Appendix B

Existing and Projected Conditions Report

Old Highway 312 Corridor Study

Exisitng and Projected Conditions Report

April 2016

DOWL

MDT

Contents

Figures

Tables

Attachments

Abbreviations and Acronyms

AADT	Annual Average Daily Traffic
AGR	Annual Growth Rate
ATS	Average Travel Speed
BBWA	Billings Bench Water Association
BLM	Bureau of Land Management
BOR	United States Bureau of Reclamation
CHSP	Comprehensive State Highway Safety Plan
DEQ	Montana Department of Environmental Quality
ETW	Edge of Traveled Way
FAS	Fishing Access Site
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FRA	Federal Railway Administration
FWP	Montana Fish, Wildlife, and Parks
GIS	Geographic Information Systems
GWIC	Groundwater Information Center
HCM	Highway Capacity Manual
HUC	Hydrologic Unit Code
ID	Identification
ISTEA	Intermodal Surface Transportation Enhancement Act
LID	Low Impact Development
LOS	Level of Service
LOSS	Level of Service of Safety
LUST	Leaking Underground Storage Tank
MBMG	Montana Bureau of Mines and Geology
MDT	Montana Department of Transportation
MET	Billings Metropolitan Transit
MPDES	Montana Pollutant Discharge Elimination System
MPH	Miles per Hour
MPO	Metropolitan Planning Organization
MRL	Montana Rail Link
MS4	Municipal Separate Storm Sewer System
MSAT	Mobile Source Air Toxins
MUTCD	Manual on Uniform Traffic Control Devices
NAAQS	National Ambient Air Quality Standards
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
PESC	Permanent Soil Erosion and Sediment Control
PFFS	Percent of Free-Flow Speed
PTSF	Percent Time Spend Following
RDM	Road Design Manual
REMI	Regional Economic Models, Inc.
ROD	Record of Decision
ROW	Right-of-Way
RP	Reference Point
RR	Railroad
SFHA	Special Flood Hazard Area
SOC	Species of Concern

SPF	Safety Performance Functions
STIP	Statewide Transportation Improvement Program
T&E	Threatened and Endangered
TIP	Transportation Improvement Plan
TWLT	Two-way Left-turn Lane
UPN	Unified Project Number
US	United States
USACE	United States Army Corps of Engineers
USC	United States Code
USDA	United State Department of Agriculture
USFWS	United State Fish and Wildlife Service
UST	Underground Storage Tank

1.0 Introduction

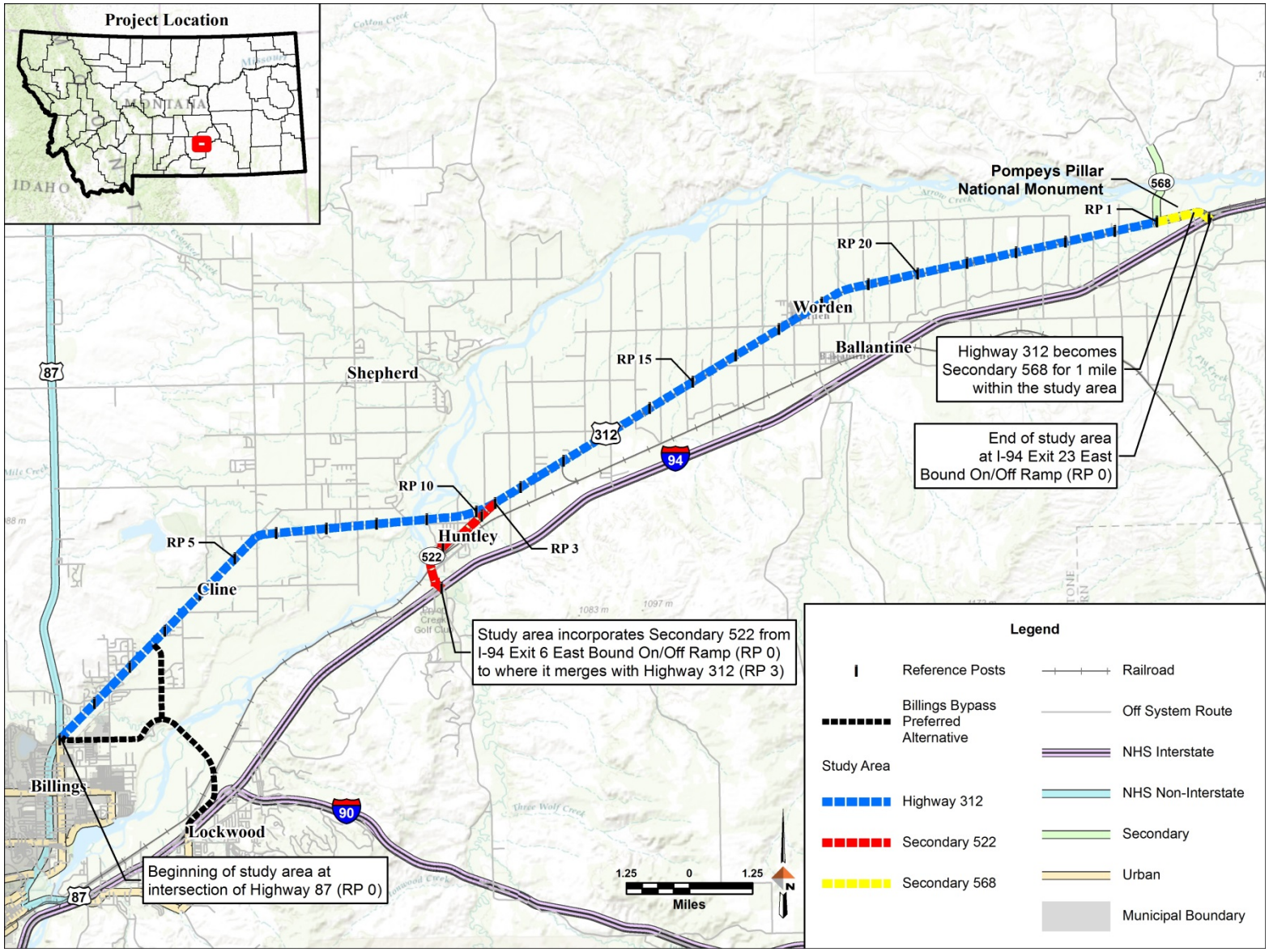
The Montana Department of Transportation (MDT), in cooperation with the City of Billings, Yellowstone County, and the Federal Highway Administration (FHWA), initiated a corridor planning study to investigate potential improvements within the Highway 312 corridor. The area has experienced substantial growth in recent years, and the influx of commuters on the system has increased traffic and congestion. The purpose of the study is to develop a comprehensive long-range plan for managing the corridor and determining what, if anything, can be done to improve the corridor based on needs, public and agency input, and financial feasibility. The study will be a collaborative process with local jurisdictions, agencies, FHWA, and the public to identify transportation needs and potential solutions given funding constraints.

The study area is illustrated in Figure 1 and includes Highway 312, starting at its intersection with US 87 (but not including the intersection) and traveling approximately 26 miles northeast through the communities of Huntley and Worden. Highway 312 becomes Secondary 568 approximately one mile before the Pompeys Pillar Interchange, and the study area continues to and includes the interchange. The study area also includes Secondary 522 from its intersection with Highway 312 to the I-94 Interchange westbound on/off ramp, a distance of approximately 3 miles.

A planning study is a planning-level assessment of a study area occurring before project-level environmental compliance activities under the National and Montana Environmental Policy Acts (NEPA/MEPA). There is no equivalent state-level environmental policy act in North Dakota. The planning study process is designed to identify potential transportation improvements and to facilitate a smooth and efficient transition from transportation planning to environmental review and potential project development. The process involves conducting a planning-level review of safety, operational, and environmental conditions to identify needs and constraints. It also allows early coordination with members of the public, resource agencies, and other interested stakeholders. This process is separate from the NEPA/MEPA environmental compliance documentation, design, right-of-way (ROW) acquisition, and construction phases of an individual project. Depending on needs and funding availability, an improvement option may be forwarded from this planning-level study and developed into a project at a later date.

This existing and projected conditions report provides a planning-level summary of transportation system features and physical, biological, social, and cultural characteristics to help identify issues, constraints, and opportunities within the study area.

Figure 1 Study Area



2.0 Recent and Future Projects and Maintenance Efforts

Table 1 identifies recent and future projects within the study area.

Table 1 Recent and Future MDT Projects

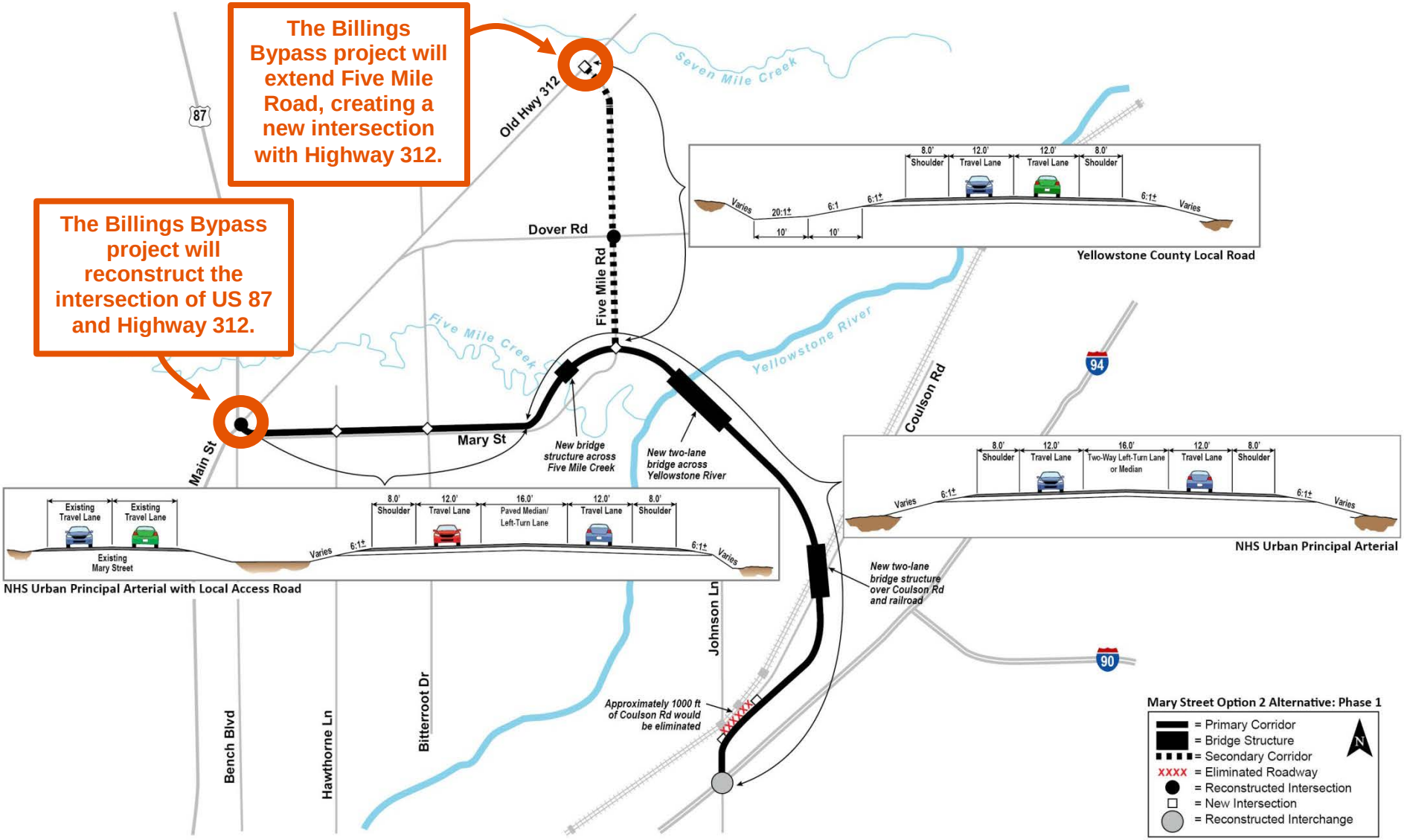
Route	UPN	Project Name	Fiscal Year (Construction Phase)	Project Scope
Highway 312	3438	Arrow Creek - NE of Hardin	2003	Box Culvert & Approaches
	4443	Safety Improvement – Old US 312	2003	Turn Lane, Widening, Bridges
	4678	D5 – Scour Protection	2003	Scour Protection
	5028	2001 – Safety Improvement – W of Huntley	(Active)	Left Turn, Flash, Sign, Approach
	5213	NE of Billings – NE	2003	Pavement Preservation, Bridge Rail and Guardrail Updates
	7960	2012 Scour Mitigation	(Active)	Scour Mitigation on 5 Structures
	8795	Fly Creek – Pompey's Pillar	(Active)	Bridge Replacement
Secondary 522	4669	Huntley Interchange – East	2004	Plant Mix Surfacing Overlay
	7690	Pryor Ck – 1 M S Huntley/MT 11-1	2011	Bridge Reconstruction
	8016	RR Xing – FAS 522 – Huntley	(Active)	Circuitry Upgrade of Existing Grade Crossing Signal System
Secondary 568	4004	BNRR – 2 KM W Pompey's Pillar	2003	Bridge Replacement
	5184	Pompey's Pillar Intch – West	2003	Pavement Preservation

Source: MDT, 2015. UPN: unified project number.

In addition to the projects noted above, the Billings Bypass project (NCDP 56(55)) will construct a new principal arterial connection for Interstate 90 east of Billings with Highway 312/US 87 northeast of Billings, connecting the unincorporated community of Lockwood with the Billings Heights neighborhood. The project is intended to improve access and connectivity between Interstate 90 and Highway 312/US 87, improve mobility in the eastern portion of Billings, relieve congestion, and reduce the physical barrier impacts to the transportation system through a new crossing of the Yellowstone River. A final environmental impact statement (FEIS) for the project was completed in March 2014, and a record of decision (ROD) was approved in July 2014. Engineering design will begin in 2015.

The project will consist of a new two-lane urban and rural arterial roadway to be constructed in phases, with accommodations to widen the facility to an ultimate four-lane section. Within the Highway 312 study area, the Bypass project will construct a new at-grade intersection at the intersection of Highway 312 and US 87. Additionally, a two-lane ancillary roadway will be extended along the existing Five Mile Road alignment, providing a secondary access to the Billings Bypass from Highway 312. Figure 2 illustrates the preferred alternative approved in the ROD, with red callouts indicating planned changes within the Highway 312 corridor.

Figure 2 Billings Bypass Preferred Alternative



Source: Billings Bypass ROD, 2014.

3.0 Transportation System Conditions

The transportation system within the study area is discussed in terms of its features, geometric characteristics, crash history, access points, traffic volumes and operational characteristics.

3.1 Features

Transportation features were identified through field observation and a review of published statistics, documentation, GIS data, and MDT as-built drawings. A field review of the corridor was conducted on June 10, 2015, to assist in identifying existing conditions and constraints. Attachment 1 contains a photo log documenting conditions observed in the field.

Functional Classification and Roadway System

Functional classification is used to characterize public roads and highways, consistent with FHWA guidelines, according to the type of service provided by the facility and the corresponding level of travel mobility and access to and from adjacent property.
In addition to the relative level of access and mobility provided by a roadway, assessment of how a roadway functions takes into considerationspeed limits, usage characteristics (such as annual average daily traffic volumes), and connectivity with other roadway types. Highway system designation is based in part on the functional classification of the roadway.

Highway 312 is currently classified as an off-system (i.e., “X route”) rural minor arterial from the Highway 312 and US 87 intersection to approximately reference point (RP) 1.75 and a rural major collector from RP 1.75 to RP 24.9. The entire lengths of Secondary 522 and Secondary 568 within the study area are classified as on-system rural major collectors.

Minor arterials provide service for trips of moderate length, serve geographic areas that are smaller than their principal arterial counterparts, and offer connectivity to the principal arterial system. In a rural setting, minor arterials are typically designed to provide relatively high overall travel speeds, with minimum interference to through movement.

Major collectors in the rural setting typically serve intra-county travel, rather than statewide travel, and typically serve shorter trips compared to arterial routes. Trips along major collectors greater in length than intra-country travel will typically funnel motorists to the arterial system.

Although the majority of Highway 312 and the entire length of Secondary 522 are currently classified as major collectors, their current function and operating characteristics suggest they may be more appropriately classified as minor arterials. Specifically, Highway 312 from Billings to Huntley accommodates daily traffic volumes ranging from 11,800 to 4,900 vehicles and Secondary 522 serves 4,300 vehicles daily (as presented in Section 3.4 of this report). These roadways serve commuter, recreational, and agricultural traffic and provide relatively high-speed travel and connectivity between the urbanized area of Billings, the community of Huntley, and Interstate 94.

Lane Configuration

Highway 312 is initially a four-lane divided highway at the intersection with US 87 (Bench Boulevard/Roundup Road, RP 0.0). A painted median transitions into a two-way left-turn (TWLT) lane approximately 750 feet east of the study beginning point, providing a five-lane section until the Highway 312 intersection with Barry Drive (RP 2.1). The remainder of the Highway 312 corridor is a two-lane undivided highway, with intermittent three-lane sections

where turn bays are provided at major intersecting roadways (at RPs 3.5, 4.2, 5.6, and 7.6). Secondary 568 and Secondary 522 are also two-lane undivided highways.

Rumble Strips and Delineation

Shoulder rumble strips were generally observed along Highway 312 in areas where the roadway has been widened and there is sufficient shoulder width. Shoulder rumble strips are not present along Secondary 522 and 568. There are no centerline rumble strips within the study area. Delineator condition is generally good and appears to meet MDT design criteria regarding spacing on tangent and curve roadway segments. The entire corridor has standard delineators, which is one of MDT's three delineator types. Delineator Design A is used for continuous delineation on the right shoulder of all routes. Delineator Designs C and F are used for curves based on the curve radius. Delineator Designs D and G are used at approaches with stop or yield signs for non-interstate and interstate ramps, respectively. Highway 312 and Secondary 522 have Design A, C, D, and F delineators spaced throughout the corridor, and Secondary 568 has Design G and F delineators. The curves within the study area appear to have correct delineators, however, there are a number of public approaches along Highway 312 and Secondary 522 that do not appear to have delineator Design D. These approaches include the following intersections.

<u>Highway 312</u>

- Lone Tree Trail, RP 4.9
- Shining Mountain Drive, RP 7.2
- Ivy Street, Sunrise Road, RP 9.8
- 1st Street (Worden, MT), RP 17.5
- 1st Street (Nibble, MT), RP 23.9
- Main Street (Nibble, MT), RP 24.0

<u>Secondary 522</u>

- Creekmore Road, RP 0.1
- North Canal Drive, RP 0.3
- South Canal Drive, RP 0.3
- Canal Drive Access Road, RP 0.4

Right-of-way

Right-of-way boundaries and widths have been estimated for the purpose of this study based on a review of available MDT as-built drawings, ROW plans, and cadastral information. Table 2 summarizes approximate ROW widths throughout the study area. Attachment 2 provides additional detail relating to estimated ROW distances throughout the corridor. Railroad closely parallels the study area along Secondary 522 within Huntley and Highway 312/Secondary 568 from Huntley to the I-94 interchange near Pompeys Pillar. Right-of-way within this portion of the study area may be part of an easement from the railroad property. Additional investigation regarding railroad easements may be necessary depending on the location of potential improvement options within the corridor.

Table 2 Right-of-way Summary

Route	Description	RP	ROW Width (feet)	
			Minimum	Maximum
Highway 312	Billings to Huntley	0 to 10.5	110	230
	Huntley to Worden	10.5 to 17.5	90	110
	Worden to End of Highway 312	17.5 to 24.9	60	95
Secondary 568	Highway 312 / Secondary 568 Intersection to I-94 Interchange	1 to 0	90	260
Secondary 522	I-94 Interchange to Highway 312 / Secondary 522 Intersection	0 to 3	80	160

Source: Available record drawings, ROW plans, and cadastral information, MDT, 2015.

Structures

The MDT Bridge Bureau identified 12 structures within the study area (including both bridges and culverts). Currently, five of 12 are rated fair, indicating they are candidates for repair or rehabilitation. Table 3 presents structure data within the study area.

Table 3 Structure Data

Route	RP	Bridge ID	Location	Feature Crossed	Year Built (Recon)	Main Span Material	Structure Condition
Highway 312	0.50	L56788004+03001	3M NE BILLINGS	FIVE MILE CREEK 183	2005	Prestressed concrete	Good
	1.60	L56788005+04001	4M NE BILLINGS	BBWA CANAL 166	2005	Steel	NA
	2.00	L56788005+08001	5M NE BILLINGS	BBWA CANAL 167	1973	Steel	NA
	2.70	L56788006+05001	5M SW HUNTLEY	SEVEN MILE CREEK 168	1947	Wood or Timber	Fair
	6.57	L56788010+03001	2M W OF HUNTLEY	TWELVE MILE CREEK 169	1947	Wood or Timber	Fair
	8.78	L56788012+07001	HUNTLEY	YELLOWSTONE RIVER 170	1949	Steel continuous	Fair
	12.15	L56788016+01001	2M E OF HUNTLEY	CUSTER COULEE 171	1928 (1939)	Steel	Fair
	18.58	L56788022+06001	1M NE WORDEN	ARROW CREEK 172	2003	Concrete	NA
Secondary 568	0.18	S00568000+00621	1 M W POMPEY'S PILLAR	BN RAILROAD	2004	Prestressed concrete	Good
	0.01	S00568000+00001	1 M W POMPEY'S PILLAR	INT POMPEYS PILLAR 1-94	1968	Steel continuous	Good
Secondary 522	0.24	S00522000+02451	1M S HUNTLEY	PRYOR CREEK	2011	Prestressed concrete	Good
	0.36	S00522000+03681	1M S HUNTLEY	HUNTLEY CANAL	1967	Prestressed concrete	Fair

Source: MDT Bridge Bureau, 2015. Highlighted cells indicate structures in fair condition.
Good: Candidate for preservation treatments. Fair: Candidate for repair or rehabilitation.
NA: no condition rating provided for culverts.

Bicycle and Pedestrian Facilities

Shoulder widths vary throughout the corridor, ranging from zero to eight feet, providing limited opportunity for non-motorized usage along the traveled way without encroaching into vehicle travel lanes.

The study area is promoted by the Adventure Cycling Association, a national bicycle-travel organization, as part of the Lewis & Clark Trail Bicycle Route, which provides an indication of use by the cycling community. Highway 312 and Secondary 568 are part of section 8, which stretches from Three Forks to Glendive. The entire Lewis & Clark Trail Bicycle Route stretches from Hartford, Illinois, to Seaside, Oregon. The City of Billings and Yellowstone County Planning and Community Services have also designated this section as an arterial bike route.

Discontinuous sidewalks occur along Secondary 522 in Huntley. A pedestrian crossing is located at Barkemeyer Park on Secondary 522 (RP 0.9). The pedestrian crossing does not

meet current MDT and Manual on Uniform Traffic Control Devices (MUTCD) signing and pavement marking guidelines, including sign placement, sign sheeting type, and crosswalk pavement marking style. There are no other dedicated pedestrian facilities in the study area.

Utilities

Utilities in the study area include overhead and underground electrical distribution, overhead and underground copper communication, and underground fiber communication.

Air Service

Billings Logan International Airport is located two miles northwest of downtown Billings and is owned by the City of Billings. It is the second largest airport in Montana in both number of gates as well as annual enplanements. The National Plan of Integrated Airport Systems for 2011-2015 categorizes it as a primary commercial service airport. Federal Aviation Administration records indicate 387,368 passenger boardings (enplanements) in 2013.

Rail Service

BNSF and Montana Rail Link (MRL) operate services adjacent to the study area. An MRL railroad parallels the southern side of Secondary 522 (RP 0.5 to 3.0) and Highway 312 (RP 10.4 to 12.0). The MRL line becomes a BNSF line at RP 12 of Highway 312. The BNSF line parallels the southern side of Highway 312 from RP 12 to 24.9 and Secondary 568 from RP 1 to 0.2. Based on 2014 data from the Federal Railroad Administration (FRA), there are approximately 20 to 22 daily trains utilizing the MRL and BNSF track lines.

There are 25 railroad crossings located within and adjacent to the study area. Two of the 25 crossings intersect study area roadways. An at-grade crossing exists on Secondary 522 at RP 0.5 within Huntley and a grade-separated crossing exists on Secondary 568 at RP 0.2. The remaining 23 crossings are located on roadways adjacent to the study area.

Table 4 outlines general rail data at the crossing locations in and adjacent to the study area.

Table 4 Rail Data

Route	RP	Road Crossed	Operating RR (Line)	Maximum Time Table Speed (mph)	AADT (Year)
Secondary 522	0.5	Secondary 522	MRL (1st Sub)	50	4,142 (2011)
	1.8	Private Crossing/Ripley Rd.		Unknown	Unknown
Highway 312	10.8	S 4th Rd. (Huntley Cemetery Rd.)		60	121 (2011)
	11.9	S 6th Rd.		60	65 (2011)
	12.7	Road b/w 7th and 8th	BNSF (Forsyth Sub)	60	65 (2014)
	13.1	S 8th Rd.		60	136 (2014)
	13.7	S 9th Rd.		60	49 (2014)
	14.2	S 10th Rd.		60	68 (2014)
	15.4	S 12th Rd.		60	261 (2014)
	16.6	S 14th Rd.		60	63 (2014)
	17.4	S 15th Rd./Main St. (Worden)		60	713 (2014)
	17.8	S 16th Rd.		60	386 (2014)
	18.9	S 18th Rd.		60	63 (2014)
	19.9	S 20th Rd.		60	24 (2014)
	20.5	S 21st Rd.		60	41 (2014)
	21.0	S 22nd Rd.		60	13 (2014)
	21.5	S 23rd Rd.		60	37 (2014)
	22.0	S 24th Rd.		60	17 (2014)
	22.5	S 25th Rd.		60	29 (2014)
	23.1	S 26th Rd.		60	43 (2014)
	24.1	S 28th Rd.		60	115 (2014)
	24.6	Private Crossing, Unknown Rd.		60	Unknown
Secondary 568	0.5	Private Crossing, Grain Storage Facility		60	Unknown
	0.2	Old Fly Creek Rd. (S. 31st Rd.)		60	82 (2014)
	0.2	Secondary 568		NA	RR-Underpass

Source: MDT, 2015.

Transit

There are no transit services in the study area. MET Transit provides service within the City of Billings boundary, but not within the study corridor.

Drainage Conditions

Drainage throughout the study area is generally sufficient along Highway 312 and Secondary 568. Highway runoff is directed to adjoining shoulders. Graded side slopes carry run-off to natural drainage conveyances through constructed ditches within the ROW or via natural drainage patterns formed by the topographic conditions of the adjacent lands.

One area of insufficient drainage was identified during the June 2015 field review. Standing water was noted on the Barkemeyer Park quadrant of the Secondary 522 and Nahmis Avenue intersection in Huntley. Evidence of standing water was also apparent along Secondary 522 throughout Huntley, especially on the north side of the road. Longitudinal grades and cross slopes are generally flat and no storm collection system exists to collect and transport storm water from the roadway.

Pavement Conditions

Rutting in the wheel paths of all three roadways was observed after a heavy rain event occurred at the time of the June 2015 field review. Rutting was generally worse within the two-lane sections of Highway 312 compared to the three- and five-lane sections. Rutting is estimated to be between ¼-inch and ½-inch in depth. Highway 312 appeared to have recently been chip sealed within the project limits.

Additionally, transverse cracking occurs consistently along the entire corridor. The transverse cracking is spaced sporadically (150- to 200-foot intervals) on Highway 312 and Secondary 568, while Secondary 522 averages transverse cracking every 75 to 100 feet.

Table 5 summarizes pavement condition information along Highway 312, Secondary 568, and Secondary 522 within the study corridor. MDT uses multiple criteria on a good/fair/poor scale to assess pavement conditions. The ride index for Secondary 568, 522, and the first 2.3 miles of Highway 312 is considered fair. All other categories are rated good for these three roadways.

Table 5 Pavement Analysis

Route		Pavement Width (ft)	# of Lanes	Pavement Type	Pavement Age (Years)	Year of Last Surface	Ride (IRI) Index	Rut Index	ACI Index	MCI Index
Highway 312	RP 0.0 to 2.3	27	2-5	Asphalt	9	2006	78.4 (**Fair**)	69.6 (Good)	97.6 (Good)	99.9 (Good)
	RP 2.3 to 8.5	27	2	Asphalt	9	2006	83.6 (Good)	69.75 (Good)	98.5 (Good)	99.8 (Good)
	RP 8.5 to 24.5	24	2	Asphalt	12	2003	80.7 (Good)	69.94 (Good)	98.6 (Good)	99.8 (Good)
Secondary 568		24	2	Asphalt	9	2005	71.5 (**Fair**)	72.1 (Good)	97.3 (Good)	98.7 (Good)
Secondary 522		34	2	Asphalt	12	2002	72.4 (**Fair**)	73.2 (Good)	98.7 (Good)	98.1 (Good)

Source: MDT, June 2015. Highlighted cells indicate pavement in fair condition.
Ride index is calculated using the International Roughness Index (IRI) in inches per mile and converting it to a 0-100 scale. Good: 80-100, Fair: 60-79.9, Poor: 0-59.9.
Rut Index is calculated by converting rut depth to a 0-100 scale. Rut measurements are collected approximately every foot and averaged into one-tenth-mile reported depths. Good: 60-100; Fair: 59.9-40; Poor: 0-39.9.
Alligator Crack Index (ACI) is calculated by combining all load-associated cracking, and converting it to a 0-100 scale. Good: 80-100; Fair: 60-79.9; Poor: 0-59.9.
Miscellaneous Crack Index (MCI) is calculated by combining all non-load-associated cracking, and converting it to a 0-100 scale. Good: 80-100; Fair: 60-79.9; Poor: 0-59.9.

3.2 Geometric Characteristics

Design Criteria

Within the study corridor, Highway 312 is currently classified as a rural minor arterial from the Highway 312 and US 87 intersection to approximately RP 1.75. Highway 312 and Secondary

568 are classified as rural major collectors from RP 1.75 to RP 24.9 and from RP 0.0 to RP 1.0, respectively. The entire length of Secondary 522 is classified as a rural major collector. Geometric design criteria used for rural minor arterial and rural collector roadways are provided in the MDT Road Design Manual (RDM) (*Chapter 12 – Geometric Design Tables*). Chapters 8-10 in the RDM were also consulted for guidance regarding horizontal and vertical alignments.

The existing roadway alignment generally exhibits level terrain characteristics throughout the study area. Based on current classifications, a design speed of 60 miles per hour (mph) in combination with rural minor arterial and rural collector design criteria was utilized for Highway 312 and Secondary 568. A design speed of 60 mph in combination with rural collector design criteria was utilized to evaluate the majority of Secondary 522, with the exception of the portion from approximately RP 0.4 to RP 1.2 where the roadway leads into and out of Huntley, which was analyzed using a 30 mph design speed for an urban collector. Although Secondary 522 is classified as a rural collector, Huntley exhibits urban characteristics reinforced by posted speed limits varying from 25 to 35 mph within the community.

The posted speed limit on Highway 312 and Secondary 568 is primarily 60 to 70 mph (55 to 65 mph at night) and 50 to 60 mph (45 to 55 mph at night) for trucks. The posted speed limit for Secondary 522 varies from 25 mph to 60 mph with a 30 mph advisory sign for one of the horizontal curves on Secondary 522. Table 6 lists the posted and advisory speeds throughout the corridor.

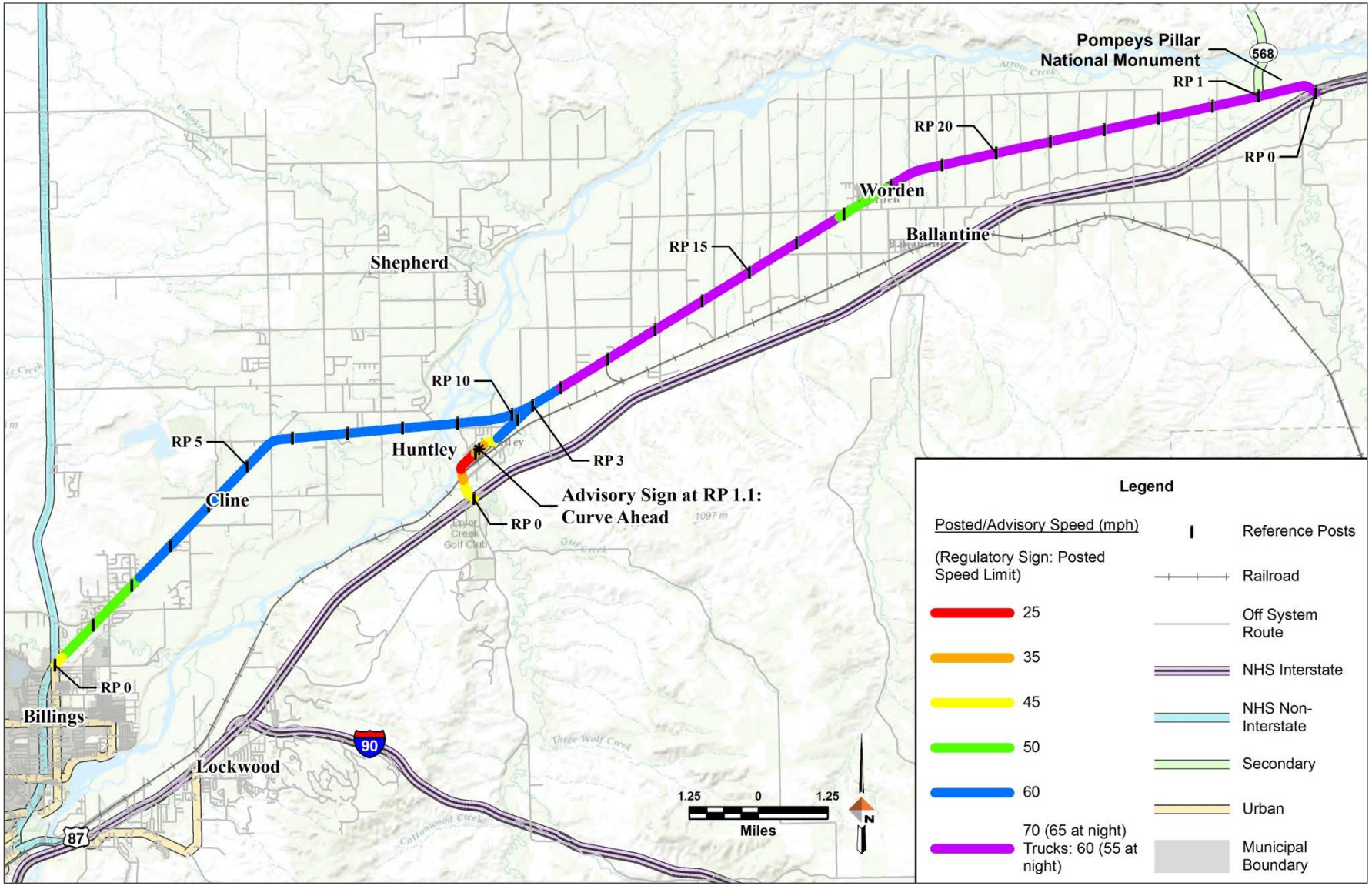
In 2000, a speed zone study was conducted on Highway 312 between the intersection with US 87 (RP 0.0) and the intersection with Secondary 522 (approximate RP 10.4). The study recommended a 55 mph speed limit east of the 45 mph zone until a distance 300 feet east of the intersection with Barry Drive (approximate RP 2.1), and a 65 mph speed limit continuing east until a distance 3,100 feet east of the intersection with Secondary 522. Posted speed limits are currently 5 mph higher than the 2000 speed study recommendations.

Table 6 Posted Speed Limits and Advisory Signing

Location	Beginning RP	Ending RP	Posted/Advisory Speed (mph)	Sign Type
Highway 312	N/A	0.2	45	Regulatory Sign Posted Speed Limit
	0.2	2.2	50	
	2.2	11.0	60	
	11.0	16.9	70 (65 at night)	
	11.1	16.9	Trucks: 60 (55 at night)	
	16.9	17.9	50	
	17.9	24.9	70 (65 at night)	
	17.9	24.9	Trucks: 60 (55 at night)	
Secondary 568	1.0	0.0	70 (65 at night)	
	1.0	0.0	Trucks: 60 (55 at night)	
Secondary 522	0.0	0.4	45	
	0.4	0.6	35	
	0.6	1.0	25	
	1.0	1.2	35	
	1.1	N/A	30	Advisory Sign Curve Ahead
	1.2	1.5	45	Regulatory Sign Posted Speed Limit
	1.5	2.4	60	

Source: DOWL, 2015. Speeds listed for northbound direction only.

Figure 3 Posted Speed Limits and Advisory Signing



Roadway Width

Highway 312 begins as a four-lane divided highway with 12-foot travel lanes and 8-foot shoulder widths, and a painted median. The painted median transitions into a 14-foot TWLT lane approximately 750 feet east of the study beginning point. The remaining Highway 312 corridor is a two-lane undivided highway with 12-foot travel lanes and 2-foot shoulder widths, except at select county road intersections. Secondary 568 and Secondary 522 are also two-lane undivided highways.

Eight-foot shoulders exist on Highway 312 along the four-lane and five-lane sections from the Highway 87 intersection (RP 0) to the Barry Drive intersection (RP 2.1), and at the three-lane Highway 312 intersections with:

- Pioneer Road/Drury Lane (RP 3.5),
- Cline Road/ McGirl Road/Larimer Lane (RP 4.2),
- Hoskins Road/12 Mile Road (RP 5.6), and
- Shepherd Road/Vermillion Road (RP 7.6).

Four-foot shoulders exist on Secondary 568 within the guardrail and bridge barrier limits from RP 0.4 to RP 0. Shoulder widths vary throughout the Secondary 522 corridor, ranging from zero to 24 feet. Shoulders within the Huntley area are eight to 24 feet and provide on-street parallel parking to business and park patrons adjacent to Secondary 522. Eight-foot shoulders extend from the southern Huntley area to the I-94 Interchange.

Table 7 presents roadway widths and surface thicknesses throughout the study corridor. The roadway data for Secondary 522 and 568 was collected from MDT's 2013 Road Log and the roadway data for Highway 312 was approximated based on available as-built data.

Table 7 Highway Width and Surface Thickness

Location	RP	Surface Thickness (inches)	Base Thickness (inches)	Surface Width (feet)	Lanes	Lane Width (feet)	Shoulder Width (feet)
Highway 312	0.2-24.9	3.50-4.00	6.00-18.00	24.0-62.0	2-5	11.0-14.0	2.0-4.0
Secondary 568	0.0-1.0	2.0-4.0	13.0-14.0	24.0-32.0	2	12.0	0.0-4.0
Secondary 522	0.0-3.0	3.0-5.4	4.0-16.0	22.0-47.0	2	11.0-12.0	0.0-8.0

Source: MDT, 2013 Road Log, and DOWL, 2015.
Surface thickness was assumed for the full corridor based on information from recent turn lane reconstruction projects.

Horizontal Alignment

Horizontal alignment is a measure of the degree of turns and bends in the road, and includes consideration of horizontal curvature, superelevation, curve type, and entering and passing sight distance. The geometric design criteria utilized for the analysis of the horizontal alignment are found in *Chapter 9 – Horizontal Alignment* in the MDT RDM. The geometric design criteria are based upon the functional classification of the roadway.

Based on these criteria and a review of available data from MDT as-built drawings, it appears that four of the 13 horizontal curves within the corridor do not meet current MDT design criteria for curve radius, stopping sight distance, and/or curve length. Superelevation was not assessed

due to lack of available data. Attachment 3 provides horizontal alignment information for the study area including a pass/fail rating for each curve based on the best available data. It is MDT practice to use a spiral curve when the curve radius is less than 3,820 ft. Because curve type is not listed in the MDT RDM as a design requirement, curve type is not considered in the pass/fail determination listed in Attachment 3.

