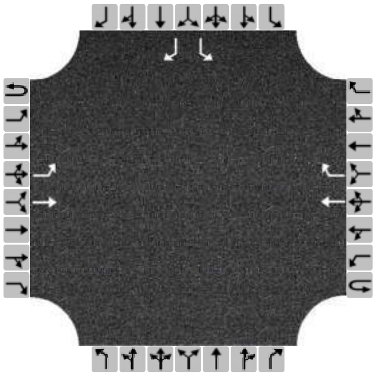
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)							47							8		
Capacity, c (veh/h)							959							1548		
v/c Ratio							0.05							0.01		
95% Queue Length, Q_{95} (veh)							0.2							0.0		
Control Delay (s/veh)							8.9							7.3		
Level of Service, LOS							A							A		
Approach Delay (s/veh)					8.9								3.5			
Approach LOS					A											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Audrey Stoltzfus	Intersection	Wicks Ln & Skyway Dr
Agency/Co.	Sanderson Stewart	Jurisdiction	City of Billings/MDT
Date Performed	6/6/2019	East/West Street	Wicks Ln/Skyway Drive
Analysis Year	2019	North/South Street	West Wicks Lane
Time Analyzed	AM Peak	Peak Hour Factor	0.78
Intersection Orientation	East-West	Analysis Time Period (hrs)	1.00
Project Description	Inner Belt Loop Corridor Study		

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	1	1	0	0	0	1	1		0	0	0		1	0	1
Configuration		L	T				T	R						L		R
Volume, V (veh/h)		6	65				28	20						36		44
Percent Heavy Vehicles (%)		17												3		0
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.27												6.43		6.20
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.35												3.53		3.30

Delay, Queue Length, and Level of Service

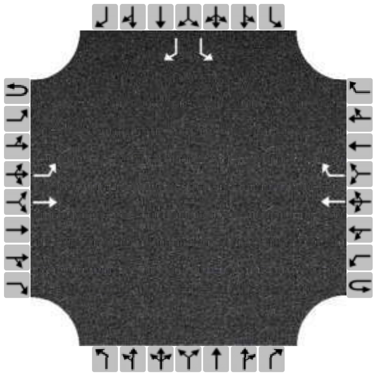
Flow Rate, v (veh/h)		8												46		56
Capacity, c (veh/h)		1452												851		1042
v/c Ratio		0.01												0.05		0.05
95% Queue Length, Q_{95} (veh)		0.0												0.2		0.2
Control Delay (s/veh)		7.5												9.5		8.6
Level of Service, LOS		A												A		A
Approach Delay (s/veh)	0.7												9.0			
Approach LOS													A			

HCS7 Two-Way Stop-Control Report

General Information / Site Information

General Information		Site Information	
Analyst	Audrey Stoltzfus	Intersection	Wicks Ln & Skyway Dr
Agency/Co.	Sanderson Stewart	Jurisdiction	City of Billings/MDT
Date Performed	6/6/2019	East/West Street	Wicks Ln/Skyway Drive
Analysis Year	2019	North/South Street	West Wicks Lane
Time Analyzed	PM Peak	Peak Hour Factor	0.72
Intersection Orientation	East-West	Analysis Time Period (hrs)	1.00
Project Description	Inner Belt Loop Corridor Study		

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	1	1	0	0	0	1	1		0	0	0		1	0	1
Configuration		L	T				T	R						L		R
Volume, V (veh/h)		36	24				36	45						27		16
Percent Heavy Vehicles (%)		0												0		0
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.10												6.40		6.20
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.20												3.50		3.30

Delay, Queue Length, and Level of Service

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Flow Rate, v (veh/h)		50												38		22
Capacity, c (veh/h)		1490												784		1024
v/c Ratio		0.03												0.05		0.02
95% Queue Length, Q_{95} (veh)		0.1												0.2		0.1
Control Delay (s/veh)		7.5												9.8		8.6
Level of Service, LOS		A												A		A
Approach Delay (s/veh)	4.5												9.4			
Approach LOS													A			

INTERSECTION CAPACITY CALCULATIONS – FUTURE CONDITIONS – BASELINE

SANDERSON
STEWART

MOVEMENT SUMMARY

Site: 101 [MT 3 & Zimmerman AM - Baseline]

AM Peak Baseline
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov	Turn	Demand Flows		Deg.	Average	Level of	95% Back of Queue		Prop.	Effective	Aver. No.	Average
ID		Total	HV	Satn	Delay	Service	Vehicles	Distance	Queued	Stop Rate	Cycles	Speed
		veh/h	%	v/c	sec		veh	ft				mph
South: Zimmerman Trail												
3	L2	40	0.0	0.310	6.1	LOS A	1.5	38.7	0.43	0.31	0.43	34.5
8	T1	313	0.0	0.310	6.1	LOS A	1.5	38.7	0.43	0.31	0.43	34.4
18	R2	362	0.3	0.309	6.0	LOS A	1.6	39.1	0.40	0.28	0.40	33.7
Approach		715	0.2	0.310	6.1	LOS A	1.6	39.1	0.42	0.29	0.42	34.0
East: MT 3												
1	L2	447	1.2	0.601	12.8	LOS B	5.9	153.3	0.73	0.84	1.11	29.6
6	T1	42	38.5	0.601	14.2	LOS B	5.9	153.3	0.73	0.84	1.11	29.1
16	R2	49	0.0	0.601	12.7	LOS B	5.9	153.3	0.73	0.84	1.11	28.8
Approach		538	4.0	0.601	12.9	LOS B	5.9	153.3	0.73	0.84	1.11	29.5
North: Zimmerman Trail												
7	L2	96	0.0	0.473	11.0	LOS B	3.1	78.4	0.71	0.80	0.95	31.8
4	T1	260	0.0	0.473	11.0	LOS B	3.1	78.4	0.71	0.80	0.95	31.7
14	R2	16	0.0	0.473	11.0	LOS B	3.1	78.4	0.71	0.80	0.95	30.8
Approach		372	0.0	0.473	11.0	LOS B	3.1	78.4	0.71	0.80	0.95	31.7
West: MT 3												
5	L2	33	0.0	0.433	12.7	LOS B	2.3	58.7	0.74	0.82	1.00	31.2
2	T1	108	5.1	0.433	13.0	LOS B	2.3	58.7	0.74	0.82	1.00	31.0
12	R2	116	0.0	0.433	12.7	LOS B	2.3	58.7	0.74	0.82	1.00	30.3
Approach		257	2.1	0.433	12.8	LOS B	2.3	58.7	0.74	0.82	1.00	30.7
All Vehicles		1882	1.5	0.601	9.9	LOS A	5.9	153.3	0.61	0.62	0.80	31.7

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6).
Roundabout Capacity Model: US HCM 6.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [MT 3 & Zimmerman PM - Baseline]

PM Peak Baseline
Site Category: (None)
Roundabout

Movement Performance - Vehicles

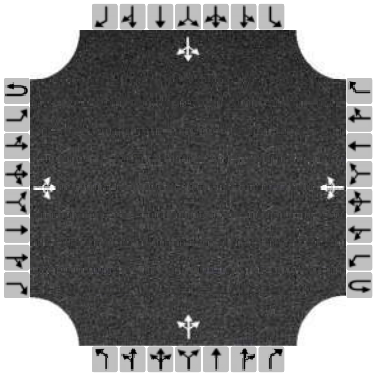
Mov ID	Turn	Demand Flows Total	Demand Flows HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed
		veh/h	%	v/c	sec		veh	ft				mph
South: Zimmerman Trail												
3	L2	130	0.8	0.354	6.4	LOS A	1.9	47.8	0.39	0.26	0.39	33.8
8	T1	297	0.0	0.354	6.4	LOS A	1.9	47.8	0.39	0.26	0.39	33.7
18	R2	508	0.9	0.415	7.1	LOS A	2.4	61.1	0.39	0.25	0.39	33.1
Approach		935	0.6	0.415	6.8	LOS A	2.4	61.1	0.39	0.25	0.39	33.4
East: MT 3												
1	L2	433	1.0	0.794	22.3	LOS C	13.6	347.4	0.93	1.36	2.02	26.7
6	T1	115	11.3	0.794	22.7	LOS C	13.6	347.4	0.93	1.36	2.02	26.6
16	R2	127	0.0	0.794	22.2	LOS C	13.6	347.4	0.93	1.36	2.02	26.1
Approach		675	2.6	0.794	22.4	LOS C	13.6	347.4	0.93	1.36	2.02	26.6
North: Zimmerman Trail												
7	L2	67	0.0	0.665	18.5	LOS C	6.0	151.2	0.85	1.08	1.55	28.9
4	T1	350	0.0	0.665	18.5	LOS C	6.0	151.2	0.85	1.08	1.55	28.9
14	R2	34	0.0	0.665	18.5	LOS C	6.0	151.2	0.85	1.08	1.55	28.2
Approach		451	0.0	0.665	18.5	LOS C	6.0	151.2	0.85	1.08	1.55	28.8
West: MT 3												
5	L2	22	0.0	0.333	11.3	LOS B	1.4	36.9	0.70	0.74	0.81	31.5
2	T1	71	23.1	0.333	12.8	LOS B	1.4	36.9	0.70	0.74	0.81	31.1
12	R2	82	2.7	0.333	11.5	LOS B	1.4	36.9	0.70	0.74	0.81	30.6
Approach		174	10.7	0.333	12.0	LOS B	1.4	36.9	0.70	0.74	0.81	30.9
All Vehicles		2235	1.9	0.794	14.3	LOS B	13.6	347.4	0.67	0.79	1.15	29.9

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6).
Roundabout Capacity Model: US HCM 6.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Audrey Stoltzfus	Intersection	Alkali Cr & Skyway Dr
Agency/Co.	Sanderson Stewart	Jurisdiction	City of Billings/MDT
Date Performed	12/10/2019	East/West Street	Skyway Drive
Analysis Year	2019	North/South Street	Alkali Creek Road
Time Analyzed	AM Peak Baseline	Peak Hour Factor	0.92
Intersection Orientation	East-West	Analysis Time Period (hrs)	1.00
Project Description	Inner Belt Loop Corridor Study		

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	1	0		0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume, V (veh/h)		7	174	73		64	181	12		66	5	60		25	4	7
Percent Heavy Vehicles (%)		3				4				3	3	3		3	3	3
Proportion Time Blocked																
Percent Grade (%)									0				0			
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.1	6.5	6.2		7.1	6.5	6.2
Critical Headway (sec)		4.13				4.14				7.13	6.53	6.23		7.13	6.53	6.23
Base Follow-Up Headway (sec)		2.2				2.2				3.5	4.0	3.3		3.5	4.0	3.3
Follow-Up Headway (sec)		2.23				2.24				3.53	4.03	3.33		3.53	4.03	3.33

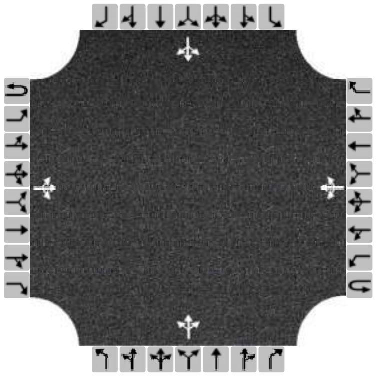
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		8				70					142				39	
Capacity, c (veh/h)		1353				1282					508				393	
v/c Ratio		0.01				0.05					0.28				0.10	
95% Queue Length, Q_{95} (veh)		0.0				0.2					1.2				0.3	
Control Delay (s/veh)		7.7				8.0					14.8				15.2	
Level of Service, LOS		A				A					B				C	
Approach Delay (s/veh)	0.3				2.4				14.8				15.2			
Approach LOS									B				C			

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Audrey Stoltzfus	Intersection	Alkali Cr & Skyway Dr
Agency/Co.	Sanderson Stewart	Jurisdiction	City of Billings/MDT
Date Performed	12/10/2019	East/West Street	Skyway Drive
Analysis Year	2019	North/South Street	Alkali Creek Road
Time Analyzed	PM Peak Baseline	Peak Hour Factor	0.92
Intersection Orientation	East-West	Analysis Time Period (hrs)	1.00
Project Description	Inner Belt Loop Corridor Study		

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	1	0		0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume, V (veh/h)		5	126	70		31	129	12		42	8	47		12	9	5
Percent Heavy Vehicles (%)		3				3				3	3	3		3	3	3
Proportion Time Blocked																
Percent Grade (%)									0				0			
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.1	6.5	6.2		7.1	6.5	6.2
Critical Headway (sec)		4.13				4.13				7.13	6.53	6.23		7.13	6.53	6.23
Base Follow-Up Headway (sec)		2.2				2.2				3.5	4.0	3.3		3.5	4.0	3.3
Follow-Up Headway (sec)		2.23				2.23				3.53	4.03	3.33		3.53	4.03	3.33

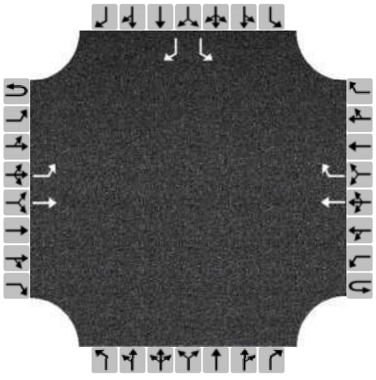
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		5				34					106				28	
Capacity, c (veh/h)		1420				1350					648				532	
v/c Ratio		0.00				0.03					0.16				0.05	
95% Queue Length, Q_{95} (veh)		0.0				0.1					0.6				0.2	
Control Delay (s/veh)		7.5				7.7					11.6				12.1	
Level of Service, LOS		A				A					B				B	
Approach Delay (s/veh)	0.2				1.6				11.6				12.1			
Approach LOS									B				B			

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Audrey Stoltzfus	Intersection	Wicks Ln & Skyway Dr
Agency/Co.	Sanderson Stewart	Jurisdiction	City of Billings/MDT
Date Performed	12/10/2019	East/West Street	Wicks Ln/Skyway Drive
Analysis Year	2019	North/South Street	West Wicks Lane
Time Analyzed	AM Peak Baseline	Peak Hour Factor	0.92
Intersection Orientation	East-West	Analysis Time Period (hrs)	1.00
Project Description	Inner Belt Loop Corridor Study		

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	1	1	0	0	0	1	1		0	0	0		1	0	1
Configuration		L	T				T	R						L		R
Volume, V (veh/h)		19	216				93	62						112		138
Percent Heavy Vehicles (%)		5												1		0
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)																
Critical Headway (sec)																
Base Follow-Up Headway (sec)																
Follow-Up Headway (sec)																

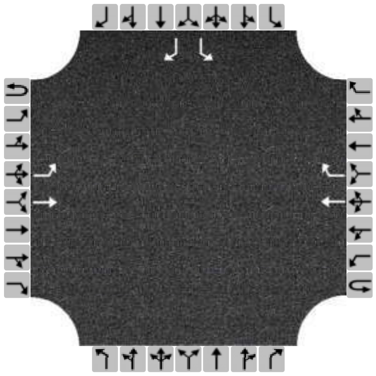
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		21												122		150
Capacity, c (veh/h)		1395												616		960
v/c Ratio		0.02												0.20		0.16
95% Queue Length, Q_{95} (veh)		0.0												0.7		0.6
Control Delay (s/veh)		7.6												12.3		9.4
Level of Service, LOS		A												B		A
Approach Delay (s/veh)	0.6												10.7			
Approach LOS													B			

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Audrey Stoltzfus	Intersection	Wicks Ln & Skyway Dr
Agency/Co.	Sanderson Stewart	Jurisdiction	City of Billings/MDT
Date Performed	12/10/2019	East/West Street	Wicks Ln/Skyway Drive
Analysis Year	2019	North/South Street	West Wicks Lane
Time Analyzed	PM Peak Baseline	Peak Hour Factor	0.92
Intersection Orientation	East-West	Analysis Time Period (hrs)	1.00
Project Description	Inner Belt Loop Corridor Study		

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	1	1	0	0	0	1	1		0	0	0		1	0	1
Configuration		L	T				T	R						L		R
Volume, V (veh/h)		113	80				120	140						84		50
Percent Heavy Vehicles (%)		0												0		0
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.10												6.40		6.20
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.20												3.50		3.30

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		123												91		54
Capacity, c (veh/h)		1292												508		925
v/c Ratio		0.10												0.18		0.06
95% Queue Length, Q_{95} (veh)		0.3												0.7		0.2
Control Delay (s/veh)		8.1												13.6		9.1
Level of Service, LOS		A												B		A
Approach Delay (s/veh)	4.7												12.0			
Approach LOS													B			

INTERSECTION CAPACITY CALCULATIONS – FUTURE CONDITIONS – AGGRESSIVE

SANDERSON
STEWART

MOVEMENT SUMMARY

Site: 101 [MT 3 & Zimmerman AM - Aggressive]

AM Peak Aggressive
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
South: Zimmerman Trail												
3	L2	41	0.0	0.401	7.7	LOS A	2.1	53.1	0.54	0.45	0.54	33.7
8	T1	382	0.0	0.401	7.7	LOS A	2.1	53.1	0.54	0.45	0.54	33.6
18	R2	362	0.3	0.330	6.5	LOS A	1.6	41.3	0.47	0.36	0.47	33.4
Approach		785	0.1	0.401	7.2	LOS A	2.1	53.1	0.51	0.41	0.51	33.5
East: MT 3												
1	L2	447	1.2	0.729	18.7	LOS C	9.7	250.5	0.86	1.18	1.69	27.7
6	T1	43	37.5	0.729	20.3	LOS C	9.7	250.5	0.86	1.18	1.69	27.2
16	R2	111	0.0	0.729	18.7	LOS C	9.7	250.5	0.86	1.18	1.69	27.0
Approach		601	3.6	0.729	18.8	LOS C	9.7	250.5	0.86	1.18	1.69	27.5
North: Zimmerman Trail												
7	L2	164	0.0	0.672	16.8	LOS C	7.2	179.3	0.84	1.08	1.51	29.3
4	T1	336	0.0	0.672	16.8	LOS C	7.2	179.3	0.84	1.08	1.51	29.2
14	R2	27	0.0	0.672	16.8	LOS C	7.2	179.3	0.84	1.08	1.51	28.5
Approach		527	0.0	0.672	16.8	LOS C	7.2	179.3	0.84	1.08	1.51	29.2
West: MT 3												
5	L2	48	0.0	0.539	17.5	LOS C	3.2	80.2	0.79	0.94	1.27	29.2
2	T1	110	4.9	0.539	17.8	LOS C	3.2	80.2	0.79	0.94	1.27	29.0
12	R2	118	0.0	0.539	17.5	LOS C	3.2	80.2	0.79	0.94	1.27	28.4
Approach		276	2.0	0.539	17.6	LOS C	3.2	80.2	0.79	0.94	1.27	28.8
All Vehicles		2189	1.3	0.729	14.0	LOS B	9.7	250.5	0.72	0.85	1.17	30.0

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6).
Roundabout Capacity Model: US HCM 6.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [MT 3 & Zimmerman PM - Aggressive]

PM Peak Aggressive
Site Category: (None)
Roundabout

Movement Performance - Vehicles

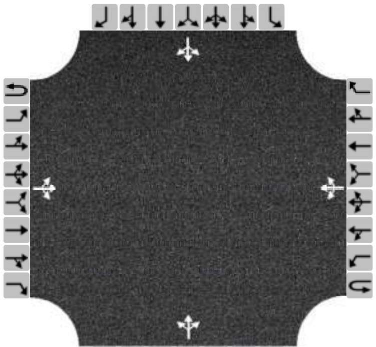
Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
South: Zimmerman Trail												
3	L2	148	0.7	0.474	8.4	LOS A	2.8	71.1	0.53	0.41	0.53	32.9
8	T1	385	0.0	0.474	8.4	LOS A	2.8	71.1	0.53	0.41	0.53	32.8
18	R2	508	0.9	0.442	7.8	LOS A	2.6	64.5	0.48	0.35	0.48	32.8
Approach		1040	0.5	0.474	8.1	LOS A	2.8	71.1	0.51	0.38	0.51	32.8
East: MT 3												
1	L2	433	1.0	0.978	50.7	LOS F	28.3	722.0	1.00	2.04	3.90	20.1
6	T1	117	11.1	0.978	51.1	LOS F	28.3	722.0	1.00	2.04	3.90	20.0
16	R2	190	0.0	0.978	50.6	LOS F	28.3	722.0	1.00	2.04	3.90	19.8
Approach		740	2.3	0.978	50.7	LOS F	28.3	722.0	1.00	2.04	3.90	20.0
North: Zimmerman Trail												
7	L2	135	0.0	0.919	42.5	LOS E	17.4	435.6	1.00	1.72	3.18	22.1
4	T1	433	0.0	0.919	42.5	LOS E	17.4	435.6	1.00	1.72	3.18	22.1
14	R2	43	0.0	0.919	42.5	LOS E	17.4	435.6	1.00	1.72	3.18	21.7
Approach		611	0.0	0.919	42.5	LOS E	17.4	435.6	1.00	1.72	3.18	22.1
West: MT 3												
5	L2	33	0.0	0.415	14.9	LOS B	1.8	49.7	0.74	0.83	1.04	29.9
2	T1	72	22.7	0.415	16.5	LOS C	1.8	49.7	0.74	0.83	1.04	29.5
12	R2	83	2.6	0.415	15.1	LOS C	1.8	49.7	0.74	0.83	1.04	29.0
Approach		187	9.9	0.415	15.6	LOS C	1.8	49.7	0.74	0.83	1.04	29.4
All Vehicles		2578	1.6	0.978	29.0	LOS D	28.3	722.0	0.78	1.21	2.15	25.0

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6).
Roundabout Capacity Model: US HCM 6.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Audrey Stoltzfus	Intersection	Alkali Cr & Skyway Dr
Agency/Co.	Sanderson Stewart	Jurisdiction	City of Billings/MDT
Date Performed	12/11/2019	East/West Street	Skyway Drive
Analysis Year	2019	North/South Street	Alkali Creek Road
Time Analyzed	AM Peak Aggressive	Peak Hour Factor	0.92
Intersection Orientation	East-West	Analysis Time Period (hrs)	1.00
Project Description	Inner Belt Loop Corridor Study		