Vertical Alignment

Vertical alignment is a measure of the elevation change on a roadway, and includes consideration of grade, vertical curve length, vertical curve type (either a sag curve or a crest curve), and K-value. K-value is the horizontal distance needed to produce a one percent change in gradient and is directly correlated to the roadway design speed and stopping sight distance. Attachment 3 provides vertical alignment information for the study area including a pass/fail rating for each curve based on the best available data.

As-built information was unavailable on Highway 312 from approximately RP 2.3 to RP 3.25. DOWL surveyed the vertical alignment by mounting GPS devices on a vehicle and collecting a series of points while driving through this portion of the corridor. A vertical alignment was generated from the survey data and vertical curve data was analyzed on a best fit basis.

Available data indicates 11 of the 37 vertical curves analyzed within the study boundaries do not meet current MDT design criteria. The MDT design criteria utilized for the analysis of the vertical alignment is found in *Chapter 10 – Vertical Alignment* in the RDM. Design elements listed in Attachment 3 are approximated, and determinations are based on the best available data.

Passing Zones

Passing zones are periodically provided within the corridor in locations with sufficient passing sight distance. Passing sight distance is defined as the minimum sight distance required to safely complete a passing maneuver. For a design speed of 30 mph and 60 mph, the minimum passing sight distance for design is 1,090 feet and 2,135 feet and the rounded minimum K-values are 424 and 1,628. Passing opportunities are limited by the frequency of oncoming vehicles (opposing flow rate), including large vehicles.

The percent of the corridor striped as no passing was assessed according to seven defined corridor segments, as listed below in Table 8.

Table 8 Percent of Segment Striped as No Passing

Segment Number	Segment Description & Location		No Passing (%)
1	Highway 312 at US 87 Intersection to Barry Drive (RP 2.1)	Highway 312 Northbound	100
		Highway 312 Southbound	100
2	Highway 312 at Barry Drive (RP 2.1) to Hoskins Road (RP 5.6)	Highway 312 Northbound	49
		Highway 312 Southbound	51
3	Highway 312 at Hoskins Road (RP 5.6) to Shepherd Road (RP 7.4)	Highway 312 Eastbound	67
		Highway 312 Westbound	71
4	Highway 312 at Shepherd Road (RP 7.4) to Secondary 522	Highway 312 Eastbound	58
		Highway 312 Westbound	55
5	Secondary 522 from I-94 Exit 6 WB (RP 0.0) to merge point with Highway 312 (RP 2.4)	Secondary 522 Northbound	100
		Secondary 522 Southbound	100
6	Secondary 522 Intersection (RP 10.4) to Highway 312 at Main Street (RP 17.4)	Highway 312 Northbound	25
		Highway 312 Southbound	27
7	Highway at Main Street (RP 17.4) to I-94 Exit 23 EB Ramp (RP 25.9)	Highway 312 Eastbound	37
		Highway 312 Westbound	36

Source: DOWL, 2015. No passing percentages approximated based on review of aerial photography.

Clear Zones

The MDT RDM specifies an offset distance from the edge of traveled way (ETW) to be free of any obstructions. The ETW is delineated by the white pavement marking located on the right-hand side of the travel lane. This offset distance, known as the “clear zone,” includes the roadway shoulder and is defined based on design speed, annual average daily traffic (AADT), horizontal curvature, the slope of cut / fill sections, and offsets from the ETW.

A cut section occurs when a roadway facility is located below natural ground elevation and excavation of earthen materials is required. Within cut sections, a roadside ditch is required by MDT for drainage. The dimensions of the ditch also provide a recovery area within the required clear zone for vehicles exiting the travel way. Cut slopes greater than a 3:1 are considered non-traversable and may warrant protection.

A fill section occurs when a roadway facility is located above the natural ground elevation and additional earthen material is required. Criteria outlined in the MDT RDM were used to analyze fill slopes and dimensions throughout the corridor. The slopes and dimensions within the clear zone provide a recovery area for vehicles exiting the traveled way. If the dimensions specified in the RDM cannot be achieved, a roadway barrier may be warranted.

Cut and fill slopes in the five-lane and three-lane sections appeared to meet current MDT design criteria; however, foreslopes and backslopes in the two-lane portions do not meet current criteria. Fill slopes throughout the two-lane sections are generally 4:1 and cut sections are 4:1 v-ditches. Mature trees, unprotected bridge rails, culvert ends, and parallel irrigation ditches were observed within the clear zone.

Guardrail location and condition within the corridor is noted in Table 9. Apart from a few dented locations, the majority of guardrail within the corridor appears to be in good condition. During the field review, it was determined that guardrail within the corridor is generally not compliant with current MDT design criteria for guardrail. There were several areas that were noted as lacking slope protection and with inadequate clear zone distance.

Table 9 Guardrail Condition

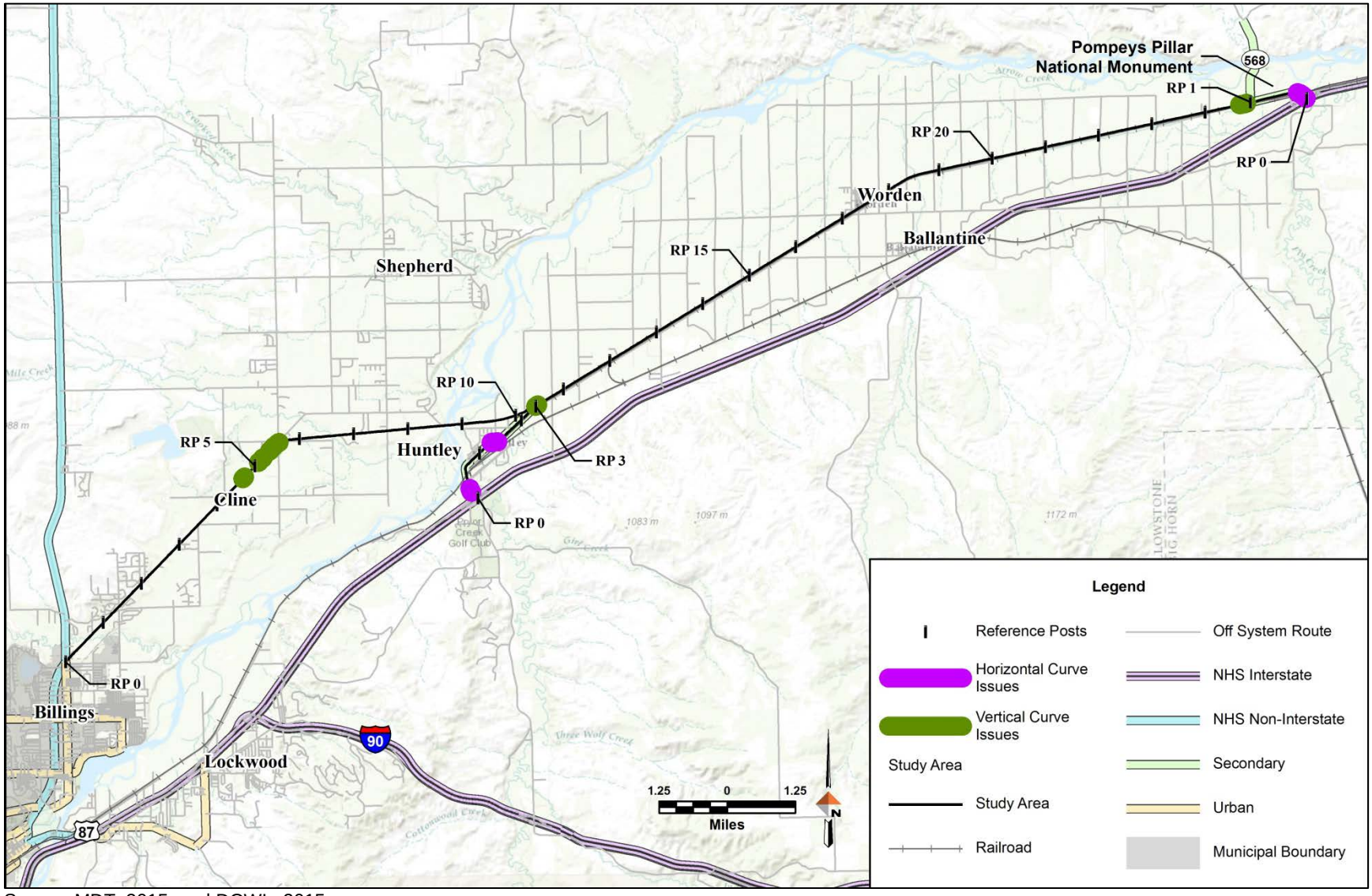
Location	Right/Left Side (RT/LT)	Beginning RP	Ending RP	Material of Guardrail Posts	Type of Guardrail	Obstruction	Guardrail Condition
Highway 312	RT	0.54	0.63	Wood + Steel	W-beam[2]	Bridge-Creek	Good
	LT	0.58	0.62[1]	Wood + Steel	W-beam[2]	Bridge-Creek	Good
	RT	0.97	1.03	Steel	W-beam	Steep Slopes	Good
	LT	1.33	1.41	Wood + Steel	W-beam[2]	Creek	Good
	RT	1.35[1]	1.40	Wood + Steel	W-beam[2]	Creek	Good
	RT	1.69[1]	1.81	Wood + Steel	W-beam	Steep Slopes	Good
	LT	1.70	1.80	Wood + Steel	W-beam	Steep Slopes	Dented
	RT	2.14	2.23	Wood + Steel	W-beam[2]	Steep Slopes	Good
	LT	2.19	2.28	Wood + Steel	W-beam[2]	Creek	Good
	LT	2.84	2.87	Steel	W-beam	Steep Slopes	Good
	RT	2.84	2.87	Steel	W-beam	Steep Slopes	Good
	LT	6.61	6.66	Steel	W-beam	Creek	Good
	RT	6.61	6.66	Steel	W-beam	Creek	Good
	LT	8.70	8.72	Wood + Steel	W-beam	Bridge-River	Good
	RT	8.70	8.71	Wood + Steel	W-beam	Bridge-River	Good
	LT	8.90	8.92	Wood + Steel	W-beam	Bridge-River	Good
	RT	8.90	8.91	Wood + Steel	W-beam	Bridge-River	Good
	LT	12.18	12.19	Custer Coulee Railing		Creek	N/A
	RT	12.18	12.19			Creek	N/A
	RT	18.50	18.57	Wood	W-beam	Steep Slopes	Good
	LT	18.52	18.59	Wood	W-beam	Steep Slopes	Good
Secondary 568	LT	0.50	25.62[1]	Wood	W-beam	Steep Slopes	Good
	RT	0.50	25.62[1]	Wood	W-beam	Steep Slopes	Good
	LT	0.63[1]	25.73	Steel	W-beam	Steep Slopes	Good
	RT	0.66	25.73	Steel	W-beam	Steep Slopes	Good
	LT	0.79	25.84	Steel	W-beam	Steep Slopes	Good
	RT	0.79	25.86[1]	Steel	W-beam	Steep Slopes	Dented
	RT	0.87[1]	25.89	Steel	W-beam	Steep Slopes	Good
	LT	0.89[1]	25.92	Steel	W-beam	Steep Slopes	Good
Secondary 522	RT	0.20	0.26	Steel	Box-beam	Creek	Good
	LT	0.23	0.30	Steel	Box-beam	Creek	Good
	RT	0.35[1]	0.38	Wood	W-beam	Creek	Good
	LT	0.36	0.38[1]	Wood	W-beam	Creek	Dented
	RT	0.45	0.47	Wood	W-beam	Steep Slopes	Good
	LT	0.48	0.68	Wood	W-beam	Steep Slopes	Dented

Source: DOWL, 2015. [1] Indicates guardrail wraps around an approach. [2] Concrete barrier present.

Summary of Geometric Issues

Figure 4 presents the location of existing horizontal and vertical curve issues within the corridor.

Figure 4 Geometric Issues



Source: MDT, 2015, and DOWL, 2015.

3.3 Crash History

MDT provided crash data for Highway 312, Secondary 568, and Secondary 522 within the study area for the ten-year period from January 1, 2005, to December 31, 2014. During the ten-year analysis period, a total of 577 crashes occurred on Highway 312, Secondary 568, Secondary 522, and minor approach roads to the study area. As a result of the crashes in the corridor, a total of 328 injuries and 6 fatalities occurred during the analysis period. Crash data extraction limits are provided in Attachment 4.

Table 10 presents the number and percentage of crashes, injuries, (including incapacitating, non-incapacitating, and possible injuries), and fatalities attributed to collisions types during the ten-year analysis period on Highway 312, Secondary 522, and Secondary 568 within the study area.

Table 10 Crash Collision Type

Collision Type	Number of Crashes	Percent of Total Crashes	Number of Injuries	Percent of Total Injuries	Number of Fatalities	Percent of Total Fatalities
Backing Vehicle	2	0.3%	0	0.0%	0	0.0%
Domestic Animal	6	1.0%	2	0.6%	0	0.0%
Fell/ Jumped from Motor Vehicle	1	0.2%	1	0.3%	0	0.0%
Fire/ Explosion	1	0.2%	0	0.0%	0	0.0%
Fixed Object	118	20.5%	48	14.6%	1	16.7%
Head On	8	1.4%	15	4.6%	0	0.0%
Jackknife	3	0.5%	0	0.0%	0	0.0%
Left Turn, Opposite Direction	5	0.9%	2	0.6%	0	0.0%
Left Turn, Same Direction	6	1.0%	3	0.9%	0	0.0%
Lost Control	9	1.6%	1	0.3%	0	0.0%
Not Fixed Object or Debris	9	1.6%	2	0.6%	0	0.0%
Other	4	0.7%	2	0.6%	0	0.0%
Parked Vehicle	2	0.3%	0	0.0%	0	0.0%
Pedestrian	3	0.5%	3	0.9%	0	0.0%
Rear To Front	1	0.2%	0	0.0%	0	0.0%
Rear-End	124	21.5%	79	24.1%	1	16.7%
Right Angle	98	17.0%	84	25.6%	2	33.3%
Right Turn, Opposite Direction	2	0.3%	1	0.3%	0	0.0%
Right Turn, Same Direction	1	0.2%	0	0.0%	0	0.0%
Roll Over	93	16.1%	59	18.0%	1	16.7%
Sideswipe, Opposite Direction	20	3.5%	14	4.3%	0	0.0%
Sideswipe, Same Direction	16	2.8%	7	2.1%	0	0.0%
Unknown	1	0.2%	0	0.0%	0	0.0%
Wild Animal	44	7.6%	5	1.5%	1	16.7%
Total	577	100.0%	328	100.0%	6	100.0%

Source: MDT, 2015. Data provided from 1/1/2005 to 12/31/2014. Shaded cells indicate most common crash types.

Rear-end, fixed-object, right angle, roll over, and wild animal crashes were the most common crash types with 477 (83 percent) combined crashes, 275 (84 percent) combined injuries, and 6 (100 percent) combined fatalities.

Behavioral Crash Characteristics

Table 11 summarizes the restraint types used by people involved in crashes during the analysis period within the study area. The data summarized in Table 11 excludes 230 people without an identified restraint type, unknown restraint type, or not applicable restraint type. Of the remaining 1,089 people involved in crashes within the study area, 918 (84 percent) used a shoulder and lap belt restraint, 109 (10 percent) did not use any type of restraint, and the remaining 62 (6 percent) used some other type of restraint.

Table 11 Crash Restriant Type

Restraint Type Used	People Involved in Crashes	Percent of Total People
Booster Seat	4	0.4%
Child Restraint System - Forward Facing	21	1.9%
Child Restraint System - Rear Facing	4	0.4%
Child Restraint System - Type Unknown	13	1.2%
Lap Belt Used Only	11	1.0%
None Used - Motor Vehicle Occupant	109	10.0%
Other	3	0.3%
Restraint Used - Type Unknown	1	0.1%
Shoulder and Lap Belt Used	918	84.3%
Shoulder Belt Used Only	5	0.5%
Total	1,089	100.0%

Source: MDT, 2015. Data provided from 1/1/2005 to 12/31/2014.

Table 12 summarizes the types of behavioral characteristics among people involved in crashes during the analysis period within the study area. The data excludes 489 people without an identified condition type or unknown condition type. Of the remaining 745 people involved in crashes within the study area, 657 (88 percent) were identified as apparently normal; 68 (9 percent) were under the influence of medication, drugs, or alcohol; and the remaining 20 (3 percent) had some other type of condition.

Table 12 Crash Condition Type

Condition at Time of Crash	People Involved in Crashes	Percent of Total People
Apparently Normal	657	88.2%
Asleep or Fatigued	9	1.2%
Emotional (Depression, Angry, Disturbed, etc.)	5	0.7%
Ill (Sick) or Fainted	1	0.1%
Other	3	0.4%
Physically Impaired	2	0.3%
Under the Influence of Medications, Drugs, Alcohol	68	9.1%
Total	745	100.0%

Source: MDT, 2015. Data provided from 1/1/2005 to 12/31/2014.

Weather, Road, and Light Conditions

Table 13 presents the number and percentage of crashes, injuries and fatalities attributed to weather, road, and light conditions within the corridor during the ten-year analysis period.

Table 13 Crash Weather, Road, and Light Conditions

Attribute		Number of Crashes	Percent of Total Crashes	Number of Injuries	Percent of Total Injuries	Number of Fatalities	Percent of Total Fatalities
Weather Condition	Blowing Snow	5	0.9%	2	0.6%	0	0.0%
	Clear	317	54.9%	194	59.1%	2	33.3%
	Cloudy	200	34.7%	91	27.7%	4	66.7%
	Fog, Smog, Smoke	3	0.5%	3	0.9%	0	0.0%
	Rain	15	2.6%	15	4.6%	0	0.0%
	Severe Crosswinds	1	0.2%	0	0.0%	0	0.0%
	Sleet, Hail, Freezing Rain, Drizzle	5	0.9%	6	1.8%	0	0.0%
	Snow	29	5.0%	15	4.6%	0	0.0%
	Unknown	2	0.3%	2	0.6%	0	0.0%
	Total	577	100.0%	328	100.0%	6	100.0%
Road Condition	Dry	442	76.6%	251	76.5%	5	83.3%
	Ice, Frost	45	7.8%	21	6.4%	1	16.7%
	Mud, Dirt, Gravel	5	0.9%	2	0.6%	0	0.0%
	Other	1	0.2%	2	0.6%	0	0.0%
	Snow	38	6.6%	16	4.9%	0	0.0%
	Wet	46	8.0%	36	11.0%	0	0.0%
	Total	577	100.0%	328	100.0%	6	100.0%
Light Condition	Dark - Lighted	24	4.2%	5	1.5%	0	0.0%
	Dark - Not Lighted	149	25.8%	70	21.3%	3	50.0%
	Dark - Unknown Lighting	1	0.2%	0	0.0%	0	0.0%
	Dawn	16	2.8%	19	5.8%	0	0.0%
	Daylight	375	65.0%	226	68.9%	3	50.0%
	Dusk	11	1.9%	7	2.1%	0	0.0%
	Unknown	1	0.2%	1	0.3%	0	0.0%
	Total	577	100.0%	328	100.0%	6	100.0%

Source: MDT, 2015. Data provided from 1/1/2005 to 12/31/2014. Shaded cells indicate most common conditions.

The majority of crashes, injuries, and fatalities occurred during clear or cloudy weather conditions, dry road conditions, and daylight light conditions. Excluding the 181 crashes without an identified contributing factor, 80 crashes out of the remaining 396 were identified as weather or road condition related.

Animal/Vehicle Conflicts

Wild animals were involved in 44 of 577 (8 percent) reported crashes. Reported crashes involving wild animals were concentrated along the western portion of the corridor from Billings to Huntley, with 38 out of 44 crashes (86 percent) occurring between RP 0 to RP 10.0 (Highway 312) and RP 0 to 3 (Secondary 522).

MDT provided carcass data for Highway 312, Secondary 568, and Secondary 522 within the study area for the ten-year period from January 1, 2005, to December 31, 2014. A review of the data indicates nine whitetail deer and four mule deer carcasses were collected within the study area. Carcass collections were concentrated between RP 21 and 24.5 on Highway 312. Carcass data may not accurately reflect animal-vehicle conflicts throughout the corridor, and not all carcasses result from vehicle collisions.

Level of Service of Safety

MDT conducted an analysis to assess the magnitude of safety problems within the Highway 312, Secondary 568, and Secondary 522 corridor through the use of safety performance functions (SPFs). An SPF reflects the relationship between traffic exposure measured in AADT and crashes per mile per year. SPF models provide an estimate of the normal expected crash frequency and severity for a range of AADT among similar facilities. MDT uses separate SPF models to assess crash frequency (i.e., the total number of crashes) and crash severity (i.e., only crashes involving an injury or fatality).

Information from the SPF models is used to assess the level of service of safety (LOSS) within a corridor. LOSS categories listed in Table 14 represent the degree of deviation from the normal expected crash frequency and severity for a range of AADT, and the associated potential for crash reduction.

Table 14 Level of Service of Safety

Level of Service of Safety	Potential for Crash Reduction
LOSS I	Low potential for crash reduction
LOSS II	Low to moderate potential for crash reduction
LOSS III	Moderate to high potential for crash reduction
LOSS IV	High potential for crash reduction

Source: MDT, 2015.

Figure 5 presents total crash LOSS, which indicates deviations from the normal expected crash frequency. Figure 6 presents crash severity LOSS, which indicates deviations from the normal expected crash severity. Portions of the corridor identified as LOSS IV represent the highest deviation from normal expected conditions, and the highest potential for crash reduction. Areas identified as LOSS IV for both total crashes and severe crashes occur near RP 4, 6, 9, 12, and 15 along Highway 312, RP 0.5 along Secondary 568, and RP 0, 1, and 2 along Secondary 522. Attachment 5 provides tables listing beginning RPs for LOSS categories within the corridor.

If a safety problem is identified within a corridor, the LOSS concept will describe its magnitude in terms of frequency and severity. The nature of the safety problem may be determined, in part, through pattern recognition techniques. MDT conducted an analysis of the Highway 312,

Secondary 522, and Secondary 568 corridors to identify abnormal crash patterns compared to normative patterns generally correlating to a range of AADT volumes on Montana highways. Abnormal patterns indicate a higher crash type frequency compared to normal expected crash frequency.

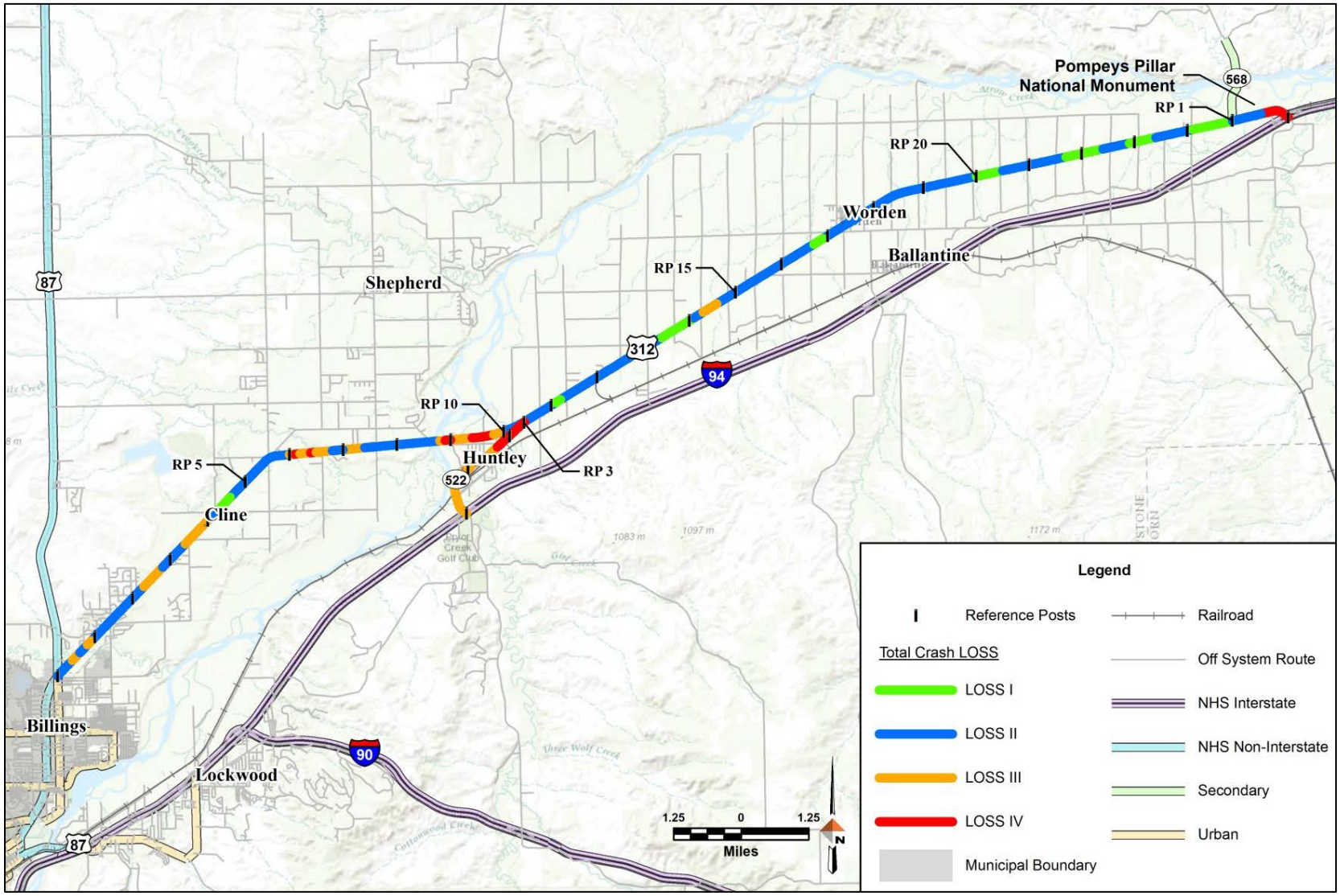
Table 15 identifies the abnormal crash pattern types occurring within the study area. Abnormal crash patterns are classified as having a minimum number of five crashes and a cumulative probability of 95% or greater. The cumulative probability indicator is the probability of observing the actual or fewer numbers of crashes listed in Table 15. A high cumulative probability indicates a highly abnormal number of crashes compared to other routes with similar characteristics.

Table 15 Crash Patterns

Route	RPs	Crash Pattern	Actual Number of Crashes	Cumulative Probability
Highway 312 & Secondary 568	RP 0 to 2.2	Single Vehicle	33	99.393%
		Off Road Right	11	99.999%
		Overturning	7	95.848%
		Guard Rail	9	100.000%
		Total Fixed Objects	12	99.958%
		No Adverse Weather	36	95.950%
		Dry Road	31	97.835%
		No Apparent Contributing Factor	39	100.000%
	RP 2.2 to 24.9 (Highway 312) RP 1 to 0 (Secondary 568)	Injury	60	99.980%
		Two Vehicles	42	98.417%
		Off Road Left	23	99.886%
		Off Road Right	41	99.999%
		Overturning	41	99.970%
		Broadside	8	97.600%
		Rear End	25	99.812%
		Other Fixed Object	8	99.969%
		Unknown Crash Type	7	99.877%
		Daylight	96	99.861%
		Dry Road	117	95.826%
		No Apparent Contributing Factor	141	100.000%
		Alcohol Involved	20	95.912%
Secondary 522	RP 0 to 3	Two Vehicles	11	95.469%
		Off Road Left	7	99.404%
		Off Road Right	11	99.742%
		Overturning	13	99.922%
		No Adverse Weather	34	97.496%
		No Apparent Contributing Factor	26	100.000%
		Alcohol Involved	10	99.977%

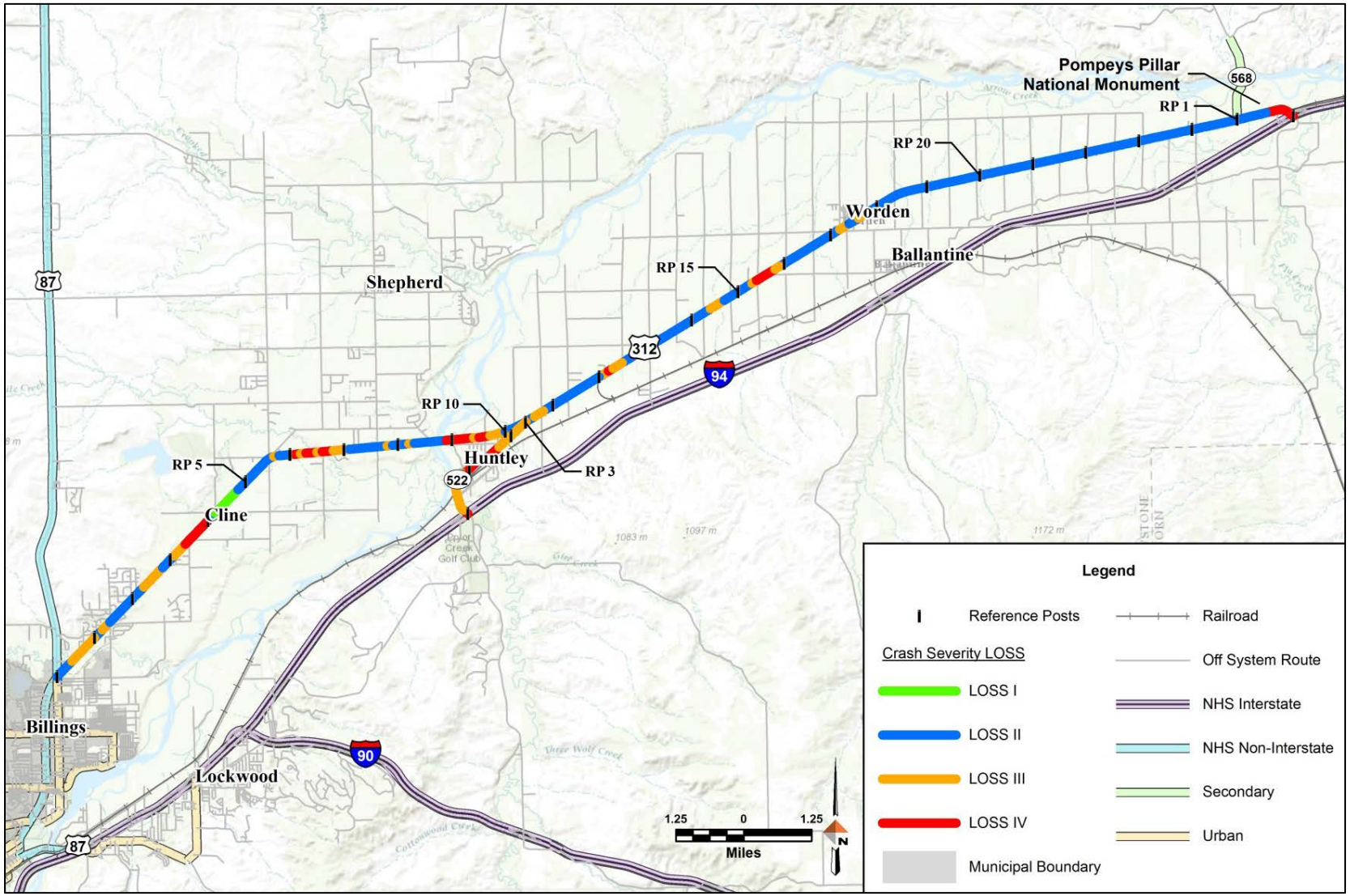
Source: MDT, 2015.

Figure 5 Total Crash LOSS



Source: MDT, 2015, and DOWL, 2015.

Figure 6 Crash Severity LOSS



Source: MDT, 2015, and DOWL, 2015.

3.4 Traffic Volumes and Operations

Historic AADT Volumes

Historic AADT was obtained from MDT at short-term traffic count sites for each of the seven corridor segments within the study corridor. Five years of historic AADT volumes from 2010 to 2014 were available at the majority of traffic count sites, as presented in Table 16.

Table 16 Historic AADT

Year	Traffic Count Site Number (Study Segment)								
	56-4A-282 (1)	56-2-15 (2)	56-2-7 (4)	56-2-16 (4)	56-2-5 (5)	56-2-6 (5)	56-2-14 (6)	56-3-30 (7)	56-3-9 (7)
2010	11070	-	4440	-	4310	1710	2730	-	480
2011	11030	-	4420	-	4360	1790	2760	-	490
2012	11370	7130	4160	1730	4010	1760	3140	-	440
2013	10750	6740	3930	1640	4170	1550	3270	-	750
2014	11600	7700	4820	1930	4180	1560	3110	730	480

Source: MDT 2015.

2015 Existing Year Traffic Volumes

MDT collected traffic data for study segments and intersections in June and July, 2015. MDT seasonal adjustment factors were applied to the 2015 counts to provide a better representation of traffic conditions on an average day. MDT reports statewide seasonal adjustment factors based on facility classification, month, and day of week. The seasonal adjustment factors shown in Table 17 were applied to p.m. peak-hour traffic volumes for the segment and intersection analysis.

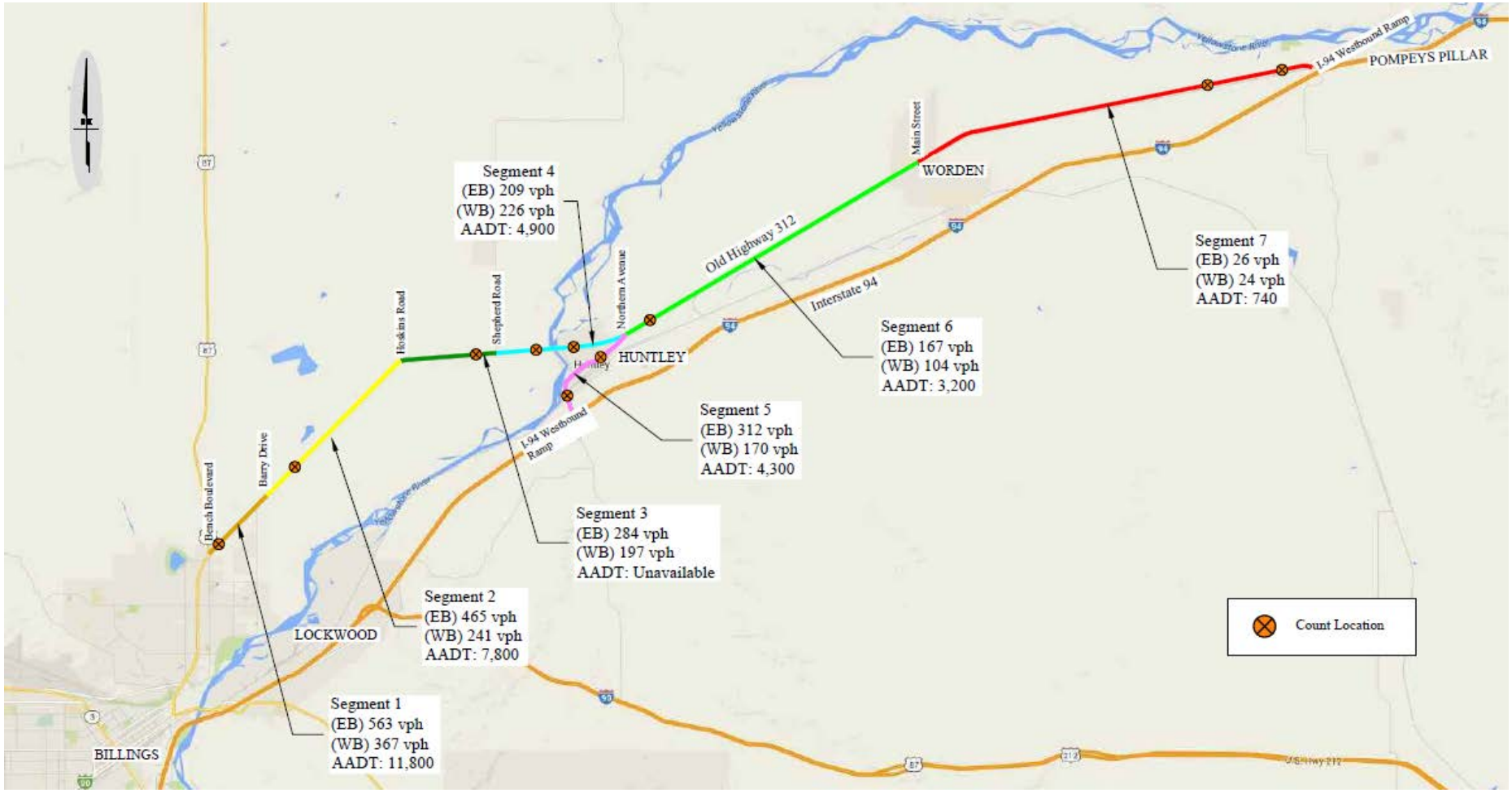
Table 17 2015 Seasonal Adjustment Factors

Segment Number	Intersection Number	Roadway Classification	June Weekday Adjustment Factor	July Weekday Adjustment Factor
1	1	Rural Minor Arterial	0.87	-
-	2	Rural Major Collector	-	0.87
2, 3, 4, 6, & 7	3, 4, 8, 9, 10, 11, & 12	Rural Major Collector	0.91	-
5	5, 6, & 7	Urban Major Collector	0.99	-

Source: MDT 2015. (http://www.mdt.mt.gov/other/traffcount/external/seasonal_axle/AXLE_FACTORS_2015.PDF)

Each corridor segment included at least one traffic count site where directional traffic volumes were collected. Segments 4, 5, and 7 included two traffic count sites; the site with higher traffic volumes was used for the segment analysis. Each traffic count covered at least one 24-hour period. Based on this data, peak-hour directional traffic volumes were calculated for each segment. Figure 7 shows the study segments, traffic count site locations, 2015 peak-hour directional traffic volumes (from 2015 counts), and 2015 AADT (which was forecasted from 2014 AADT by applying a growth factor).

Figure 7 2015 Existing Year Peak Hour Directional Volumes



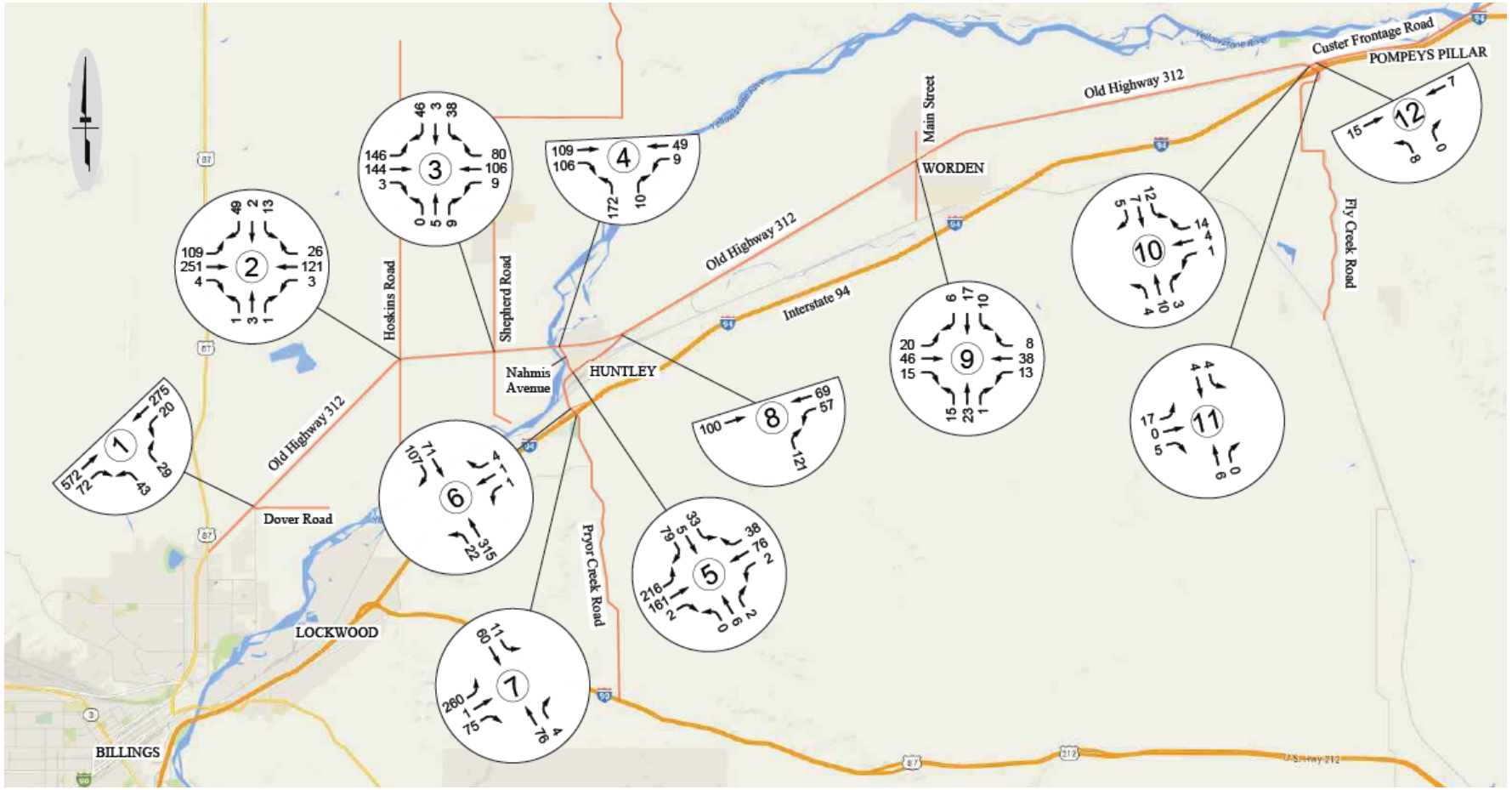
Source: MDT, 2015, and DOWL, 2015.