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	1	0		0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume, V (veh/h)		7	258	125		64	236	16		127	9	75		25	4	7
Percent Heavy Vehicles (%)		3				4				3	3	3		3	3	3
Proportion Time Blocked																
Percent Grade (%)									0				0			
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)																
Critical Headway (sec)																
Base Follow-Up Headway (sec)																
Follow-Up Headway (sec)																

Delay, Queue Length, and Level of Service

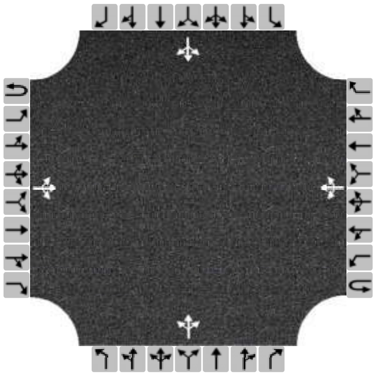
Flow Rate, v (veh/h)		8				70					230				39	
Capacity, c (veh/h)		1282				1131					364				281	
v/c Ratio		0.01				0.06					0.63				0.14	
95% Queue Length, Q_{95} (veh)		0.0				0.2					4.8				0.5	
Control Delay (s/veh)		7.8				8.4					31.4				19.8	
Level of Service, LOS		A				A					D				C	
Approach Delay (s/veh)	0.2				2.2				31.4				19.8			
Approach LOS									D				C			

HCS7 Two-Way Stop-Control Report

General Information

Analyst	Audrey Stoltzfus	Intersection	Alkali Cr & Skyway Dr
Agency/Co.	Sanderson Stewart	Jurisdiction	City of Billings/MDT
Date Performed	12/11/2019	East/West Street	Skyway Drive
Analysis Year	2019	North/South Street	Alkali Creek Road
Time Analyzed	PM Peak Aggressive	Peak Hour Factor	0.92
Intersection Orientation	East-West	Analysis Time Period (hrs)	1.00
Project Description	Inner Belt Loop Corridor Study		

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	1	0		0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume, V (veh/h)		5	174	90		31	179	16		85	13	60		12	9	5
Percent Heavy Vehicles (%)		3				3				3	3	3		3	3	3
Proportion Time Blocked																
Percent Grade (%)									0				0			
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.1	6.5	6.2		7.1	6.5	6.2
Critical Headway (sec)		4.13				4.13				7.13	6.53	6.23		7.13	6.53	6.23
Base Follow-Up Headway (sec)		2.2				2.2				3.5	4.0	3.3		3.5	4.0	3.3
Follow-Up Headway (sec)		2.23				2.23				3.53	4.03	3.33		3.53	4.03	3.33

Delay, Queue Length, and Level of Service

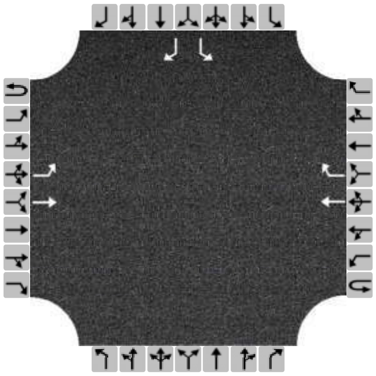
Flow Rate, v (veh/h)		5				34					171				28	
Capacity, c (veh/h)		1351				1268					528				437	
v/c Ratio		0.00				0.03					0.32				0.06	
95% Queue Length, Q_{95} (veh)		0.0				0.1					1.4				0.2	
Control Delay (s/veh)		7.7				7.9					15.1				13.8	
Level of Service, LOS		A				A					C				B	
Approach Delay (s/veh)	0.2				1.3				15.1				13.8			
Approach LOS									C				B			

HCS7 Two-Way Stop-Control Report

General Information / Site Information

Analyst	Audrey Stoltzfus	Intersection	Wicks Ln & Skyway Dr
Agency/Co.	Sanderson Stewart	Jurisdiction	City of Billings/MDT
Date Performed	12/11/2019	East/West Street	Wicks Ln/Skyway Drive
Analysis Year	2019	North/South Street	West Wicks Lane
Time Analyzed	AM Peak Aggressive	Peak Hour Factor	0.92
Intersection Orientation	East-West	Analysis Time Period (hrs)	1.00
Project Description	Inner Belt Loop Corridor Study		

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	1	1	0	0	0	1	1		0	0	0		1	0	1
Configuration		L	T				T	R						L		R
Volume, V (veh/h)		22	280				123	62						112		161
Percent Heavy Vehicles (%)		5												1		0
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.15												6.41		6.20
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.24												3.51		3.30

Delay, Queue Length, and Level of Service

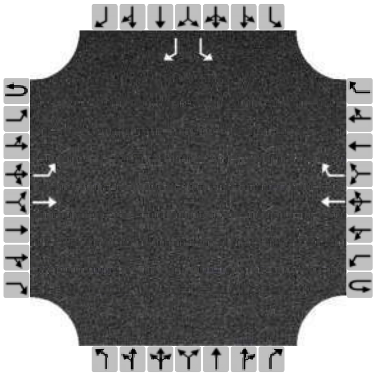
Flow Rate, v (veh/h)		24												122		175
Capacity, c (veh/h)		1356												533		920
v/c Ratio		0.02												0.23		0.19
95% Queue Length, Q_{95} (veh)		0.1												0.9		0.7
Control Delay (s/veh)		7.7												13.8		9.8
Level of Service, LOS		A												B		A
Approach Delay (s/veh)	0.6												11.4			
Approach LOS													B			

HCS7 Two-Way Stop-Control Report

General Information / Site Information

Analyst	Audrey Stoltzfus	Intersection	Wicks Ln & Skyway Dr
Agency/Co.	Sanderson Stewart	Jurisdiction	City of Billings/MDT
Date Performed	12/11/2019	East/West Street	Wicks Ln/Skyway Drive
Analysis Year	2019	North/South Street	West Wicks Lane
Time Analyzed	PM Peak Aggressive	Peak Hour Factor	0.92
Intersection Orientation	East-West	Analysis Time Period (hrs)	1.00
Project Description	Inner Belt Loop Corridor Study		

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	1	1	0	0	0	1	1		0	0	0		1	0	1
Configuration		L	T				T	R						L		R
Volume, V (veh/h)		131	113				166	140						84		58
Percent Heavy Vehicles (%)		0												0		0
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

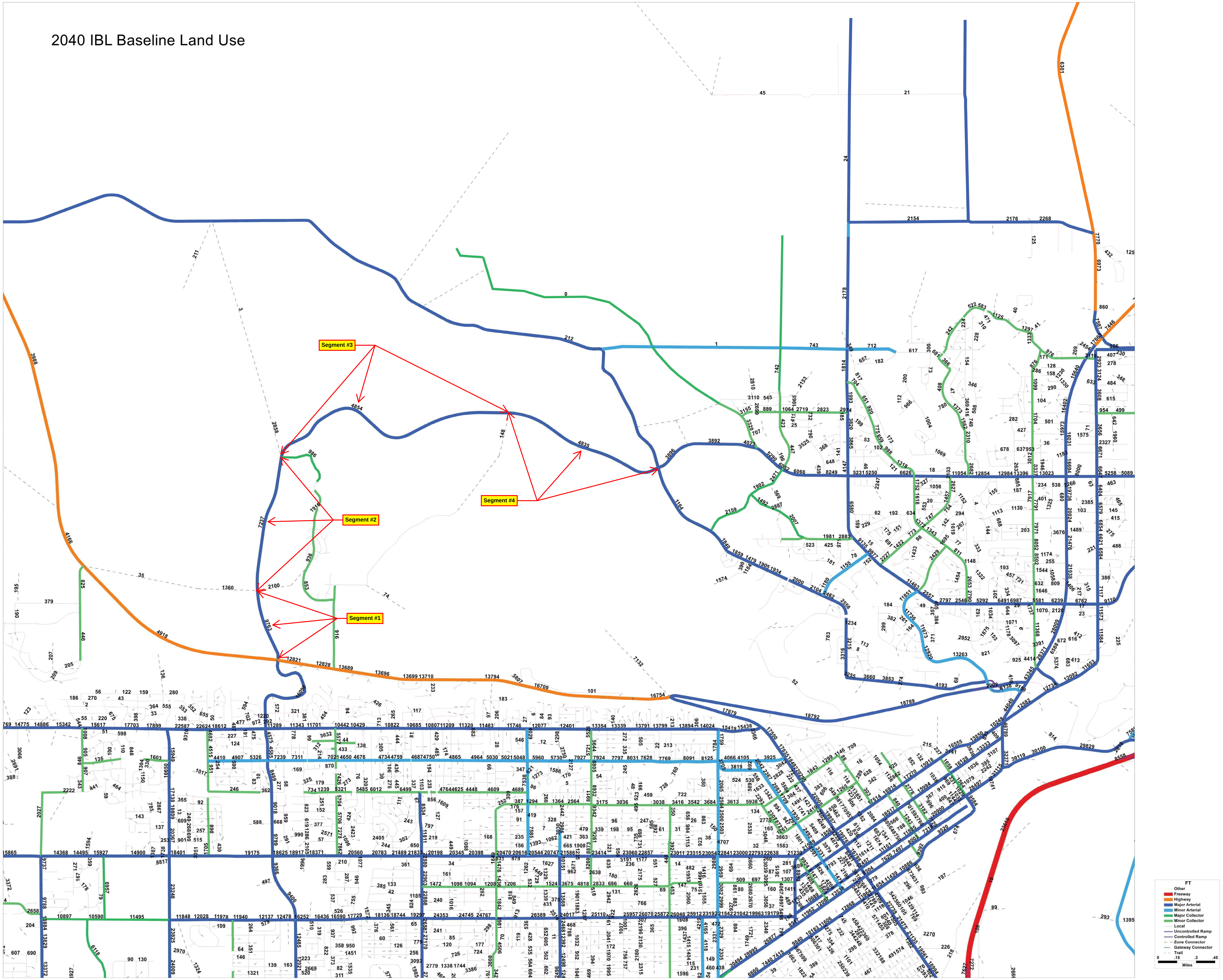
Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.10												6.40		6.20
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.20												3.50		3.30

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		142												91		63
Capacity, c (veh/h)		1239												421		868
v/c Ratio		0.11												0.22		0.07
95% Queue Length, Q_{95} (veh)		0.4												0.8		0.2
Control Delay (s/veh)		8.3												15.9		9.5
Level of Service, LOS		A												C		A
Approach Delay (s/veh)	4.4												13.3			
Approach LOS													B			

CORRIDOR CAPACITY CALCULATIONS – BASELINE CONDITIONS (CLASS II & III)

2040 IBL Baseline Land Use



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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 1/ NB
From/To                 Airport Road/Iron Horse Trail
Jurisdiction            City of Billings
Analysis Year           Baseline Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 2             Peak hour factor, PHF    0.92
Shoulder width       2.0     ft    % Trucks and buses       6       %
Lane width           12.0    ft    % Trucks crawling        0.0     %
Segment length       0.7     mi    Truck crawl speed        0.0     mi/hr
Terrain type         Rolling       % Recreational vehicles  0       %
Grade:  Length       -       mi    % No-passing zones       100     %
        Up/down      -       %     Access point density     3       /mi

Analysis direction volume, Vd  489     veh/h
Opposing direction volume, Vo  489     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.8                 1.8
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.954               0.954
Grade adj. factor,(note-1) fg             0.96                0.96
Directional flow rate,(note-2) vi         580     pc/h        580     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM               -      mi/h
Observed total demand,(note-3) V                 -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS              50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA       0.8     mi/h

Free-flow speed, FFSd                           46.7    mi/h

Adjustment for no-passing zones, fnp            1.9     mi/h
Average travel speed, ATSd                      35.7    mi/h
Percent Free Flow Speed, PFFS                   76.6    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.2                 1.2
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.988               0.988
Grade adjustment factor,(note-1) fg       0.96                0.96
Directional flow rate,(note-2) vi         560    pc/h         560     pc/h
Base percent time-spent-following,(note-4) BPTSFd  55.8   %
Adjustment for no-passing zones, fnp               37.0
Percent time-spent-following, PTSFd                74.3   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              D
Volume to capacity ratio, v/c                      0.31
Peak 15-min vehicle-miles of travel, VMT15         93      veh-mi
Peak-hour vehicle-miles of travel, VMT60           342     veh-mi
Peak 15-min total travel time, TT15                2.6     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1700    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.7     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      35.7    mi/h
Percent time-spent-following, PTSFd (from above)             74.3
Level of service, LOSd (from above)                          D

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     A
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            531.5
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   6.07
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
```

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                    HCS7: Two-Lane Highways Release 7.2.1




Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 1/ SB
From/To                 Iron Horse Trail/Airport Road
Jurisdiction            City of Billings
Analysis Year           Baseline Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 2              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.7     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     3       /mi

Analysis direction volume, Vd  489     veh/h
Opposing direction volume, Vo  489     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.8                 1.8
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.954               0.954
Grade adj. factor,(note-1) fg             0.96                0.96
Directional flow rate,(note-2) vi         580     pc/h        580     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM               -      mi/h
Observed total demand,(note-3) V                 -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS              50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS   2.6     mi/h
Adj. for access point density,(note-3) fA       0.8     mi/h

Free-flow speed, FFSd                           46.7    mi/h

Adjustment for no-passing zones, fnp            1.9     mi/h
Average travel speed, ATSd                      35.7    mi/h
Percent Free Flow Speed, PFFS                   76.6    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.2                 1.2
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.988               0.988
Grade adjustment factor,(note-1) fg       0.96                0.96
Directional flow rate,(note-2) vi         560    pc/h         560     pc/h
Base percent time-spent-following,(note-4) BPTSFd  55.8   %
Adjustment for no-passing zones, fnp               37.0
Percent time-spent-following, PTSFd                74.3   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              D
Volume to capacity ratio, v/c                      0.31
Peak 15-min vehicle-miles of travel, VMT15         93      veh-mi
Peak-hour vehicle-miles of travel, VMT60           342     veh-mi
Peak 15-min total travel time, TT15                2.6     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1700    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.7     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      35.7    mi/h
Percent time-spent-following, PTSFd (from above)             74.3
Level of service, LOSd (from above)                          D

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     A
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            531.5
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   6.07
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
```

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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 2/ NB
From/To                 Airport Road/Iron Horse Trail
Jurisdiction            City of Billings
Analysis Year           Baseline Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 2             Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       5       %
        Up/down      -       %      Access point density     2       /mi

Analysis direction volume, Vd  362     veh/h
Opposing direction volume, Vo  362     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.0                 2.0
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.943               0.943
Grade adj. factor,(note-1) fg             0.90                0.90
Directional flow rate,(note-2) vi         464     pc/h        464     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM               -      mi/h
Observed total demand,(note-3) V                 -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS              50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.5     mi/h

Free-flow speed, FFSd                           46.9    mi/h

Adjustment for no-passing zones, fnp            0.8     mi/h
Average travel speed, ATSd                      38.9    mi/h
Percent Free Flow Speed, PFFS                   82.9    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.6                 1.6
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.965               0.965
Grade adjustment factor,(note-1) fg       0.90                0.90
Directional flow rate,(note-2) vi         453    pc/h         453     pc/h
Base percent time-spent-following,(note-4) BPTSFd  47.8   %
Adjustment for no-passing zones, fnp               19.3
Percent time-spent-following, PTSFd                57.4   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.23
Peak 15-min vehicle-miles of travel, VMT15         89      veh-mi
Peak-hour vehicle-miles of travel, VMT60           326     veh-mi
Peak 15-min total travel time, TT15                2.3     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1700    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      38.9    mi/h
Percent time-spent-following, PTSFd (from above)             57.4
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     A
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            393.5
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.92
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
```

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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 2/ SB
From/To                 Iron Horse Trail/Airport Road
Jurisdiction            City of Billings
Analysis Year           Baseline Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 2              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       50      %
        Up/down      -       %      Access point density     2       /mi

Analysis direction volume, Vd  362     veh/h
Opposing direction volume, Vo  362     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.0                 2.0
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.943               0.943
Grade adj. factor,(note-1) fg             0.90                0.90
Directional flow rate,(note-2) vi         464     pc/h        464     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.5     mi/h

Free-flow speed, FFSd                          46.9    mi/h

Adjustment for no-passing zones, fnp           1.3     mi/h
Average travel speed, ATSd                     38.4    mi/h
Percent Free Flow Speed, PFFS                  81.8    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.6                 1.6
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.965               0.965
Grade adjustment factor,(note-1) fg       0.90                0.90
Directional flow rate,(note-2) vi         453    pc/h         453     pc/h
Base percent time-spent-following,(note-4) BPTSFd  47.8   %
Adjustment for no-passing zones, fnp               39.2
Percent time-spent-following, PTSFd                67.4   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.23
Peak 15-min vehicle-miles of travel, VMT15         89      veh-mi
Peak-hour vehicle-miles of travel, VMT60           326     veh-mi
Peak 15-min total travel time, TT15                2.3     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1700    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      38.4    mi/h
Percent time-spent-following, PTSFd (from above)             67.4
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     A
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            393.5
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.92
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
```

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                    HCS7: Two-Lane Highways Release 7.2.1




Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 3/ EB
From/To                 Airport Road/Iron Horse Trail
Jurisdiction            City of Billings
Analysis Year           Baseline Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 2              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       1.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     2       /mi

Analysis direction volume, Vd  243     veh/h
Opposing direction volume, Vo  243     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.2                 2.2
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.933               0.933
Grade adj. factor,(note-1) fg             0.80                0.80
Directional flow rate,(note-2) vi         354     pc/h        354     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.5     mi/h

Free-flow speed, FFSd                          46.9    mi/h

Adjustment for no-passing zones, fnp           3.0     mi/h
Average travel speed, ATSd                     38.4    mi/h
Percent Free Flow Speed, PFFS                  81.9    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.7                 1.7
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.960               0.960
Grade adjustment factor,(note-1) fg       0.83                0.83
Directional flow rate,(note-2) vi         332    pc/h         332     pc/h
Base percent time-spent-following,(note-4) BPTSFd  35.9   %
Adjustment for no-passing zones, fnp               53.5
Percent time-spent-following, PTSFd                62.7   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.16
Peak 15-min vehicle-miles of travel, VMT15         125     veh-mi
Peak-hour vehicle-miles of travel, VMT60           462     veh-mi
Peak 15-min total travel time, TT15                3.3     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1700    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      38.4    mi/h
Percent time-spent-following, PTSFd (from above)             62.7
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     A
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            264.1
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.72
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 3/ WB
From/To                 Iron Horse Trail/Airport Road
Jurisdiction            City of Billings
Analysis Year           Baseline Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 2              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       1.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     2       /mi

Analysis direction volume, Vd  243     veh/h
Opposing direction volume, Vo  243     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.2                 2.2
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.933               0.933
Grade adj. factor,(note-1) fg             0.80                0.80
Directional flow rate,(note-2) vi         354     pc/h        354     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.5     mi/h

Free-flow speed, FFSd                          46.9    mi/h

Adjustment for no-passing zones, fnp           3.0     mi/h
Average travel speed, ATSd                     38.4    mi/h
Percent Free Flow Speed, PFFS                  81.9    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.7                 1.7
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.960               0.960
Grade adjustment factor,(note-1) fg       0.83                0.83
Directional flow rate,(note-2) vi         332    pc/h         332     pc/h
Base percent time-spent-following,(note-4) BPTSFd  35.9   %
Adjustment for no-passing zones, fnp               53.5
Percent time-spent-following, PTSFd                62.7   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.16
Peak 15-min vehicle-miles of travel, VMT15         125     veh-mi
Peak-hour vehicle-miles of travel, VMT60           462     veh-mi
Peak 15-min total travel time, TT15                3.3     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1700    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      38.4    mi/h
Percent time-spent-following, PTSFd (from above)             62.7
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     A
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            264.1
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.72
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 4/ EB
From/To                 Airport Road/Iron Horse Trail
Jurisdiction            City of Billings
Analysis Year           Baseline Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 2              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       1.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     1       /mi

Analysis direction volume, Vd  242     veh/h
Opposing direction volume, Vo  242     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.2                 2.2
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.933               0.933
Grade adj. factor,(note-1) fg             0.80                0.80
Directional flow rate,(note-2) vi         352     pc/h        352     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM               -      mi/h
Observed total demand,(note-3) V                 -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS              50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.3     mi/h

Free-flow speed, FFSd                           47.2    mi/h

Adjustment for no-passing zones, fnp            3.0     mi/h
Average travel speed, ATSd                      38.7    mi/h
Percent Free Flow Speed, PFFS                   82.0    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.7                 1.7
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.960               0.960
Grade adjustment factor,(note-1) fg       0.83                0.83
Directional flow rate,(note-2) vi         330    pc/h         330     pc/h
Base percent time-spent-following,(note-4) BPTSFd  35.8   %
Adjustment for no-passing zones, fnp               53.7
Percent time-spent-following, PTSFd                62.7   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.15
Peak 15-min vehicle-miles of travel, VMT15         125     veh-mi
Peak-hour vehicle-miles of travel, VMT60           460     veh-mi
Peak 15-min total travel time, TT15                3.2     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1700    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      38.7    mi/h
Percent time-spent-following, PTSFd (from above)             62.7
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     A
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
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```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            263.0
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.71
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
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_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 4/ WB
From/To                 Iron Horse Trail/Airport Road
Jurisdiction            City of Billings
Analysis Year           Baseline Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 2              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       1.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     1       /mi

Analysis direction volume, Vd  242     veh/h
Opposing direction volume, Vo  242     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.2                 2.2
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.933               0.933
Grade adj. factor,(note-1) fg             0.80                0.80
Directional flow rate,(note-2) vi         352     pc/h        352     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM             -      mi/h
Observed total demand,(note-3) V               -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS            50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA     0.3     mi/h