Peak-hour turning movement volumes were used for the intersection analysis. Turning movement counts were collected at the following 12 intersections:

1. Highway 312 and Dover Road (counted on 6/22/2015),
2. Highway 312 and Hoskins Road (counted on 7/16/2015),
3. Highway 312 and Shepherd Road/Vermillion Road (counted on 6/22/2015),
4. Highway 312 and Nahmis Avenue (counted on 6/22/2015),
5. Secondary 522 and Nahmis Avenue (counted on 6/22/2015),
6. Secondary 522 and I-94 WB Ramp (counted on 6/23/2015),
7. Secondary 522 and I-94 EB Ramp (counted on 6/23/2015),
8. Highway 312 and Northern Avenue (counted on 6/22/2015),
9. Highway 312 and Main Street/S 15th Road (counted on 6/22/2015),
10. Highway 312 and I-94 WB Ramp (counted on 6/23/2015),
11. Highway 312 and I-94 EB Ramp (counted on 6/23/2015), and
12. I-94 WB Ramp and Custer Frontage Road (counted on 6/23/2015).

Turning movement counts at each intersection covered at least one 24-hour period. Based on this data, a peak hour with the highest consecutive 15-minute volumes was determined for each intersection. Since these study intersections are widely spread out with many access points in between, each study intersection used its own peak-hour volumes for analysis. All peak hours were during the afternoon, within the range from 2:00 p.m. to 6:15 p.m. Figure 8 shows the peak-hour turning movement volumes at the study intersections.

Figure 8 2015 Existing Year Peak Hour Turning Movement Volumes



Source: MDT, 2015, and DOWL, 2015.

2015 Existing Year Traffic Capacity

Segment Analysis

Based on the 2015 peak-hour volumes, the existing traffic capacities for study segments were determined using Highway Capacity Software 2010, following the methodologies specified in the current *Highway Capacity Manual 2010* (HCM). Procedures outlined in Chapter 14 of the HCM 2010 were used to analyze the four-lane road segment, and the procedures outlined in Chapter 15 were used to analyze the two-lane road segment.

Density of access points along the road is a required input for the segment analysis. Access points include intersecting roads and driveways. The access points for each segment were manually counted from an aerial map. Table 18 shows the access point density for each analysis segment.

Table 18 Access Point Density

Segment Number	Segment Length (miles)	Number of Access Points	Access Points per Mile
1	2.12	28	13
2	3.49	45	13
3	2.00	34	17
4	2.78	33	12
5	2.32	34	15
6	6.97	36	5
7	8.51	46	5

Source: DOWL 2015.

The operational effectiveness of the roadway is generally described in terms of level of service (LOS). LOS describes the quality of traffic operations and is graded from A to F, with LOS A representing free-flow conditions and LOS F representing heavily-congested conditions. MDT targets LOS C in the design year. For multilane highway segments, LOS is defined on the basis of density, which is a measure of the proximity of vehicles to each other in the traffic stream. For Class I two-lane highway segments where motorists expect to travel at relatively high speeds, LOS is defined on the basis of Average Travel Speed (ATS) and Percent Time Spent Following (PTSF). For Class III two-lane highway segments that serve moderately developed areas, LOS is defined on the basis of Percent of Free-Flow Speed (PFFS), the vehicles' ability to travel at or near the posted speed limit. Additional information is provided in Attachment 6.

Table 19, Table 20, and Table 21 show the 2015 existing year LOS for each study segment. Additional information is provided in Attachment 6.

Table 19 2015 Peak Hour Segment Traffic Conditions, Multilane Highway

Segment	Direction	Free-Flow Speed, FFS (mph)	Density (pc/mi/ln)	LOS
1	Eastbound	46.8	6.9	A
	Westbound	46.8	4.3	A

Source: DOWL, 2015.

Table 20 2015 Peak Hour Segment Traffic Conditions, Class I Two-Lane Highway

Segment	Direction	ATS (mph)	Percent Time Spent Following	LOS
2	Eastbound	44.5	68.8%	D
	Westbound	45.2	43.9%	C
3	Eastbound	44.5	63.3%	D
	Westbound	44.6	48.0%	D
4	Eastbound	46.5	49.9%	C
	Westbound	46.9	52.8%	C
6	Eastbound	51.4	41.5%	B
	Westbound	50.5	27.2%	B
7	Eastbound	53.0	25.1%	B
	Westbound	53.1	23.0%	B

Source: DOWL, 2015. Highlighted cells indicate segments operating below target LOS.

Table 21 2015 Peak Hour Segment Traffic Conditions, Class III Two-Lane Highway

Segment	Direction	PFFS	LOS
5	Eastbound	83.9%	B
	Westbound	84.1%	B

Source: DOWL, 2015.

As shown in the tables above, segment 2 and segment 3 operate at LOS D in 2015. All other study segments operate at LOS C or better.

Intersection Analysis

Based on peak-hour volumes, the existing traffic capacities for the study intersections were determined using Synchro Studio 8 software, following the methodologies specified in the current HCM. All of the study intersections are stop controlled, with the major road having free movement. Procedures outlined in Chapter 19 of the HCM 2010 were used to analyze intersection performance at stop-controlled intersections. The HCM intersection operation analysis has two key components: worst approach delay and volume-to-capacity (v/c) ratio. These characteristics are used to define LOS. MDT targets LOS C in the design year. Table 22 shows the worst approach, delay, and LOS at the study intersections in 2015.

Table 22 2015 Peak Hour Intersection Delay and LOS

Intersection		Worst Approach	Delay (s)	LOS
1	Highway 312 and Dover Road	NB	19.6	C
2	Highway 312 and Hoskins Road	NB	14.2	B
3	Highway 312 and Shepherd Road/Vermillion Road	SB	14.9	B
4	Highway 312 and Nahmis Avenue	NB	11.6	B
5	Secondary 522 and Nahmis Avenue	NB	17.1	C
6	Secondary 522 and I-94 WB Ramp	WB	11.5	B
7	Secondary 522 and I-94 EB Ramp	EB	13.3	B
8	Highway 312 and Northern Avenue	NB	9.4	A
9	Highway 312 and Main Street/S 15th Road	NB	10.1	B
10	Highway 312 and I-94 WB Ramp	SB	8.7	A
11	Highway 312 and I-94 EB Ramp	EB	8.7	A
12	I-94 WB Ramp and Custer Frontage Road	NB	8.6	A

Source: DOWL, 2015.

As shown in Table 22, all study intersections are operating at an acceptable level in 2015.

2035 Forecasts – Without Billings Bypass Project

Growth Rate

Annual growth rates (AGRs) were determined based on historic AADT as shown in Table 16. An AGR for each count location was determined by plotting the historic AADT on a chart, and placing an exponential best-fit trend line through those points. Table 23 shows the historical AGR at each traffic count location.

Table 23 Annual Growth Rates

Traffic Count Site Number (Study Segment)	56-4A-282	56-2-15	56-2-7	56-2-16	56-2-5	56-2-6	56-2-14	56-3-30	56-3-9
	(1)	(2)	(3)	(4)	(5)	(5)	(6)	(7)	(7)
Growth Rate	0.7%	3.9%	0.5%	5.5%	-1.1%	-3.3%	4.3%	N/A	4.3%

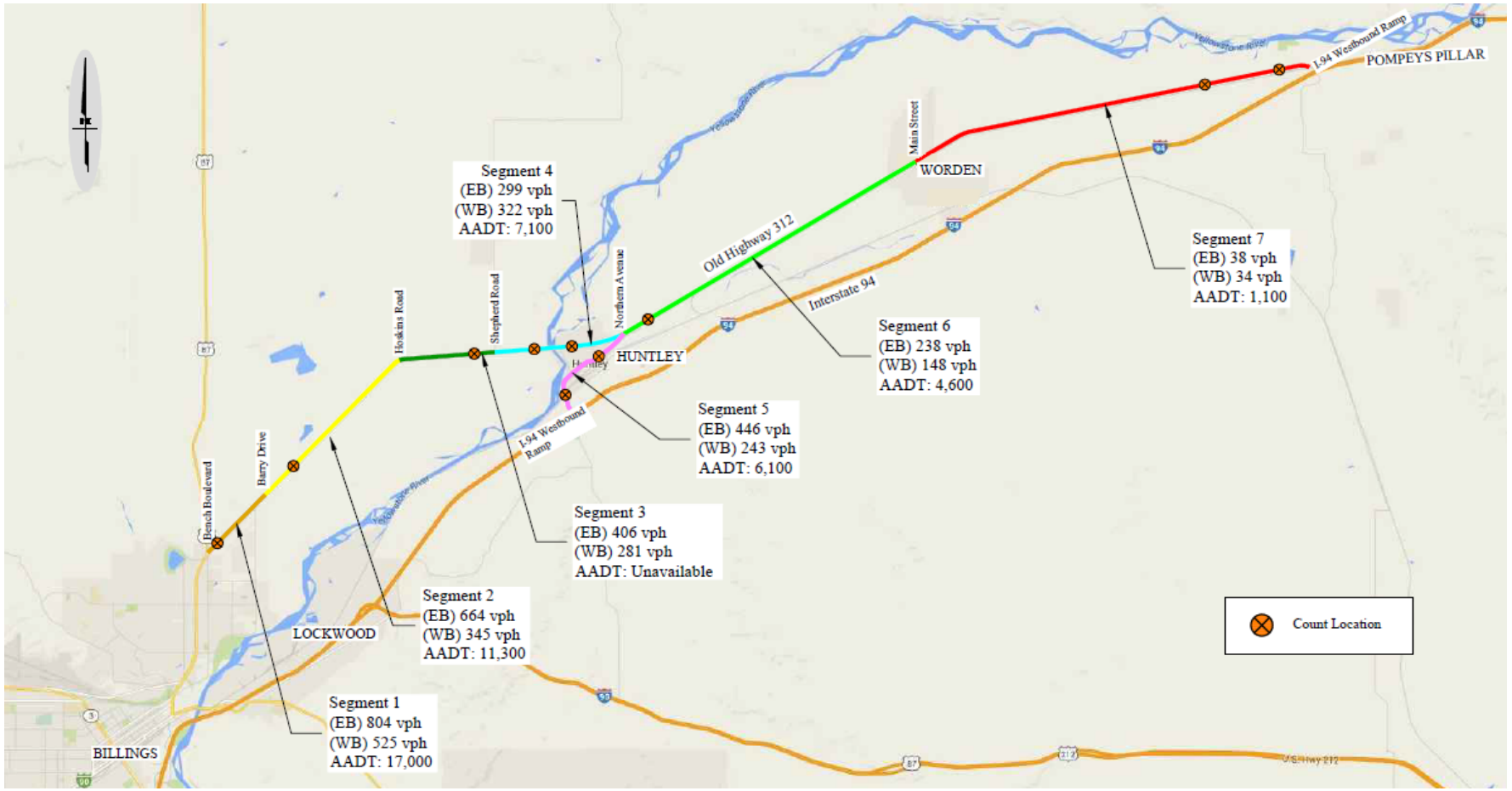
Source: DOWL, 2015.

Based on these growth rates, an average growth rate of 1.8% was determined as the growth rate for this study.

2035 Future Year Traffic Volumes

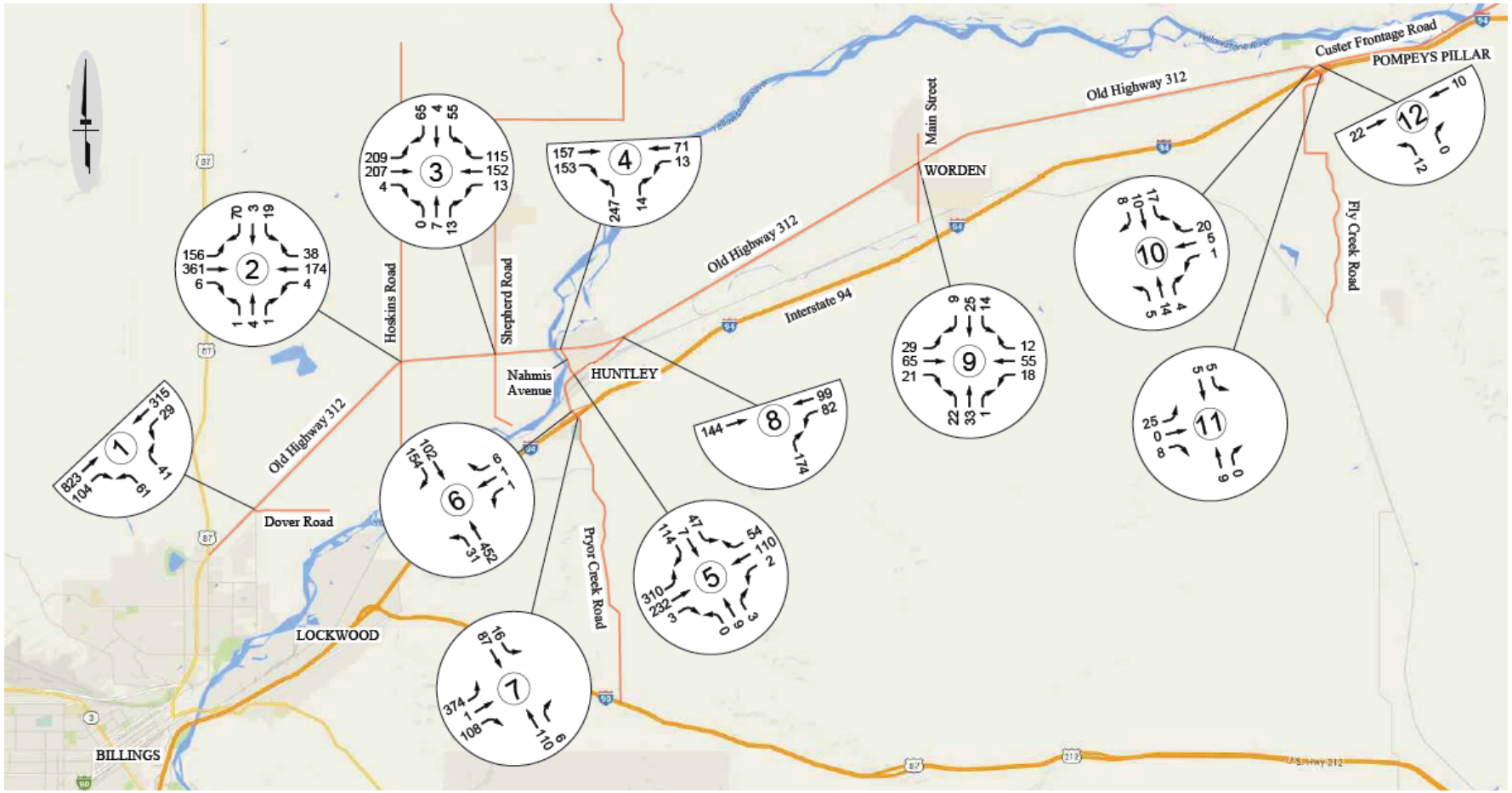
Future year traffic volumes were calculated by projecting existing year volumes using the 1.8% AGR. Figure 9 shows the 2035 peak-hour directional traffic volumes and AADT, and Figure 10 shows the 2035 peak-hour turning movement volumes.

Figure 9 2035 Peak Hour Directional Volumes



Source: MDT, 2015, and DOWL, 2015.

Figure 10 2035 Peak Hour Turning Movement Volumes



Source: MDT, 2015, and DOWL, 2015.

Segment Analysis

Based on the 2035 peak-hour volumes, the future traffic capacities for the study segments were determined using the same HCM methodologies as used for existing year analysis. This future year analysis assumed no-build conditions in the project corridor, therefore the input parameters such as access point density and percent no-passing zones are identical to those used in the existing year analysis. Table 24, Table 25, and Table 26 show the 2035 peak-hour LOS at the study segments.

Table 24 2035 Peak Hour Segment Traffic Conditions, Multilane Highway

Segment	Direction	Free-Flow Speed, FFS (mph)	Density (pc/mi/ln)	LOS
1	Eastbound	46.8	9.9	A
	Westbound	46.8	6.2	A

Source: DOWL, 2015.

Table 25 2035 Peak Hour Segment Traffic Conditions, Class I Two-Lane Highway

Segment	Direction	ATS (mph)	Percent Time Spent Following	LOS
2	Eastbound	42.4	76.9%	D
	Westbound	43.4	53.3%	D
3	Eastbound	42.9	68.3%	D
	Westbound	43.5	54.1%	D
4	Eastbound	45.4	57.3%	C
	Westbound	45.7	59.4%	C
6	Eastbound	49.9	50.1%	C
	Westbound	49.5	33.7%	C
7	Eastbound	52.8	27.3%	B
	Westbound	52.9	23.8%	B

Source: DOWL, 2015. Highlighted cells indicate segments operating below target LOS.

Table 26 2035 Peak Hour Segment Traffic Conditions, Class III Two-Lane Highway

Segment	Direction	PFFS	LOS
5	Eastbound	81.4%	C
	Westbound	83.8%	B

Source: DOWL, 2015.

As shown in the above tables, segment 2 and segment 3 are expected to operate at LOS D in 2035. All other study segments are expected to operate at LOS C or better.

Intersection Analysis

Based on the 2035 peak-hour volumes, future traffic capacities for the study intersections were determined using the same HCM methodologies as used for the existing year analysis. Table 27 shows the worst approach, delay, and LOS at the study intersections in 2035.

Table 27 2035 Peak Hour Intersection Delay and LOS

Intersection		Worst Approach	Delay (s)	LOS
1	Highway 312 and Dover Road	NB	43.2	E
2	Highway 312 and Hoskins Road	NB	19.5	C
3	Highway 312 and Shepherd Road/Vermillion Road	SB	27.8	D
4	Highway 312 and Nahmis Avenue	NB	14.9	B
5	Secondary 522 and Nahmis Avenue	NB	29.6	D
6	Secondary 522 and I-94 WB Ramp	WB	13.6	B
7	Secondary 522 and I-94 EB Ramp	EB	23.8	C
8	Highway 312 and Northern Avenue	NB	10.1	B
9	Highway 312 and Main Street/S 15th Road	NB	11.2	B
10	Highway 312 and I-94 WB Ramp	SB	8.7	A
11	Highway 312 and I-94 EB Ramp	EB	8.8	A
12	I-94 WB Ramp and Custer Frontage Road	NB	8.7	A

Source: DOWL, 2015. Highlighted cells indicate intersections operating below target LOS.

As shown in Table 27, study intersections 1, 3, and 5 are expected to operate at LOS D or worse in 2035. All other study intersections are expected to operate at LOS C or better.

2035 Forecasts – With Billings Bypass Project

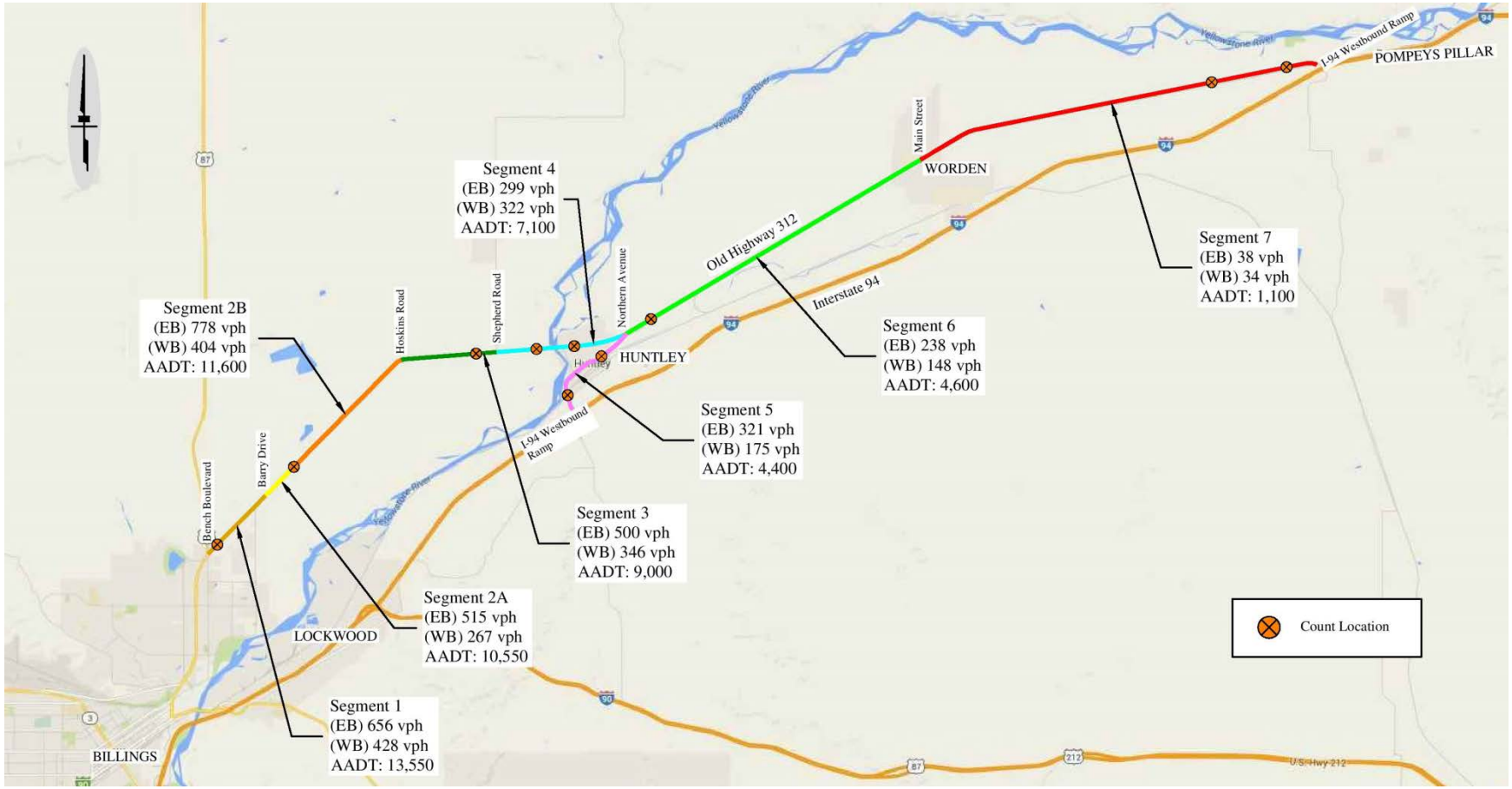
2035 Traffic Volumes

The forecasted traffic from the August 2013 Billings Bypass FEIS was referenced to adjust the forecasted traffic volumes and account for expected changes in traffic patterns resulting from the Billings Bypass project. The FEIS provides 2035 no build and full buildout traffic volume forecasts for Old Highway 312 from US 87 to just east of the proposed Five Mile Road intersection (which are provided in Attachment 7). It was assumed that drivers in the Shepherd area that currently route through Huntley and along Secondary 522 to reach I-94 west towards Billings will instead access the Billings Bypass via the Five Mile Road extension that will connect with Old Highway 312. Based on the Billings Bypass FEIS, 2035 ADT volumes east of Five Mile Road are assumed to increase by 1,700 vehicles per day (vpd) when the Billings Bypass is constructed. Since the 1,700 vpd are assumed to originate from the Shepherd area, traffic from Shepherd Road to I-94 west via Nahmis Road is expected to decrease by the same amount when the Billings Bypass is constructed.

The percent change in ADT between the no-build and build scenarios in the FEIS was multiplied by the 2035 forecasted traffic volumes shown in Figure 9 and Figure 10, based on location, to estimate forecasted 2035 traffic volumes for the Billings Bypass project scenario for this study.

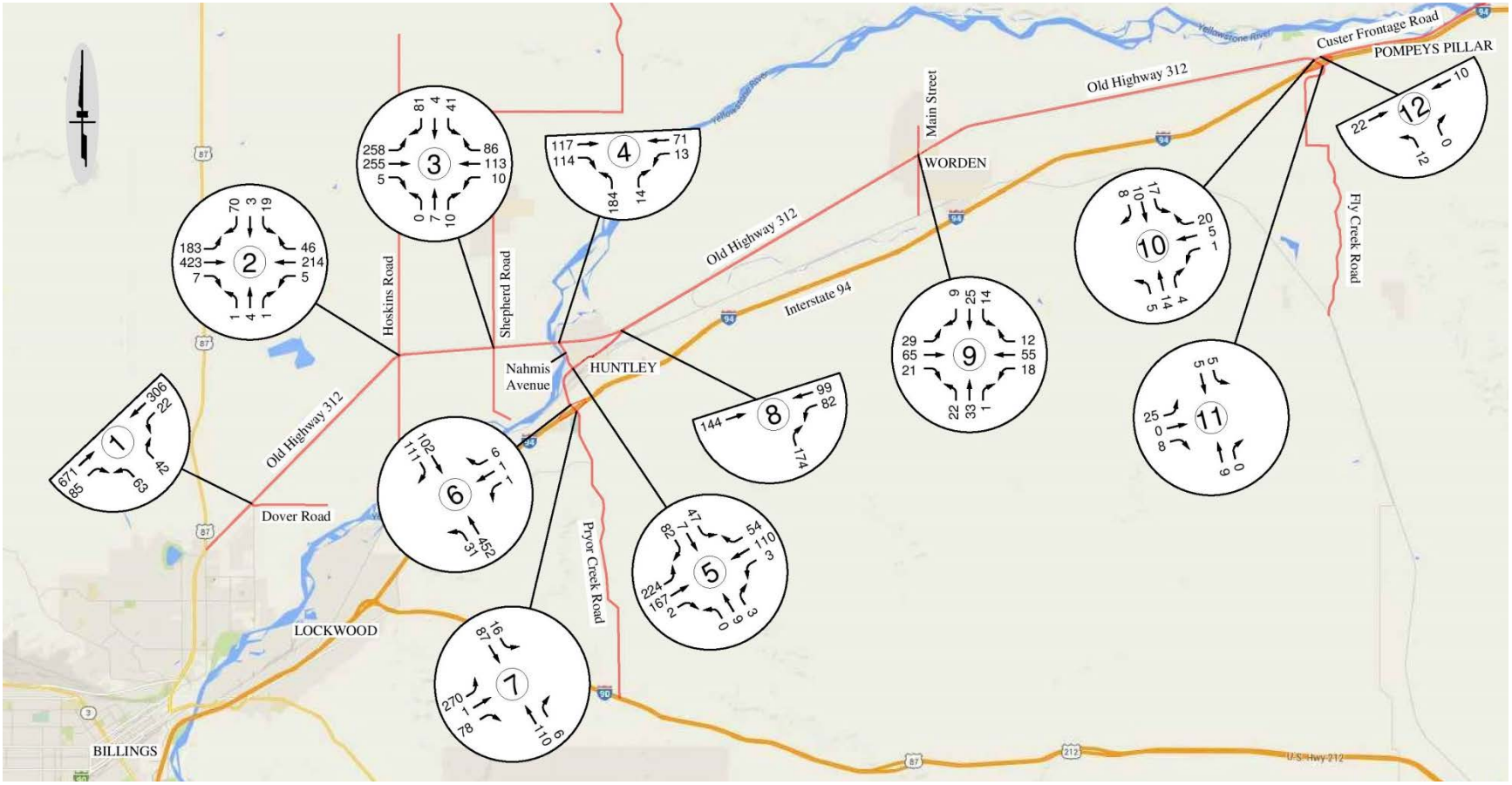
Roadway segments 4, 6, 7, and study intersections 8 through 12 were assumed to be unaffected by Billings Bypass. Figure 11 shows the expected 2035 peak-hour directional traffic volumes and AADT with the Billings Bypass, and Figure 12 shows the expected 2035 peak-hour turning movement volumes with the Billings Bypass. For the purpose of this analysis, roadway segment 2 was split at the new Five Mile Road intersection that will be constructed with the Billings Bypass project. As a result of the Billings Bypass project, traffic volumes are expected to decrease on roadway segments 1, 2A, 5, and study intersections 1, 4, 5, 6, and 7, and increase on roadway segments 2B, 3, and study intersections 2 and 3.

Figure 11 2035 Peak Hour Directional Volumes with Billings Bypass



Source: MDT, 2015, and DOWL, 2015.

Figure 12 2035 Peak Hour Turning Movement Volumes with Billings Bypass



Source: MDT, 2015, and DOWL, 2015.

Segment Analysis

Table 28, Table 29, and Table 30 show the LOS at the study segments during the 2035 peak-hour period with the Billings Bypass project.

Table 28 2035 Multilane Highway Traffic Conditions with Billings Bypass

Segment	Direction	Free-Flow Speed, FFS (mph)	Density (pc/mi/ln)	LOS
1	Eastbound	46.8	8.0	A
	Westbound	46.8	5.0	A

Source: DOWL, 2015.

Table 29 2035 Class I Two-Lane Highway Traffic Conditions with Billings Bypass

Segment	Direction	ATS (mph)	Percent Time Spent Following	LOS
2A	Eastbound	44.6	67.7	D
	Westbound	44.8	45.7	D
2B	Eastbound	41.1	81.9	E
	Westbound	42.3	57.9	D
3	Eastbound	41.9	73.2	D
	Westbound	42.5	59.4	D
4	Eastbound	45.4	57.3%	C
	Westbound	45.7	59.4%	C
6	Eastbound	49.9	50.1%	C
	Westbound	49.5	33.7%	C
7	Eastbound	52.8	27.3%	B
	Westbound	52.9	23.8%	B

Source: DOWL, 2015. Highlighted cells indicate segments operating below target LOS.

Table 30 2035 Class III Two-Lane Highway Traffic Conditions with Billings Bypass

Segment	Direction	PFFS	LOS
5	Eastbound	83.7%	B
	Westbound	85.8%	B

Source: DOWL, 2015.

As shown in the above tables, segments 2A, 2B, and 3 are expected to operate at LOS D in 2035. All other study segments are expected to operate at LOS C or better.

Intersection Analysis

Table 31 shows the worst approach, delay, and LOS at the study intersections during 2035 peak hour with Billings Bypass.

Table 31 2035 Peak Hour Intersection Delay and LOS with Billings Bypass

Intersection		Worst Approach	Delay (s)	LOS
1	Highway 312 and Dover Road	NB	25.7	D
2	Highway 312 and Hoskins Road	NB	25.0	D
3	Highway 312 and Shepherd Road/Vermillion Road	SB	25.6	D
4	Highway 312 and Nahmis Avenue	NB	12.4	B
5	Secondary 522 and Nahmis Avenue	NB	20.4	C
6	Secondary 522 and I-94 WB Ramp	WB	13.5	B
7	Secondary 522 and I-94 EB Ramp	EB	15.7	C
8	Highway 312 and Northern Avenue	NB	10.1	B
9	Highway 312 and Main Street/S 15th Road	NB	11.2	B
10	Highway 312 and I-94 WB Ramp	SB	8.7	A
11	Highway 312 and I-94 EB Ramp	EB	8.8	A
12	I-94 WB Ramp and Custer Frontage Road	NB	8.7	A

Source: DOWL, 2015. Highlighted cells indicate intersections operating below target LOS.

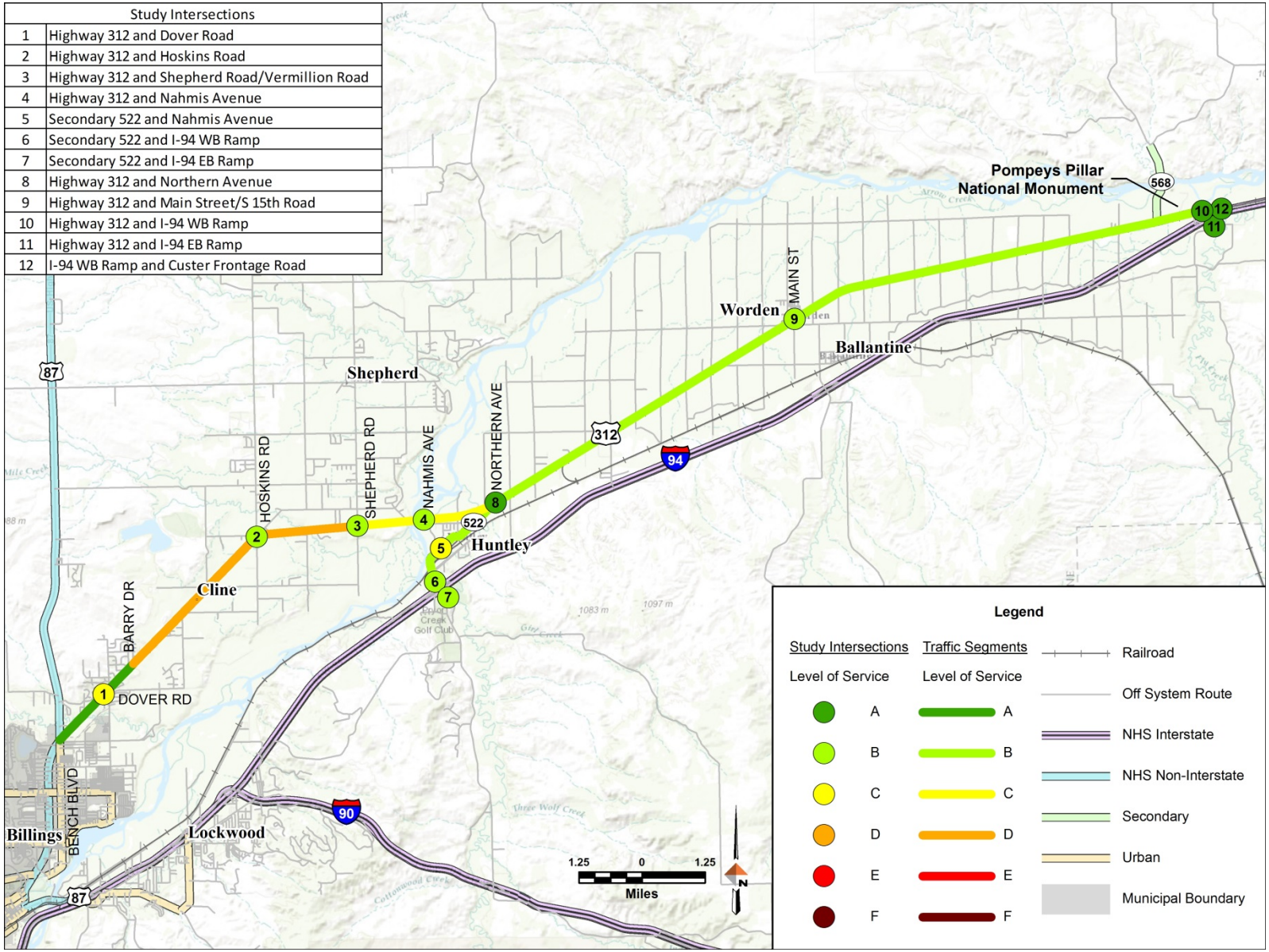
As shown in

Table 31, study intersections 1, 2, and 3 are expected to operate at LOS D or worse in 2035. All other study intersections are expected to operate at LOS C or better.

Traffic Operations Summary

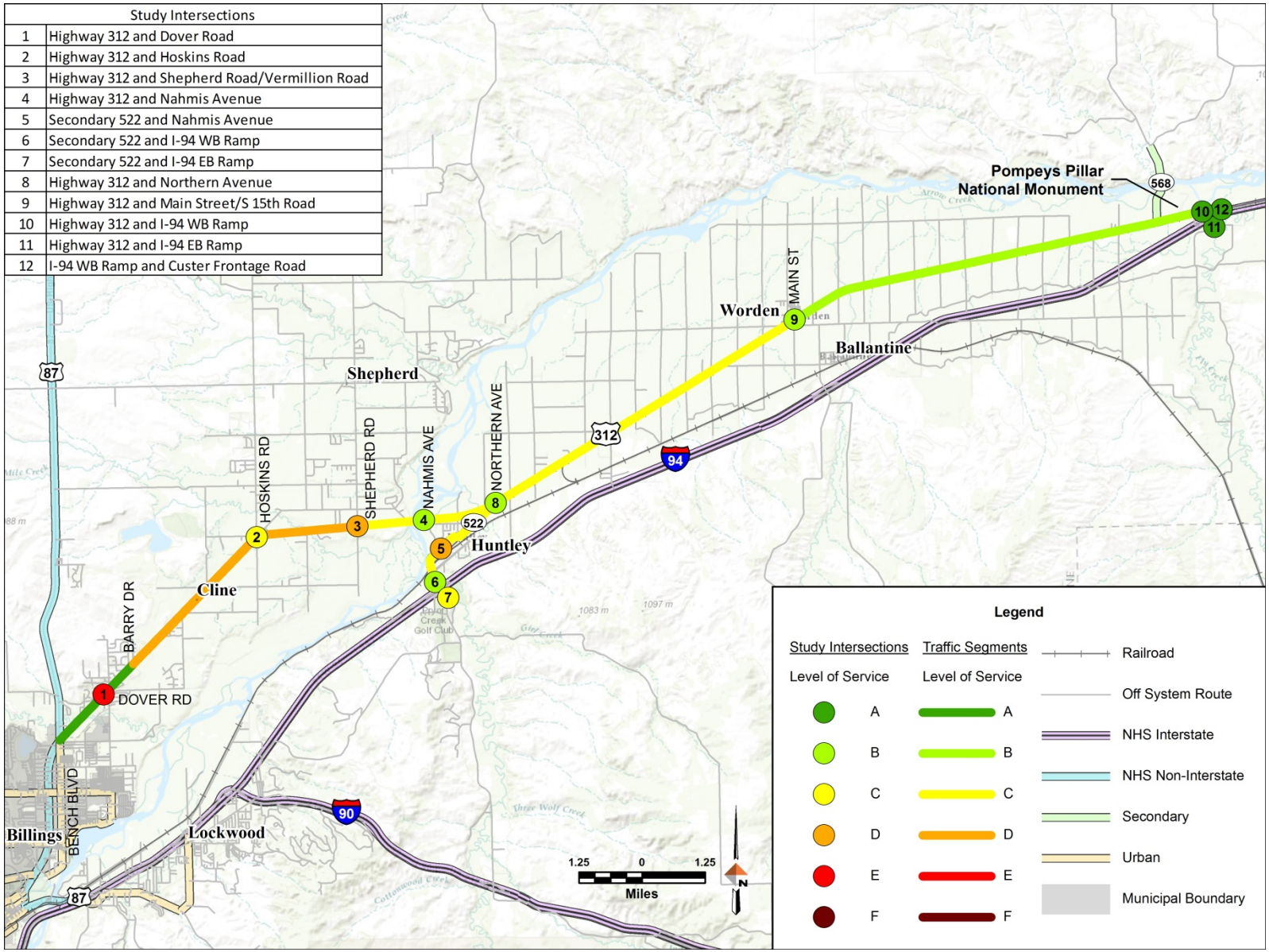
Segment and intersection LOS results for 2015 (existing), 2035 (forecasted without the Billings Bypass project), and 2035BB (forecasted with the Billings Bypass project) are shown in Figures 13, 14, and 15. Additional information is provided in Attachment 6.