Free-flow speed, FFSd                         47.2    mi/h

Adjustment for no-passing zones, fnp          3.0     mi/h
Average travel speed, ATSd                    38.7    mi/h
Percent Free Flow Speed, PFFS                 82.0    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.7                 1.7
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.960               0.960
Grade adjustment factor,(note-1) fg       0.83                0.83
Directional flow rate,(note-2) vi         330    pc/h         330     pc/h
Base percent time-spent-following,(note-4) BPTSFd  35.8   %
Adjustment for no-passing zones, fnp               53.7
Percent time-spent-following, PTSFd                62.7   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.15
Peak 15-min vehicle-miles of travel, VMT15         125     veh-mi
Peak-hour vehicle-miles of travel, VMT60           460     veh-mi
Peak 15-min total travel time, TT15                3.2     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1700    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      38.7    mi/h
Percent time-spent-following, PTSFd (from above)             62.7
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     A
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            263.0
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.71
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
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_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 1/ NB
From/To                 Airport Road/Iron Horse Trail
Jurisdiction            City of Billings
Analysis Year           Baseline Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 3              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.7     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     3       /mi

Analysis direction volume, Vd  489     veh/h
Opposing direction volume, Vo  489     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.8                 1.8
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.954               0.954
Grade adj. factor,(note-1) fg             0.96                0.96
Directional flow rate,(note-2) vi         580     pc/h        580     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM               -      mi/h
Observed total demand,(note-3) V                 -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS              50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA       0.8     mi/h

Free-flow speed, FFSd                           46.7    mi/h

Adjustment for no-passing zones, fnp            1.9     mi/h
Average travel speed, ATSd                      35.7    mi/h
Percent Free Flow Speed, PFFS                   76.6    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.2                 1.2
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.988               0.988
Grade adjustment factor,(note-1) fg       0.96                0.96
Directional flow rate,(note-2) vi         560    pc/h         560     pc/h
Base percent time-spent-following,(note-4) BPTSFd  55.8   %
Adjustment for no-passing zones, fnp               37.0
Percent time-spent-following, PTSFd                74.3   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.32
Peak 15-min vehicle-miles of travel, VMT15         93      veh-mi
Peak-hour vehicle-miles of travel, VMT60           342     veh-mi
Peak 15-min total travel time, TT15                2.6     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.7     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      35.7    mi/h
Percent time-spent-following, PTSFd (from above)             74.3
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
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```
Posted speed limit, Sp                                          45
Percent of segment with occupied on-highway parking             0
Pavement rating, P                                              3
Flow rate in outside lane, vOL                                  531.5
Effective width of outside lane, We                             14.00
Effective speed factor, St                                      4.42
Bicycle LOS Score, BLOS                                         6.07
Bicycle LOS                                                     F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 1/ SB
From/To                 Iron Horse Trail/Airport Road
Jurisdiction            City of Billings
Analysis Year           Baseline Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 3              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.7     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     3       /mi

Analysis direction volume, Vd  489     veh/h
Opposing direction volume, Vo  489     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.8                 1.8
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.954               0.954
Grade adj. factor,(note-1) fg             0.96                0.96
Directional flow rate,(note-2) vi         580     pc/h        580     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.8     mi/h

Free-flow speed, FFSd                          46.7    mi/h

Adjustment for no-passing zones, fnp           1.9     mi/h
Average travel speed, ATSd                     35.7    mi/h
Percent Free Flow Speed, PFFS                  76.6    %
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_________________________Percent Time-Spent-Following__________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.2                 1.2
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.988               0.988
Grade adjustment factor,(note-1) fg       0.96                0.96
Directional flow rate,(note-2) vi         560    pc/h         560     pc/h
Base percent time-spent-following,(note-4) BPTSFd  55.8   %
Adjustment for no-passing zones, fnp               37.0
Percent time-spent-following, PTSFd                74.3   %

________________Level of Service and Other Performance Measures________________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.32
Peak 15-min vehicle-miles of travel, VMT15         93      veh-mi
Peak-hour vehicle-miles of travel, VMT60           342     veh-mi
Peak 15-min total travel time, TT15                2.6     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis_____________________________

Total length of analysis segment, Lt                         0.7     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      35.7    mi/h
Percent time-spent-following, PTSFd (from above)             74.3
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane_____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane_________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service ___________________________
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```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            531.5
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   6.07
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 2/ NB
From/To                 Airport Road/Iron Horse Trail
Jurisdiction            City of Billings
Analysis Year           Baseline Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 3             Peak hour factor, PHF    0.92
Shoulder width       2.0     ft    % Trucks and buses       6       %
Lane width           12.0    ft    % Trucks crawling        0.0     %
Segment length       0.9     mi    Truck crawl speed        0.0     mi/hr
Terrain type         Rolling       % Recreational vehicles  0       %
Grade:  Length       -       mi    % No-passing zones       5       %
        Up/down      -       %     Access point density     2       /mi

Analysis direction volume, Vd  362     veh/h
Opposing direction volume, Vo  362     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.0                 2.0
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.943               0.943
Grade adj. factor,(note-1) fg             0.90                0.90
Directional flow rate,(note-2) vi         464     pc/h        464     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.5     mi/h

Free-flow speed, FFSd                          46.9    mi/h

Adjustment for no-passing zones, fnp           0.8     mi/h
Average travel speed, ATSd                     38.9    mi/h
Percent Free Flow Speed, PFFS                  82.9    %
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```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.6                 1.6
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.965               0.965
Grade adjustment factor,(note-1) fg       0.90                0.90
Directional flow rate,(note-2) vi         453    pc/h         453     pc/h
Base percent time-spent-following,(note-4) BPTSFd  47.8   %
Adjustment for no-passing zones, fnp               19.3
Percent time-spent-following, PTSFd                57.4   %

________________Level of Service and Other Performance Measures________________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.24
Peak 15-min vehicle-miles of travel, VMT15         89      veh-mi
Peak-hour vehicle-miles of travel, VMT60           326     veh-mi
Peak 15-min total travel time, TT15                2.3     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      38.9    mi/h
Percent time-spent-following, PTSFd (from above)             57.4
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            393.5
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.92
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 2/ SB
From/To                 Iron Horse Trail/Airport Road
Jurisdiction            City of Billings
Analysis Year           Baseline Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 3             Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       50      %
        Up/down      -       %      Access point density     2       /mi

Analysis direction volume, Vd  362     veh/h
Opposing direction volume, Vo  362     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.0                 2.0
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.943               0.943
Grade adj. factor,(note-1) fg             0.90                0.90
Directional flow rate,(note-2) vi         464     pc/h        464     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM               -      mi/h
Observed total demand,(note-3) V                 -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS              50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.5     mi/h

Free-flow speed, FFSd                           46.9    mi/h

Adjustment for no-passing zones, fnp            1.3     mi/h
Average travel speed, ATSd                      38.4    mi/h
Percent Free Flow Speed, PFFS                   81.8    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.6                 1.6
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.965               0.965
Grade adjustment factor,(note-1) fg       0.90                0.90
Directional flow rate,(note-2) vi         453    pc/h         453     pc/h
Base percent time-spent-following,(note-4) BPTSFd  47.8   %
Adjustment for no-passing zones, fnp               39.2
Percent time-spent-following, PTSFd                67.4   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.24
Peak 15-min vehicle-miles of travel, VMT15         89      veh-mi
Peak-hour vehicle-miles of travel, VMT60           326     veh-mi
Peak 15-min total travel time, TT15                2.3     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      38.4    mi/h
Percent time-spent-following, PTSFd (from above)             67.4
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            393.5
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.92
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
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_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 3/ EB
From/To                 Airport Road/Iron Horse Trail
Jurisdiction            City of Billings
Analysis Year           Baseline Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 3              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       1.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     2       /mi

Analysis direction volume, Vd  243     veh/h
Opposing direction volume, Vo  243     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.2                 2.2
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.933               0.933
Grade adj. factor,(note-1) fg             0.80                0.80
Directional flow rate,(note-2) vi         354     pc/h        354     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.5     mi/h

Free-flow speed, FFSd                          46.9    mi/h

Adjustment for no-passing zones, fnp           3.0     mi/h
Average travel speed, ATSd                     38.4    mi/h
Percent Free Flow Speed, PFFS                  81.9    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.7                 1.7
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.960               0.960
Grade adjustment factor,(note-1) fg       0.83                0.83
Directional flow rate,(note-2) vi         332    pc/h         332     pc/h
Base percent time-spent-following,(note-4) BPTSFd  35.9   %
Adjustment for no-passing zones, fnp               53.5
Percent time-spent-following, PTSFd                62.7   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.16
Peak 15-min vehicle-miles of travel, VMT15         125     veh-mi
Peak-hour vehicle-miles of travel, VMT60           462     veh-mi
Peak 15-min total travel time, TT15                3.3     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      38.4    mi/h
Percent time-spent-following, PTSFd (from above)             62.7
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            264.1
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.72
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
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_________________Directional Two-Lane Highway Segment Analysis_________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 3/ WB
From/To                 Iron Horse Trail/Airport Road
Jurisdiction            City of Billings
Analysis Year           Baseline Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 3             Peak hour factor, PHF    0.92
Shoulder width       2.0     ft    % Trucks and buses       6       %
Lane width           12.0    ft    % Trucks crawling        0.0     %
Segment length       1.9     mi    Truck crawl speed        0.0     mi/hr
Terrain type         Rolling       % Recreational vehicles  0       %
Grade:  Length       -       mi    % No-passing zones       100     %
        Up/down      -       %     Access point density     2       /mi

Analysis direction volume, Vd  243     veh/h
Opposing direction volume, Vo  243     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.2                 2.2
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.933               0.933
Grade adj. factor,(note-1) fg             0.80                0.80
Directional flow rate,(note-2) vi         354     pc/h        354     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM                -      mi/h
Observed total demand,(note-3) V                  -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS               50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS    2.6     mi/h
Adj. for access point density,(note-3) fA        0.5     mi/h

Free-flow speed, FFSd                            46.9    mi/h

Adjustment for no-passing zones, fnp             3.0     mi/h
Average travel speed, ATSd                       38.4    mi/h
Percent Free Flow Speed, PFFS                    81.9    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.7                 1.7
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.960               0.960
Grade adjustment factor,(note-1) fg       0.83                0.83
Directional flow rate,(note-2) vi         332    pc/h         332     pc/h
Base percent time-spent-following,(note-4) BPTSFd  35.9   %
Adjustment for no-passing zones, fnp               53.5
Percent time-spent-following, PTSFd                62.7   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.16
Peak 15-min vehicle-miles of travel, VMT15         125     veh-mi
Peak-hour vehicle-miles of travel, VMT60           462     veh-mi
Peak 15-min total travel time, TT15                3.3     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      38.4    mi/h
Percent time-spent-following, PTSFd (from above)             62.7
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
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```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking      0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            264.1
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.72
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
```

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                    HCS7: Two-Lane Highways Release 7.2.1




Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 4/ EB
From/To                 Airport Road/Iron Horse Trail
Jurisdiction            City of Billings
Analysis Year           Baseline Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 3              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft      % Trucks and buses       6       %
Lane width           12.0    ft      % Trucks crawling        0.0     %
Segment length       1.9     mi      Truck crawl speed        0.0     mi/hr
Terrain type         Rolling         % Recreational vehicles  0       %
Grade:  Length       -       mi      % No-passing zones       100     %
        Up/down      -       %       Access point density     1       /mi

Analysis direction volume, Vd  242     veh/h
Opposing direction volume, Vo  242     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.2                 2.2
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.933               0.933
Grade adj. factor,(note-1) fg             0.80                0.80
Directional flow rate,(note-2) vi         352     pc/h        352     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.3     mi/h

Free-flow speed, FFSd                          47.2    mi/h

Adjustment for no-passing zones, fnp           3.0     mi/h
Average travel speed, ATSd                     38.7    mi/h
Percent Free Flow Speed, PFFS                  82.0    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.7                 1.7
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.960               0.960
Grade adjustment factor,(note-1) fg       0.83                0.83
Directional flow rate,(note-2) vi         330    pc/h         330     pc/h
Base percent time-spent-following,(note-4) BPTSFd  35.8   %
Adjustment for no-passing zones, fnp               53.7
Percent time-spent-following, PTSFd                62.7   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.16
Peak 15-min vehicle-miles of travel, VMT15         125     veh-mi
Peak-hour vehicle-miles of travel, VMT60           460     veh-mi
Peak 15-min total travel time, TT15                3.2     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      38.7    mi/h
Percent time-spent-following, PTSFd (from above)             62.7
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            263.0
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.71
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
```

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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 4/ WB
From/To                 Iron Horse Trail/Airport Road
Jurisdiction            City of Billings
Analysis Year           Baseline Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 3             Peak hour factor, PHF    0.92
Shoulder width       2.0     ft    % Trucks and buses       6       %
Lane width           12.0    ft    % Trucks crawling        0.0     %
Segment length       1.9     mi    Truck crawl speed        0.0     mi/hr
Terrain type         Rolling       % Recreational vehicles  0       %
Grade:  Length       -       mi    % No-passing zones       100     %
        Up/down      -       %     Access point density     1       /mi

Analysis direction volume, Vd  242     veh/h
Opposing direction volume, Vo  242     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.2                 2.2
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.933               0.933
Grade adj. factor,(note-1) fg             0.80                0.80
Directional flow rate,(note-2) vi         352     pc/h        352     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM               -      mi/h
Observed total demand,(note-3) V                 -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS              50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.3     mi/h

Free-flow speed, FFSd                           47.2    mi/h

Adjustment for no-passing zones, fnp            3.0     mi/h
Average travel speed, ATSd                      38.7    mi/h
Percent Free Flow Speed, PFFS                   82.0    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.7                 1.7
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.960               0.960
Grade adjustment factor,(note-1) fg       0.83                0.83
Directional flow rate,(note-2) vi         330    pc/h         330     pc/h
Base percent time-spent-following,(note-4) BPTSFd  35.8   %
Adjustment for no-passing zones, fnp               53.7
Percent time-spent-following, PTSFd               62.7   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.16
Peak 15-min vehicle-miles of travel, VMT15         125     veh-mi
Peak-hour vehicle-miles of travel, VMT60           460     veh-mi
Peak 15-min total travel time, TT15                3.2     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      38.7    mi/h
Percent time-spent-following, PTSFd (from above)             62.7
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking      0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            263.0
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.71
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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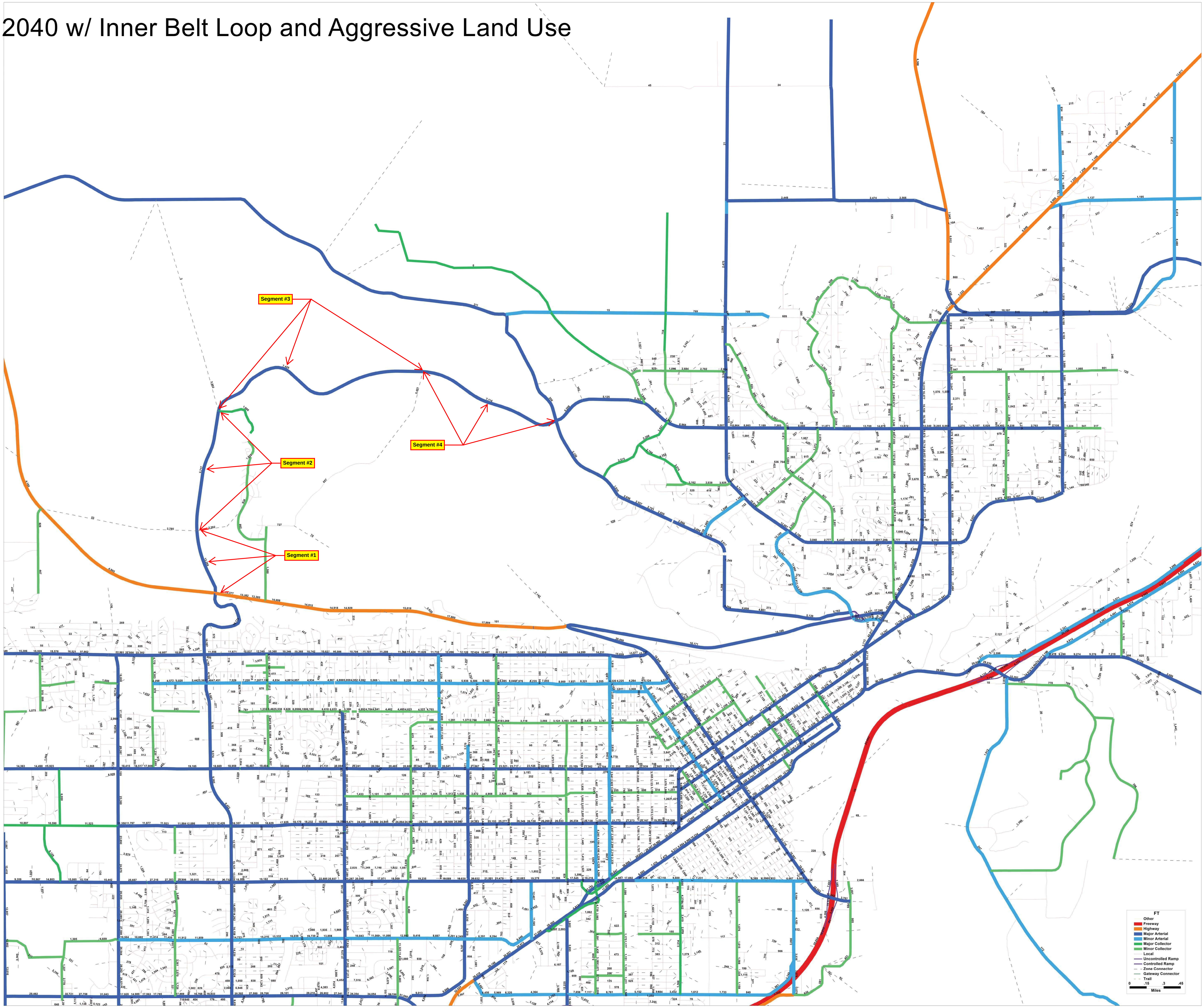
CORRIDOR CAPACITY CALCULATIONS – AGGRESSIVE CONDITIONS (CLASS II & III)

2040 w/ Inner Belt Loop and Aggressive Land Use



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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 1/ NB
From/To                 Airport Road/Iron Horse Trail
Jurisdiction            City of Billings
Analysis Year           Aggressive Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 2              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.7     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       0       %
        Up/down      -       %      Access point density     3       /mi

Analysis direction volume, Vd  665     veh/h
Opposing direction volume, Vo  665     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.6                 1.6
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.965               0.965
Grade adj. factor,(note-1) fg             0.98                0.98
Directional flow rate,(note-2) vi         764     pc/h        764     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.8     mi/h

Free-flow speed, FFSd                          46.7    mi/h

Adjustment for no-passing zones, fnp           0.4     mi/h
Average travel speed, ATSd                     34.4    mi/h
Percent Free Flow Speed, PFFS                  73.8    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.0                 1.0
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      1.000               1.000
Grade adjustment factor,(note-1) fg       0.99                0.99
Directional flow rate,(note-2) vi         730    pc/h         730     pc/h
Base percent time-spent-following,(note-4) BPTSFd  66.2   %
Adjustment for no-passing zones, fnp               12.5
Percent time-spent-following, PTSFd                72.4   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              D
Volume to capacity ratio, v/c                      0.43
Peak 15-min vehicle-miles of travel, VMT15         126     veh-mi
Peak-hour vehicle-miles of travel, VMT60           465     veh-mi
Peak 15-min total travel time, TT15                3.7     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1700    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.7     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      34.4    mi/h
Percent time-spent-following, PTSFd (from above)             72.4
Level of service, LOSd (from above)                          D

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     A
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            722.8
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   6.23
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
```

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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 1/ SB
From/To                 Iron Horse Trail/Airport Road
Jurisdiction            City of Billings
Analysis Year           Aggressive Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 2              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.7     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     3       /mi

Analysis direction volume, Vd  665     veh/h
Opposing direction volume, Vo  665     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.6                 1.6
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.965               0.965
Grade adj. factor,(note-1) fg             0.98                0.98
Directional flow rate,(note-2) vi         764     pc/h        764     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.8     mi/h

Free-flow speed, FFSd                          46.7    mi/h

Adjustment for no-passing zones, fnp           1.3     mi/h
Average travel speed, ATSd                     33.5    mi/h
Percent Free Flow Speed, PFFS                  71.7    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.0                 1.0
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      1.000               1.000
Grade adjustment factor,(note-1) fg       0.99                0.99
Directional flow rate,(note-2) vi         730    pc/h         730     pc/h
Base percent time-spent-following,(note-4) BPTSFd  66.2   %
Adjustment for no-passing zones, fnp               27.6
Percent time-spent-following, PTSFd                80.0   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              D
Volume to capacity ratio, v/c                      0.43
Peak 15-min vehicle-miles of travel, VMT15         126     veh-mi
Peak-hour vehicle-miles of travel, VMT60           465     veh-mi
Peak 15-min total travel time, TT15                3.8     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1700    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.7     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      33.5    mi/h
Percent time-spent-following, PTSFd (from above)             80.0
Level of service, LOSd (from above)                          D

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     A
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            722.8
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   6.23
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
```

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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 2/ NB
From/To                 Airport Road/Iron Horse Trail
Jurisdiction            City of Billings
Analysis Year           Aggressive Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 2              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       5       %
        Up/down      -       %      Access point density     2       /mi

Analysis direction volume, Vd  486     veh/h
Opposing direction volume, Vo  486     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.8                 1.8
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.954               0.954
Grade adj. factor,(note-1) fg             0.96                0.96
Directional flow rate,(note-2) vi         577     pc/h        577     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM               -      mi/h
Observed total demand,(note-3) V                 -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS              50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.5     mi/h