Figure 13 2015 Operations



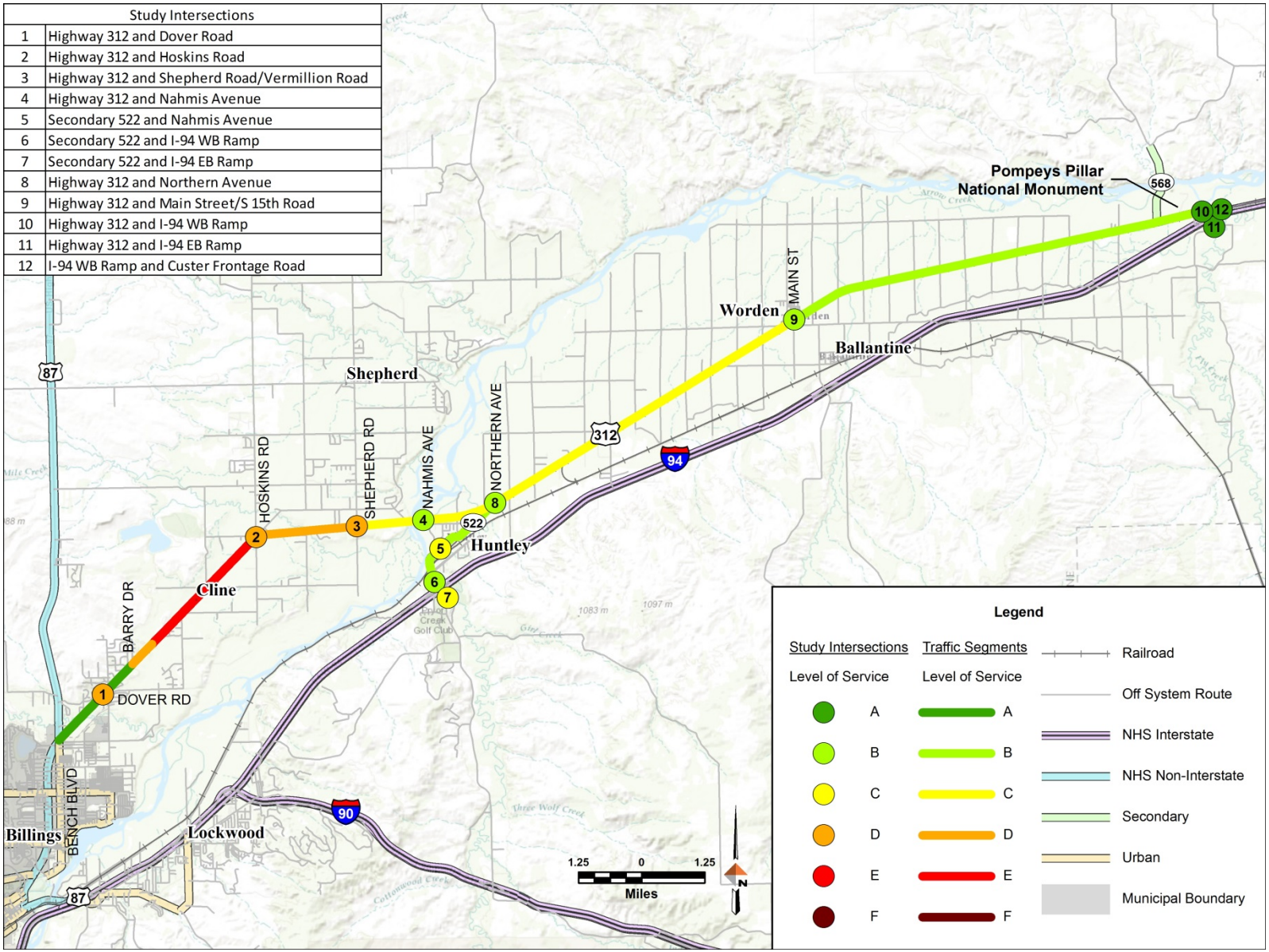
Source: DOWL, 2015.

Figure 14 2035 Operations (without the Billings Bypass Project)



Source: DOWL, 2015.

Figure 15 2035 Operations (with the Billings Bypass Project)



Source: DOWL, 2015.

4.0 Environmental Conditions

4.1 Physical Environment

Soil Resources and Prime Farmland

Soil surveys of the study area from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) indicate the presence of farmland of state or local importance, or prime farmland if irrigated within the study area. The actual percentage of the study area comprised of farmland of state or local importance or prime farmland if irrigated is low. Additionally, some of the areas previously designated as prime farmland may have been subsequently developed.

Any forwarded improvement options that require ROW within identified farmlands and are supported with federal funds will require a CPA-106 Farmland Conversion Impact Rating Form for Linear Projects completed by MDT and coordinated with NRCS. The NRCS uses information from the impact rating form to keep inventory of the prime and important farmlands within the state.

Geologic Resources

The western portion of the corridor from the junction with US Highway 87 to the area around Huntley initially traverses colluvium and alluvial fan deposits of silty clay related to the Cretaceous Judith River Formation. This formation consists of a light colored sandstone, gray siltstone, sandy shale, greenish-gray clay, with some lignite beds. With the exception of the alluvial deposits associated with crossings of Twelve Mile Creek and the Yellowstone River, the majority of the material is Pleistocene alluvial gravel terraces (cobbles and pebbles with minor amounts of sand and silt) approximately 50 to 90 feet above the present elevation of Yellowstone River. There are clasts or mixed rock fragments present. They are mainly composed of granitic igneous rocks, granitic gneiss, schist, and quartzite, with much less limestone and sandstone. From Huntley, the corridor continues over terrace deposits as noted above, as well as alluvial fan deposits consisting of gravel, sand, silt, and clay deposited in fans by modern streams.

The majority of soils along the corridor are silts, fine silty sands, and clays. Specific to the existing road alignment of Highway 312, the soils exhibit moderate to high corrosion potential for steel, and low to moderate corrosion potential for concrete. Frost susceptibility of these soil types is low to moderate. In addition, the soil types that will be encountered during excavation will likely be moisture-sensitive soils that can adversely affect construction as well as the long-term viability of the roadway. These soils are sensitive to scour, which is the erosion of soil from around the base of bridge pier abutments due to the flow of air, ice, or water. Embankment construction, which is the placement of compacted materials for a roadway or structure to be built on this corridor, will likely require foundation reinforcement due to the moisture sensitivity of the soils present.

These types of soils can create revegetation challenges. The clay heavy soil reacts in extremes to either the lack of or presence of moisture. The design of future projects forwarded from the study should consider including permanent erosion and sediment control (PESC) measures to extent practicable to help the soils stay in place long enough for the plants and grasses to take hold and revegetate the project. Native plant and grass types that can live in soils with higher silt and/or clay content should be chosen.

Improvements brought forward from the study will be subject to more detailed geotechnical analysis. Part of this detailed analysis may involve taking advance borings to evaluate soil characteristics at exact project locations. This is standard procedure for the majority of MDT road projects. The design of any improvements should take into consideration specific requirements that come from the detailed analysis.

Surface Waters

The following named streams occur within the study area.

- Five Mile Creek
- Seven Mile Creek
- Twelve Mile Creek
- Yellowstone River
- Pryor Creek
- Arrow Creek

A variety of additional surface waters, including unnamed streams, natural drainages, wetlands, and ponds are present in the study area. Impacts to these surface waters could occur from improvements such as culverts under the roadway, placement of fill, or rip rap armoring of banks. The United States Army Corps of Engineers (USACE), the Montana Fish, Wildlife and Parks (FWP), and the Montana Department of Environmental Quality (DEQ) all regulate portions of work within surface waters. Coordination with federal, state, and local agencies would be necessary to determine the appropriate permits based on choice of improvement options forwarded from this study. Impacts should be avoided and minimized to the maximum extent practicable. Stream and wetland impacts may trigger compensatory mitigation requirements of the USACE. Construction of forwarded improvement options may trigger the need to obtain coverage under the Montana Pollutant Discharge Elimination System (MPDES) General Permit for Storm Water Discharges Associated with Construction Activity.

Total Maximum Daily Loads

The study area is located in the Middle Yellowstone Watershed (hydrologic unit code [HUC] 10070007). DEQ lists both the Yellowstone River (MT43Q001_011) and Pryor Creek (MT43E001_010) as having impairments in the Draft 2014 Integrated 303(d)/305(b) Water Quality Report for Montana. Both water bodies are characterized as Category 5, defined as waters where one or more applicable beneficial uses are impaired or threatened, and a TMDL is required to address the factors causing the impairment or threat. At this time, the TMDL for these two water bodies is not completed. For the Yellowstone River inside the study area, two probable sources of impairment are agriculture and irrigated crop production. Two possible other causes are industrial and municipal point source discharges, which could be a result of release of water from wastewater treatment systems. Probable sources of impairment for Pryor Creek are flow alterations from water diversions, and irrigated crop production. Currently the probable sources of impairments are not listed as being associated with road construction activities. If improvement options are advanced from this study, it will be necessary to reevaluate the 303(d)/305(b) integrated report for changes to listed impairments along with possible completed TMDLs.

Storm Water

The western end of corridor is located within the Billings Municipal Separate Storm Sewer System (MS4) area. Under the current Small MS4 General Permit, new development or redevelopment projects greater than or equal to one acre in size must implement, when

practicable, low impact development (LID) practices that infiltrate, evapo-transpire, or capture for reuse the runoff generated from the first half-inch of rainfall from a 24-hour storm preceded by 48 hours of no measurable precipitation.

The City of Billings, Yellowstone County, and MDT all manage MS4 programs that overlap the study area. Each program has specific requirements based on their individual storm water management plans. Information on the MS4 programs including specific requirements for the individual programs can be located on the respective permit holder's storm water website, which can be found in the references section at the end this document. These and other MS4 issues will need to be further evaluated during any future project design. The current MS4 permit is in the process of being reissued and MDT has applied for an Individual MS4 permit. As such, it is likely the permit requirements will be slightly different in the future.

Wild and Scenic Rivers

None of the waterways within the study area carry the wild and scenic designation.

Groundwater

According to the Montana Bureau of Mines and Geology (MBMG) Groundwater Information Center (GWIC), there are 13,184 wells on record in Yellowstone County. A portion of these wells are located within the study area. The newest well on record is from February 10, 2015, and the oldest well on record is from January 1881. Approximately 80 percent (10,463) of wells within Yellowstone County are at a depth of 0 to 99 feet. There are 40 statewide monitoring network wells in Yellowstone County. The wells in Yellowstone County have widely varying uses, with domestic wells being the most common, followed by stock water wells.

Wells can be a costly item to mitigate if they are not avoided. Mitigation of a well usually involves drilling a new well for the owner in a new location that will not be impacted by the potential project. Well costs are based on per foot price; the deeper and higher volume needed results in a higher cost.

In addition to private wells, three public water supply wells are located inside the buffer zone, two of which are in the community of Huntley. DEQ requires a 100-foot isolation zone around all public water supply wells to prevent the introduction of potential pollutant sources. Public water supply wells can also be deeper and require a higher volume of water to be discharged. This can translate into more costly well replacement, along with affecting a larger number of users compared to a private well if impacted. For any future roadway improvements on the corridor, MDT will take measures to avoid adverse impacts to public water supply wells. Impacts to existing domestic wells will also be considered if improvement options are forwarded from the study.

Wetlands

Potential wetland areas identified within the study area are primarily in the vicinity of Five Mile Creek, Seven Mile Creek, Twelve Mile Creek, and the Yellowstone River. A few natural drainages and channelized waters are also present in the study area and may have associated wetlands.

Future wetland delineations would be required if improvement options are forwarded from the study that could potentially impact wetlands. Future projects in the study area would need to incorporate project design features to avoid and minimize adverse impacts to wetlands to the

maximum extent practicable. Unavoidable impacts to wetlands must be compensated through mitigation in accordance with the USACE regulatory requirements and/or requirements of Executive Order 11990. Work within jurisdictional wetlands would require a Clean Water Act 404 permit from the USACE.

Floodplains and Floodways

Federal Emergency Management Agency (FEMA)-issued flood maps for Yellowstone County indicate three floodplain zones exist within the study area as follows.

> Zone A: Areas subject to inundation by the 1% annual chance flood event, generally determined using approximate methodologies;
>
> Zone AE: Special Flood Hazard Area (SFHA) – The 1% annual chance flood (100-Year Flood), Base Flood Elevations Determined; and
>
> Zone X: Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

The delineated 100-year flood plains (Zone AE) that cross through the corridor study area buffer are on Five Mile Creek, Yellowstone River bridge and roadway immediately west of Huntley, Pryor Creek bridge on Secondary 522, and Yellowstone River for approximately the last mile of the corridor's eastern terminus (Bundy Road area).

Roadway improvements or developments could involve placement of fill within the regulatory floodplain and would require a floodplain permit. Project development would require coordination with Yellowstone County to minimize floodplain impacts and obtain necessary floodplain permits for project construction.

Irrigation

Irrigated agriculture land exists in Yellowstone County within the study area. Depending on the improvement option(s) proposed during the study, there is potential to impact irrigation facilities. Impacts to irrigation facilities should be avoided when practicable. Future modifications to existing irrigation canals, ditches, or pressurized systems could require redesigning and constructing in consultation with the owners to minimize impacts to agricultural operations. If there is impact to irrigation structures, there could be additional costs above typical project costs associated with the redesign, or moving of the irrigation structure(s). Water resources survey maps indicate an abundance of water rights and agricultural land use throughout study area. As such, a large number of irrigation structures are not easily identified at the high-level review conducted for this study. A more in-depth review for irrigation structures should occur at the project development stage to identify possible impacts.

The communities of Huntley and Worden were established as a result of the Bureau of Reclamation's (BOR) Huntley Irrigation Project. The Huntley Irrigation Project is currently managed by BOR to provide water for agricultural purposes in the corridor and the surrounding area. In addition to the Huntley Irrigation Project's associated ditches and canals, the Billings Bench Water Association (BBWA) Irrigation System owns main canals and lateral ditches within the corridor. Currently 30,000 acres of alfalfa and other hay crops, sugar beets, silage, irrigated pasture, and small grains are watered from the Huntley Project waters. The portion of the canal

that crosses Pryor Creek has been rebuilt three times because of flooding, evidencing the importance of these structures to the surrounding areas.

These canals are of high importance to the areas surrounding the corridor and will need to be considered as part of the design process if the MDT forwards projects in the corridor.

Air Quality

The study area is not located in a non-attainment area for any criteria pollutant. Additionally, there are currently no non-attainment areas nearby, although carbon monoxide and sulfur dioxide were historically ambient air quality concerns in Billings. As a result, special design considerations will not be required in future project design to accommodate National Ambient Air Quality Standards (NAAQS) non-attainment issues.

Depending on the scope of improvements considered in the study area, an evaluation of mobile source air toxics (MSATs) may be required. MSATs are compounds emitted from highway vehicles and off-road equipment, which are known or suspected to cause cancer or other serious health and environmental effects.

Hazardous Substances

There are no abandoned mine sites, landfills, NPL sites, hazardous waste handling facilities, oil and gas production wells, or toxic release inventory sites identified within the study area.

There are three active and 55 closed underground storage tank (UST) sites located in or adjacent to the study area. These UST sites are concentrated in Billings, Huntley, and Worden. However, there are several rural UST sites located throughout the study area. It is unlikely that a closed UST site will affect project development. However, project activities occurring in the vicinity of an active UST site may warrant additional soil/groundwater investigations or special provisions. Additional investigation regarding the precise locations of the USTs may need to take place depending on what improvement options are forwarded from this study.

There are nine active LUST sites and 15 resolved LUST sites located in or adjacent to the study area. There are also LUST sites concentrated in Billings, Huntley, and Worden. However, there are several rural LUST sites located throughout the study area. It is unlikely that a resolved LUST site will affect project development. If project activities occur near an active LUST site, further investigation and possible remediation may be necessary. This could create additional costs associated with a forwarded improvement.

Two crude oil pipelines owned by Phillips 66 cross Highway 312 within approximately the first three miles of the study area, just northeast of the City of Billings. A third crude oil pipeline is located adjacent to the study area south of Highway 312, between Huntley and Worden. If improvements are proposed in these areas, additional research and coordination with the owners should occur to identify pipeline locations and what, if any, potential conflicts exist.

Two remediation response sites are located adjacent to the study area. The Cenex Pipeline Huntley is an eight-inch diameter petroleum product pipeline located approximately one mile northeast of Huntley, and would require further review to verify current conditions and boundaries of the remediation site. The Jones Junction Fueling Facility is an inactive, temporary railroad fueling facility located three miles northeast of Huntley. It has been delisted and should not influence potential projects forwarded from this study.

None of the hazardous substance sites identified in the study area vicinity are expected to be substantial impediments for future project design. Although it is unlikely that any of these sites will substantially impact projects forwarded from the study, any projects overlapping one of these sites should incorporate a soil survey. If contaminated soils are present, a special provision regarding handling contaminated soils is recommended to be included in project documentation. In addition, contaminated soils could result in the need for remediation.

4.2 Biological Resources

Vegetation

Dominant land-cover types in the study area are Big Sagebrush Steppe, Cultivated Fields, and Great Plains Mixed Prairie. Lands adjacent to the corridor study area include cultivated fields and developed human land use in the form of low-density residential, roads, and some commercial land. Highway 312 crosses Five Mile Creek, Seven Mile Creek, Twelve Mile Creek, Arrow Creek, and the Yellowstone River; these drainages provide wetland and riparian vegetation along the corridor. All land types in the project area are either moderately or highly disturbed.

If improvement options are forwarded from the study, practices outlined in MDT standard specifications should be followed to minimize adverse impacts to vegetation and facilitate establishment of final stabilization of disturbed areas. Removal of mature trees and shrubs should be limited to the extent practicable.

Noxious Weeds

The Invaders Database System lists 147 exotic plant species and 14 noxious weed species in Yellowstone County, some of which may be present in the study area. Yellowstone County has weed management criteria in place that can be found on their website (http://www.co.yellowstone.mt.gov/publicworks/weed/).

If improvements are forwarded from the study, field surveys for noxious weeds should take place prior to any ground disturbance and coordination with Yellowstone County Weed Board should occur. Proposed projects should incorporate the practices outlined in MDT standard specifications to minimize adverse impacts.

General Wildlife Species

Mammals

Wildlife species inhabiting or traversing the project study area are typical of those that occur in moderately developed areas of south central Montana. Since many species in this area are habituated to somewhat disturbed areas, species present in this area are predominantly, though not exclusively, generalists.

Game species mapped by FWP include Antelope and White-tailed Deer. The study area is home to a variety of unmapped mammal species including Mule Deer, Mountain Lion, and Coyote. Other common mammals potentially occurring in the study area include Porcupine, Raccoon, Striped Skunk, Beaver, Badger, Bobcat, Red Fox, Northern River Otter, Muskrat, Desert Cottontail, Bushy-tailed Woodrat, Western Harvest Mouse, House Mouse, Deer Mouse, Hayden's Shrew, Prairie Vole, Montane Vole, Least Chipmunk, Eastern Fox Squirrel, Eastern Gray Squirrel, Richardson's Ground Squirrel, Big Brown Bat, Long-eared Myotis, and Silver-haired Bat.

White-tailed and Mule Deer account for the majority of the recorded wildlife mortality. In addition one Mountain Lion, one Raccoon, one domestic dog, and four unidentified animal carcasses were recorded in the MDT Maintenance Animal Incident Database.

If improvement options are forwarded from the study, the need for and viability of wildlife crossing mitigation measures should be considered during the project development process.

Amphibians and Reptiles

Amphibian and reptile species known to occur within the study area include, but are not limited to, the Boreal Chorus Frog, Northern Leopard Frog, Woodhouse's Toad, Plains Gartersnake, and Terrestrial Gartersnake. Any improvements forwarded from the study should take into consideration and minimize impacts to amphibian and reptile habitat where practicable.

Birds

Forty species of birds have been documented with the potential to occur and nest in the study area. An additional 58 species have been documented during the winter in the general vicinity of the study area. These species include representative songbirds, birds of prey, waterfowl, owls, and shorebirds. Of the listed birds, many are tree and shrub nesters, which may constrain the ability to remove trees or structures within the study area. Game birds present in the study area include Wild Turkey and Ring-necked Pheasant.

There are no known Bald Eagle or Golden Eagle nests within the buffer zone of the study area. However, there are known Bald Eagle nests along this stretch of the Yellowstone River. The required half-mile buffer areas around these nests do not overlap the study area. This area is not typical Golden Eagle habitat so presence of Golden Eagle nests is unlikely.

Any improvements forwarded from this study should consider potential constraints that may result from nesting/breeding periods of migratory birds and presence of unknown or future Bald and Golden Eagles nests. Any work that involves the disturbance or removal of trees or structures associated with nesting birds will need to schedule this work to take place outside of the typical nesting season of April 15 to August 15.

Fisheries

There are four aquatic resources listed as possessing warm water fishery resources in the study area. The largest is the Yellowstone River, which is listed as a high-value fishery resource and managed as a warm/cool fishery by FWP. Fish species commonly occurring within the Yellowstone River within the study area are Brown Trout, Channel Catfish, Common Carp, Emerald Shiner, Fathead Minnow, Flathead Chub, Goldeye, Longnose Sucker, Mountain Sucker, River Carpsucker, Sauger, Shorthead Redhorse, Smallmouth Bass, Stonecat, Western Silvery Minnow, and White Sucker. Twenty-four additional fish species have been recorded for this stretch of the Yellowstone River, but are considered rare.

The other three aquatic resources are listed as limited fisheries. Of the three, Arrow Creek and Five Mile Creek are managed as trout fisheries while Twelve Mile Creek has an undesignated management classification. All of the streams have other fish species listed as common, rare, or unknown for varying reaches of the stream.

Fish passage and/or barrier opportunities should be considered at affected drainages if improvements are forwarded from this study. Permitting from regulatory agencies for any future study area improvements may also require incorporation of design measures to facilitate aquatic species passage.

Threatened and Endangered (T&E) Species

According to the USFWS, four threatened, endangered, proposed, or candidate species are listed as occurring in Yellowstone County. Only the Greater Sage-Grouse has documented breeding occurrence boundaries recorded within 500 feet of the study corridor. However, on September 22, 2015, the USFWS determined that the Greater Sage-Grouse no longer warrants protection under the ESA.

If improvements are forwarded from the study, an evaluation of potential effects to T&E species will need to be completed during the project development process. As federal status of protected species changes over time, reevaluation of the listed status and afforded protection to each species should be completed prior to issuing a determination of effect relative to potential impacts.

Species of Concern

Twelve Montana species of concern (SOC) occur in Yellowstone County, including the Greater Sage-Grouse, Great Blue Heron, Bobolink, Loggerhead Shrike, Pinyon Jay, Spiny Softshell, Snapping Turtle, Greater Short-horned Lizard, Sauger, Spotted Bat, Hoary Bat, and Little Brown Myotis. These species have the potential to occur and breed in the study area based on presence of suitable habitat.

The “Montana Strategy to address threats to the Sage-Grouse in Montana” should be taken into consideration if habitat for the Greater Sage-Grouse could be impacted. A thorough field investigation for the presence and extent of SOC should be conducted if improvement options are forwarded from this study. If present, special conditions that apply to the project design and/or during construction such as timing restrictions should be considered to avoid or minimize impacts to these species.

Social and Cultural Resources

Population Demographics and Economic Conditions
An initial review of both City of Billings and Yellowstone County’s currently-available growth and planning documents was conducted. This review did not identify any constraints for future forwarded projects.

2013 Census data indicates Yellowstone County ranks 1st out 56 for total county population in Montana. A large share of the population in Yellowstone County (70.7 percent) resides within the City of Billings. Ethnicity within Yellowstone County is primarily White/Caucasian (91.5 percent). American Indian Reservations are located within a short distance of Yellowstone County, which may contribute to the American Indian population at just over four percent, almost identical to the City of Billings. Hispanic or Latino individuals comprise just over five percent of the population.

According to the United States Census Bureau’s estimate, Yellowstone County had a population of 154,162 people in 2013, and was the most populous county in Montana. Billings, the largest city in the state, had a population of 109,059. All population projections are based on Regional Economic Models, Inc. (REMI) forecasts of net migration and natural growth.

Over the last 25 years, Yellowstone County has experienced consistent population growth. Yellowstone County’s population is expected to surpass 190,000 by the year 2030 if growth

continues at its current pace. Population growth in Yellowstone County has outpaced Montana over the last 15 years and that trend is projected to continue.

Some of Billings' growth can be attributed to the boom in the oil industry in the Bakken shale play. Billings is the closest urban area with a population over 100,000 people to the Bakken oil boom and many of its services support the Bakken and other energy development. Also, Billings serves as an economic hub for much of Montana and Wyoming and even parts of the Dakotas.

The Yellowstone County median age is 38.3, which is slightly lower than the state average of 39.8 years. Yellowstone County has a higher percentage of people under the age of 18, and a lower percentage over the age of 65 than the state average, resulting in a slightly younger population in Yellowstone County relative to the state.

Yellowstone County demonstrates a strong labor market, which is expected to continue. As of December 2014, Yellowstone County's unemployment rate was a low 3%. Job orders through the Billings Job Service numbered 641 in January 2013, 997 in January 2014, and 944 in January 2015. Typically, employers requesting job orders through the Job Service represent about 25% of total available jobs in the market. Overall, these factors illustrate a high demand for labor in Billings and Yellowstone County. High demand for labor often means increased wages for workers and more economic activity in general.

Retail and wholesale trade, finance and insurance, transportation and warehousing, and utilities are slightly more predominant in the County than the rest of Montana, although the County's large size influences the industry trends of Montana as a whole. Nonetheless, Billings is a retail, transportation, and finance hub for much of central and eastern Montana as well as northern Wyoming.

The County's largest industry is comprised of educational services, health care, and social assistance, which is 1.6 percentage points less than the state's share. According to a December 2014 article in the Billings Gazette, health care alone accounts for approximately 20% of Billings' total wages, and health care employment is expected to increase by 3,700 jobs in the next seven years according to the University of Montana's Bureau of Business and Economic Research.

Yellowstone County's median household income is $51,342, well above the state median of $46,230, an indicator that points to a strong economy in Yellowstone County. Yellowstone County's poverty rate of 12.3%, compared to 15.2% for Montana, also confirms the vitality of the Billings area economy. According to the University of Montana's Bureau of Business and Economic Research, nonfarm earnings are projected to grow between 2.4 and 2.8 percent annually from 2015 to 2018 in Yellowstone County. In 2013 and 2014, these numbers were 1.3 and 1.1 percent, respectively.

In summary, Yellowstone County and Billings weathered the 2008 recession relatively well and have experienced strong growth and performance in many areas of the economy. A slowdown in oil development in the Bakken region due to low oil prices or other factors could potentially impact the Billings economy but as of spring 2015, oil prices are on the rise which may spur renewed energy development. Billings' diverse economy is well positioned for continued growth. A reflection of this growth may also be seen in the suburbs surrounding Billings including the communities of Huntley and Worden, which are both within the study area. Investigation should take place to determine the possibility of low-income person(s) being disproportionately isolated,

displaced, or otherwise subjected to adverse effects by any forwarded improvements on a project-by-project basis.

Land Ownership and Land Use

Ownership of land in the study area is predominantly private, with some interspersed state and federal owners, including FWP, MDT, Montana State Trust lands, US Bureau of Land Management (BLM), and the US Bureau of Reclamation. Much of the private land throughout the study area is residential or agricultural. Commercial land use is seen at a higher frequency closer to the vicinity of the City of Billings.

Mixed land use arises from the varied land ownership throughout the study area. These land uses include commercial, industrial, crop/pasture, and mixed urban. Even though there is a large amount of privately-owned land in the study area, the need to purchase ROW for possible improvements is minimal as most improvements brought forward would not require ROW. If the scope of possible projects requires purchasing ROW, land acquisition costs will depend on the per acre price at the time of purchase. If improvements are forwarded from this study, land use at and adjacent to possible projects will need to be considered during design to determine overall project costs.

Potential Section 4(f) Recreational Resources and 6(f) Resources

Several potential Section 4(f) recreational resources could be impacted from possible improvements within the buffer of the study area. These include:

- Lewis and Clark Trail, (RP 0.0 on Secondary 658);
- Pompey's Pillar, (658, RP 0.6);
- BLM public land hunting access and picnic area (658, RP 0.6 and 0.7); and
- Barkemeyer Park (522, RP 1.1).

The Lewis and Clark Trail crosses Highway 312 where it becomes Secondary 658 for one mile on the eastern end of the study area. The trail crosses the study area at an overpass over the BNSF railroad near the intersection of Secondary 658 and Interstate 94.

The most prominent resource in the corridor is Pompeys Pillar National Monument, which has land that crosses into the study area buffer zone. Acquiring ROW from this potential Section 4(f) site would need to go through a formal evaluation process which could add time and cost to a project. There are also two BLM hunting access sites adjacent to Pompeys Pillar that would likely be subject to the same Section 4(f) evaluation process.

Secondary 522 through Huntley is adjacent to Barkemeyer Park on the southeastern side of the road. The park contains a flag and memorial plaque, playground, picnic benches, and volleyball court.

At the time potential future improvements are forwarded to a project, reevaluation of possible Section 4(f) resources should take place. Efforts should be made with projects advanced from the study to avoid adverse impacts to ROW acquisitions from these recreational resources.

There are no Section 6(f) resources directly within the buffer or adjacent to the study area. If improvement options are forwarded from this corridor study, a reevaluation of Section 6(f) resources should take place to determine if any new Section 6(f) resources are present. As

general guidance, converting these resources to a non-recreational purpose can be a difficult and time-consuming task and should be avoided if practicable.

Cultural Resources

Eleven historic properties are located within 0.15 miles of the existing alignments. Table 32 lists the properties, their approximate locations, and National Register of Historic Places (NRHP) eligibility. All of the sites have been previously recorded and their NRHP status established.

An aerial examination of the study area indicates that there are likely unrecorded historic properties along the entire length of the corridor. The Northern Pacific Railway (now BNSF Railway Company) grade (24YL0277) parallels Highway 312 from the intersection of Northern Avenue in Huntley to the end of the corridor at Interstate-94 Interchange #23. There are also likely historic age buildings and other segments of the abandoned Billings & Central Montana Railroad (24YL1592) paralleling the route between Billings and Huntley.

Table 32 Historical Properties

Site	Site No.	Section	Township	Region	NRHP elig.	Route and RP±
Huntley Irrigation Project*	24YL0285	Multiple	Multiple	Multiple	Eligible	Multiple
BBWA System*	24YL0161	Multiple	Multiple	Multiple	Eligible	Multiple
Elevated Ditch	24YL1593	31	2N	27E	Eligible	3.5
BBWA Field Ditch	24YL1594	29 and 31	2N	27E	Eligible	4.2
Huntley Bridge	24YL0656	24	2N	27E	Listed	12.7
Abandoned Billings & Central Montana Railway	24YL1592	20, 29, 30 31, 1	2N 1N	27E 26E	Eligible	Multiple
Chicago, Burlington & Quincy Railway	24YL1599	25	2N	27E	Eligible	Multiple
Pryor Creek Battlefield	24YL0933	24 and 25 19 and 30	2N 2N	27E 28E	Eligible	N/A
Pompeys Pillar National Historic Landmark	24YL0176	21	3N	30E	NHL	N/A
Bundy Bridge	24YL0784	20	3N	30E	Eligible	S-568, RP 1.9
Yellowstone Trail and Bridge	24YL0695	28	3N	30E	Eligible	S-568, RP 0.06

Source: SHPO, 2015.
* The Huntley Irrigation Project and the BBWA Irrigation System are located within multiple sections/townships/ranges within the project corridor. The systems include main canals and lateral ditches. See Exhibit 16 for locations. An in-depth discussion of historic irrigation systems and ditches is located in section 2.7 Irrigation.

Direct and indirect impacts (such as visual, noise, and access impacts) to eligible or listed properties would need to be considered if improvements options are carried forward. If an improvement option is forwarded from the corridor study, a cultural resource survey for

unrecorded historic and archaeological properties within the APE will need to be completed during the project development process.

Noise

Evaluation of traffic noise may need to occur for any future improvements in the study area. Noise analysis is necessary for Type I projects, which involve a substantial shift in the horizontal or vertical alignments, increase the number of through lanes, provide passing lanes, or increase traffic speed and volume.

Type I projects require a detailed noise analysis, consistent with FHWA requirements and MDT policy, which includes measuring ambient noise levels at selected receivers and modeling design year noise levels using projected traffic volumes. If noise levels approach or substantially exceed noise abatement criteria for the project, noise abatement measures may be necessary. A number of possible abatement measures available for consideration include but are not limited to the following:

- alternating the horizontal or vertical alignment;
- constructing noise barriers such as sound walls or earthen berms; and/or
- decreasing traffic speed limits.

Noise abatement measures must be considered reasonable and feasible prior to implementation.

Construction activities in the study area may cause localized, short-duration noise impacts. These impacts can be minimized by using standard MDT specifications for the control of noise sources during construction.

Visual Resources

Yellowstone County is located in south central Montana, and is the most populated county in Montana, resulting in a higher percentage of residential areas and anthropogenic features. The study corridor extends to the east from Billings leading to a moderately level agricultural setting, with the Yellowstone River meandering along Highway 312 just west of the community of Huntley.

Throughout the City of Billings, sandstone outcroppings are visible in the distance. The Rimrocks sometimes referred to as the “Rims” are a valued visual resource to many of the local residents. Topography surrounding the study area and the actual locations of the rimrock outcroppings varies. Future improvements forwarded from this study should take into consideration the impact to scenic views of the Rimrocks.

At the east end of the corridor, Pompeys Pillar juts 150 feet from the ground, creating a visual interest against the flat land surrounding it. Future improvements forwarded from this study should take into consideration the impact to scenic views of Pompeys Pillar. The landscape in the study area predominantly presents itself as a typical central Montana environment with scattered agricultural fields and intermixed urbanization.

Evaluation of the potential effects on visual resources would need to be conducted if improvement options are forwarded from this study.

5.0 Local Facilities, Services, and Amenities

Schools and Colleges

The Huntley Project School District serves students living in the communities of Worden, Ballantine, Huntley and Pompeys Pillar. The district consists of three schools within the study area. Huntley Project Elementary serves grades K-6. Huntley Project Junior High serves grades 7-8. Huntley Project High School serves grades 9-12.

Hospitals

There are no hospitals located within the study area.

Fire Department

Two volunteer fire stations are located within the study area. The Shepherd Volunteer Fire Station is located on Highway 312 and the Worden Volunteer Fire Department is located along Secondary 522.

Recreational Opportunities

Yellowstone County and the Billings area offer a variety of year-round outdoor activities including fishing, boating, and swimming in the summer. In the winter, snowmobiling, ice-skating, and cross-country skiing are popular.

Three FASs are accessed from Highway 312 within the area of study. These include Gritty Stone, Voyagers Rest, and Bundy Bridge FAS. Eagle Rock Golf Course is also accessed from Highway 312 via Larimer Lane. Two parks including Barkemeyer Park located on Secondary 522 and Osborne Park located on Highway 312 are located within the study area. The Huntley Rodeo Facility is located along Secondary 522.

6.0 Local Planning

Local plans were reviewed to identify areas of relevance with this study. Summarizes are provided below.

Billings Exposition Gateway Concept Plan – 2013

This plan addresses the Exposition Gateway planning area which includes eight properties within the City of Billings and 42 properties within Yellowstone County. The study area is situated in close proximity to the MetraPark event center and downtown Billings, including properties both within and adjacent to the eastern-most edge of the East Billings Urban Renewal District. This plan presents recommendations and implementation actions that can be used to guide future development within the Exposition Gateway such as stormwater management, utility replacements, street improvements, creation of public spaces and landmarks, and a land development concept. The Exposition Gateway planning area is located approximately three miles south of the Highway 312/US 87 intersection and is outside of the Old Highway 312 Corridor study area.

Billings Urban Area Long Range Transportation Plan – 2014

This plan provides the framework to guide the development and implementation of multimodal transportation system projects for the Billings Urban Area. The plan identifies short- and long-range planning goals to address expected population, land use, employment, and traffic needs.

The area encompasses the City of Billings, as well as the planning area extending approximately 4.5 miles outside the city limits. A portion of Highway 312 from the US 87 intersection (RP 0) to the Barry Drive intersection (RP 2.1) falls within the area considered in the Long Range Transportation Plan. Public feedback as part of this plan identified deficiencies and needs at the Roundup Road (US 87)/Highway 312/Main Street intersection. The plan also discusses and takes into consideration the effects of the proposed Billings Bypass project. The Bypass Project will construct a new principal arterial connecting Interstate 90 east of Billings with Highway 312.

Billings Urban Area Transportation Improvement Program (TIP), 2015-2019 (Draft)

The TIP is a short-range program of highway and transit projects in the Billings metropolitan planning area and is prepared by the Yellowstone County Board of Planning staff in cooperation with state and local agencies. The purpose of the TIP is to provide the mechanism for scheduling federal funds for surface transportation projects, indicating regional priorities, and demonstrating a short-range transportation vision for the area. The Bench Boulevard/US 87 intersection is listed in the TIP as a reconstruction project scheduled for 2015.

Heritage Trail Plan – The Greater Billings Non-Motorized Trail System – 2004

The Heritage Trail Plan is the non-motorized transportation element of the Billings Urban Area 2000 Transportation Plan and serves to update and supercede the former plan known as BikeNet. The Heritage Trail Plan is a multi-use trails plan that serves the Greater Billings community. The goal of the plan is to create trail links throughout Yellowstone County connecting communities, neighborhoods, natural and cultural features, commercial and employment centers, schools, and parks. The plan develops a vision, identity, and implementation strategy for the trail network in the Greater Billings Area. The plan identifies the portion of Highway 312 from the US 87 intersection (RP 0) to the Hoskins Road intersection (RP 5.6) as an arterial bikeway. The plan defines arterial bikeways as the least desirable routes for on-street bike travel but travel can usually be accommodated where sufficient pavement width exists and where no alternative route exists. The plan also identifies two potential multi-use trail routes that would intersect the portion of Highway 312 from US 87 (RP 0) to the Barry Drive intersection (RP 2.1).

Montana Comprehensive Highway Safety Plan (CHSP) – 2015

The CHSP identifies the top traffic safety problems on all of Montana's public roadways and includes a strategic focus on coordinating statewide efforts to reduce fatalities and incapacitating injuries. The plan is data driven and includes 10-year crash data trend analysis to determine emphasis areas with the greatest opportunity to reduce crashes. The CHSP identified four emphasis areas including roadway departure crashes, intersection crashes, impaired driving crashes, and crashes involving unrestrained occupants. The plan includes measureable objectives and identifies safety strategies and implementation steps to reduce emphasis area crashes. Improvement options identified as part of the Old Highway 312 Corridor Study will consider and reflect the strategies for crash reduction within the identified emphasis areas.

Montana Statewide Transportation Improvement Program (STIP), 2015-2019

The STIP is developed in accordance with the requirements of Section 135 of 23 USC (United States Code). The STIP details projects that will address Montana's transportation needs for fiscal years 2015 through 2019. There are several projects programmed in the current STIP within the study area. Recent and planned projects are discussed in Section 2.0.