Free-flow speed, FFSd                          46.9    mi/h

Adjustment for no-passing zones, fnp           0.5     mi/h
Average travel speed, ATSd                     37.4    mi/h
Percent Free Flow Speed, PFFS                  79.8    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.2                 1.2
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.988               0.988
Grade adjustment factor,(note-1) fg       0.96                0.96
Directional flow rate,(note-2) vi         557    pc/h         557     pc/h
Base percent time-spent-following,(note-4) BPTSFd  55.7   %
Adjustment for no-passing zones, fnp               17.3
Percent time-spent-following, PTSFd                64.3   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.31
Peak 15-min vehicle-miles of travel, VMT15         119     veh-mi
Peak-hour vehicle-miles of travel, VMT60           437     veh-mi
Peak 15-min total travel time, TT15                3.2     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1700    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      37.4    mi/h
Percent time-spent-following, PTSFd (from above)             64.3
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     A
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            528.3
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   6.07
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 2/ SB
From/To                 Iron Horse Trail/Airport Road
Jurisdiction            City of Billings
Analysis Year           Aggressive Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 2              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       50      %
        Up/down      -       %      Access point density     2       /mi

Analysis direction volume, Vd  486     veh/h
Opposing direction volume, Vo  486     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.8                 1.8
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.954               0.954
Grade adj. factor,(note-1) fg             0.96                0.96
Directional flow rate,(note-2) vi         577     pc/h        577     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.5     mi/h

Free-flow speed, FFSd                          46.9    mi/h

Adjustment for no-passing zones, fnp           1.0     mi/h
Average travel speed, ATSd                     36.9    mi/h
Percent Free Flow Speed, PFFS                  78.8    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.2                 1.2
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.988               0.988
Grade adjustment factor,(note-1) fg       0.96                0.96
Directional flow rate,(note-2) vi         557    pc/h         557     pc/h
Base percent time-spent-following,(note-4) BPTSFd  55.7   %
Adjustment for no-passing zones, fnp               33.2
Percent time-spent-following, PTSFd                72.3   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              D
Volume to capacity ratio, v/c                      0.31
Peak 15-min vehicle-miles of travel, VMT15         119     veh-mi
Peak-hour vehicle-miles of travel, VMT60           437     veh-mi
Peak 15-min total travel time, TT15                3.2     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1700    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      36.9    mi/h
Percent time-spent-following, PTSFd (from above)             72.3
Level of service, LOSd (from above)                          D

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     A
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            528.3
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   6.07
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 3/ EB
From/To                 Airport Road/Iron Horse Trail
Jurisdiction            City of Billings
Analysis Year           Aggressive Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 2              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       1.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     2       /mi

Analysis direction volume, Vd  372     veh/h
Opposing direction volume, Vo  372     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.0                 2.0
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.943               0.943
Grade adj. factor,(note-1) fg             0.90                0.90
Directional flow rate,(note-2) vi         476     pc/h        476     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.5     mi/h

Free-flow speed, FFSd                          46.9    mi/h

Adjustment for no-passing zones, fnp           2.4     mi/h
Average travel speed, ATSd                     37.1    mi/h
Percent Free Flow Speed, PFFS                  79.2    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.4                 1.4
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.977               0.977
Grade adjustment factor,(note-1) fg       0.90                0.90
Directional flow rate,(note-2) vi         460    pc/h         460     pc/h
Base percent time-spent-following,(note-4) BPTSFd  47.8   %
Adjustment for no-passing zones, fnp               43.0
Percent time-spent-following, PTSFd                69.3   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.24
Peak 15-min vehicle-miles of travel, VMT15         192     veh-mi
Peak-hour vehicle-miles of travel, VMT60           707     veh-mi
Peak 15-min total travel time, TT15                5.2     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1700    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      37.1    mi/h
Percent time-spent-following, PTSFd (from above)             69.3
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     A
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                      45
Percent of segment with occupied on-highway parking         0
Pavement rating, P                                          3
Flow rate in outside lane, vOL                              404.3
Effective width of outside lane, We                         14.00
Effective speed factor, St                                  4.42
Bicycle LOS Score, BLOS                                     5.93
Bicycle LOS                                                 F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 3/ WB
From/To                 Iron Horse Trail/Airport Road
Jurisdiction            City of Billings
Analysis Year           Aggressive Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 2              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       1.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     2       /mi

Analysis direction volume, Vd  372     veh/h
Opposing direction volume, Vo  372     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.0                 2.0
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.943               0.943
Grade adj. factor,(note-1) fg             0.90                0.90
Directional flow rate,(note-2) vi         476     pc/h        476     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM               -      mi/h
Observed total demand,(note-3) V                 -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS              50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.5     mi/h

Free-flow speed, FFSd                           46.9    mi/h

Adjustment for no-passing zones, fnp            2.4     mi/h
Average travel speed, ATSd                      37.1    mi/h
Percent Free Flow Speed, PFFS                   79.2    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.4                 1.4
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.977               0.977
Grade adjustment factor,(note-1) fg       0.90                0.90
Directional flow rate,(note-2) vi         460    pc/h         460     pc/h
Base percent time-spent-following,(note-4) BPTSFd  47.8   %
Adjustment for no-passing zones, fnp               43.0
Percent time-spent-following, PTSFd                69.3   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.24
Peak 15-min vehicle-miles of travel, VMT15         192     veh-mi
Peak-hour vehicle-miles of travel, VMT60           707     veh-mi
Peak 15-min total travel time, TT15                5.2     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1700    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      37.1    mi/h
Percent time-spent-following, PTSFd (from above)             69.3
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     A
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                      45
Percent of segment with occupied on-highway parking         0
Pavement rating, P                                          3
Flow rate in outside lane, vOL                              404.3
Effective width of outside lane, We                         14.00
Effective speed factor, St                                  4.42
Bicycle LOS Score, BLOS                                     5.93
Bicycle LOS                                                 F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
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_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 4/ EB
From/To                 Airport Road/Iron Horse Trail
Jurisdiction            City of Billings
Analysis Year           Aggressive Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 2              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       1.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     1       /mi

Analysis direction volume, Vd  356     veh/h
Opposing direction volume, Vo  356     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.0                 2.0
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.943               0.943
Grade adj. factor,(note-1) fg             0.89                0.89
Directional flow rate,(note-2) vi         461     pc/h        461     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.3     mi/h

Free-flow speed, FFSd                          47.2    mi/h

Adjustment for no-passing zones, fnp           2.4     mi/h
Average travel speed, ATSd                     37.6    mi/h
Percent Free Flow Speed, PFFS                  79.7    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.6                 1.6
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.965               0.965
Grade adjustment factor,(note-1) fg       0.89                0.89
Directional flow rate,(note-2) vi         450    pc/h         450     pc/h
Base percent time-spent-following,(note-4) BPTSFd  47.8   %
Adjustment for no-passing zones, fnp               43.6
Percent time-spent-following, PTSFd                69.6   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.23
Peak 15-min vehicle-miles of travel, VMT15         184     veh-mi
Peak-hour vehicle-miles of travel, VMT60           676     veh-mi
Peak 15-min total travel time, TT15                4.9     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1700    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      37.6    mi/h
Percent time-spent-following, PTSFd (from above)             69.6
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     A
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            387.0
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.91
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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                    HCS7: Two-Lane Highways Release 7.2.1




Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 4/ WB
From/To                 Iron Horse Trail/Airport Road
Jurisdiction            City of Billings
Analysis Year           Aggressive Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 2             Peak hour factor, PHF    0.92
Shoulder width       2.0     ft    % Trucks and buses       6       %
Lane width           12.0    ft    % Trucks crawling        0.0     %
Segment length       1.9     mi    Truck crawl speed        0.0     mi/hr
Terrain type         Rolling       % Recreational vehicles  0       %
Grade:  Length       -       mi    % No-passing zones       100     %
        Up/down      -       %     Access point density     1       /mi

Analysis direction volume, Vd  356     veh/h
Opposing direction volume, Vo  356     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.0                 2.0
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.943               0.943
Grade adj. factor,(note-1) fg             0.89                0.89
Directional flow rate,(note-2) vi         461     pc/h        461     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM               -      mi/h
Observed total demand,(note-3) V                 -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS              50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS   2.6     mi/h
Adj. for access point density,(note-3) fA       0.3     mi/h

Free-flow speed, FFSd                           47.2    mi/h

Adjustment for no-passing zones, fnp            2.4     mi/h
Average travel speed, ATSd                      37.6    mi/h
Percent Free Flow Speed, PFFS                   79.7    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.6                 1.6
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.965               0.965
Grade adjustment factor,(note-1) fg       0.89                0.89
Directional flow rate,(note-2) vi         450    pc/h         450     pc/h
Base percent time-spent-following,(note-4) BPTSFd  47.8   %
Adjustment for no-passing zones, fnp               43.6
Percent time-spent-following, PTSFd                69.6   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.23
Peak 15-min vehicle-miles of travel, VMT15         184     veh-mi
Peak-hour vehicle-miles of travel, VMT60           676     veh-mi
Peak 15-min total travel time, TT15                4.9     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1700    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      37.6    mi/h
Percent time-spent-following, PTSFd (from above)             69.6
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     A
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            387.0
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.91
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 1/ NB
From/To                 Airport Road/Iron Horse Trail
Jurisdiction            City of Billings
Analysis Year           Aggressive Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 3             Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.7     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     3       /mi

Analysis direction volume, Vd  665     veh/h
Opposing direction volume, Vo  665     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.6                 1.6
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.965               0.965
Grade adj. factor,(note-1) fg             0.98                0.98
Directional flow rate,(note-2) vi         764     pc/h        764     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM               -      mi/h
Observed total demand,(note-3) V                 -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS              50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS   2.6     mi/h
Adj. for access point density,(note-3) fA       0.8     mi/h

Free-flow speed, FFSd                           46.7    mi/h

Adjustment for no-passing zones, fnp            1.3     mi/h
Average travel speed, ATSd                      33.5    mi/h
Percent Free Flow Speed, PFFS                   71.7    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.0                 1.0
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      1.000               1.000
Grade adjustment factor,(note-1) fg       0.99                0.99
Directional flow rate,(note-2) vi         730    pc/h         730     pc/h
Base percent time-spent-following,(note-4) BPTSFd  66.2   %
Adjustment for no-passing zones, fnp               27.6
Percent time-spent-following, PTSFd                80.0   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              D
Volume to capacity ratio, v/c                      0.43
Peak 15-min vehicle-miles of travel, VMT15         126     veh-mi
Peak-hour vehicle-miles of travel, VMT60           465     veh-mi
Peak 15-min total travel time, TT15                3.8     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.7     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      33.5    mi/h
Percent time-spent-following, PTSFd (from above)             80.0
Level of service, LOSd (from above)                          D

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            722.8
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   6.23
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 2/ NB
From/To                 Airport Road/Iron Horse Trail
Jurisdiction            City of Billings
Analysis Year           Aggressive Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 3             Peak hour factor, PHF    0.92
Shoulder width      2.0     ft     % Trucks and buses       6       %
Lane width          12.0    ft     % Trucks crawling        0.0     %
Segment length      0.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type        Rolling        % Recreational vehicles  0       %
Grade:  Length      -       mi     % No-passing zones       5       %
        Up/down     -       %      Access point density     2       /mi