Shepherd Community Action Plan

This plan discusses actions of the Shepherd Community Committee, formed in 2002 to consider options for organizing as a community and identifying abilities to access local, state, and federal funds. One of the initial projects originated by the community was a survey among Shepherd residents to help identify projects and goals for Shepherd's future. Safety issues with Highway 312 were identified as a concern by the Shepherd Community. As a result of the community survey, the committee identified potential community-preferred projects to further investigate. The plan identified the installation of turn lanes and widening of Highway 312 from Billings to the Yellowstone River crossing as a potential roadway improvement. The plan also discussed the possibility of planting trees and flowers in the right-of-way easements at the intersection of Highway 312 and Shepherd Road (RP 7.6) as part of a welcome to the Shepherd Community.

Trail Asset Management Plan – Billings, Montana – 2011

This plan addresses management and maintenance of the trail systems within the City of Billings and Yellowstone County jurisdictions. The plan provides an overview of existing trails and trail maintenance activities, and identifies recommended maintenance activities and associated costs, funding opportunities, and implementation strategies. The plan does not outline any recommendations directly relevant to the Old Highway 312 Corridor Study.

TranPlan 21 – 2008

TranPlan 21 is Montana's federally-mandated statewide transportation plan. Originally adopted in 1995 and most recently amended in 2008, TranPlan 21 is an essential component of the continuing statewide planning process that develops and implements MDT policy goals and actions in cooperation with the public and Montana's transportation stakeholders.

TranPlan 21 establishes statewide transportation policies in six key areas within the federally-required 20-year planning horizon. These policy areas include:

- economic development,
- traveler safety,
- roadway system performance,
- access management/land use planning,
- bicycle and pedestrian transportation, and
- public transportation.

The Roadway System Performance Policy Paper noted improvements will be needed in response to traffic growth in certain corridors.

Yellowstone County and City of Billings Growth Policy Update – 2008

The Yellowstone County/City of Billings Growth Policy outlines existing conditions; issues, goals, and objectives; and implementation strategies relating to land use, economic development, aesthetics, natural resources, open space and recreation, transportation, public facilities and services, and cultural and historic resources. Transportation issues identified in the plan include safe and efficient traffic circulation around and through the City of Billings, deteriorated roadway conditions, and lack of adequate bicycle facilities.

7.0 Conclusion

Table 33 summarizes key findings from this report.

Table 33 Summary of Key Findings

Category	Key Findings
Transportation System Conditions	**Delineation** • 10 public approaches along Highway 312 and Secondary 522 do not appear to have appropriate delineation. **Bridges** • Five bridges in the study area are candidates for rehabilitation/repair. **Bicycle and Pedestrian Facilities** • A crosswalk is located at Barkemeyer Park in Huntley and discontinuous sidewalks occur along Secondary 522 in Huntley. **Utilities** • Overhead and underground utilities occur throughout the study area. **Rail Facilities** • Two rail crossings intersect study area roadways, including an at-grade crossing on Secondary 522 at RP 0.5 within Huntley, and a grade-separated crossing on Secondary 568 at RP 0.2. **Drainage Condition** • Insufficient drainage occurs along Secondary 522 and specifically at the Secondary 522 intersection with Nahmis Road near Barkemeyer Park. **Pavement Condition** • Rutting occurs in the wheel paths of Highway 312, Secondary 522, and Secondary 568. • Transverse cracking occurs consistently along the entire corridor. • The ride index for Secondary 568, 522, and the first 2.3 miles of Highway 312 is considered fair. **Horizontal Alignment** • Four of 13 curve locations do not meet current MDT design criteria. **Vertical Alignment** • Eleven of 37 curve locations do not meet current MDT design criteria. **Clear Zones** • Foreslopes and backslopes in the two-lane portions of the corridor do not meet current MDT design criteria. • Mature trees, unprotected bridge rails, culvert ends, and parallel irrigation ditches occur within the clear zone. • Guardrail within the corridor is generally not compliant with current MDT design criteria. • Several areas lack slope protection and have inadequate clear zone distance. **Crash History** • Areas identified as LOSS IV for both total crashes and severe crashes occur near RP 4, 6, 9, 12, and 15 along Highway 312, RP 0.5 along Secondary 568, and RP 0, 1, and 2 along Secondary 522. • Multiple abnormal crash pattern types occur within the corridor. **Traffic Volumes and Operations** • Segments 2 and 3 currently operate at LOS D in 2015, and are projected to operate at LOS D or LOS E by 2035 (after construction of the Billings Bypass project). • Intersections 1 (Highway 312 and Dover Road), 2 (Highway 312 and Hoskins Road), and 3 (Highway 312 and Shepherd Road/Vermillion Road) are projected to operate at LOS D by 2035 (after construction of the Billings Bypass project).

Environmental Conditions	**Soil Resources and Prime Farmland** • A low percentage of land within the study area is classified as farmland of state or local importance, or prime farmland if irrigated. **Geologic Resources** • Soils within the study area exhibit moderate to high corrosion potential for steel, low to moderate corrosion potential for concrete, and low to moderate frost susceptibility **Surface Waters** • Six named streams, and several unnamed streams, natural drainages, and ponds occur within the study area. **Storm Water** • The western end of corridor is located within the Billings Municipal Separate Storm Sewer System (MS4) area. **Groundwater** • Multiple private wells and three public water supply wells are located within the study area. **Wetlands** • Wetland areas potentially occur in the vicinity of Five Mile Creek, Seven Mile Creek, Twelve Mile Creek, the Yellowstone River, natural drainages and channelized waters. **Floodplains and Floodways** • Three floodplain zones exist within the study area. **Irrigation** • Irrigated agriculture land exists within the study area. • The Huntley Irrigation Project and the Billings Bench Water Association (BBWA) Irrigation System operate main canals and lateral ditches within the study area. **Hazardous Substances** • Three active and 55 closed UST sites, and nine active and 15 resolved LUST sites occur within the study area. • Two crude oil pipelines cross Highway 312 within approximately the first three miles of the study area. A third crude oil pipeline is located adjacent to the study area south of Highway 312, between Huntley and Worden. • Two remediation response sites are located adjacent to the study area approximately one mile and three miles northeast of Huntley, respectively. **Noxious Weeds** • Noxious weed species may be present in the study area. **General Wildlife Species** • Numerous mammal, amphibian, bird, and fish species occur in the study area. **Threatened/Endangered/Species of Concern/Species of Conservation** • The Greater Sage-Grouse has documented breeding occurrence boundaries recorded within 500 feet of the study corridor. • Twelve Montana species of concern (SOC) have the potential to occur and breed in the study area based on presence of suitable habitat. **Land Use** • Land ownership in the study area is predominantly private, with some interspersed state and federal owners, including FWP, MDT, Montana State Trust lands, US Bureau of Land Management, and the US Bureau of Reclamation. **Potential Section 4(f) Recreational Resources** • Four potential Section 4(f) recreational resources occur within the study area.

Environmental Conditions	
	Cultural Resources • Eleven historic properties are located within 0.15 miles of the existing roadway alignments. **Noise** • Noise receptors likely occur within the study area. **Visual Resources** • Visual resources within the study area include the Rimrocks and Pompeys Pillar.

8.0 References

Big Sky Economic Development. (2013). Billings Exposition Gateway Concept Plan. Retrieved July 2015 from: http://mt-billings.civicplus.com/DocumentCenter/View/22585

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ATTACHMENT 1

Field Review Photo Log

Old Highway 312 Corridor Study

Field Review Photo Log

July 2015

DOWL

MDT

This photo log illustrates conditions observed along Highway 312 (MT 312), Secondary 522, and Secondary 658 during a field review on June 10, 2015. The study area begins at the intersection of Highway 312 with US Highway 87 and extends east to the Interstate 94 interchange near Pompeys Pillar National Monument. The study area also includes approximately 2.4 miles of Secondary 522 from Highway 312 to I-94. Photo categories include environmental conditions and transportation system conditions. This photo log does not provide a comprehensive account of all conditions within the study area. Conditions were visually inspected; no testing, delineations, or measurements were conducted. Photos within each category progress west/south to east/north. RP locations are approximated.

Environmental Conditions

Photo 1. Looking north (upstream) on Five Mile Creek and associated wetland. Highway 312, RP 0.6.

Photo 2. Looking east (downstream) on Billings Bench Water Association Canal. Highway 312, RP 1.3.

Photo 3. Looking northeast on Highway 312. Highway 312, RP 1.7.

Photo 4. Looking southeast (downstream) on irrigation ditch. Highway 312, RP 1.75.

Photo 5. Looking northeast on emergent/open water wetland complex. Highway 312, RP 2.4.

Photo 6. Looking west on the Shepherd Volunteer Fire Department. Highway 312, RP 3.0.

Photo 7. Looking south (upstream) on Twelve Mile Creek. Highway 312, RP 8.7.

Photo 8. Looking east along Highway 312 bridge over the Yellowstone River. Highway 312, RP 8.7.

Photo 9. Looking northwest at Yellowstone River access point sign. Highway 312, RP 8.9**.**

Photo 10. Looking northwest at Yellowstone River access ramp. Highway 312, RP 8.9.

Photo 11. Looking west (downstream) on Pryor Creek. Secondary 522, RP 0.3.

Photo 12. Looking southwest (upstream) on irrigation canal. Secondary 522, RP 0.4.

Photo 13. Looking northeast at the Worden Fire Department, Huntley Station. Secondary 522, RP 0.6.

Photo 14. Barkemeyer Park sign in Huntley. Secondary 522, RP 1.0.

Photo 15. Looking south on Barkemeyer Park in Huntley. Secondary 522, RP 1.0.

Photo 16. Looking northeast on Huntley rodeo facility. Secondary 522, RP 1.2.

Photo 17. Looking northeast at wetland and Miller Coors LLC grain elevator. Secondary 522, RP 2.2.

Photo 18. Looking northwest on BNSF-owned Jones Junction Fueling Facility, a remediation response site. Highway 312, RP 12.1.

Photo 19. Looking southeast at the Huntley Museum of Irrigated Agriculture along Railroad Highway. Highway 312, RP 12.7.

Photo 20. Looking southeast at Osborne Park, adjacent to the Huntley Museum along Railroad Highway. Highway 312, RP 12.7.

Photo 21. Looking north on irrigation ditch flowing under Highway 312. Highway 312, RP 14.25.

Photo 22. Looking northeast at approximate location of crude oil pipeline. Highway 312, RP 14.4.

Photo 23. Looking northeast along Highway 312. Highway 312, RP 15.35.

Photo 24. Looking northeast at the Gritty Stone Fishing Access Site (FAS) sign on Highway 312. Highway 312, RP 16.6.

Photo 25. Looking north at the Huntley Project High School recreational facility along W I Road. Highway 312, RP 17.1.

Photo 26. Red Giant Oil Company along Highway 312 in Worden, registered as LUST Facility ID #5602326. Highway 312, RP 17.5.

Photo 27. Looking north (downstream) on Arrow Creek. Highway 312, RP 18.6.

Photo 28. Looking southwest on Voyagers Rest FAS sign. Highway 312, RP 18.9.

Photo 29. Bundy Bridge FAS sign. Highway 312, RP 20.5.

Photo 30. Looking southwest on irrigation ditch along Highway 312. Highway 312, RP 20.5.

Photo 31. Looking north on BLM public land hunting access site. Secondary 568, RP 0.7.

Photo 32. Looking east at the Pompeys Pillar National Monument sign. Secondary 568, RP 0.8.

Photo 33. Roadside interpretive sign for Pompeys Pillar. Secondary 568, RP 0.8.

Photo 34. Roadside interpretive sign for the 1873 Yellowstone Expedition. Secondary 568, RP 0.8.

Photo 35. Looking north on BLM public land hunting access site. Secondary 568, RP 0.6.

Photo 36. Looking northwest on Lewis and Clark Trail sign with Pompeys Pillar in background. Secondary 568, RP 0.05.

Photo 37. Looking southeast on wetland and stream complex under ramp approaching I-94. Secondary 568, RP 0.1.

Transportation System Conditions

Photo 38. Looking west at the western/southern terminus of the corridor at the intersection of US 87 and Highway 312 (under construction for intersection improvements). Highway 312, RP 0.1.

Photo 39. Looking east on Highway 312. Highway 312, RP 0.1.

Photo 40. Dover Road intersection. Highway 312, RP 1.3.

Photo 41. Looking east on Highway 312, transition from 5-lane to 2-lane. Highway 312, RP 2.0.

Photo 42. Looking east on Highway 312 showing typical shoulder and roadside features. Highway 312, RP 2.3.

Photo 43. Looking north at Pioneer Road/Drury Lane intersections with Highway 312. Highway 312, RP 3.5.

Photo 44. Cline Road intersection. Highway 312, RP 4.2.

Photo 45. Hoskins Road intersection. Highway 312, RP 5.7.

Photo 46. Possible sight distance issues northeast of Hoskins Road intersection. Highway 312, RP 5.6.

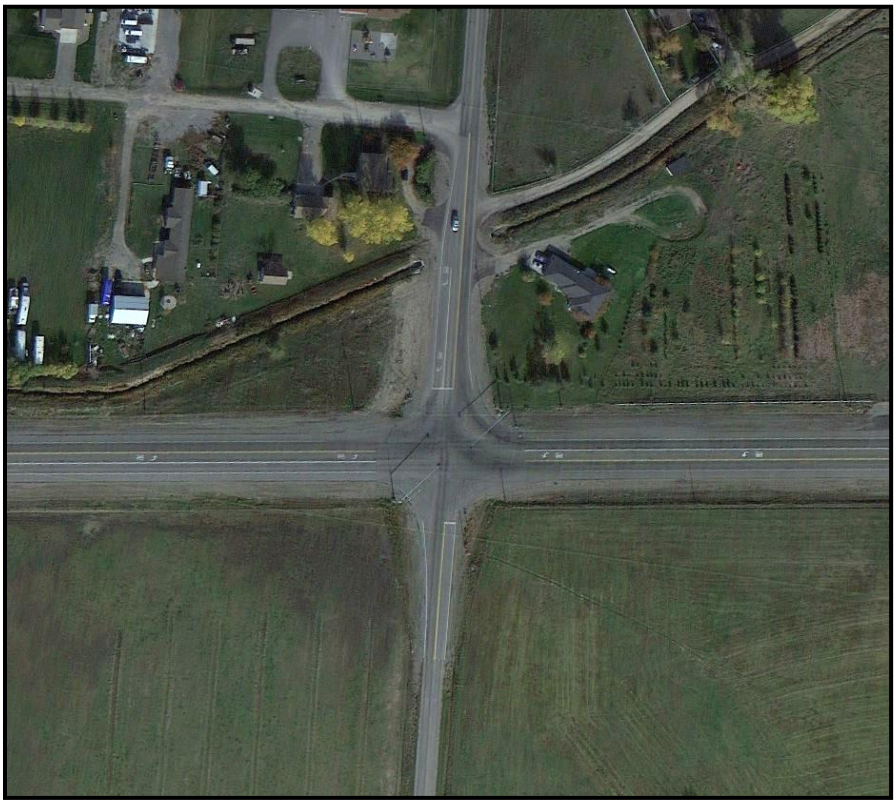


Photo 47. Shepherd Road intersection. Highway 312, RP 7.6.

Photo 48. Looking east at Shepherd Road intersection. Highway 312, RP 7.6.

Photo 49. Looking east at Yellowstone River bridge. Highway 312, 8.7.

Photo 50. Looking east at Yellowstone River bridge. Jersey barrier on south side, curb on north side. Highway 312, RP 8.7.

Photo 51. Nahmis Avenue intersection. Highway 312, RP 8.9.

Photo 52. Northern Avenue and I-94 ramps. Secondary 522, RP 0.0.

Photo 53. Looking east at pedestrian crossing and Barkemeyer Park. Secondary 522, RP 0.9.

Photo 54. Nahmis Avenue/Northern Avenue intersection. Secondary 522, RP 1.0.

Photo 55. Drainage issues at Barkemeyer Park. Secondary 522, 1.0.

Photo 56. Transverse asphalt cracking on 522. Secondary 522, RP 1.8.

Photo 57. Northern Avenue intersection. Highway 312, RP 10.4.

Photo 58. Looking west at Custer Coulee railing within clear zone. Highway 312 RP 12.2.

Photo 59. Worden Main Street intersection. Highway 312, RP 17.4.

Photo 60. Looking west at water in rutted pavement. Highway 312, RP 17.5.

Photo 61. Looking west on Highway 312. Typical shoulder and roadside features. Highway 312, RP 24.9.

Photo 62. Looking southeast at I-94 ramps. Highway 312, RP 25.8.

Photo 63. I-94 Exit 23 ramps (Pompeys Pillar exit). Highway 312, RP 25.9.

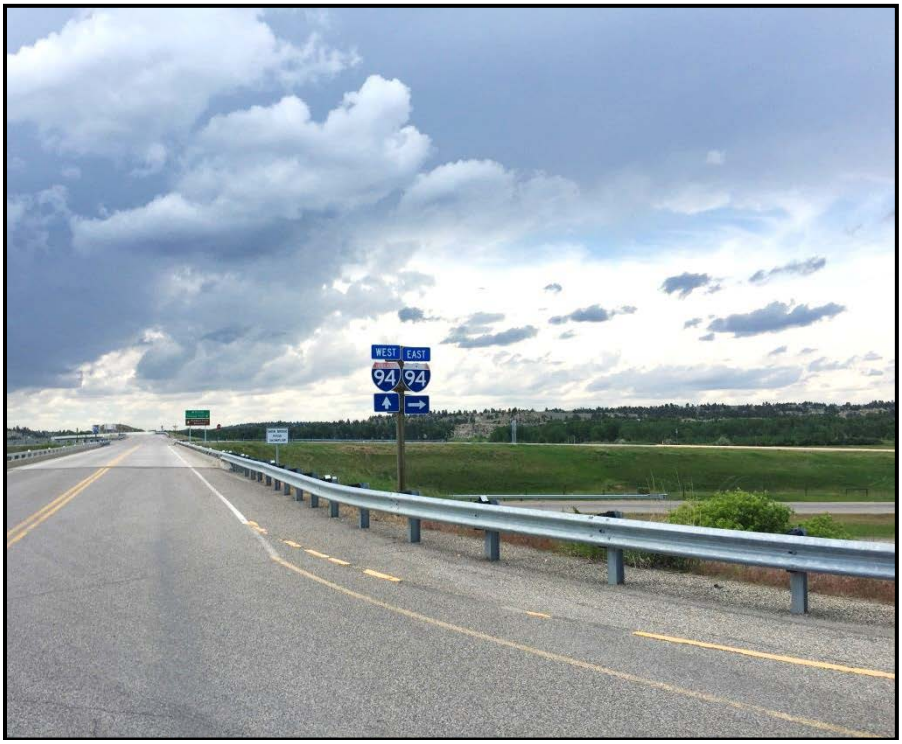


Photo 64. Looking northwest on Highway 312 at faded signs. Highway 312, RP 26.0.

Photo 65. Looking west on Custer Frontage Road I-94 westbound off ramp. Custer Frontage Road, RP 0.1.

ATTACHMENT 2

Right-of-way Data

Old Highway 312 Corridor Study - Right-of-way Analysis

Corridor	As-built / ROW Plan	RP	R/W Offset from Centerline (ft)		Total ROW Width (ft)	Distance (ft)
			Left	Right		
Highway 312	SFCX-STPHS 56(54) / STPHS 56(59)	0.0	70	60	130	1,086
		0.2	70	70	140	951
		0.4	70	80	150	164
		0.4	75	80	155	1,624
		0.7	75	75	150	919
		0.9	75	60	135	312
		1.0	75	75	150	66
		1.0	80	75	155	26
		1.0	80	50	130	157
		1.0	80	70	150	190
		1.0	70	70	140	3,392
		1.7	70	80	150	105
		1.7	90	110	200	131
		1.7	90	85	175	66
		1.7	70	85	155	2,684
		2.2	END SFCX-STPHS 56(54) / STPHS 56(59)			
	FAP 53(8)	2.3	60	60	120	1,901
		2.6	100	100	200	1,056
		2.8	60	60	120	2,323
		3.3	60	50	110	11,299
		5.4	60	60	120	1,690
		5.7	60	80	140	4,858
		6.6	100	100	200	739
		6.8	60	60	120	7,181
		8.1	100	80	180	2,640
		8.6	130	100	230	422
		8.7	END FAP 53(8)			
	FI 53(10)	8.7	Yellowstone River Crossing		0	739
		8.9	100	130	230	739
		9.0	60	60	120	4,858
		9.9	80	60	140	1,003
		10.1	60	60	120	1,901
		10.5	END FI 53(10)			
	NO 53 RECON	10.5	60	35	95	2,925
		11.0	65	35	100	1,800
		11.4	75	35	110	1,500
		11.6	60	35	95	2,200
		12.1	70	35	105	1,000
		12.2	60	35	95	2,500
		12.7	65	35	100	3,000
		13.3	75	35	110	3,000
		13.9	65	35	100	3,000
		14.4	75	35	110	6,000
		15.6	65	35	100	5,500
		16.6	70	35	105	2,000
		17.0	65	35	100	400
		17.1	65	25	90	2,100
		17.5	65	30	95	500
		17.5	END NO 53 RECON			
	NO 53	17.8	65	30	95	1,500
		18.0	60	35	95	3,000
		18.6	35	35	70	3,000
		19.2	45	40	85	3,000
		19.7	60	30	90	3,000
		20.3	65	30	95	6,000
		21.4	40	30	70	3,500
		22.1	50	30	80	2,500
		22.6	30	30	60	3,000
		23.1	55	30	85	3,000
		23.7	60	35	95	3,000
		24.3	60	30	90	3,000
		24.9	End Highway 312/Begin Secondary 568			
Secondary 568	NO 53 / BR 568-1(14)0	1.0	60	30	90	3,485
		0.3	130	130	260	1,795
		0.0	End Secondary 568			
Secondary 522	S-422	0.1	60	90	150	40
		0.1	60	80	140	160
		0.2	80	80	160	760
		0.3	70	80	150	560
		0.4	70	50	120	180
		0.4	50	50	100	720
		0.6	40	50	90	80
		0.6	40	70	110	168
		0.6	50	70	120	133
		0.6	70	60	130	245
		0.7	70	50	120	337
		0.8	40	50	90	198
		0.8	40	40	80	959
		1.0	Secondary 522/Nahmis Avenue Intersection			
	NO 53 RECON	1.0	40	40	80	4,500
		1.9	50	40	90	2,800
		2.4	End Secondary 522			

Source: Available record drawings, ROW plans, and cadastral information, MDT, 2015.

ATTACHMENT 3

Horizontal and Vertical Alignment Data

Old Highway 312 Corridor Study - Horizontal Alignment Analysis

Route	Curve PI [1] (RP)	Curve Type	Curve Length (ft)	Radius (ft)	Deflection Angle [2]	Design Speed (mph)	Superelevation Rate [3]	Min. Sight Obstruction Distance (60 mph: 570') (30 mph: 200')	Meets Max. Superelevation	Meets Min. Sight [4] Distance (60 mph: 570') (30 mph: 200')	Curve Type Correct [5]	Meets Min. Radius [6] (60 mph: 1200') (30 mph: 200')	Meets Min. Curve Length [7] (60 mph: 900') (30 mph: 450')	Curve Pass/Fail	Comments
Hwy 312	0.1	SIMPLE	631	5,732	6° 18' 51"	60	UNKNOWN	7.1	N/A	YES	YES	YES	NO	PASS	All values were converted to English from Metric
Hwy 312	5.6	SIMPLE	1,356	1,910	40° 41'	60	UNKNOWN	21.2	N/A	YES	NO	YES	YES	PASS	No PI from rtx 56(10) & V = 50mph per as-built
Hwy 312	10.0	SIMPLE	2,627	5,730	26° 16'	60	UNKNOWN	7.1	N/A	YES	YES	YES	YES	PASS	
Hwy 312	10.4	SIMPLE	789	3,820	11° 50'	60	UNKNOWN	10.6	N/A	YES	NO	YES	NO	PASS	
Hwy 312	18.4	SIMPLE	217	1,910	6° 30'	60	UNKNOWN	21.2	N/A	YES	NO	YES	NO	PASS	
Hwy 312	18.5	SIMPLE	171	1,433	5° 30'	60	UNKNOWN	28.3	N/A	YES	NO	YES	NO	PASS	
Hwy 312	18.6	SIMPLE	206	1,910	6° 11'	60	UNKNOWN	21.2	N/A	YES	NO	YES	NO	PASS	
S-568	0.1	SPIRAL	1,008	1,148	54° 22' 38"	60	5.00%	35.2	YES	**NO**	YES	**NO**	YES	FAIL	V = 45 mph from UPN 4004, all metric values converted
S-522	0.2	SIMPLE	381	674	32° 25'	60	7.00%	47.1	YES	YES	NO	**NO**	NO	FAIL	Posted speed = 45 mph
S-522	0.4	SIMPLE	239	2,292	5° 50' 30"	30	2.00%	2.2	YES	YES	NO	YES	NO	PASS	Posted speed = 25 mph
S-522	0.6	SIMPLE	568	573	56° 48'	30	4.00%	8.7	YES	YES	NO	YES	YES	PASS	Posted speed = 25 mph
S-522	1.3	SIMPLE	125	193	37° 15'	60	UNKNOWN	174.8	N/A	**NO**	NO	**NO**	NO	FAIL	Posted speed = 45 mph
S-522	1.4	SIMPLE	125	193	37° 15'	60	UNKNOWN	174.8	N/A	**NO**	NO	**NO**	NO	FAIL	Posted speed = 45 mph

Source: MDT, 2015; DOWL, 2015; MDT Record Drawings; MDT Road Design Manual, 2004. All values are approximated based on available data.

[1] PI indicates the point of tangent intersection, which is defined as the intersection of the initial and final tangents.

[2] Deflection angle indicates the average degree of curvature and is a measure of the sharpness of the curve. A larger deflection angle indicates a sharper curve.

[3] Superelevation rate was considered in the Pass/Fail determination where necessary data was available.

[4] Shaded "No" cells result in "Fail" determination.

[5] Per MDT Road Design Manual page 9.2(1), it is MDT practice to use a spiral curve when the radius is less than 3,820 ft. Because curve type is not listed as a design requirement, curve type is not considered in the pass/fail determination.

[6] Shaded "No" cells result in "Fail" determination.

[7] Per MDT Road Design Manual page 9.2(7), it is MDT practice to specify a minimum curve length of 900 ft. and 450' for a design speed of 60 mph and 30 mph, respectively. Because curve length is not listed as a design requirement, curve length is not considered in the pass/fail determination.

Note: Geometrics were analyzed using rural arterial and level terrain design criteria from the HWY 312/US 87 intersection to RP 1.75. Geometrics were analyzed using rural collector and level terrain design criteria for the remainder of the corridor (HWY 312 from RP 1.75 to RP 24.9 and S568 from RP 0.0 to RP 1.0). Geometrics were analyzed using rural collector and level terrain design criteria for the majority of Secondary 522. Where Secondary 522 leads into and out of Huntley (RP 0.4 to RP 1.2), urban design criteria were used to evaluate the geometrics.

As-built information was unavailable between RP 2.3 to RP 3.25; curve data estimated on a best-fit basis using GIS and reference post data.

Old Highway 312 Corridor Study - Vertical Alignment Analysis

Route	RP	Point Type	Curve Type [2]	Curve Length (ft)	K Value[3]	Grade Back	Grade Ahead	Design Speed (mph)	Meet Min. K Value 60 mph: 151/136 [4] 30 mph: 19/37	Meet Max. Grade [5] Minor Arterial: 3% Rural Collector: 5%	Meet Min. Curve Length [6] (60 mph: 180'/1000') (30 mph: 90'/1000')	Curve/Tangent Pass/Fail	Comments
Hwy 312	0.3	VPI	CREST	787	388	-0.201%	-2.230%	60	YES	YES	YES	PASS	All values were converted to English from Metric
Hwy 312	0.4	VPI	SAG	394	215	-2.230%	-0.400%	60	YES	YES	YES	PASS	All values were converted to English from Metric
Hwy 312	0.6	VPI	SAG	656	206	-0.400%	2.782%	60	YES	YES	YES	PASS	All values were converted to English from Metric
Hwy 312	0.8	VPI	CREST	656	417	2.782%	1.210%	60	YES	YES	YES	PASS	All values were converted to English from Metric
Hwy 312	1.1	VPI	SAG	197	334	1.210%	1.799%	60	YES	YES	YES	PASS	All values were converted to English from Metric
Hwy 312	1.3	VPI	SAG	328	404	1.799%	2.610%	60	YES	YES	YES	PASS	All values were converted to English from Metric
Hwy 312	1.7	VPI	CREST	2362	418	2.610%	-3.036%	60	YES	YES	YES	PASS	All values were converted to English from Metric
Hwy 312	2.0	VPI	SAG	394	180	-3.036%	-0.853%	60	YES	YES	YES	PASS	All values were converted to English from Metric
Hwy 312	2.1	VPI	CREST	722	371	-0.853%	-2.801%	60	YES	YES	YES	PASS	All values were converted to English from Metric
Hwy 312	2.7	VPI	SAG	809	245	-4.002%	-0.694%	60	YES	YES	YES	PASS	
Hwy 312	3.2	VPI	CREST	796	1,414	-0.694%	-1.257%	60	YES	YES	YES	PASS	
Hwy 312	3.4	VPI	SAG	332	220	-1.257%	0.249%	60	YES	YES	YES	PASS	
Hwy 312	4.7	VPI	CREST	80	31	0.300%	-2.310%	60	**NO**	YES	NO	FAIL	
Hwy 312	4.7	VPI	SAG	200	95	-2.310%	-0.200%	60	**NO**	YES	YES	FAIL	
Hwy 312	5.1	VPI	CREST	100	60	0.710%	-0.960%	60	**NO**	YES	NO	FAIL	
Hwy 312	5.2	VPI	CREST	200	48	0.510%	-3.660%	60	**NO**	YES	YES	FAIL	
Hwy 312	5.4	VPI	SAG	200	59	-3.660%	-0.270%	60	**NO**	YES	YES	FAIL	
Hwy 312	5.5	VPI	SAG	150	62	1.730%	4.160%	60	**NO**	YES	NO	FAIL	
Hwy 312	5.6	VPI	CREST	200	53	4.160%	0.360%	60	**NO**	YES	YES	FAIL	
Hwy 312	8.4	VPI	CREST	1,186	260	-0.060%	-4.629%	60	YES	YES	YES	PASS	
Hwy 312	8.7	VPI	SAG	600	168	-4.629%	-1.067%	60	YES	YES	YES	PASS	
Hwy 312	9.2	VPI	SAG	800	750	-1.067%	0.000%	60	YES	YES	YES	PASS	
Hwy 312	10.2	VPI	SAG	200	328	0.000%	0.610%	60	YES	YES	YES	PASS	
Hwy 312	10.3	VPI	CREST	200	408	0.610%	0.120%	60	YES	YES	YES	PASS	
Hwy 312	10.5	VPI	CREST	200	1,667	0.120%	0.000%	60	YES	YES	YES	PASS	
Hwy 312	17.8	VPI	CREST	200	258	0.150%	-0.625%	60	YES	YES	YES	PASS	
Hwy 312	18.8	VPI	CREST	400	234	0.460%	-1.250%	60	YES	YES	YES	PASS	
Hwy 312	24.7	VPI	SAG	200	104	-0.625%	1.290%	60	**NO**	YES	YES	FAIL	
Hwy 312	24.8	VPI	CREST	200	146	1.290%	-0.078%	60	**NO**	YES	YES	FAIL	
S-568	0.0	VPI	SAG	197	159	-1.960%	-0.720%	60	YES	YES	YES	PASS	All values were converted to English from Metric
S-568	0.1	VPI	CREST	919	168	3.500%	-1.960%	60	YES	YES	YES	PASS	All values were converted to English from Metric
S-522	0.2	VPI	SAG	406	168	-2.690%	-0.267%	60	YES	YES	YES	PASS	Posted speed = 45 mph
S-522	0.3	VPI	CREST	400	391	-0.267%	-1.290%	60	YES	YES	YES	PASS	Posted speed = 45 mph
S-522	0.6	VPI	CREST	420	491	0.840%	-0.016%	30	YES	YES	YES	PASS	Posted speed = 25 mph
S-522	0.9	VPI	CREST	400	1,509	-0.065%	-0.330%	30	YES	YES	YES	PASS	Posted speed = 25 mph
S-522	3.0/10.4	VPI	CREST	54	16	1.030%	-2.330%	60	**NO**	YES	NO	FAIL	Posted speed = 60 mph
S-522	3.1/10.5	VPI	SAG	200	94	-2.330%	-0.200%	60	**NO**	YES	YES	FAIL	Posted speed = 60 mph

Source: MDT, 2015; DOWL, 2015; MDT Record Drawings; MDT Road Design Manual, 2004. All values are approximated based on best available data.

(1) PVI indicates the point of vertical intersection, which is defined as the intersection of the initial and final tangents.

(2) Sag curves have a positive grade change (as in a valley); crest curves have a negative grade change (as on a hill).

(3) K value is the horizontal distance needed to produce a one percent change in gradient.

(4) Shaded "No" cells result in "Fail" determination.

(5) Shaded "No" cells result in "Fail" determination.

(6) Per MDT Road Design Manual pages 10.5(3) and 10.5(7), it is MDT practice to specify a minimum curve length of 180 ft. and 90 ft. for a design speed of 60 mph and 30 mph, respectively. For aesthetic purposes, a curve length of 1000 ft. is desirable. Because curve length is not listed as a design requirement, curve length is not considered in the pass/fail determination.

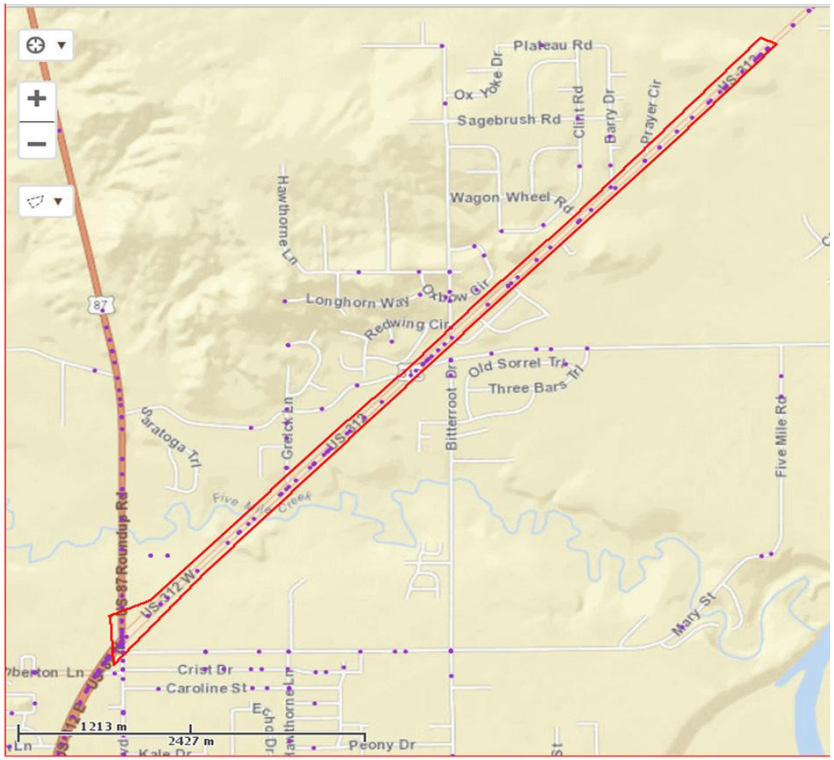
Note: Geometrics were analyzed using rural arterial and level terrain design criteria from the HWY 312/US 87 intersection to RP 1.75. Geometrics were analyzed using rural collector and level terrain design criteria for the remainder of the corridor (HWY 312 from RP 1.75 to RP 24.9 and S568 from RP 0.0 to RP 1.0). Geometrics were analyzed using rural collector and level terrain design criteria for the majority of Secondary 522. Where Secondary 522 leads into and out of Huntley (RP 0.4 to RP 1.2), urban design criteria were used to evaluate the geometrics.

As-built information was unavailable between RP 2.3 to RP 3.25; curve data estimated on a best-fit basis using GIS and reference post data.

ATTACHMENT 4

Crash Data Extraction Limits

Segment 1: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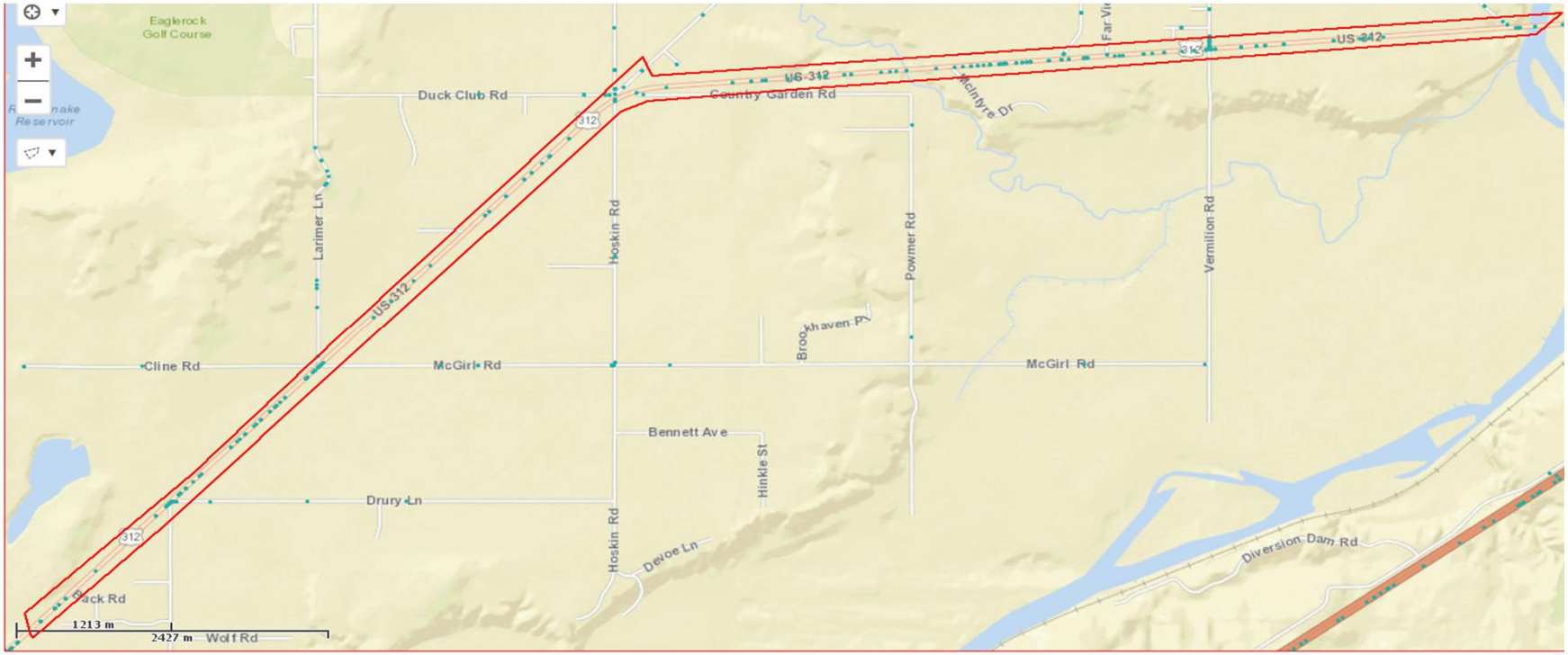
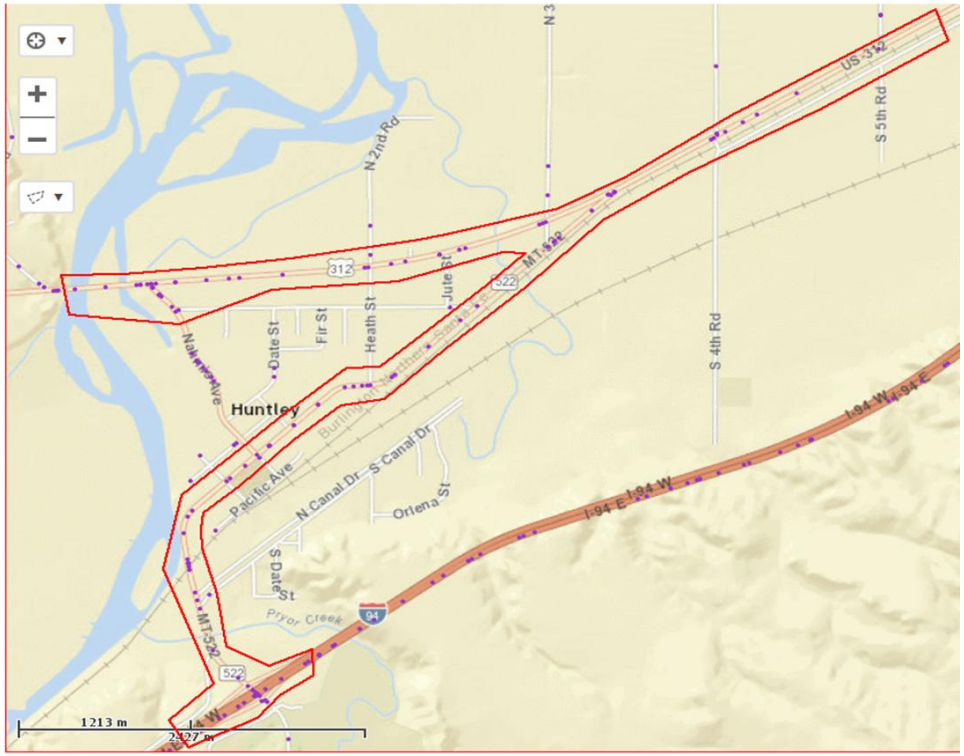
Sagebrush Rd
Clint Rd
Barry Dr
Prayer Cir
Wagon Wheel Rd
Hawthorne Ln
Longhorn Way
Oxbow Cir
Redwing Cir
Old Sorrel Trl
Three Bars Trl
Bitterroot Dr
Five Mile Rd
Saratoga Trl
Gretchen Ln
US-87 Roundup Rd
US-87
US-312 W
US-312
Five Mile Creek
Mary St
Crist Dr
Caroline St
Peony Dr
1213 m
2427 m

Old Highway 312 Corridor Study - Crash Data Extraction Limits

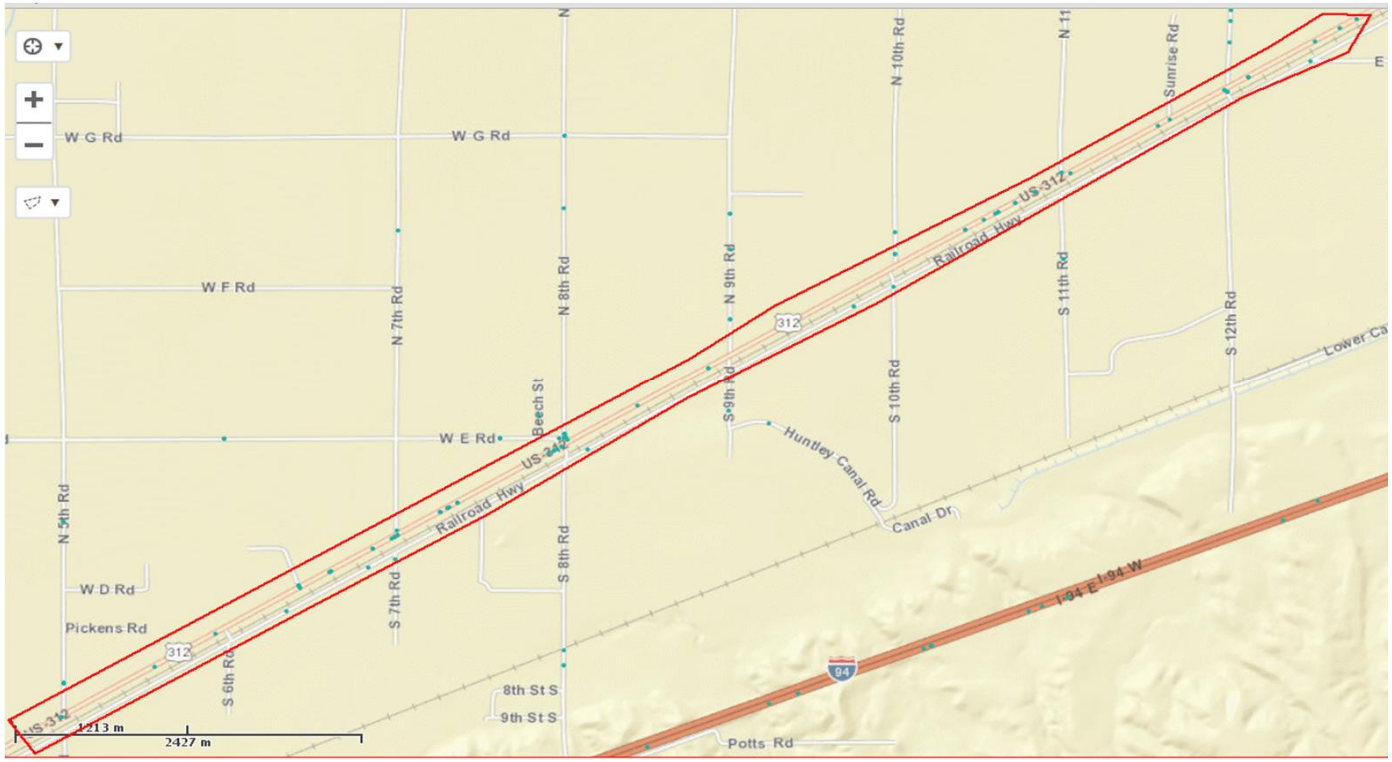
Segment 2:



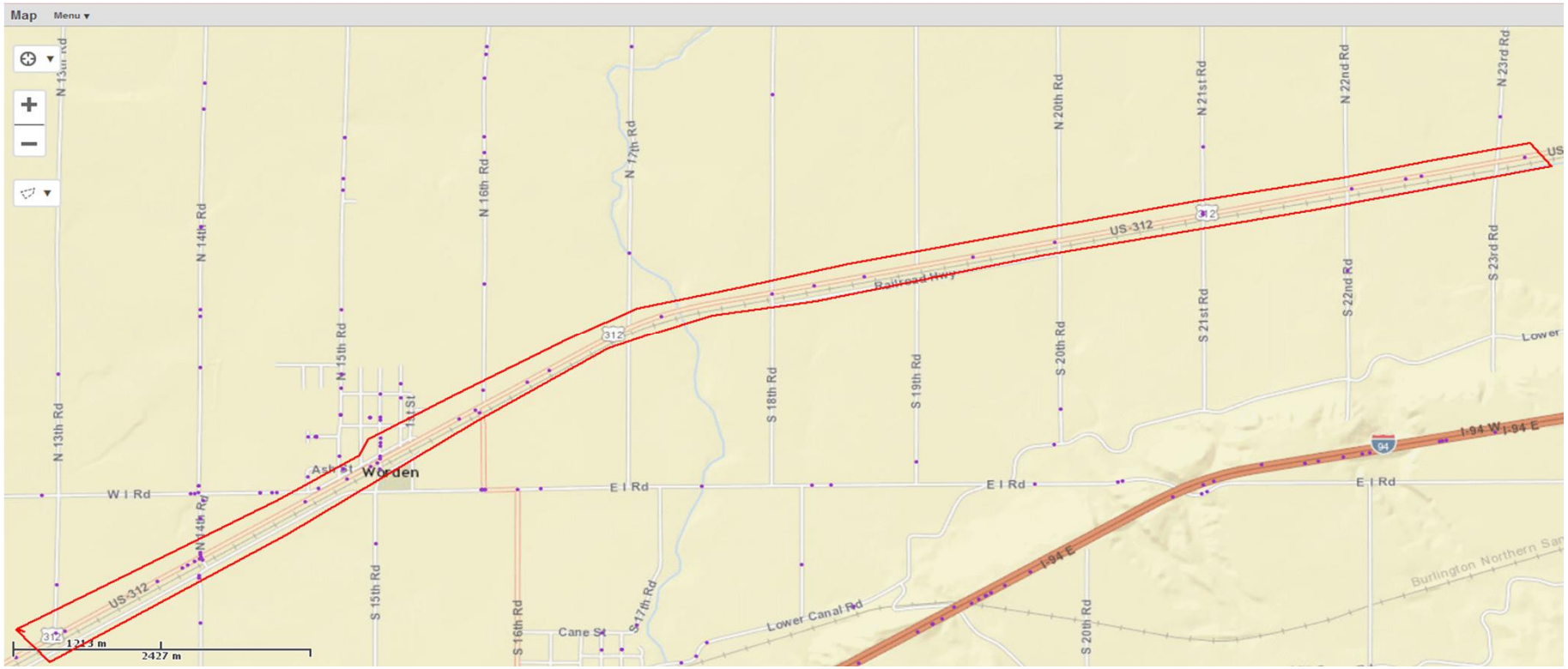
Segment 3:


N 2nd Rd
US-312
S 5th Rd
312
MT-522
522
Jute St
Heath St
Fir St
Date St
S 4th Rd
Huntley
Pacific Ave
N Canal Dr
S Canal Dr
Oriena St
S Date St
I-94 E
I-94 W
94
Pryor Creek
1213 m

Segment 4:

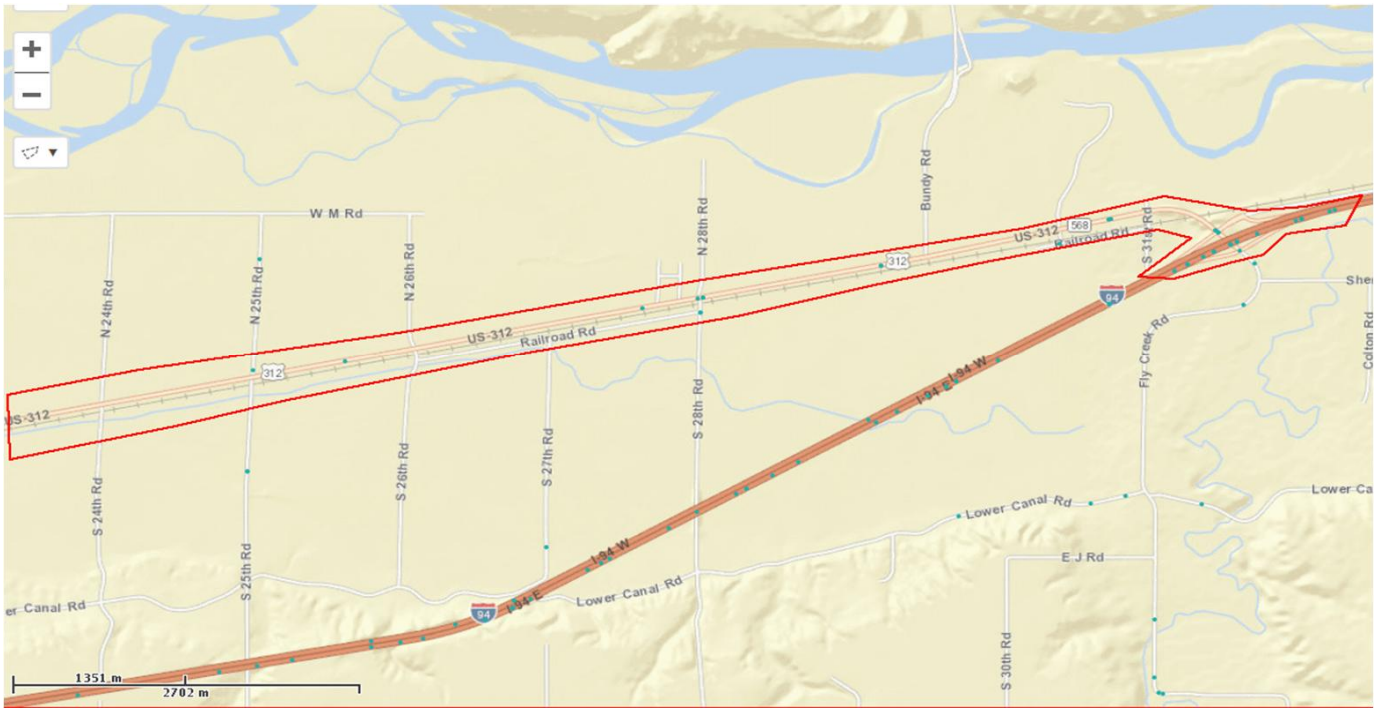

W G Rd
W G Rd
W F Rd
W E Rd
W D Rd
Pickens Rd
N 5th Rd
N 7th Rd
N 8th Rd
N 9th Rd
N 10th Rd
S 6th Rd
S 7th Rd
S 8th Rd
S 9th Rd
S 10th Rd
S 11th Rd
S 12th Rd
Sunrise Rd
Beech St
US 312
Railroad Hwy
312
Huntley Canal Rd
Canal Dr
I-94 E I-94 W
94
8th St S
9th St S
Potts Rd
1213 m
2427 m

Segment 5:


Map
Menu
N 14th Rd
N 16th Rd
N 17th Rd
N 20th Rd
N 21st Rd
N 22nd Rd
N 23rd Rd
US-312
Railroad Hwy
312
N 15th Rd
1st St
Ash St
Worden
N 13th Rd
W I Rd
E I Rd
S 18th Rd
S 19th Rd
S 20th Rd
S 21st Rd
S 22nd Rd
S 23rd Rd
Lower
I-94 W
I-94 E
94
S 15th Rd
S 16th Rd
Cane St
S 17th Rd
Lower Canal Rd
Burlington Northern San
1213 m
2427 m

Old Highway 312 Corridor Study - Crash Data Extraction Limits

Segment 6:



ATTACHMENT 5

LOSS Limits

Old Highway 312 Corridor Study - LOSS

Route	Beginning RP	Total Crash LOSS	Crash Severity LOSS
Highway 312	0.0	LOSS II	LOSS II
	0.1	LOSS II	LOSS II
	0.2	LOSS II	LOSS II
	0.3	LOSS II	LOSS II
	0.4	LOSS III	LOSS III
	0.5	LOSS III	LOSS III
	0.6	LOSS II	LOSS III
	0.7	LOSS II	LOSS III
	0.8	LOSS III	LOSS III
	0.9	LOSS II	LOSS III
	1.0	LOSS II	LOSS II
	1.1	LOSS II	LOSS II
	1.2	LOSS II	LOSS III
	1.3	LOSS II	LOSS III
	1.4	LOSS II	LOSS II
	1.5	LOSS II	LOSS II
	1.6	LOSS II	LOSS II
	1.7	LOSS II	LOSS II
	1.8	LOSS II	LOSS II
	1.9	LOSS II	LOSS II
	2.0	LOSS II	LOSS I
	2.1	LOSS II	LOSS II
	2.2	LOSS II	LOSS II
	2.3	LOSS III	LOSS III
	2.4	LOSS III	LOSS III
	2.5	LOSS III	LOSS III
	2.6	LOSS III	LOSS III
	2.7	LOSS III	LOSS III
	2.8	LOSS II	LOSS II
	2.9	LOSS II	LOSS II
	3.0	LOSS II	LOSS II
	3.1	LOSS II	LOSS III
	3.2	LOSS II	LOSS III
	3.3	LOSS II	LOSS III
	3.4	LOSS III	LOSS IV
	3.5	LOSS III	LOSS IV
	3.6	LOSS III	LOSS IV
	3.7	LOSS III	LOSS IV
	3.8	LOSS III	LOSS IV
	3.9	LOSS III	LOSS IV
	4.0	LOSS II	LOSS II
	4.1	LOSS II	LOSS II
	4.2	LOSS II	LOSS I
	4.3	LOSS I	LOSS I
	4.4	LOSS I	LOSS I
	4.5	LOSS I	LOSS I
	4.6	LOSS II	LOSS I
	4.7	LOSS II	LOSS I
	4.8	LOSS II	LOSS II
	4.9	LOSS II	LOSS II
	5.0	LOSS II	LOSS II
	5.1	LOSS II	LOSS II
	5.2	LOSS II	LOSS II
	5.3	LOSS II	LOSS II
	5.4	LOSS II	LOSS II
	5.5	LOSS II	LOSS II
	5.6	LOSS II	LOSS II
	5.7	LOSS II	LOSS III
	5.8	LOSS II	LOSS II
	5.9	LOSS II	LOSS II
	6.0	LOSS III	LOSS III
	6.1	LOSS IV	LOSS IV
	6.2	LOSS III	LOSS III
	6.3	LOSS III	LOSS IV
	6.4	LOSS IV	LOSS IV
	6.5	LOSS III	LOSS III
	6.6	LOSS III	LOSS IV
	6.7	LOSS III	LOSS IV
	6.8	LOSS II	LOSS III
	6.9	LOSS II	LOSS III
	7.0	LOSS III	LOSS III
	7.1	LOSS III	LOSS II
	7.2	LOSS III	LOSS II
	7.3	LOSS III	LOSS II
	7.4	LOSS II	LOSS II
	7.5	LOSS II	LOSS II
	7.6	LOSS II	LOSS II
	7.7	LOSS II	LOSS II
	7.8	LOSS II	LOSS III
	7.9	LOSS II	LOSS II
	8.0	LOSS II	LOSS II
	8.1	LOSS II	LOSS II
	8.2	LOSS II	LOSS III
	8.3	LOSS II	LOSS II
	8.4	LOSS II	LOSS II
	8.5	LOSS II	LOSS II
	8.6	LOSS II	LOSS II
	8.7	LOSS II	LOSS II
	8.8	LOSS III	LOSS II
	8.9	LOSS IV	LOSS IV
	9.0	LOSS III	LOSS IV
	9.1	LOSS III	LOSS IV
	9.2	LOSS III	LOSS IV
	9.3	LOSS III	LOSS IV
	9.4	LOSS IV	LOSS III
	9.5	LOSS IV	LOSS IV
	9.6	LOSS IV	LOSS IV
	9.7	LOSS IV	LOSS III
	9.8	LOSS III	LOSS III
	9.9	LOSS II	LOSS III
	10.0	LOSS II	LOSS II
	10.1	LOSS II	LOSS II
	10.2	LOSS II	LOSS II
	10.3	LOSS II	LOSS II
	10.4	LOSS II	LOSS II
	10.5	LOSS II	LOSS II
	10.6	LOSS II	LOSS III
	10.7	LOSS II	LOSS III
	10.8	LOSS II	LOSS II
	10.9	LOSS II	LOSS II
	11.0	LOSS II	LOSS II
	11.1	LOSS I	LOSS II
	11.2	LOSS II	LOSS II
	11.3	LOSS II	LOSS II
	11.4	LOSS II	LOSS II
	11.5	LOSS II	LOSS II
	11.6	LOSS II	LOSS II
	11.7	LOSS II	LOSS II
	11.8	LOSS II	LOSS II
	11.9	LOSS II	LOSS II
	12.0	LOSS II	LOSS III
	12.1	LOSS II	LOSS III
	12.2	LOSS II	LOSS IV
	12.3	LOSS II	LOSS III
	12.4	LOSS II	LOSS III
	12.5	LOSS II	LOSS II
	12.6	LOSS II	LOSS II
	12.7	LOSS II	LOSS II
	12.8	LOSS II	LOSS II
	12.9	LOSS II	LOSS II
	13.0	LOSS II	LOSS II
	13.1	LOSS II	LOSS II
	13.2	LOSS II	LOSS II
	13.3	LOSS II	LOSS II
	13.4	LOSS I	LOSS II
	13.5	LOSS I	LOSS II
	13.6	LOSS I	LOSS II
	13.7	LOSS I	LOSS II
	13.8	LOSS I	LOSS II
	13.9	LOSS I	LOSS II
	14.0	LOSS I	LOSS II
	14.1	LOSS II	LOSS II
	14.2	LOSS II	LOSS II
	14.3	LOSS III	LOSS II
	14.4	LOSS III	LOSS III
	14.5	LOSS III	LOSS III
	14.6	LOSS II	LOSS III
	14.7	LOSS II	LOSS II
	14.8	LOSS II	LOSS II
	14.9	LOSS II	LOSS II

Old Highway 312 Corridor Study - LOSS

Route	Beginning RP	Total Crash LOSS	Crash Severity LOSS
Highway 312	15.0	LOSS II	LOSS II
	15.1	LOSS II	LOSS II
	15.2	LOSS II	LOSS II
	15.3	LOSS II	LOSS III
	15.4	LOSS II	LOSS IV
	15.5	LOSS II	LOSS IV
	15.6	LOSS II	LOSS IV
	15.7	LOSS II	LOSS IV
	15.8	LOSS II	LOSS III
	15.9	LOSS II	LOSS II
	16.0	LOSS II	LOSS II
	16.1	LOSS II	LOSS II
	16.2	LOSS II	LOSS II
	16.3	LOSS II	LOSS II
	16.4	LOSS II	LOSS II
	16.5	LOSS II	LOSS II
	16.6	LOSS II	LOSS II
	16.7	LOSS I	LOSS II
	16.8	LOSS I	LOSS II
	16.9	LOSS II	LOSS II
	17.0	LOSS II	LOSS II
	17.1	LOSS II	LOSS II
	17.2	LOSS II	LOSS III
	17.3	LOSS II	LOSS III
	17.4	LOSS II	LOSS II
	17.5	LOSS II	LOSS II
	17.6	LOSS II	LOSS III
	17.7	LOSS II	LOSS II
	17.8	LOSS II	LOSS II
	17.9	LOSS II	LOSS II
	18.0	LOSS II	LOSS II
	18.1	LOSS II	LOSS II
	18.2	LOSS II	LOSS II
	18.3	LOSS II	LOSS II
	18.4	LOSS II	LOSS II
	18.5	LOSS II	LOSS II
	18.6	LOSS II	LOSS II
	18.7	LOSS II	LOSS II
	18.8	LOSS II	LOSS II
	18.9	LOSS II	LOSS II
	19.0	LOSS II	LOSS II
	19.1	LOSS II	LOSS II
	19.2	LOSS II	LOSS II
	19.3	LOSS II	LOSS II
	19.4	LOSS II	LOSS II
	19.5	LOSS II	LOSS II
	19.6	LOSS II	LOSS II
	19.7	LOSS II	LOSS II
	19.8	LOSS II	LOSS II
	19.9	LOSS II	LOSS II
	20.0	LOSS I	LOSS II
	20.1	LOSS I	LOSS II
	20.2	LOSS I	LOSS II
	20.3	LOSS I	LOSS II
	20.4	LOSS I	LOSS II
	20.5	LOSS II	LOSS II
	20.6	LOSS II	LOSS II
	20.7	LOSS II	LOSS II
	20.8	LOSS II	LOSS II
	20.9	LOSS II	LOSS II
	21.0	LOSS II	LOSS II
	21.1	LOSS II	LOSS II
	21.2	LOSS II	LOSS II
	21.3	LOSS II	LOSS II
	21.4	LOSS II	LOSS II
	21.5	LOSS II	LOSS II
	21.6	LOSS II	LOSS II
	21.7	LOSS I	LOSS II
	21.8	LOSS I	LOSS II
	21.9	LOSS I	LOSS II
	22.0	LOSS I	LOSS II
	22.1	LOSS I	LOSS II
	22.2	LOSS I	LOSS II
	22.3	LOSS I	LOSS II
	22.4	LOSS II	LOSS II
Highway 312	22.5	LOSS II	LOSS II
	22.6	LOSS II	LOSS II
	22.7	LOSS II	LOSS II
	22.8	LOSS II	LOSS II
	22.9	LOSS I	LOSS II
	23.0	LOSS I	LOSS II
	23.1	LOSS I	LOSS II
	23.2	LOSS I	LOSS II
	23.3	LOSS I	LOSS II
	23.4	LOSS II	LOSS II
	23.5	LOSS II	LOSS II
	23.6	LOSS II	LOSS II
	23.7	LOSS II	LOSS II
	23.8	LOSS II	LOSS II
	23.9	LOSS II	LOSS II
	24.0	LOSS II	LOSS II
	24.1	LOSS I	LOSS II
	24.2	LOSS I	LOSS II
	24.3	LOSS I	LOSS II
	24.4	LOSS I	LOSS II
	24.5	LOSS I	LOSS II
	24.6	LOSS I	LOSS II
	24.7	LOSS I	LOSS II
	24.8	LOSS I	LOSS II
	24.9	LOSS I	LOSS II
Secondary 568	0.0	LOSS IV	LOSS IV
	0.1	LOSS IV	LOSS IV
	0.2	LOSS IV	LOSS IV
	0.3	LOSS IV	LOSS IV
	0.4	LOSS IV	LOSS IV
	0.5	LOSS II	LOSS II
	0.6	LOSS II	LOSS II
	0.7	LOSS II	LOSS II
	0.8	LOSS II	LOSS II
Secondary 522	0.0	LOSS III	LOSS IV
	0.1	LOSS III	LOSS III
	0.2	LOSS III	LOSS III
	0.3	LOSS III	LOSS III
	0.4	LOSS III	LOSS III
	0.5	LOSS III	LOSS III
	0.6	LOSS III	LOSS III
	0.7	LOSS III	LOSS III
	0.8	LOSS III	LOSS III
	0.9	LOSS III	LOSS III
	1.0	LOSS III	LOSS IV
	1.1	LOSS III	LOSS IV
	1.2	LOSS IV	LOSS IV
	1.3	LOSS IV	LOSS IV
	1.4	LOSS III	LOSS IV
	1.5	LOSS III	LOSS IV
	1.6	LOSS III	LOSS IV
	1.7	LOSS IV	LOSS III
	1.8	LOSS IV	LOSS III
	1.9	LOSS IV	LOSS III

Source: MDT, 2015.

Beginning RPs listed above correspond to Total Crash LOSS and Crash Severity LOSS figures in the Existing and Projected Conditions Report.

LOSS I: Indicates low potential for crash reduction.

LOSS II: Indicates low to moderate potential for crash reduction.

LOSS III: Indicates moderate to high potential for crash reduction.

LOSS IV: Indicates high potential for crash reduction.

ATTACHMENT 6

Operational Analysis Worksheets

Segment Analysis

2015

Phone: Fax:
E-mail:

OPERATIONAL ANALYSIS

Analyst:	JSP
Agency/Co:	DOWL
Date:	7/17/2015
Analysis Period:	Peak Hour
Highway:	Old Highway 312, Segment 1
From/To:	Bench Blvd to Barry Dr
Jurisdiction:	MDT
Analysis Year:	2015
Project ID:	-

FREE-FLOW SPEED

Direction	1		2	
Lane width	12.0	ft	12.0	ft
Lateral clearance:				
Right edge	6.0	ft	6.0	ft
Left edge	6.0	ft	6.0	ft
Total lateral clearance	12.0	ft	12.0	ft
Access points per mile	13		13	
Median type	Divided		Divided	
Free-flow speed:	Base		Base	
FFS or BFFS	50.0	mph	50.0	mph
Lane width adjustment, FLW	0.0	mph	0.0	mph
Lateral clearance adjustment, FLC	0.0	mph	0.0	mph
Median type adjustment, FM	0.0	mph	0.0	mph
Access points adjustment, FA	3.3	mph	3.3	mph
Free-flow speed	46.8	mph	46.8	mph

VOLUME

Direction	1		2	
Volume, V	647	vph	422	vph
Peak-hour factor, PHF	0.96		0.96	
Peak 15-minute volume, v15	168		110	
Trucks and buses	12	%	3	%
Recreational vehicles	1	%	1	%
Terrain type	Level		Level	
Grade	0.00	%	0.00	%
Segment length	0.00	mi	0.00	mi
Number of lanes	2		2	
Driver population adjustment, fP	1.00		1.00	
Trucks and buses PCE, ET	1.5		1.5	
Recreational vehicles PCE, ER	1.2		1.2	
Heavy vehicle adjustment, fHV	0.942		0.983	
Flow rate, vp	357	pcphpl	223	pcphpl

RESULTS

Direction	1		2	
Flow rate, vp	357	pcphpl	223	pcphpl
Free-flow speed, FFS	46.8	mph	46.8	mph
Avg. passenger-car travel speed, S	45.0	mph	45.0	mph
Level of service, LOS	A		A	
Density, D	7.9	pc/mi/ln	5.0	pc/mi/ln

Bicycle Level of Service

Posted speed limit, Sp	55	55
Percent of segment with occupied on-highway parking	0	0
Pavement rating, P	3	3
Flow rate in outside lane, vOL	337.0	219.8
Effective width of outside lane, We	24.00	24.00
Effective speed factor, St	4.79	4.79
Bicycle LOS Score, BLOS	5.74	2.34
Bicycle LOS	F	B

Overall results are not computed when free-flow speed is less than 45 mph.

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 2
From/To	Barry Dr to Hoskins Rd
Jurisdiction	MDT
Analysis Year	2015
Description	Eastbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.97	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	3.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	46	%
Up/down	-	%	Access point density	13	/mi

Analysis direction volume, Vd	511	veh/h
Opposing direction volume, Vo	265	veh/h

Average Travel Speed

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.2	1.4
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adj. factor,(note-5) fHV	0.998	0.996
Grade adj. factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	528 pc/h	274 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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	52.5	mi/h
Adjustment for no-passing zones, fnp	2.3	mi/h
Average travel speed, ATSd	44.0	mi/h
Percent Free Flow Speed, PFFS	83.7	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.0	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	1.000	0.999
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	527 pc/h	273 pc/h
Base percent time-spent-following,(note-4) BPTSFd	49.1 %	
Adjustment for no-passing zones, fnp	32.0	
Percent time-spent-following, PTSFd	70.2 %	

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	461	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1789	veh-mi
Peak 15-min total travel time, TT15	10.5	veh-h
Capacity from ATS, CdATS	1693	veh/h
Capacity from PTSF, CdPTSF	1698	veh/h
Directional Capacity	1693	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	3.5	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)	44.0	mi/h
Percent time-spent-following, PTSFd (from above)	70.2	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	526.8
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.34
Bicycle LOS	D

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.

HCS 2010: Two-Lane Highways Release 6.65

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 2
From/To	Barry Dr to Hoskins Rd
Jurisdiction	MDT
Analysis Year	2015
Description	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.97	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	3.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	1	%
Grade: Length	-	mi	% No-passing zones	49	%
Up/down	-	%	Access point density	13	/mi

Analysis direction volume, Vd	265	veh/h
Opposing direction volume, Vo	511	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.4		1.2	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.996		0.998	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	274	pc/h	528	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	52.5	mi/h
Adjustment for no-passing zones, fnp	1.5	mi/h
Average travel speed, ATSd	44.8	mi/h
Percent Free Flow Speed, PFFS	85.3	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.0
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.999	1.000
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	273 pc/h	527 pc/h
Base percent time-spent-following,(note-4) BPTSFd	34.6 %	
Adjustment for no-passing zones, fnp	32.7	
Percent time-spent-following, PTSFd	45.8 %	

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.16	
Peak 15-min vehicle-miles of travel, VMT15	239	veh-mi
Peak-hour vehicle-miles of travel, VMT60	928	veh-mi
Peak 15-min total travel time, TT15	5.3	veh-h
Capacity from ATS, CdATS	1697	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1697	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	3.5	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)	44.8	mi/h
Percent time-spent-following, PTSFd (from above)	45.8	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	273.2
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.01
Bicycle LOS	D

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.

HCS 2010: Two-Lane Highways Release 6.65

Phone: Fax:
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Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 3
From/To	Hoskins Rd to Nahmis Ave
Jurisdiction	MDT
Analysis Year	2015
Description	Eastbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.90	
Shoulder width	1.0	ft	% Trucks and buses	0	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	59	%
Up/down	-	%	Access point density	17	/mi

Analysis direction volume, Vd	312	veh/h
Opposing direction volume, Vo	216	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.4		1.5	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	1.000		1.000	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	347	pc/h	240	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	4.3	mi/h
Free-flow speed, FFSd	51.5	mi/h
Adjustment for no-passing zones, fnp	3.1	mi/h
Average travel speed, ATSd	43.9	mi/h
Percent Free Flow Speed, PFFS	85.2	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	1.000	1.000
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	347 pc/h	240 pc/h
Base percent time-spent-following,(note-4) BPTSFd	36.1 %	
Adjustment for no-passing zones, fnp	51.1	
Percent time-spent-following, PTSFd	66.3 %	

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.20	
Peak 15-min vehicle-miles of travel, VMT15	173	veh-mi
Peak-hour vehicle-miles of travel, VMT60	624	veh-mi
Peak 15-min total travel time, TT15	3.9	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1700	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.0	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)	43.9	mi/h
Percent time-spent-following, PTSFd (from above)	66.3	
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	E	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	346.7
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	3.92
Bicycle LOS	D

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	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 3
From/To	Hoskins Rd to Nahmis Ave
Jurisdiction	MDT
Analysis Year	2015
Description	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.90	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	1	%
Grade: Length	-	mi	% No-passing zones	64	%
Up/down	-	%	Access point density	17	/mi

Analysis direction volume, Vd	216	veh/h
Opposing direction volume, Vo	312	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.5		1.4	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.995		0.996	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	241	pc/h	348	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	4.3	mi/h
Free-flow speed, FFSd	51.5	mi/h
Adjustment for no-passing zones, fnp	2.6	mi/h
Average travel speed, ATSd	44.3	mi/h
Percent Free Flow Speed, PFFS	86.0	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.999	0.999
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	240 pc/h	347 pc/h
Base percent time-spent-following,(note-4) BPTSFd	28.7 %	
Adjustment for no-passing zones, fnp	51.8	
Percent time-spent-following, PTSFd	49.9 %	

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.14	
Peak 15-min vehicle-miles of travel, VMT15	120	veh-mi
Peak-hour vehicle-miles of travel, VMT60	432	veh-mi
Peak 15-min total travel time, TT15	2.7	veh-h
Capacity from ATS, CdATS	1693	veh/h
Capacity from PTSF, CdPTSF	1698	veh/h
Directional Capacity	1693	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.0	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)	44.3	mi/h
Percent time-spent-following, PTSFd (from above)	49.9	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	240.0
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	3.94
Bicycle LOS	D

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	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 4
From/To	Nahmis Ave to Northern Ave
Jurisdiction	MDT
Analysis Year	2015
Description	Eastbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.96	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.8	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	1	%
Grade: Length	-	mi	% No-passing zones	51	%
Up/down	-	%	Access point density	12	/mi

Analysis direction volume, Vd	230	veh/h
Opposing direction volume, Vo	248	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.5		1.4	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.995		0.996	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	241	pc/h	259	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.0	mi/h
Free-flow speed, FFSd	52.8	mi/h
Adjustment for no-passing zones, fnp	2.6	mi/h
Average travel speed, ATSd	46.3	mi/h
Percent Free Flow Speed, PFFS	87.7	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.999	0.999
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	240 pc/h	259 pc/h
Base percent time-spent-following,(note-4) BPTSFd	26.3 %	
Adjustment for no-passing zones, fnp	53.5	
Percent time-spent-following, PTSFd	52.0 %	

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.14	
Peak 15-min vehicle-miles of travel, VMT15	167	veh-mi
Peak-hour vehicle-miles of travel, VMT60	639	veh-mi
Peak 15-min total travel time, TT15	3.6	veh-h
Capacity from ATS, CdATS	1693	veh/h
Capacity from PTSF, CdPTSF	1698	veh/h
Directional Capacity	1693	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.8	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)	46.3	mi/h
Percent time-spent-following, PTSFd (from above)	52.0	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	239.6
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.02
Bicycle LOS	D

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	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 4
From/To	Nahmis Ave to Northern Ave
Jurisdiction	MDT
Analysis Year	2015
Description	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.96	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.8	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	43	%
Up/down	-	%	Access point density	12	/mi

Analysis direction volume, Vd	248	veh/h
Opposing direction volume, Vo	230	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.4		1.5	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.996		0.995	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	259	pc/h	241	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.0	mi/h
Free-flow speed, FFSd	52.8	mi/h
Adjustment for no-passing zones, fnp	2.3	mi/h
Average travel speed, ATSd	46.6	mi/h
Percent Free Flow Speed, PFFS	88.3	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.999	0.999
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	259 pc/h	240 pc/h
Base percent time-spent-following,(note-4) BPTSFd	28.6 %	
Adjustment for no-passing zones, fnp	50.8	
Percent time-spent-following, PTSFd	55.0 %	

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	180	veh-mi
Peak-hour vehicle-miles of travel, VMT60	689	veh-mi
Peak 15-min total travel time, TT15	3.9	veh-h
Capacity from ATS, CdATS	1692	veh/h
Capacity from PTSF, CdPTSF	1698	veh/h
Directional Capacity	1692	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.8	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)	46.6	mi/h
Percent time-spent-following, PTSFd (from above)	55.0	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	258.3
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	3.98
Bicycle LOS	D

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	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 5
From/To	I-94 WB Ramp to Northern Ave
Jurisdiction	MDT
Analysis Year	2015
Description	Eastbound Traffic

Input Data

Highway class	Class 3		Peak hour factor, PHF	0.87	
Shoulder width	1.0	ft	% Trucks and buses	3	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.3	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	1	%
Grade: Length	-	mi	% No-passing zones	100	%
Up/down	-	%	Access point density	15	/mi

Analysis direction volume, Vd	315	veh/h
Opposing direction volume, Vo	172	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.3		1.5	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.991		0.985	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	365	pc/h	201	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.8	mi/h
Free-flow speed, FFSd	52.0	mi/h
Adjustment for no-passing zones, fnp	4.0	mi/h
Average travel speed, ATSd	43.6	mi/h
Percent Free Flow Speed, PFFS	83.8	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.997	0.997
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	363 pc/h	198 pc/h
Base percent time-spent-following,(note-4) BPTSFd	35.2 %	
Adjustment for no-passing zones, fnp	51.4	
Percent time-spent-following, PTSFd	68.5 %	

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.21	
Peak 15-min vehicle-miles of travel, VMT15	208	veh-mi
Peak-hour vehicle-miles of travel, VMT60	724	veh-mi
Peak 15-min total travel time, TT15	4.8	veh-h
Capacity from ATS, CdATS	1675	veh/h
Capacity from PTSF, CdPTSF	1695	veh/h
Directional Capacity	1675	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.3	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)	43.6	mi/h
Percent time-spent-following, PTSFd (from above)	68.5	
Level of service, LOSd (from above)	B	

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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	362.1
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.63
Bicycle LOS	E

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	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 5
From/To	I-94 WB Ramp to Northern Ave
Jurisdiction	MDT
Analysis Year	2015
Description	Westbound Traffic

Input Data

Highway class	Class 3		Peak hour factor, PHF	0.87	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.3	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	1	%
Grade: Length	-	mi	% No-passing zones	100	%
Up/down	-	%	Access point density	15	/mi

Analysis direction volume, Vd	172	veh/h
Opposing direction volume, Vo	315	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.5		1.3	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.995		0.997	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	199	pc/h	363	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.8	mi/h
Free-flow speed, FFSd	52.0	mi/h
Adjustment for no-passing zones, fnp	3.0	mi/h
Average travel speed, ATSd	44.7	mi/h
Percent Free Flow Speed, PFFS	85.9	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.999	0.999
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	198 pc/h	362 pc/h
Base percent time-spent-following,(note-4) BPTSFd	24.3 %	
Adjustment for no-passing zones, fnp	51.4	
Percent time-spent-following, PTSFd	42.5 %	

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.12	
Peak 15-min vehicle-miles of travel, VMT15	114	veh-mi
Peak-hour vehicle-miles of travel, VMT60	396	veh-mi
Peak 15-min total travel time, TT15	2.5	veh-h
Capacity from ATS, CdATS	1695	veh/h
Capacity from PTSF, CdPTSF	1698	veh/h
Directional Capacity	1695	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.3	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)	44.7	mi/h
Percent time-spent-following, PTSFd (from above)	42.5	
Level of service, LOSd (from above)	B	

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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	197.7
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	3.85
Bicycle LOS	D

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	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 6
From/To	Northern Ave to Main St
Jurisdiction	MDT
Analysis Year	2015
Description	Eastbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.91	
Shoulder width	1.0	ft	% Trucks and buses	2	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	7.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	2	%
Grade: Length	-	mi	% No-passing zones	25	%
Up/down	-	%	Access point density	5	/mi

Analysis direction volume, Vd	183	veh/h
Opposing direction volume, Vo	114	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.5		1.8	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.990		0.984	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	203	pc/h	127	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	1.3	mi/h
Free-flow speed, FFSd	54.5	mi/h
Adjustment for no-passing zones, fnp	0.9	mi/h
Average travel speed, ATSd	51.1	mi/h
Percent Free Flow Speed, PFFS	93.6	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.998	0.998
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	202 pc/h	126 pc/h
Base percent time-spent-following,(note-4) BPTSFd	21.7 %	
Adjustment for no-passing zones, fnp	35.7	
Percent time-spent-following, PTSFd	43.7 %	

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.12	
Peak 15-min vehicle-miles of travel, VMT15	352	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1281	veh-mi
Peak 15-min total travel time, TT15	6.9	veh-h
Capacity from ATS, CdATS	1673	veh/h
Capacity from PTSF, CdPTSF	1697	veh/h
Directional Capacity	1673	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	7.0	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)	51.1	mi/h
Percent time-spent-following, PTSFd (from above)	43.7	
Level of service, LOSd (from above)	B	

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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	201.1
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.08
Bicycle LOS	D

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	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 6
From/To	Northern Ave to Main St
Jurisdiction	MDT
Analysis Year	2015
Description	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.91	
Shoulder width	1.0	ft	% Trucks and buses	2	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	7.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	28	%
Up/down	-	%	Access point density	5	/mi

Analysis direction volume, Vd	114	veh/h
Opposing direction volume, Vo	183	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.8		1.5	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.984		0.990	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	127	pc/h	203	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	1.3	mi/h
Free-flow speed, FFSd	54.5	mi/h
Adjustment for no-passing zones, fnp	1.8	mi/h
Average travel speed, ATSd	50.2	mi/h
Percent Free Flow Speed, PFFS	92.0	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.998	0.998
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	126 pc/h	202 pc/h
Base percent time-spent-following,(note-4) BPTSFd	14.3 %	
Adjustment for no-passing zones, fnp	37.1	
Percent time-spent-following, PTSFd	28.6 %	

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.07	
Peak 15-min vehicle-miles of travel, VMT15	219	veh-mi
Peak-hour vehicle-miles of travel, VMT60	798	veh-mi
Peak 15-min total travel time, TT15	4.4	veh-h
Capacity from ATS, CdATS	1683	veh/h
Capacity from PTSF, CdPTSF	1697	veh/h
Directional Capacity	1683	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	7.0	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)	50.2	mi/h
Percent time-spent-following, PTSFd (from above)	28.6	
Level of service, LOSd (from above)	B	

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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	125.3
Effective width of outside lane, We	18.59
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	2.96
Bicycle LOS	C

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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Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 7
From/To	Main St to Custer Frontage Rd
Jurisdiction	MDT
Analysis Year	2015
Description	Eastbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.81	
Shoulder width	1.0	ft	% Trucks and buses	0	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	8.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	37	%
Up/down	-	%	Access point density	5	/mi

Analysis direction volume, Vd	29	veh/h
Opposing direction volume, Vo	26	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.9		1.9	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	1.000		1.000	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	36	pc/h	32	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	1.3	mi/h
Free-flow speed, FFSd	54.5	mi/h
Adjustment for no-passing zones, fnp	1.1	mi/h
Average travel speed, ATSd	53.0	mi/h
Percent Free Flow Speed, PFFS	97.1	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	1.000	1.000
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	36 pc/h	32 pc/h
Base percent time-spent-following,(note-4) BPTSFd	4.5 %	
Adjustment for no-passing zones, fnp	40.8	
Percent time-spent-following, PTSFd	26.1 %	

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.02	
Peak 15-min vehicle-miles of travel, VMT15	76	veh-mi
Peak-hour vehicle-miles of travel, VMT60	247	veh-mi
Peak 15-min total travel time, TT15	1.4	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1700	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	8.5	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)	53.0	mi/h
Percent time-spent-following, PTSFd (from above)	26.1	
Level of service, LOSd (from above)	B	

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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	35.8
Effective width of outside lane, We	24.11
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	0.71
Bicycle LOS	A

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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Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 7
From/To	Main St to Custer Frontage Rd
Jurisdiction	MDT
Analysis Year	2015
Description	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.81	
Shoulder width	1.0	ft	% Trucks and buses	4	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	8.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	35	%
Up/down	-	%	Access point density	5	/mi

Analysis direction volume, Vd	26	veh/h
Opposing direction volume, Vo	29	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.9		1.9	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.965		0.965	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	33	pc/h	37	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	1.3	mi/h
Free-flow speed, FFSd	54.5	mi/h
Adjustment for no-passing zones, fnp	1.0	mi/h
Average travel speed, ATSd	53.0	mi/h
Percent Free Flow Speed, PFFS	97.2	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.996	0.996
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	32 pc/h	36 pc/h
Base percent time-spent-following,(note-4) BPTSFd	4.0 %	
Adjustment for no-passing zones, fnp	39.5	
Percent time-spent-following, PTSFd	22.6 %	

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.02	
Peak 15-min vehicle-miles of travel, VMT15	68	veh-mi
Peak-hour vehicle-miles of travel, VMT60	221	veh-mi
Peak 15-min total travel time, TT15	1.3	veh-h
Capacity from ATS, CdATS	1641	veh/h
Capacity from PTSF, CdPTSF	1693	veh/h
Directional Capacity	1641	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	8.5	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)	53.0	mi/h
Percent time-spent-following, PTSFd (from above)	22.6	
Level of service, LOSd (from above)	B	

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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	32.1
Effective width of outside lane, We	24.31
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.56
Bicycle LOS	B

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.