Analysis direction volume, Vd  486     veh/h
Opposing direction volume, Vo  486     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.8                 1.8
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.954               0.954
Grade adj. factor,(note-1) fg             0.96                0.96
Directional flow rate,(note-2) vi         577     pc/h        577     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM               -      mi/h
Observed total demand,(note-3) V                 -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS              50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.5     mi/h

Free-flow speed, FFSd                           46.9    mi/h

Adjustment for no-passing zones, fnp            0.5     mi/h
Average travel speed, ATSd                      37.4    mi/h
Percent Free Flow Speed, PFFS                   79.8    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)        Opposing (o)
PCE for trucks, ET                        1.2                 1.2
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.988               0.988
Grade adjustment factor,(note-1) fg       0.96                0.96
Directional flow rate,(note-2) vi         557    pc/h         557     pc/h
Base percent time-spent-following,(note-4) BPTSFd  55.7   %
Adjustment for no-passing zones, fnp               17.3
Percent time-spent-following, PTSFd                64.3   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.32
Peak 15-min vehicle-miles of travel, VMT15         119     veh-mi
Peak-hour vehicle-miles of travel, VMT60           437     veh-mi
Peak 15-min total travel time, TT15                3.2     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      37.4    mi/h
Percent time-spent-following, PTSFd (from above)             64.3
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            528.3
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   6.07
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 1/ SB
From/To                 Iron Horse Trail/Airport Road
Jurisdiction            City of Billings
Analysis Year           Aggressive Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 3              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.7     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     3       /mi

Analysis direction volume, Vd  665     veh/h
Opposing direction volume, Vo  665     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.6                 1.6
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.965               0.965
Grade adj. factor,(note-1) fg             0.98                0.98
Directional flow rate,(note-2) vi         764     pc/h        764     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.8     mi/h

Free-flow speed, FFSd                          46.7    mi/h

Adjustment for no-passing zones, fnp           1.3     mi/h
Average travel speed, ATSd                     33.5    mi/h
Percent Free Flow Speed, PFFS                  71.7    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.0                 1.0
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      1.000               1.000
Grade adjustment factor,(note-1) fg       0.99                0.99
Directional flow rate,(note-2) vi         730    pc/h         730     pc/h
Base percent time-spent-following,(note-4) BPTSFd  66.2   %
Adjustment for no-passing zones, fnp               27.6
Percent time-spent-following, PTSFd                80.0   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              D
Volume to capacity ratio, v/c                      0.43
Peak 15-min vehicle-miles of travel, VMT15         126     veh-mi
Peak-hour vehicle-miles of travel, VMT60           465     veh-mi
Peak 15-min total travel time, TT15                3.8     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.7     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      33.5    mi/h
Percent time-spent-following, PTSFd (from above)             80.0
Level of service, LOSd (from above)                          D

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            722.8
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   6.23
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 2/ SB
From/To                 Iron Horse Trail/Airport Road
Jurisdiction            City of Billings
Analysis Year           Aggressive Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 3              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       50      %
        Up/down      -       %      Access point density     2       /mi

Analysis direction volume, Vd  486     veh/h
Opposing direction volume, Vo  486     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.8                 1.8
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.954               0.954
Grade adj. factor,(note-1) fg             0.96                0.96
Directional flow rate,(note-2) vi         577     pc/h        577     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.5     mi/h

Free-flow speed, FFSd                          46.9    mi/h

Adjustment for no-passing zones, fnp           1.0     mi/h
Average travel speed, ATSd                     36.9    mi/h
Percent Free Flow Speed, PFFS                  78.8    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.2                 1.2
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.988               0.988
Grade adjustment factor,(note-1) fg       0.96                0.96
Directional flow rate,(note-2) vi         557    pc/h         557     pc/h
Base percent time-spent-following,(note-4) BPTSFd  55.7   %
Adjustment for no-passing zones, fnp               33.2
Percent time-spent-following, PTSFd                72.3   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.32
Peak 15-min vehicle-miles of travel, VMT15         119     veh-mi
Peak-hour vehicle-miles of travel, VMT60           437     veh-mi
Peak 15-min total travel time, TT15                3.2     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      36.9    mi/h
Percent time-spent-following, PTSFd (from above)             72.3
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
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```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            528.3
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   6.07
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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                    HCS7: Two-Lane Highways Release 7.2.1




Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 3/ EB
From/To                 Airport Road/Iron Horse Trail
Jurisdiction            City of Billings
Analysis Year           Aggressive Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 3              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       1.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     2       /mi

Analysis direction volume, Vd  372     veh/h
Opposing direction volume, Vo  372     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.0                 2.0
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.943               0.943
Grade adj. factor,(note-1) fg             0.90                0.90
Directional flow rate,(note-2) vi         476     pc/h        476     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.5     mi/h

Free-flow speed, FFSd                          46.9    mi/h

Adjustment for no-passing zones, fnp           2.4     mi/h
Average travel speed, ATSd                     37.1    mi/h
Percent Free Flow Speed, PFFS                  79.2    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)        Opposing (o)
PCE for trucks, ET                        1.4                 1.4
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.977               0.977
Grade adjustment factor,(note-1) fg       0.90                0.90
Directional flow rate,(note-2) vi         460    pc/h         460     pc/h
Base percent time-spent-following,(note-4) BPTSFd  47.8   %
Adjustment for no-passing zones, fnp               43.0
Percent time-spent-following, PTSFd                69.3   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.24
Peak 15-min vehicle-miles of travel, VMT15         192     veh-mi
Peak-hour vehicle-miles of travel, VMT60           707     veh-mi
Peak 15-min total travel time, TT15                5.2     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      37.1    mi/h
Percent time-spent-following, PTSFd (from above)             69.3
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
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```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            404.3
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.93
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 4/ EB
From/To                 Airport Road/Iron Horse Trail
Jurisdiction            City of Billings
Analysis Year           Aggressive Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 3              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       1.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     1       /mi

Analysis direction volume, Vd  356     veh/h
Opposing direction volume, Vo  356     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.0                 2.0
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.943               0.943
Grade adj. factor,(note-1) fg             0.89                0.89
Directional flow rate,(note-2) vi         461     pc/h        461     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      0.3     mi/h

Free-flow speed, FFSd                          47.2    mi/h

Adjustment for no-passing zones, fnp           2.4     mi/h
Average travel speed, ATSd                     37.6    mi/h
Percent Free Flow Speed, PFFS                  79.7    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)        Opposing (o)
PCE for trucks, ET                        1.6                 1.6
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.965               0.965
Grade adjustment factor,(note-1) fg       0.89                0.89
Directional flow rate,(note-2) vi         450    pc/h         450     pc/h
Base percent time-spent-following,(note-4) BPTSFd  47.8   %
Adjustment for no-passing zones, fnp               43.6
Percent time-spent-following, PTSFd                69.6   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.23
Peak 15-min vehicle-miles of travel, VMT15         184     veh-mi
Peak-hour vehicle-miles of travel, VMT60           676     veh-mi
Peak 15-min total travel time, TT15                4.9     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      37.6    mi/h
Percent time-spent-following, PTSFd (from above)             69.6
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            387.0
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.91
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
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_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 3/ WB
From/To                 Iron Horse Trail/Airport Road
Jurisdiction            City of Billings
Analysis Year           Aggressive Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data__________________________________

Highway class  Class 3             Peak hour factor, PHF    0.92
Shoulder width       2.0     ft    % Trucks and buses       6       %
Lane width           12.0    ft    % Trucks crawling        0.0     %
Segment length       1.9     mi    Truck crawl speed        0.0     mi/hr
Terrain type         Rolling       % Recreational vehicles  0       %
Grade:  Length       -       mi    % No-passing zones       100     %
        Up/down      -       %     Access point density     2       /mi

Analysis direction volume, Vd  372     veh/h
Opposing direction volume, Vo  372     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.0                 2.0
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.943               0.943
Grade adj. factor,(note-1) fg             0.90                0.90
Directional flow rate,(note-2) vi         476     pc/h        476     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM               -      mi/h
Observed total demand,(note-3) V                 -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS              50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA       0.5     mi/h

Free-flow speed, FFSd                           46.9    mi/h

Adjustment for no-passing zones, fnp            2.4     mi/h
Average travel speed, ATSd                      37.1    mi/h
Percent Free Flow Speed, PFFS                   79.2    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)        Opposing (o)
PCE for trucks, ET                        1.4                 1.4
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.977               0.977
Grade adjustment factor,(note-1) fg       0.90                0.90
Directional flow rate,(note-2) vi         460    pc/h         460     pc/h
Base percent time-spent-following,(note-4) BPTSFd  47.8   %
Adjustment for no-passing zones, fnp               43.0
Percent time-spent-following, PTSFd                69.3   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.24
Peak 15-min vehicle-miles of travel, VMT15         192     veh-mi
Peak-hour vehicle-miles of travel, VMT60           707     veh-mi
Peak 15-min total travel time, TT15                5.2     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      37.1    mi/h
Percent time-spent-following, PTSFd (from above)             69.3
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            404.3
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.93
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
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_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 D.J. Clark
Agency/Co.
Date Performed          12/17/2019
Analysis Time Period    PM Peak Hour
Highway                 Inner Belt Loop Segment 4/ WB
From/To                 Iron Horse Trail/Airport Road
Jurisdiction            City of Billings
Analysis Year           Aggressive Scenario (2040)
Description  Inner Belt Loop Corridor Study

__________________________________Input Data___________________________________

Highway class  Class 3              Peak hour factor, PHF    0.92
Shoulder width       2.0     ft     % Trucks and buses       6       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       1.9     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     1       /mi

Analysis direction volume, Vd  356     veh/h
Opposing direction volume, Vo  356     veh/h

____________________________Average Travel Speed_______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.0                 2.0
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.943               0.943
Grade adj. factor,(note-1) fg             0.89                0.89
Directional flow rate,(note-2) vi         461     pc/h        461     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM               -      mi/h
Observed total demand,(note-3) V                 -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS              50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS   2.6     mi/h
Adj. for access point density,(note-3) fA       0.3     mi/h

Free-flow speed, FFSd                           47.2    mi/h

Adjustment for no-passing zones, fnp            2.4     mi/h
Average travel speed, ATSd                      37.6    mi/h
Percent Free Flow Speed, PFFS                   79.7    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.6                 1.6
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.965               0.965
Grade adjustment factor,(note-1) fg       0.89                0.89
Directional flow rate,(note-2) vi         450    pc/h         450     pc/h
Base percent time-spent-following,(note-4) BPTSFd  47.8   %
Adjustment for no-passing zones, fnp               43.6
Percent time-spent-following, PTSFd                69.6   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.23
Peak 15-min vehicle-miles of travel, VMT15         184     veh-mi
Peak-hour vehicle-miles of travel, VMT60           676     veh-mi
Peak 15-min total travel time, TT15                4.9     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.9     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      37.6    mi/h
Percent time-spent-following, PTSFd (from above)             69.6
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
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```
Posted speed limit, Sp                                    45
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            387.0
Effective width of outside lane, We                       14.00
Effective speed factor, St                                4.42
Bicycle LOS Score, BLOS                                   5.91
Bicycle LOS                                               F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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