Segment Analysis

2035 Without Billings Bypass

Phone: Fax:
E-mail:

OPERATIONAL ANALYSIS

Analyst: JSP
Agency/Co: DOWL
Date: 7/17/2015
Analysis Period: Peak Hour
Highway: Old Highway 312, Segment 1
From/To: Bench Blvd to Barry Dr
Jurisdiction: MDT
Analysis Year: 2035
Project ID: -

FREE-FLOW SPEED

Direction	1		2	
Lane width	12.0	ft	12.0	ft
Lateral clearance:				
Right edge	6.0	ft	6.0	ft
Left edge	6.0	ft	6.0	ft
Total lateral clearance	12.0	ft	12.0	ft
Access points per mile	13		13	
Median type	Divided		Divided	
Free-flow speed:	Base		Base	
FFS or BFFS	50.0	mph	50.0	mph
Lane width adjustment, FLW	0.0	mph	0.0	mph
Lateral clearance adjustment, FLC	0.0	mph	0.0	mph
Median type adjustment, FM	0.0	mph	0.0	mph
Access points adjustment, FA	3.3	mph	3.3	mph
Free-flow speed	46.8	mph	46.8	mph

VOLUME

Direction	1		2	
Volume, V	924	vph	603	vph
Peak-hour factor, PHF	0.96		0.96	
Peak 15-minute volume, v15	241		157	
Trucks and buses	12	%	3	%
Recreational vehicles	1	%	1	%
Terrain type	Level		Level	
Grade	0.00	%	0.00	%
Segment length	0.00	mi	0.00	mi
Number of lanes	2		2	
Driver population adjustment, fP	1.00		1.00	
Trucks and buses PCE, ET	1.5		1.5	
Recreational vehicles PCE, ER	1.2		1.2	
Heavy vehicle adjustment, fHV	0.942		0.983	
Flow rate, vp	511	pcphpl	319	pcphpl

RESULTS

Direction	1		2	
Flow rate, vp	511	pcphpl	319	pcphpl
Free-flow speed, FFS	46.8	mph	46.8	mph
Avg. passenger-car travel speed, S	45.0	mph	45.0	mph
Level of service, LOS	B		A	
Density, D	11.4	pc/mi/ln	7.1	pc/mi/ln

Bicycle Level of Service

Posted speed limit, Sp	55	55
Percent of segment with occupied on-highway parking	0	0
Pavement rating, P	3	3
Flow rate in outside lane, vOL	481.3	314.1
Effective width of outside lane, We	24.00	24.00
Effective speed factor, St	4.79	4.79
Bicycle LOS Score, BLOS	5.92	2.52
Bicycle LOS	F	C

Overall results are not computed when free-flow speed is less than 45 mph.

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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 2
From/To	Barry Dr to Hoskins Rd
Jurisdiction	MDT
Analysis Year	2035
Description	Eastbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.97	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	3.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	46	%
Up/down	-	%	Access point density	13	/mi

Analysis direction volume, Vd	730	veh/h
Opposing direction volume, Vo	379	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.1		1.3	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.999		0.997	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	753	pc/h	392	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	52.5	mi/h
Adjustment for no-passing zones, fnp	1.9	mi/h
Average travel speed, ATSd	41.7	mi/h
Percent Free Flow Speed, PFFS	79.4	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.0	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	1.000	0.999
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	753 pc/h	391 pc/h
Base percent time-spent-following,(note-4) BPTSFd	63.5 %	
Adjustment for no-passing zones, fnp	25.4	
Percent time-spent-following, PTSFd	80.2 %	

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.44	
Peak 15-min vehicle-miles of travel, VMT15	659	veh-mi
Peak-hour vehicle-miles of travel, VMT60	2555	veh-mi
Peak 15-min total travel time, TT15	15.8	veh-h
Capacity from ATS, CdATS	1695	veh/h
Capacity from PTSF, CdPTSF	1698	veh/h
Directional Capacity	1695	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	3.5	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)	41.7	mi/h
Percent time-spent-following, PTSFd (from above)	80.2	
Level of service, LOSd (from above)	E	

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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	752.6
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.52
Bicycle LOS	E

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	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 2
From/To	Barry Dr to Hoskins Rd
Jurisdiction	MDT
Analysis Year	2035
Description	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.97	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	3.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	1	%
Grade: Length	-	mi	% No-passing zones	49	%
Up/down	-	%	Access point density	13	/mi

Analysis direction volume, Vd	379	veh/h
Opposing direction volume, Vo	730	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.3		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.997		0.999	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	392	pc/h	753	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	52.5	mi/h
Adjustment for no-passing zones, fnp	0.9	mi/h
Average travel speed, ATSd	42.8	mi/h
Percent Free Flow Speed, PFFS	81.4	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.0
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.999	1.000
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	391 pc/h	753 pc/h
Base percent time-spent-following,(note-4) BPTSFd	47.2 %	
Adjustment for no-passing zones, fnp	26.0	
Percent time-spent-following, PTSFd	56.1 %	

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.23	
Peak 15-min vehicle-miles of travel, VMT15	342	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1327	veh-mi
Peak 15-min total travel time, TT15	8.0	veh-h
Capacity from ATS, CdATS	1698	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1698	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	3.5	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)	42.8	mi/h
Percent time-spent-following, PTSFd (from above)	56.1	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	390.7
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.19
Bicycle LOS	D

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.

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 3
From/To	Hoskins Rd to Nahmis Ave
Jurisdiction	MDT
Analysis Year	2035
Description	Eastbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.90	
Shoulder width	1.0	ft	% Trucks and buses	0	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	59	%
Up/down	-	%	Access point density	17	/mi

Analysis direction volume, Vd	446	veh/h
Opposing direction volume, Vo	309	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.2		1.4	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	1.000		1.000	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	496	pc/h	343	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	4.3	mi/h
Free-flow speed, FFSd	51.5	mi/h
Adjustment for no-passing zones, fnp	2.5	mi/h
Average travel speed, ATSd	42.5	mi/h
Percent Free Flow Speed, PFFS	82.4	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.0	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	1.000	1.000
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	496 pc/h	343 pc/h
Base percent time-spent-following,(note-4) BPTSFd	48.9 %	
Adjustment for no-passing zones, fnp	38.0	
Percent time-spent-following, PTSFd	71.4 %	

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.29	
Peak 15-min vehicle-miles of travel, VMT15	248	veh-mi
Peak-hour vehicle-miles of travel, VMT60	892	veh-mi
Peak 15-min total travel time, TT15	5.8	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1700	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.0	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)	42.5	mi/h
Percent time-spent-following, PTSFd (from above)	71.4	
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	E	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	495.6
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.10
Bicycle LOS	D

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	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 3
From/To	Hoskins Rd to Nahmis Ave
Jurisdiction	MDT
Analysis Year	2035
Description	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.90	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	1	%
Grade: Length	-	mi	% No-passing zones	64	%
Up/down	-	%	Access point density	17	/mi

Analysis direction volume, Vd	309	veh/h
Opposing direction volume, Vo	446	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.4		1.2	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.996		0.998	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	345	pc/h	497	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	4.3	mi/h
Free-flow speed, FFSd	51.5	mi/h
Adjustment for no-passing zones, fnp	1.9	mi/h
Average travel speed, ATSd	43.1	mi/h
Percent Free Flow Speed, PFFS	83.6	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.0
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.999	1.000
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	344 pc/h	496 pc/h
Base percent time-spent-following,(note-4) BPTSFd	40.1 %	
Adjustment for no-passing zones, fnp	38.4	
Percent time-spent-following, PTSFd	55.8 %	

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.20	
Peak 15-min vehicle-miles of travel, VMT15	172	veh-mi
Peak-hour vehicle-miles of travel, VMT60	618	veh-mi
Peak 15-min total travel time, TT15	4.0	veh-h
Capacity from ATS, CdATS	1697	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1697	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.0	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)	43.1	mi/h
Percent time-spent-following, PTSFd (from above)	55.8	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	343.3
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.12
Bicycle LOS	D

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	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 4
From/To	Nahmis Ave to Northern Ave
Jurisdiction	MDT
Analysis Year	2035
Description	Eastbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.96	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.8	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	1	%
Grade: Length	-	mi	% No-passing zones	51	%
Up/down	-	%	Access point density	12	/mi

Analysis direction volume, Vd	329	veh/h
Opposing direction volume, Vo	354	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.4		1.3	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.996		0.997	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	344	pc/h	370	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.0	mi/h
Free-flow speed, FFSd	52.8	mi/h
Adjustment for no-passing zones, fnp	2.2	mi/h
Average travel speed, ATSd	45.1	mi/h
Percent Free Flow Speed, PFFS	85.4	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.999	0.999
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	343 pc/h	369 pc/h
Base percent time-spent-following,(note-4) BPTSFd	38.2 %	
Adjustment for no-passing zones, fnp	45.2	
Percent time-spent-following, PTSFd	60.0 %	

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.20	
Peak 15-min vehicle-miles of travel, VMT15	240	veh-mi
Peak-hour vehicle-miles of travel, VMT60	921	veh-mi
Peak 15-min total travel time, TT15	5.3	veh-h
Capacity from ATS, CdATS	1695	veh/h
Capacity from PTSF, CdPTSF	1698	veh/h
Directional Capacity	1695	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.8	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)	45.1	mi/h
Percent time-spent-following, PTSFd (from above)	60.0	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	342.7
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.12
Bicycle LOS	D

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	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 4
From/To	Nahmis Ave to Northern Ave
Jurisdiction	MDT
Analysis Year	2035
Description	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.96	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.8	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	43	%
Up/down	-	%	Access point density	12	/mi

Analysis direction volume, Vd	354	veh/h
Opposing direction volume, Vo	329	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.3		1.4	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.997		0.996	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	370	pc/h	344	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.0	mi/h
Free-flow speed, FFSd	52.8	mi/h
Adjustment for no-passing zones, fnp	2.0	mi/h
Average travel speed, ATSd	45.3	mi/h
Percent Free Flow Speed, PFFS	85.7	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.999	0.999
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	369 pc/h	343 pc/h
Base percent time-spent-following,(note-4) BPTSFd	39.9 %	
Adjustment for no-passing zones, fnp	43.3	
Percent time-spent-following, PTSFd	62.3 %	

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.22	
Peak 15-min vehicle-miles of travel, VMT15	258	veh-mi
Peak-hour vehicle-miles of travel, VMT60	991	veh-mi
Peak 15-min total travel time, TT15	5.7	veh-h
Capacity from ATS, CdATS	1693	veh/h
Capacity from PTSF, CdPTSF	1698	veh/h
Directional Capacity	1693	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.8	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)	45.3	mi/h
Percent time-spent-following, PTSFd (from above)	62.3	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	368.8
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.16
Bicycle LOS	D

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	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 5
From/To	I-94 WB Ramp to Northern Ave
Jurisdiction	MDT
Analysis Year	2035
Description	Eastbound Traffic

Input Data

Highway class	Class 3		Peak hour factor, PHF	0.87	
Shoulder width	1.0	ft	% Trucks and buses	3	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.3	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	1	%
Grade: Length	-	mi	% No-passing zones	100	%
Up/down	-	%	Access point density	15	/mi

Analysis direction volume, Vd	450	veh/h
Opposing direction volume, Vo	246	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.2		1.4	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.994		0.988	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	520	pc/h	286	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.8	mi/h
Free-flow speed, FFSd	52.0	mi/h
Adjustment for no-passing zones, fnp	3.5	mi/h
Average travel speed, ATSd	42.3	mi/h
Percent Free Flow Speed, PFFS	81.3	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.0	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	1.000	0.997
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	517 pc/h	284 pc/h
Base percent time-spent-following,(note-4) BPTSFd	47.9 %	
Adjustment for no-passing zones, fnp	38.6	
Percent time-spent-following, PTSFd	72.8 %	

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	297	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1035	veh-mi
Peak 15-min total travel time, TT15	7.0	veh-h
Capacity from ATS, CdATS	1680	veh/h
Capacity from PTSF, CdPTSF	1695	veh/h
Directional Capacity	1680	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.3	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)	42.3	mi/h
Percent time-spent-following, PTSFd (from above)	72.8	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	517.2
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.81
Bicycle LOS	E

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	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 5
From/To	I-94 WB Ramp to Northern Ave
Jurisdiction	MDT
Analysis Year	2035
Description	Westbound Traffic

Input Data

Highway class	Class 3		Peak hour factor, PHF	0.87	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.3	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	1	%
Grade: Length	-	mi	% No-passing zones	100	%
Up/down	-	%	Access point density	15	/mi

Analysis direction volume, Vd	246	veh/h
Opposing direction volume, Vo	450	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.4		1.2	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.996		0.998	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	284	pc/h	518	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.8	mi/h
Free-flow speed, FFSd	52.0	mi/h
Adjustment for no-passing zones, fnp	2.2	mi/h
Average travel speed, ATSd	43.6	mi/h
Percent Free Flow Speed, PFFS	83.7	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.0
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.999	1.000
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	283 pc/h	517 pc/h
Base percent time-spent-following,(note-4) BPTSFd	35.0 %	
Adjustment for no-passing zones, fnp	38.6	
Percent time-spent-following, PTSFd	48.7 %	

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.17	
Peak 15-min vehicle-miles of travel, VMT15	163	veh-mi
Peak-hour vehicle-miles of travel, VMT60	566	veh-mi
Peak 15-min total travel time, TT15	3.7	veh-h
Capacity from ATS, CdATS	1697	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1697	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.3	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)	43.6	mi/h
Percent time-spent-following, PTSFd (from above)	48.7	
Level of service, LOSd (from above)	B	

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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	282.8
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.03
Bicycle LOS	D

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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Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 6
From/To	Northern Ave to Main St
Jurisdiction	MDT
Analysis Year	2035
Description	Eastbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.91	
Shoulder width	1.0	ft	% Trucks and buses	2	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	7.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	2	%
Grade: Length	-	mi	% No-passing zones	25	%
Up/down	-	%	Access point density	5	/mi

Analysis direction volume, Vd 261 veh/h
Opposing direction volume, Vo 163 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.4		1.6	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.992		0.988	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	289	pc/h	181	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	1.3	mi/h
Free-flow speed, FFSd	54.5	mi/h
Adjustment for no-passing zones, fnp	1.5	mi/h
Average travel speed, ATSd	49.4	mi/h
Percent Free Flow Speed, PFFS	90.6	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.998	0.998
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	287 pc/h	179 pc/h
Base percent time-spent-following,(note-4) BPTSFd	29.2 %	
Adjustment for no-passing zones, fnp	37.5	
Percent time-spent-following, PTSFd	52.3 %	

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.17	
Peak 15-min vehicle-miles of travel, VMT15	502	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1827	veh-mi
Peak 15-min total travel time, TT15	10.2	veh-h
Capacity from ATS, CdATS	1680	veh/h
Capacity from PTSF, CdPTSF	1697	veh/h
Directional Capacity	1680	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	7.0	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)	49.4	mi/h
Percent time-spent-following, PTSFd (from above)	52.3	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	286.8
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.26
Bicycle LOS	D

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	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 6
From/To	Northern Ave to Main St
Jurisdiction	MDT
Analysis Year	2035
Description	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.91	
Shoulder width	1.0	ft	% Trucks and buses	2	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	7.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	28	%
Up/down	-	%	Access point density	5	/mi

Analysis direction volume, Vd 163 veh/h
Opposing direction volume, Vo 261 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.6		1.4	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.988		0.992	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	181	pc/h	289	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	1.3	mi/h
Free-flow speed, FFSd	54.5	mi/h
Adjustment for no-passing zones, fnp	1.7	mi/h
Average travel speed, ATSd	49.2	mi/h
Percent Free Flow Speed, PFFS	90.2	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.998	0.998
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	179 pc/h	287 pc/h
Base percent time-spent-following,(note-4) BPTSFd	21.0 %	
Adjustment for no-passing zones, fnp	38.7	
Percent time-spent-following, PTSFd	35.9 %	

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.11	
Peak 15-min vehicle-miles of travel, VMT15	313	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1141	veh-mi
Peak 15-min total travel time, TT15	6.4	veh-h
Capacity from ATS, CdATS	1686	veh/h
Capacity from PTSF, CdPTSF	1697	veh/h
Directional Capacity	1686	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	7.0	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)	49.2	mi/h
Percent time-spent-following, PTSFd (from above)	35.9	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	179.1
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.02
Bicycle LOS	D

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.

HCS 2010: Two-Lane Highways Release 6.65

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 7
From/To	Main St to Custer Frontage Rd
Jurisdiction	MDT
Analysis Year	2035
Description	Eastbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.81	
Shoulder width	1.0	ft	% Trucks and buses	0	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	8.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	37	%
Up/down	-	%	Access point density	5	/mi

Analysis direction volume, Vd	41	veh/h
Opposing direction volume, Vo	37	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.9		1.9	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	1.000		1.000	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	51	pc/h	46	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	1.3	mi/h
Free-flow speed, FFSd	54.5	mi/h
Adjustment for no-passing zones, fnp	1.1	mi/h
Average travel speed, ATSd	52.7	mi/h
Percent Free Flow Speed, PFFS	96.7	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	1.000	1.000
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	51 pc/h	46 pc/h
Base percent time-spent-following,(note-4) BPTSFd	6.2 %	
Adjustment for no-passing zones, fnp	40.8	
Percent time-spent-following, PTSFd	27.7 %	

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.03	
Peak 15-min vehicle-miles of travel, VMT15	108	veh-mi
Peak-hour vehicle-miles of travel, VMT60	349	veh-mi
Peak 15-min total travel time, TT15	2.0	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1700	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	8.5	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)	52.7	mi/h
Percent time-spent-following, PTSFd (from above)	27.7	
Level of service, LOSd (from above)	B	

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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	50.6
Effective width of outside lane, We	23.34
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.07
Bicycle LOS	A

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	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 7
From/To	Main St to Custer Frontage Rd
Jurisdiction	MDT
Analysis Year	2035
Description	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.81	
Shoulder width	1.0	ft	% Trucks and buses	4	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	8.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	35	%
Up/down	-	%	Access point density	5	/mi

Analysis direction volume, Vd 37 veh/h
Opposing direction volume, Vo 41 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.9		1.9	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.965		0.965	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	47	pc/h	52	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	1.3	mi/h
Free-flow speed, FFSd	54.5	mi/h
Adjustment for no-passing zones, fnp	1.0	mi/h
Average travel speed, ATSd	52.8	mi/h
Percent Free Flow Speed, PFFS	96.8	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.996	0.996
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	46 pc/h	51 pc/h
Base percent time-spent-following,(note-4) BPTSFd	5.6 %	
Adjustment for no-passing zones, fnp	39.5	
Percent time-spent-following, PTSFd	24.3 %	

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.03	
Peak 15-min vehicle-miles of travel, VMT15	97	veh-mi
Peak-hour vehicle-miles of travel, VMT60	315	veh-mi
Peak 15-min total travel time, TT15	1.8	veh-h
Capacity from ATS, CdATS	1641	veh/h
Capacity from PTSF, CdPTSF	1693	veh/h
Directional Capacity	1641	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	8.5	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)	52.8	mi/h
Percent time-spent-following, PTSFd (from above)	24.3	
Level of service, LOSd (from above)	B	

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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	45.7
Effective width of outside lane, We	23.59
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.92
Bicycle LOS	B

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.

Segment Analysis

2035 With Billings Bypass

Phone: Fax:
E-mail:

OPERATIONAL ANALYSIS

Analyst:	JSP
Agency/Co:	DOWL
Date:	9/2/2015
Analysis Period:	Peak Hour
Highway:	Old Highway 312, Segment 1
From/To:	Bench Blvd to Barry Dr
Jurisdiction:	MDT
Analysis Year:	2035 with Billings Bypass
Project ID:	-

FREE-FLOW SPEED

Direction	1		2	
Lane width	12.0	ft	12.0	ft
Lateral clearance:				
Right edge	6.0	ft	6.0	ft
Left edge	6.0	ft	6.0	ft
Total lateral clearance	12.0	ft	12.0	ft
Access points per mile	13		13	
Median type	Divided		Divided	
Free-flow speed:	Base		Base	
FFS or BFFS	50.0	mph	50.0	mph
Lane width adjustment, FLW	0.0	mph	0.0	mph
Lateral clearance adjustment, FLC	0.0	mph	0.0	mph
Median type adjustment, FM	0.0	mph	0.0	mph
Access points adjustment, FA	3.3	mph	3.3	mph
Free-flow speed	46.8	mph	46.8	mph

VOLUME

Direction	1		2	
Volume, V	656	vph	428	vph
Peak-hour factor, PHF	0.96		0.96	
Peak 15-minute volume, v15	171		111	
Trucks and buses	12	%	3	%
Recreational vehicles	1	%	1	%
Terrain type	Level		Level	
Grade	0.00	%	0.00	%
Segment length	0.00	mi	0.00	mi
Number of lanes	2		2	
Driver population adjustment, fP	1.00		1.00	
Trucks and buses PCE, ET	1.5		1.5	
Recreational vehicles PCE, ER	1.2		1.2	
Heavy vehicle adjustment, fHV	0.942		0.983	
Flow rate, vp	362	pcphpl	226	pcphpl

RESULTS

Direction	1		2	
Flow rate, vp	362	pcphpl	226	pcphpl
Free-flow speed, FFS	46.8	mph	46.8	mph
Avg. passenger-car travel speed, S	45.0	mph	45.0	mph
Level of service, LOS	A		A	
Density, D	8.0	pc/mi/ln	5.0	pc/mi/ln

Bicycle Level of Service

Posted speed limit, Sp	55	55
Percent of segment with occupied on-highway parking	0	0
Pavement rating, P	3	3
Flow rate in outside lane, vOL	341.7	222.9
Effective width of outside lane, We	24.00	24.00
Effective speed factor, St	4.79	4.79
Bicycle LOS Score, BLOS	5.75	2.35
Bicycle LOS	F	B

Overall results are not computed when free-flow speed is less than 45 mph.

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
Date Performed	9/2/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 2A
From/To	Barry Dr to Five Mile Rd
Jurisdiction	MDT
Analysis Year	2035 with Billings Bypass
Description	Eastbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.97	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	3.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	31	%
Up/down	-	%	Access point density	13	/mi

Analysis direction volume, Vd	515	veh/h
Opposing direction volume, Vo	267	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.2		1.4	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.998		0.996	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	532	pc/h	276	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	52.5	mi/h
Adjustment for no-passing zones, fnp	1.7	mi/h
Average travel speed, ATSd	44.6	mi/h
Percent Free Flow Speed, PFFS	84.8	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.0	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	1.000	0.999
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	531 pc/h	276 pc/h
Base percent time-spent-following,(note-4) BPTSFd	49.2 %	
Adjustment for no-passing zones, fnp	28.1	
Percent time-spent-following, PTSFd	67.7 %	

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	465	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1803	veh-mi
Peak 15-min total travel time, TT15	10.4	veh-h
Capacity from ATS, CdATS	1693	veh/h
Capacity from PTSF, CdPTSF	1698	veh/h
Directional Capacity	1693	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	3.5	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)	44.6	mi/h
Percent time-spent-following, PTSFd (from above)	67.7	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	530.9
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.35
Bicycle LOS	D

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.

HCS 2010: Two-Lane Highways Release 6.65

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
Date Performed	9/2/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 2A
From/To	Barry Dr to Five Mile Rd
Jurisdiction	MDT
Analysis Year	2035 with Billings Bypass
Description	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.97	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	3.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	1	%
Grade: Length	-	mi	% No-passing zones	47	%
Up/down	-	%	Access point density	13	/mi

Analysis direction volume, Vd	267	veh/h
Opposing direction volume, Vo	515	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.4		1.2	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.996		0.998	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	276	pc/h	532	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	52.5	mi/h
Adjustment for no-passing zones, fnp	1.4	mi/h
Average travel speed, ATSd	44.8	mi/h
Percent Free Flow Speed, PFFS	85.3	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.0
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.999	1.000
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	276 pc/h	531 pc/h
Base percent time-spent-following,(note-4) BPTSFd	34.7 %	
Adjustment for no-passing zones, fnp	32.1	
Percent time-spent-following, PTSFd	45.7 %	

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.16	
Peak 15-min vehicle-miles of travel, VMT15	241	veh-mi
Peak-hour vehicle-miles of travel, VMT60	935	veh-mi
Peak 15-min total travel time, TT15	5.4	veh-h
Capacity from ATS, CdATS	1697	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1697	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	3.5	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)	44.8	mi/h
Percent time-spent-following, PTSFd (from above)	45.7	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	275.3
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.01
Bicycle LOS	D

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.

HCS 2010: Two-Lane Highways Release 6.65

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
Date Performed	9/2/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 2B
From/To	Five Mile Rd to Hoskins Rd
Jurisdiction	MDT
Analysis Year	2035 with Billings Bypass
Description	Eastbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.97	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	3.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	49	%
Up/down	-	%	Access point density	13	/mi

Analysis direction volume, Vd	778	veh/h
Opposing direction volume, Vo	404	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.1		1.3	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.999		0.997	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	803	pc/h	418	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	52.5	mi/h
Adjustment for no-passing zones, fnp	1.9	mi/h
Average travel speed, ATSd	41.1	mi/h
Percent Free Flow Speed, PFFS	78.3	%

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	1.00	1.00
Directional flow rate,(note-2) vi	802 pc/h	416 pc/h
Base percent time-spent-following,(note-4) BPTSFd	65.8 %	
Adjustment for no-passing zones, fnp	24.5	
Percent time-spent-following, PTSFd	81.9 %	

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.47	
Peak 15-min vehicle-miles of travel, VMT15	702	veh-mi
Peak-hour vehicle-miles of travel, VMT60	2723	veh-mi
Peak 15-min total travel time, TT15	17.1	veh-h
Capacity from ATS, CdATS	1695	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1695	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	3.5	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)	41.1	mi/h
Percent time-spent-following, PTSFd (from above)	81.9	
Level of service, LOSd (from above)	E	

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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	802.1
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.55
Bicycle LOS	E

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	JSP
Agency/Co.	DOWL
Date Performed	9/2/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 2B
From/To	Five Mile Rd to Hoskins Rd
Jurisdiction	MDT
Analysis Year	2035 with Billings Bypass
Description	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.97	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	3.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	1	%
Grade: Length	-	mi	% No-passing zones	49	%
Up/down	-	%	Access point density	13	/mi

Analysis direction volume, Vd	404	veh/h
Opposing direction volume, Vo	778	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.3		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.997		0.999	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	418	pc/h	803	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	52.5	mi/h
Adjustment for no-passing zones, fnp	0.8	mi/h
Average travel speed, ATSd	42.3	mi/h
Percent Free Flow Speed, PFFS	80.4	%

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	1.00	1.00
Directional flow rate,(note-2) vi	416 pc/h	802 pc/h
Base percent time-spent-following,(note-4) BPTSFd	49.5 %	
Adjustment for no-passing zones, fnp	24.5	
Percent time-spent-following, PTSFd	57.9 %	

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.25	
Peak 15-min vehicle-miles of travel, VMT15	364	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1414	veh-mi
Peak 15-min total travel time, TT15	8.6	veh-h
Capacity from ATS, CdATS	1698	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1698	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	3.5	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)	42.3	mi/h
Percent time-spent-following, PTSFd (from above)	57.9	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	416.5
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.22
Bicycle LOS	D

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.

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
Date Performed	9/2/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 3
From/To	Hoskins Rd to Nahmis Ave
Jurisdiction	MDT
Analysis Year	2035 with Billings Bypass
Description	Eastbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.90	
Shoulder width	1.0	ft	% Trucks and buses	0	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	59	%
Up/down	-	%	Access point density	17	/mi

Analysis direction volume, Vd	500	veh/h
Opposing direction volume, Vo	346	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.1		1.3	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	1.000		1.000	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	556	pc/h	384	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	4.3	mi/h
Free-flow speed, FFSd	51.5	mi/h
Adjustment for no-passing zones, fnp	2.3	mi/h
Average travel speed, ATSd	41.9	mi/h
Percent Free Flow Speed, PFFS	81.4	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.0	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	1.000	1.000
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	556 pc/h	384 pc/h
Base percent time-spent-following,(note-4) BPTSFd	52.1 %	
Adjustment for no-passing zones, fnp	35.7	
Percent time-spent-following, PTSFd	73.2 %	

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.33	
Peak 15-min vehicle-miles of travel, VMT15	278	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1000	veh-mi
Peak 15-min total travel time, TT15	6.6	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1700	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.0	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)	41.9	mi/h
Percent time-spent-following, PTSFd (from above)	73.2	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	555.6
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.16
Bicycle LOS	D

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	JSP
Agency/Co.	DOWL
Date Performed	9/2/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 3
From/To	Hoskins Rd to Nahmis Ave
Jurisdiction	MDT
Analysis Year	2035 with Billings Bypass
Description	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.90	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	1	%
Grade: Length	-	mi	% No-passing zones	64	%
Up/down	-	%	Access point density	17	/mi

Analysis direction volume, Vd	346	veh/h
Opposing direction volume, Vo	500	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.3		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.997		0.999	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	386	pc/h	556	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	4.3	mi/h
Free-flow speed, FFSd	51.5	mi/h
Adjustment for no-passing zones, fnp	1.7	mi/h
Average travel speed, ATSd	42.5	mi/h
Percent Free Flow Speed, PFFS	82.5	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.0
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.999	1.000
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	385 pc/h	556 pc/h
Base percent time-spent-following,(note-4) BPTSFd	44.6 %	
Adjustment for no-passing zones, fnp	36.1	
Percent time-spent-following, PTSFd	59.4 %	

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.23	
Peak 15-min vehicle-miles of travel, VMT15	192	veh-mi
Peak-hour vehicle-miles of travel, VMT60	692	veh-mi
Peak 15-min total travel time, TT15	4.5	veh-h
Capacity from ATS, CdATS	1698	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1698	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.0	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)	42.5	mi/h
Percent time-spent-following, PTSFd (from above)	59.4	
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	E	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	384.4
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.18
Bicycle LOS	D

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	JSP
Agency/Co.	DOWL
Date Performed	9/2/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 4
From/To	Nahmis Ave to Northern Ave
Jurisdiction	MDT
Analysis Year	2035 with Billings Bypass
Description	Eastbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.96	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.8	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	1	%
Grade: Length	-	mi	% No-passing zones	51	%
Up/down	-	%	Access point density	12	/mi

Analysis direction volume, Vd	329	veh/h
Opposing direction volume, Vo	354	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.4		1.3	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.996		0.997	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	344	pc/h	370	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.0	mi/h
Free-flow speed, FFSd	52.8	mi/h
Adjustment for no-passing zones, fnp	2.2	mi/h
Average travel speed, ATSd	45.1	mi/h
Percent Free Flow Speed, PFFS	85.4	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.999	0.999
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	343 pc/h	369 pc/h
Base percent time-spent-following,(note-4) BPTSFd	38.2 %	
Adjustment for no-passing zones, fnp	45.2	
Percent time-spent-following, PTSFd	60.0 %	

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.20	
Peak 15-min vehicle-miles of travel, VMT15	240	veh-mi
Peak-hour vehicle-miles of travel, VMT60	921	veh-mi
Peak 15-min total travel time, TT15	5.3	veh-h
Capacity from ATS, CdATS	1695	veh/h
Capacity from PTSF, CdPTSF	1698	veh/h
Directional Capacity	1695	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.8	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)	45.1	mi/h
Percent time-spent-following, PTSFd (from above)	60.0	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	342.7
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.12
Bicycle LOS	D

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.

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
Date Performed	9/2/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 4
From/To	Nahmis Ave to Northern Ave
Jurisdiction	MDT
Analysis Year	2035 with Billings Bypass
Description	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.96	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.8	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	43	%
Up/down	-	%	Access point density	12	/mi

Analysis direction volume, Vd	354	veh/h
Opposing direction volume, Vo	329	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.3		1.4	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.997		0.996	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	370	pc/h	344	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.0	mi/h
Free-flow speed, FFSd	52.8	mi/h
Adjustment for no-passing zones, fnp	2.0	mi/h
Average travel speed, ATSd	45.3	mi/h
Percent Free Flow Speed, PFFS	85.7	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.999	0.999
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	369 pc/h	343 pc/h
Base percent time-spent-following,(note-4) BPTSFd	39.9 %	
Adjustment for no-passing zones, fnp	43.3	
Percent time-spent-following, PTSFd	62.3 %	

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.22	
Peak 15-min vehicle-miles of travel, VMT15	258	veh-mi
Peak-hour vehicle-miles of travel, VMT60	991	veh-mi
Peak 15-min total travel time, TT15	5.7	veh-h
Capacity from ATS, CdATS	1693	veh/h
Capacity from PTSF, CdPTSF	1698	veh/h
Directional Capacity	1693	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.8	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)	45.3	mi/h
Percent time-spent-following, PTSFd (from above)	62.3	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	368.8
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.16
Bicycle LOS	D

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	JSP
Agency/Co.	DOWL
Date Performed	9/2/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 5
From/To	I-94 WB Ramp to Northern Ave
Jurisdiction	MDT
Analysis Year	2035 with Billings Bypass
Description	Eastbound Traffic

Input Data

Highway class	Class 3		Peak hour factor, PHF	0.87	
Shoulder width	1.0	ft	% Trucks and buses	3	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.3	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	1	%
Grade: Length	-	mi	% No-passing zones	100	%
Up/down	-	%	Access point density	15	/mi

Analysis direction volume, Vd	321	veh/h
Opposing direction volume, Vo	175	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.3		1.5	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.991		0.985	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	372	pc/h	204	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.8	mi/h
Free-flow speed, FFSd	52.0	mi/h
Adjustment for no-passing zones, fnp	4.0	mi/h
Average travel speed, ATSd	43.6	mi/h
Percent Free Flow Speed, PFFS	83.7	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.997	0.997
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	370 pc/h	202 pc/h
Base percent time-spent-following,(note-4) BPTSFd	35.5 %	
Adjustment for no-passing zones, fnp	51.3	
Percent time-spent-following, PTSFd	68.7 %	

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.22	
Peak 15-min vehicle-miles of travel, VMT15	212	veh-mi
Peak-hour vehicle-miles of travel, VMT60	738	veh-mi
Peak 15-min total travel time, TT15	4.9	veh-h
Capacity from ATS, CdATS	1675	veh/h
Capacity from PTSF, CdPTSF	1695	veh/h
Directional Capacity	1675	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.3	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)	43.6	mi/h
Percent time-spent-following, PTSFd (from above)	68.7	
Level of service, LOSd (from above)	B	

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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	369.0
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.64
Bicycle LOS	E

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	JSP
Agency/Co.	DOWL
Date Performed	7/17/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 5
From/To	I-94 WB Ramp to Northern Ave
Jurisdiction	MDT
Analysis Year	2035 with Billings Bypass
Description	Westbound Traffic

Input Data

Highway class	Class 3		Peak hour factor, PHF	0.87	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.3	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	1	%
Grade: Length	-	mi	% No-passing zones	100	%
Up/down	-	%	Access point density	15	/mi

Analysis direction volume, Vd	175	veh/h
Opposing direction volume, Vo	321	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.5		1.3	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.995		0.997	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	202	pc/h	370	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	3.8	mi/h
Free-flow speed, FFSd	52.0	mi/h
Adjustment for no-passing zones, fnp	2.9	mi/h
Average travel speed, ATSd	44.7	mi/h
Percent Free Flow Speed, PFFS	85.8	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.999	0.999
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	201 pc/h	369 pc/h
Base percent time-spent-following,(note-4) BPTSFd	25.4 %	
Adjustment for no-passing zones, fnp	51.3	
Percent time-spent-following, PTSFd	43.5 %	

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.12	
Peak 15-min vehicle-miles of travel, VMT15	116	veh-mi
Peak-hour vehicle-miles of travel, VMT60	402	veh-mi
Peak 15-min total travel time, TT15	2.6	veh-h
Capacity from ATS, CdATS	1695	veh/h
Capacity from PTSF, CdPTSF	1698	veh/h
Directional Capacity	1695	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.3	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)	44.7	mi/h
Percent time-spent-following, PTSFd (from above)	43.5	
Level of service, LOSd (from above)	B	

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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	201.1
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	3.85
Bicycle LOS	D

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.

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
Date Performed	9/2/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 6
From/To	Northern Ave to Main St
Jurisdiction	MDT
Analysis Year	2035 with Billings Bypass
Description	Eastbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.91	
Shoulder width	1.0	ft	% Trucks and buses	2	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	7.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	2	%
Grade: Length	-	mi	% No-passing zones	25	%
Up/down	-	%	Access point density	5	/mi

Analysis direction volume, Vd	261	veh/h
Opposing direction volume, Vo	163	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.4		1.6	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.992		0.988	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	289	pc/h	181	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	1.3	mi/h
Free-flow speed, FFSd	54.5	mi/h
Adjustment for no-passing zones, fnp	1.5	mi/h
Average travel speed, ATSd	49.4	mi/h
Percent Free Flow Speed, PFFS	90.6	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.998	0.998
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	287 pc/h	179 pc/h
Base percent time-spent-following,(note-4) BPTSFd	29.2 %	
Adjustment for no-passing zones, fnp	37.5	
Percent time-spent-following, PTSFd	52.3 %	

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.17	
Peak 15-min vehicle-miles of travel, VMT15	502	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1827	veh-mi
Peak 15-min total travel time, TT15	10.2	veh-h
Capacity from ATS, CdATS	1680	veh/h
Capacity from PTSF, CdPTSF	1697	veh/h
Directional Capacity	1680	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	7.0	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)	49.4	mi/h
Percent time-spent-following, PTSFd (from above)	52.3	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	286.8
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.26
Bicycle LOS	D

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	JSP
Agency/Co.	DOWL
Date Performed	9/2/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 6
From/To	Northern Ave to Main St
Jurisdiction	MDT
Analysis Year	2035 with Billings Bypass
Description	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.91	
Shoulder width	1.0	ft	% Trucks and buses	2	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	7.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	28	%
Up/down	-	%	Access point density	5	/mi

Analysis direction volume, Vd	163	veh/h
Opposing direction volume, Vo	261	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.6		1.4	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.988		0.992	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	181	pc/h	289	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	1.3	mi/h
Free-flow speed, FFSd	54.5	mi/h
Adjustment for no-passing zones, fnp	1.7	mi/h
Average travel speed, ATSd	49.2	mi/h
Percent Free Flow Speed, PFFS	90.2	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.998	0.998
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	179 pc/h	287 pc/h
Base percent time-spent-following,(note-4) BPTSFd	21.0 %	
Adjustment for no-passing zones, fnp	38.7	
Percent time-spent-following, PTSFd	35.9 %	

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.11	
Peak 15-min vehicle-miles of travel, VMT15	313	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1141	veh-mi
Peak 15-min total travel time, TT15	6.4	veh-h
Capacity from ATS, CdATS	1686	veh/h
Capacity from PTSF, CdPTSF	1697	veh/h
Directional Capacity	1686	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	7.0	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)	49.2	mi/h
Percent time-spent-following, PTSFd (from above)	35.9	
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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	179.1
Effective width of outside lane, We	13.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.02
Bicycle LOS	D

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	JSP
Agency/Co.	DOWL
Date Performed	9/2/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 7
From/To	Main St to Custer Frontage Rd
Jurisdiction	MDT
Analysis Year	2035 with Billings Bypass
Description	Eastbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.81	
Shoulder width	1.0	ft	% Trucks and buses	0	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	8.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	37	%
Up/down	-	%	Access point density	5	/mi

Analysis direction volume, Vd	41	veh/h
Opposing direction volume, Vo	37	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.9		1.9	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	1.000		1.000	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	51	pc/h	46	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	1.3	mi/h
Free-flow speed, FFSd	54.5	mi/h
Adjustment for no-passing zones, fnp	1.1	mi/h
Average travel speed, ATSd	52.7	mi/h
Percent Free Flow Speed, PFFS	96.7	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	1.000	1.000
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	51 pc/h	46 pc/h
Base percent time-spent-following,(note-4) BPTSFd	6.2 %	
Adjustment for no-passing zones, fnp	40.8	
Percent time-spent-following, PTSFd	27.7 %	

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.03	
Peak 15-min vehicle-miles of travel, VMT15	108	veh-mi
Peak-hour vehicle-miles of travel, VMT60	349	veh-mi
Peak 15-min total travel time, TT15	2.0	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1700	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	8.5	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)	52.7	mi/h
Percent time-spent-following, PTSFd (from above)	27.7	
Level of service, LOSd (from above)	B	

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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	50.6
Effective width of outside lane, We	23.34
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.07
Bicycle LOS	A

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.

HCS 2010: Two-Lane Highways Release 6.65

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Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
Date Performed	9/2/2015
Analysis Time Period	PM Peak Hour
Highway	Old Highway 312, Segment 7
From/To	Main St to Custer Frontage Rd
Jurisdiction	MDT
Analysis Year	2035 with Billings Bypass
Description	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.81	
Shoulder width	1.0	ft	% Trucks and buses	4	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	8.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	35	%
Up/down	-	%	Access point density	5	/mi

Analysis direction volume, Vd 37 veh/h
Opposing direction volume, Vo 41 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.9		1.9	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.965		0.965	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	47	pc/h	52	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	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	4.2	mi/h
Adj. for access point density,(note-3) fA	1.3	mi/h
Free-flow speed, FFSd	54.5	mi/h
Adjustment for no-passing zones, fnp	1.0	mi/h
Average travel speed, ATSd	52.8	mi/h
Percent Free Flow Speed, PFFS	96.8	%

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.996	0.996
Grade adjustment factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	46 pc/h	51 pc/h
Base percent time-spent-following,(note-4) BPTSFd	5.6 %	
Adjustment for no-passing zones, fnp	39.5	
Percent time-spent-following, PTSFd	24.3 %	

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.03	
Peak 15-min vehicle-miles of travel, VMT15	97	veh-mi
Peak-hour vehicle-miles of travel, VMT60	315	veh-mi
Peak 15-min total travel time, TT15	1.8	veh-h
Capacity from ATS, CdATS	1641	veh/h
Capacity from PTSF, CdPTSF	1693	veh/h
Directional Capacity	1641	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	8.5	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)	52.8	mi/h
Percent time-spent-following, PTSFd (from above)	24.3	
Level of service, LOSd (from above)	B	

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	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	45.7
Effective width of outside lane, We	23.59
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.92
Bicycle LOS	B

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.

Intersection Analysis

2015

Intersection	
Int Delay, s/veh	1.6

Movement	NWL	NWR	NET	NER	SWL	SWT
Traffic Vol, veh/h	43	29	572	72	20	275
Future Vol, veh/h	43	29	572	72	20	275
Conflicting Peds, #/hr	29	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	100	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	88	88	88	88	88	88
Heavy Vehicles, %	3	3	3	3	3	3
Mvmt Flow	49	33	650	82	23	313

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	922	395	0	0	761	0
Stage 1	720	-	-	-	-	-
Stage 2	202	-	-	-	-	-
Critical Hdwy	6.86	6.96	-	-	4.16	-
Critical Hdwy Stg 1	5.86	-	-	-	-	-
Critical Hdwy Stg 2	5.86	-	-	-	-	-
Follow-up Hdwy	3.53	3.33	-	-	2.23	-
Pot Cap-1 Maneuver	267	601	-	-	840	-
Stage 1	440	-	-	-	-	-
Stage 2	809	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	253	586	-	-	840	-
Mov Cap-2 Maneuver	253	-	-	-	-	-
Stage 1	429	-	-	-	-	-
Stage 2	787	-	-	-	-	-

Approach	NW	NE	SW
HCM Control Delay, s	19.6	0	0.6
HCM LOS	C		

Minor Lane/Major Mvmt	NET	NER	NWLn1	SWL	SWT
Capacity (veh/h)	-	-	328	840	-
HCM Lane V/C Ratio	-	-	0.249	0.027	-
HCM Control Delay (s)	-	-	19.6	9.4	-
HCM Lane LOS	-	-	C	A	-
HCM 95th %tile Q(veh)	-	-	1	0.1	-

Intersection	
Int Delay, s/veh	3.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Vol, veh/h	109	251	4	5	121	26	5	5	5	13	5	49
Future Vol, veh/h	109	251	4	5	121	26	5	5	5	13	5	49
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	320	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	94	94	94	94	94	94	94	94	94	94	94	94
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	116	267	4	5	129	28	5	5	5	14	5	52

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	156	0	0	271	0	0	683	668	269	659	656	143
Stage 1	-	-	-	-	-	-	501	501	-	153	153	-
Stage 2	-	-	-	-	-	-	182	167	-	506	503	-
Critical Hdwy	4.13	-	-	4.13	-	-	7.13	6.53	6.23	7.13	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Follow-up Hdwy	2.227	-	-	2.227	-	-	3.527	4.027	3.327	3.527	4.027	3.327
Pot Cap-1 Maneuver	1418	-	-	1287	-	-	362	378	767	376	384	902
Stage 1	-	-	-	-	-	-	550	541	-	847	769	-
Stage 2	-	-	-	-	-	-	817	758	-	547	540	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1418	-	-	1287	-	-	315	346	767	345	351	902
Mov Cap-2 Maneuver	-	-	-	-	-	-	315	346	-	345	351	-
Stage 1	-	-	-	-	-	-	505	497	-	778	766	-
Stage 2	-	-	-	-	-	-	761	755	-	493	496	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2.3	0.3	14.2	11.4
HCM LOS			B	B

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	407	1418	-	-	1287	-	-	631
HCM Lane V/C Ratio	0.039	0.082	-	-	0.004	-	-	0.113
HCM Control Delay (s)	14.2	7.8	-	-	7.8	0	-	11.4
HCM Lane LOS	B	A	-	-	A	A	-	B
HCM 95th %tile Q(veh)	0.1	0.3	-	-	0	-	-	0.4

Intersection	
Int Delay, s/veh	4.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Vol, veh/h	146	144	5	9	106	80	5	5	9	38	5	46
Future Vol, veh/h	146	144	5	9	106	80	5	5	9	38	5	46
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	510	-	-	510	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	87	87	87	87	87	87	87	87	87	87	87	87
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	168	166	6	10	122	92	6	6	10	44	6	53

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	214	0	0	171	0	0	722	738	168	701	696	168
Stage 1	-	-	-	-	-	-	504	504	-	189	189	-
Stage 2	-	-	-	-	-	-	218	234	-	512	507	-
Critical Hdwy	4.13	-	-	4.13	-	-	7.13	6.53	6.23	7.13	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Follow-up Hdwy	2.227	-	-	2.227	-	-	3.527	4.027	3.327	3.527	4.027	3.327
Pot Cap-1 Maneuver	1350	-	-	1400	-	-	341	344	874	352	364	874
Stage 1	-	-	-	-	-	-	548	539	-	810	742	-
Stage 2	-	-	-	-	-	-	782	709	-	543	538	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1350	-	-	1400	-	-	284	299	874	308	316	874
Mov Cap-2 Maneuver	-	-	-	-	-	-	284	299	-	308	316	-
Stage 1	-	-	-	-	-	-	480	472	-	709	737	-
Stage 2	-	-	-	-	-	-	724	704	-	464	471	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	4	0.4	13.9	14.9
HCM LOS			B	B

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	426	1350	-	-	1400	-	-	464
HCM Lane V/C Ratio	0.051	0.124	-	-	0.007	-	-	0.22
HCM Control Delay (s)	13.9	8	-	-	7.6	-	-	14.9
HCM Lane LOS	B	A	-	-	A	-	-	B
HCM 95th %tile Q(veh)	0.2	0.4	-	-	0	-	-	0.8

Intersection	
Int Delay, s/veh	4.8

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Traffic Vol, veh/h	109	106	9	49	172	10
Future Vol, veh/h	109	106	9	49	172	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	3	3	3	3	3	3
Mvmt Flow	117	114	10	53	185	11

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	231	0	246	174
Stage 1	-	-	-	-	174	-
Stage 2	-	-	-	-	72	-
Critical Hdwy	-	-	4.13	-	6.43	6.23
Critical Hdwy Stg 1	-	-	-	-	5.43	-
Critical Hdwy Stg 2	-	-	-	-	5.43	-
Follow-up Hdwy	-	-	2.227	-	3.527	3.327
Pot Cap-1 Maneuver	-	-	1331	-	740	867
Stage 1	-	-	-	-	854	-
Stage 2	-	-	-	-	948	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1331	-	734	867
Mov Cap-2 Maneuver	-	-	-	-	734	-
Stage 1	-	-	-	-	854	-
Stage 2	-	-	-	-	940	-

Approach	EB	WB	NW
HCM Control Delay, s	0	1.2	11.6
HCM LOS			B

Minor Lane/Major Mvmt	NWLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	740	-	-	1331	-
HCM Lane V/C Ratio	0.264	-	-	0.007	-
HCM Control Delay (s)	11.6	-	-	7.7	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	1.1	-	-	0	-

Intersection	
Int Delay, s/veh	5.8

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Traffic Vol, veh/h	33	5	79	5	6	5	216	161	5	5	76	38
Future Vol, veh/h	33	5	79	5	6	5	216	161	5	5	76	38
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	91	91	91	91	91	91	91	91	91	91	91	91
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	36	5	87	5	7	5	237	177	5	5	84	42

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	775	772	104	816	790	180	125	0	0	182	0	0
Stage 1	115	115	-	654	654	-	-	-	-	-	-	-
Stage 2	660	657	-	162	136	-	-	-	-	-	-	-
Critical Hdwy	7.13	6.53	6.23	7.13	6.53	6.23	4.13	-	-	4.13	-	-
Critical Hdwy Stg 1	6.13	5.53	-	6.13	5.53	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.13	5.53	-	6.13	5.53	-	-	-	-	-	-	-
Follow-up Hdwy	3.527	4.027	3.327	3.527	4.027	3.327	2.227	-	-	2.227	-	-
Pot Cap-1 Maneuver	314	329	948	295	321	860	1455	-	-	1387	-	-
Stage 1	887	798	-	454	462	-	-	-	-	-	-	-
Stage 2	450	460	-	838	782	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	263	268	948	227	262	860	1455	-	-	1387	-	-
Mov Cap-2 Maneuver	263	268	-	227	262	-	-	-	-	-	-	-
Stage 1	726	795	-	372	378	-	-	-	-	-	-	-
Stage 2	360	377	-	753	779	-	-	-	-	-	-	-

Approach	SE	NW	NE	SW
HCM Control Delay, s	14.3	17.1	4.5	0.3
HCM LOS	B	C		

Minor Lane/Major Mvmt	NEL	NET	NER	NWLn1	SELn1	SWL	SWT	SWR
Capacity (veh/h)	1455	-	-	315	514	1387	-	-
HCM Lane V/C Ratio	0.163	-	-	0.056	0.25	0.004	-	-
HCM Control Delay (s)	8	0	-	17.1	14.3	7.6	0	-
HCM Lane LOS	A	A	-	C	B	A	A	-
HCM 95th %tile Q(veh)	0.6	-	-	0.2	1	0	-	-

Intersection	
Int Delay, s/veh	0.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Traffic Vol, veh/h	0	0	0	5	5	5	0	71	107	22	315	0
Future Vol, veh/h	0	0	0	5	5	5	0	71	107	22	315	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	88	88	88	88	88	88	88	88	88	88	88	88
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	0	0	0	6	6	6	0	81	122	25	358	0

Major/Minor	Minor2			Major1			Major2		
Conflicting Flow All	549	610	358	358	0	0	202	0	0
Stage 1	408	408	-	-	-	-	-	-	-
Stage 2	141	202	-	-	-	-	-	-	-
Critical Hdwy	6.43	6.53	6.23	4.13	-	-	4.13	-	-
Critical Hdwy Stg 1	5.43	5.53	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.43	5.53	-	-	-	-	-	-	-
Follow-up Hdwy	3.527	4.027	3.327	2.227	-	-	2.227	-	-
Pot Cap-1 Maneuver	495	408	684	1195	-	-	1364	-	-
Stage 1	669	595	-	-	-	-	-	-	-
Stage 2	883	732	-	-	-	-	-	-	-
Platoon blocked, %					-	-		-	-
Mov Cap-1 Maneuver	484	0	684	1195	-	-	1364	-	-
Mov Cap-2 Maneuver	484	0	-	-	-	-	-	-	-
Stage 1	654	0	-	-	-	-	-	-	-
Stage 2	883	0	-	-	-	-	-	-	-

Approach	WB	SE	NW
HCM Control Delay, s	11.5	0	0.5
HCM LOS	B		

Minor Lane/Major Mvmt	NWL	NWT	NWR	WBLn1	SEL	SET	SER
Capacity (veh/h)	1364	-	-	567	1195	-	-
HCM Lane V/C Ratio	0.018	-	-	0.03	-	-	-
HCM Control Delay (s)	7.7	0	-	11.5	0	-	-
HCM Lane LOS	A	A	-	B	A	-	-
HCM 95th %tile Q(veh)	0.1	-	-	0.1	0	-	-

Intersection	
Int Delay, s/veh	9.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Traffic Vol, veh/h	260	5	75	0	0	0	11	60	0	0	76	5
Future Vol, veh/h	260	5	75	0	0	0	11	60	0	0	76	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	85	85	85	85	85	85	85	85	85	85	85	85
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	306	6	88	0	0	0	13	71	0	0	89	6

Major/Minor	Minor1			Major1			Major2		
Conflicting Flow All	188	191	71	95	0	0	71	0	0
Stage 1	96	96	-	-	-	-	-	-	-
Stage 2	92	95	-	-	-	-	-	-	-
Critical Hdwy	6.43	6.53	6.23	4.13	-	-	4.13	-	-
Critical Hdwy Stg 1	5.43	5.53	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.43	5.53	-	-	-	-	-	-	-
Follow-up Hdwy	3.527	4.027	3.327	2.227	-	-	2.227	-	-
Pot Cap-1 Maneuver	799	702	989	1493	-	-	1523	-	-
Stage 1	925	814	-	-	-	-	-	-	-
Stage 2	929	814	-	-	-	-	-	-	-
Platoon blocked, %					-	-		-	-
Mov Cap-1 Maneuver	792	0	989	1493	-	-	1523	-	-
Mov Cap-2 Maneuver	792	0	-	-	-	-	-	-	-
Stage 1	917	0	-	-	-	-	-	-	-
Stage 2	929	0	-	-	-	-	-	-	-

Approach	EB	SE	NW
HCM Control Delay, s	13.3	1.2	0
HCM LOS	B		

Minor Lane/Major Mvmt	NWL	NWT	NWR	EBLn1	SEL	SET	SER
Capacity (veh/h)	1523	-	-	829	1493	-	-
HCM Lane V/C Ratio	-	-	-	0.483	0.009	-	-
HCM Control Delay (s)	0	-	-	13.3	7.4	0	-
HCM Lane LOS	A	-	-	B	A	A	-
HCM 95th %tile Q(veh)	0	-	-	2.7	0	-	-

Intersection	
Int Delay, s/veh	4.5

Movement	EBT	EBR	WBL	WBT	NEL	NER
Traffic Vol, veh/h	100	0	57	69	0	121
Future Vol, veh/h	100	0	57	69	0	121
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	3	3	3	3	3	3
Mvmt Flow	105	0	60	73	0	127

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	105	0	298	105
Stage 1	-	-	-	-	105	-
Stage 2	-	-	-	-	193	-
Critical Hdwy	-	-	4.13	-	6.43	6.23
Critical Hdwy Stg 1	-	-	-	-	5.43	-
Critical Hdwy Stg 2	-	-	-	-	5.43	-
Follow-up Hdwy	-	-	2.227	-	3.527	3.327
Pot Cap-1 Maneuver	-	-	1480	-	691	947
Stage 1	-	-	-	-	917	-
Stage 2	-	-	-	-	837	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1480	-	662	947
Mov Cap-2 Maneuver	-	-	-	-	662	-
Stage 1	-	-	-	-	917	-
Stage 2	-	-	-	-	802	-

Approach	EB	WB	NE
HCM Control Delay, s	0	3.4	9.4
HCM LOS			A

Minor Lane/Major Mvmt	NELn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	947	-	-	1480	-
HCM Lane V/C Ratio	0.134	-	-	0.041	-
HCM Control Delay (s)	9.4	-	-	7.5	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.5	-	-	0.1	-

Intersection	
Int Delay, s/veh	4.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Vol, veh/h	20	46	15	13	38	8	15	23	5	10	17	6
Future Vol, veh/h	20	46	15	13	38	8	15	23	5	10	17	6
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	22	50	16	14	41	9	16	25	5	11	18	7

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	50	0	0	66	0	0	188	180	58	191	184	46
Stage 1	-	-	-	-	-	-	102	102	-	74	74	-
Stage 2	-	-	-	-	-	-	86	78	-	117	110	-
Critical Hdwy	4.13	-	-	4.13	-	-	7.13	6.53	6.23	7.13	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Follow-up Hdwy	2.227	-	-	2.227	-	-	3.527	4.027	3.327	3.527	4.027	3.327
Pot Cap-1 Maneuver	1550	-	-	1529	-	-	770	712	1005	767	708	1021
Stage 1	-	-	-	-	-	-	902	809	-	933	831	-
Stage 2	-	-	-	-	-	-	919	828	-	885	802	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1550	-	-	1529	-	-	736	695	1005	728	691	1021
Mov Cap-2 Maneuver	-	-	-	-	-	-	736	695	-	728	691	-
Stage 1	-	-	-	-	-	-	888	797	-	919	824	-
Stage 2	-	-	-	-	-	-	885	821	-	840	790	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	1.8	1.6	10.2	10.1
HCM LOS			B	B

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	736	1550	-	-	1529	-	-	746
HCM Lane V/C Ratio	0.064	0.014	-	-	0.009	-	-	0.048
HCM Control Delay (s)	10.2	7.4	0	-	7.4	0	-	10.1
HCM Lane LOS	B	A	A	-	A	A	-	B
HCM 95th %tile Q(veh)	0.2	0	-	-	0	-	-	0.2

Intersection	
Int Delay, s/veh	4.9

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Traffic Vol, veh/h	12	7	5	5	10	5	0	0	0	5	5	14
Future Vol, veh/h	12	7	5	5	10	5	0	0	0	5	5	14
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	74	74	74	74	74	74	74	74	74	74	74	74
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	16	9	7	7	14	7	0	0	0	7	7	19

Major/Minor	Major1			Major2			Minor2		
Conflicting Flow All	20	0	0	16	0	0	75	79	17
Stage 1	-	-	-	-	-	-	30	30	-
Stage 2	-	-	-	-	-	-	45	49	-
Critical Hdwy	4.13	-	-	4.13	-	-	6.43	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	5.43	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	5.43	5.53	-
Follow-up Hdwy	2.227	-	-	2.227	-	-	3.527	4.027	3.327
Pot Cap-1 Maneuver	1590	-	-	1595	-	-	926	809	1059
Stage 1	-	-	-	-	-	-	990	868	-
Stage 2	-	-	-	-	-	-	975	852	-
Platoon blocked, %		-	-		-	-			
Mov Cap-1 Maneuver	1590	-	-	1595	-	-	913	0	1059
Mov Cap-2 Maneuver	-	-	-	-	-	-	913	0	-
Stage 1	-	-	-	-	-	-	986	0	-
Stage 2	-	-	-	-	-	-	965	0	-

Approach	SE	NW	SW
HCM Control Delay, s	3.6	1.8	8.7
HCM LOS			A

Minor Lane/Major Mvmt	NWL	NWT	NWR	SEL	SET	SER	SWLn1
Capacity (veh/h)	1595	-	-	1590	-	-	1016
HCM Lane V/C Ratio	0.004	-	-	0.01	-	-	0.032
HCM Control Delay (s)	7.3	0	-	7.3	0	-	8.7
HCM Lane LOS	A	A	-	A	A	-	A
HCM 95th %tile Q(veh)	0	-	-	0	-	-	0.1

Intersection	
Int Delay, s/veh	5.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Traffic Vol, veh/h	17	5	5	0	0	0	5	5	0	0	6	5
Future Vol, veh/h	17	5	5	0	0	0	5	5	0	0	6	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	77	77	77	77	77	77	77	77	77	77	77	77
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	22	6	6	0	0	0	6	6	0	0	8	6

Major/Minor	Minor1			Major1			Major2		
Conflicting Flow All	30	33	6	14	0	0	6	0	0
Stage 1	19	19	-	-	-	-	-	-	-
Stage 2	11	14	-	-	-	-	-	-	-
Critical Hdwy	6.43	6.53	6.23	4.13	-	-	4.13	-	-
Critical Hdwy Stg 1	5.43	5.53	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.43	5.53	-	-	-	-	-	-	-
Follow-up Hdwy	3.527	4.027	3.327	2.227	-	-	2.227	-	-
Pot Cap-1 Maneuver	982	858	1074	1598	-	-	1608	-	-
Stage 1	1001	878	-	-	-	-	-	-	-
Stage 2	1009	882	-	-	-	-	-	-	-
Platoon blocked, %					-	-		-	-
Mov Cap-1 Maneuver	978	0	1074	1598	-	-	1608	-	-
Mov Cap-2 Maneuver	978	0	-	-	-	-	-	-	-
Stage 1	997	0	-	-	-	-	-	-	-
Stage 2	1009	0	-	-	-	-	-	-	-

Approach	EB	SE	NW
HCM Control Delay, s	8.7	3.6	0
HCM LOS	A		

Minor Lane/Major Mvmt	NWL	NWT	NWR	EBLn1	SEL	SET	SER
Capacity (veh/h)	1608	-	-	998	1598	-	-
HCM Lane V/C Ratio	-	-	-	0.035	0.004	-	-
HCM Control Delay (s)	0	-	-	8.7	7.3	0	-
HCM Lane LOS	A	-	-	A	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0.1	0	-	-

Intersection	
Int Delay, s/veh	3.2

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Traffic Vol, veh/h	15	0	0	7	8	5
Future Vol, veh/h	15	0	0	7	8	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	25
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	77	77	77	77	77	77
Heavy Vehicles, %	3	3	3	3	3	3
Mvmt Flow	19	0	0	9	10	6

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	19	0	28	19
Stage 1	-	-	-	-	19	-
Stage 2	-	-	-	-	9	-
Critical Hdwy	-	-	4.13	-	6.43	6.23
Critical Hdwy Stg 1	-	-	-	-	5.43	-
Critical Hdwy Stg 2	-	-	-	-	5.43	-
Follow-up Hdwy	-	-	2.227	-	3.527	3.327
Pot Cap-1 Maneuver	-	-	1591	-	984	1056
Stage 1	-	-	-	-	1001	-
Stage 2	-	-	-	-	1011	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1591	-	984	1056
Mov Cap-2 Maneuver	-	-	-	-	984	-
Stage 1	-	-	-	-	1001	-
Stage 2	-	-	-	-	1011	-

Approach	EB	WB	NW
HCM Control Delay, s	0	0	8.6
HCM LOS			A

Minor Lane/Major Mvmt	NWLn1	NWLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	984	1056	-	-	1591	-
HCM Lane V/C Ratio	0.011	0.006	-	-	-	-
HCM Control Delay (s)	8.7	8.4	-	-	0	-
HCM Lane LOS	A	A	-	-	A	-
HCM 95th %tile Q(veh)	0	0	-	-	0	-

Intersection Analysis

2035 Without Billings Bypass

Intersection	
Int Delay, s/veh	3.2

Movement	NWL	NWR	NET	NER	SWL	SWT
Traffic Vol, veh/h	61	41	823	104	29	395
Future Vol, veh/h	61	41	823	104	29	395
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	100	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	88	88	88	88	88	88
Heavy Vehicles, %	3	3	3	3	3	3
Mvmt Flow	69	47	935	118	33	449

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1284	527	0	0	1053	0
Stage 1	994	-	-	-	-	-
Stage 2	290	-	-	-	-	-
Critical Hdwy	6.86	6.96	-	-	4.16	-
Critical Hdwy Stg 1	5.86	-	-	-	-	-
Critical Hdwy Stg 2	5.86	-	-	-	-	-
Follow-up Hdwy	3.53	3.33	-	-	2.23	-
Pot Cap-1 Maneuver	155	493	-	-	651	-
Stage 1	317	-	-	-	-	-
Stage 2	731	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	147	493	-	-	651	-
Mov Cap-2 Maneuver	147	-	-	-	-	-
Stage 1	317	-	-	-	-	-
Stage 2	694	-	-	-	-	-

Approach	NW	NE	SW
HCM Control Delay, s	43.2	0	0.7
HCM LOS	E		

Minor Lane/Major Mvmt	NET	NER	NWLn1	SWL	SWT
Capacity (veh/h)	-	-	205	651	-
HCM Lane V/C Ratio	-	-	0.565	0.051	-
HCM Control Delay (s)	-	-	43.2	10.8	-
HCM Lane LOS	-	-	E	B	-
HCM 95th %tile Q(veh)	-	-	3.1	0.2	-

Intersection	
Int Delay, s/veh	3.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Vol, veh/h	156	361	6	5	174	38	5	5	5	19	5	70
Future Vol, veh/h	156	361	6	5	174	38	5	5	5	19	5	70
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	320	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	94	94	94	94	94	94	94	94	94	94	94	94
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	166	384	6	5	185	40	5	5	5	20	5	74

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	226	0	0	390	0	0	975	955	387	940	938	205
Stage 1	-	-	-	-	-	-	719	719	-	216	216	-
Stage 2	-	-	-	-	-	-	256	236	-	724	722	-
Critical Hdwy	4.13	-	-	4.13	-	-	7.13	6.53	6.23	7.13	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Follow-up Hdwy	2.227	-	-	2.227	-	-	3.527	4.027	3.327	3.527	4.027	3.327
Pot Cap-1 Maneuver	1337	-	-	1163	-	-	230	257	659	243	263	833
Stage 1	-	-	-	-	-	-	418	431	-	784	722	-
Stage 2	-	-	-	-	-	-	746	708	-	415	430	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1337	-	-	1163	-	-	186	224	659	213	229	833
Mov Cap-2 Maneuver	-	-	-	-	-	-	186	224	-	213	229	-
Stage 1	-	-	-	-	-	-	366	377	-	687	718	-
Stage 2	-	-	-	-	-	-	671	704	-	355	377	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2.4	0.2	19.5	14.4
HCM LOS			C	B

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	264	1337	-	-	1163	-	-	482
HCM Lane V/C Ratio	0.06	0.124	-	-	0.005	-	-	0.207
HCM Control Delay (s)	19.5	8.1	-	-	8.1	0	-	14.4
HCM Lane LOS	C	A	-	-	A	A	-	B
HCM 95th %tile Q(veh)	0.2	0.4	-	-	0	-	-	0.8

Intersection	
Int Delay, s/veh	6.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Vol, veh/h	209	207	5	13	152	115	5	7	13	55	5	65
Future Vol, veh/h	209	207	5	13	152	115	5	7	13	55	5	65
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	510	-	-	510	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	87	87	87	87	87	87	87	87	87	87	87	87
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	240	238	6	15	175	132	6	8	15	63	6	75

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	307	0	0	244	0	0	1032	1058	241	1004	995	241
Stage 1	-	-	-	-	-	-	721	721	-	271	271	-
Stage 2	-	-	-	-	-	-	311	337	-	733	724	-
Critical Hdwy	4.13	-	-	4.13	-	-	7.13	6.53	6.23	7.13	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Follow-up Hdwy	2.227	-	-	2.227	-	-	3.527	4.027	3.327	3.527	4.027	3.327
Pot Cap-1 Maneuver	1248	-	-	1316	-	-	210	224	795	220	244	795
Stage 1	-	-	-	-	-	-	417	430	-	733	683	-
Stage 2	-	-	-	-	-	-	697	639	-	411	429	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1248	-	-	1316	-	-	157	179	795	176	195	795
Mov Cap-2 Maneuver	-	-	-	-	-	-	157	179	-	176	195	-
Stage 1	-	-	-	-	-	-	337	347	-	592	675	-
Stage 2	-	-	-	-	-	-	619	632	-	318	347	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	4.3	0.4	19	27.8
HCM LOS			C	D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	286	1248	-	-	1316	-	-	298
HCM Lane V/C Ratio	0.1	0.192	-	-	0.011	-	-	0.482
HCM Control Delay (s)	19	8.6	-	-	7.8	-	-	27.8
HCM Lane LOS	C	A	-	-	A	-	-	D
HCM 95th %tile Q(veh)	0.3	0.7	-	-	0	-	-	2.5

Intersection	
Int Delay, s/veh	6.1

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Traffic Vol, veh/h	157	153	13	71	247	14
Future Vol, veh/h	157	153	13	71	247	14
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	3	3	3	3	3	3
Mvmt Flow	169	165	14	76	266	15

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	333	0	355	251
Stage 1	-	-	-	-	251	-
Stage 2	-	-	-	-	104	-
Critical Hdwy	-	-	4.13	-	6.43	6.23
Critical Hdwy Stg 1	-	-	-	-	5.43	-
Critical Hdwy Stg 2	-	-	-	-	5.43	-
Follow-up Hdwy	-	-	2.227	-	3.527	3.327
Pot Cap-1 Maneuver	-	-	1221	-	641	785
Stage 1	-	-	-	-	788	-
Stage 2	-	-	-	-	918	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1221	-	633	785
Mov Cap-2 Maneuver	-	-	-	-	633	-
Stage 1	-	-	-	-	788	-
Stage 2	-	-	-	-	907	-

Approach	EB	WB	NW
HCM Control Delay, s	0	1.2	14.9
HCM LOS			B

Minor Lane/Major Mvmt	NWLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	640	-	-	1221	-
HCM Lane V/C Ratio	0.439	-	-	0.011	-
HCM Control Delay (s)	14.9	-	-	8	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	2.2	-	-	0	-

Intersection	
Int Delay, s/veh	9.1

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Traffic Vol, veh/h	47	7	114	5	9	5	310	232	5	3	110	54
Future Vol, veh/h	47	7	114	5	9	5	310	232	5	3	110	54
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	91	91	91	91	91	91	91	91	91	91	91	91
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	52	8	125	5	10	5	341	255	5	3	121	59

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1104	1099	151	1163	1126	258	180	0	0	260	0	0
Stage 1	157	157	-	939	939	-	-	-	-	-	-	-
Stage 2	947	942	-	224	187	-	-	-	-	-	-	-
Critical Hdwy	7.13	6.53	6.23	7.13	6.53	6.23	4.13	-	-	4.13	-	-
Critical Hdwy Stg 1	6.13	5.53	-	6.13	5.53	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.13	5.53	-	6.13	5.53	-	-	-	-	-	-	-
Follow-up Hdwy	3.527	4.027	3.327	3.527	4.027	3.327	2.227	-	-	2.227	-	-
Pot Cap-1 Maneuver	188	212	893	171	204	778	1389	-	-	1299	-	-
Stage 1	843	766	-	316	341	-	-	-	-	-	-	-
Stage 2	312	340	-	776	743	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	138	151	893	110	145	778	1389	-	-	1299	-	-
Mov Cap-2 Maneuver	138	151	-	110	145	-	-	-	-	-	-	-
Stage 1	601	764	-	225	243	-	-	-	-	-	-	-
Stage 2	212	242	-	658	741	-	-	-	-	-	-	-

Approach	SE	NW	NE	SW
HCM Control Delay, s	29.5	29.6	4.8	0.1
HCM LOS	D	D		

Minor Lane/Major Mvmt	NEL	NET	NER	NWLn1	SELn1	SWL	SWT	SWR
Capacity (veh/h)	1389	-	-	167	326	1299	-	-
HCM Lane V/C Ratio	0.245	-	-	0.125	0.566	0.003	-	-
HCM Control Delay (s)	8.4	0	-	29.6	29.5	7.8	0	-
HCM Lane LOS	A	A	-	D	D	A	A	-
HCM 95th %tile Q(veh)	1	-	-	0.4	3.3	0	-	-

Intersection	
Int Delay, s/veh	0.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Traffic Vol, veh/h	0	0	0	5	5	6	0	102	154	31	452	0
Future Vol, veh/h	0	0	0	5	5	6	0	102	154	31	452	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	88	88	88	88	88	88	88	88	88	88	88	88
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	0	0	0	6	6	7	0	116	175	35	514	0

Major/Minor	Minor2			Major1			Major2		
Conflicting Flow All	787	875	514	514	0	0	291	0	0
Stage 1	584	584	-	-	-	-	-	-	-
Stage 2	203	291	-	-	-	-	-	-	-
Critical Hdwy	6.43	6.53	6.23	4.13	-	-	4.13	-	-
Critical Hdwy Stg 1	5.43	5.53	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.43	5.53	-	-	-	-	-	-	-
Follow-up Hdwy	3.527	4.027	3.327	2.227	-	-	2.227	-	-
Pot Cap-1 Maneuver	359	287	558	1046	-	-	1265	-	-
Stage 1	555	496	-	-	-	-	-	-	-
Stage 2	829	670	-	-	-	-	-	-	-
Platoon blocked, %					-	-		-	-
Mov Cap-1 Maneuver	345	0	558	1046	-	-	1265	-	-
Mov Cap-2 Maneuver	345	0	-	-	-	-	-	-	-
Stage 1	533	0	-	-	-	-	-	-	-
Stage 2	829	0	-	-	-	-	-	-	-

Approach	WB	SE	NW
HCM Control Delay, s	13.6	0	0.5
HCM LOS	B		

Minor Lane/Major Mvmt	NWL	NWT	NWR	WBLn1	SEL	SET	SER
Capacity (veh/h)	1265	-	-	436	1046	-	-
HCM Lane V/C Ratio	0.028	-	-	0.042	-	-	-
HCM Control Delay (s)	7.9	0	-	13.6	0	-	-
HCM Lane LOS	A	A	-	B	A	-	-
HCM 95th %tile Q(veh)	0.1	-	-	0.1	0	-	-

Intersection	
Int Delay, s/veh	16.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Traffic Vol, veh/h	374	5	108	0	0	0	16	87	0	0	110	6
Future Vol, veh/h	374	5	108	0	0	0	16	87	0	0	110	6
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	85	85	85	85	85	85	85	85	85	85	85	85
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	440	6	127	0	0	0	19	102	0	0	129	7

Major/Minor	Minor1			Major1			Major2		
Conflicting Flow All	273	276	102	136	0	0	102	0	0
Stage 1	140	140	-	-	-	-	-	-	-
Stage 2	133	136	-	-	-	-	-	-	-
Critical Hdwy	6.43	6.53	6.23	4.13	-	-	4.13	-	-
Critical Hdwy Stg 1	5.43	5.53	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.43	5.53	-	-	-	-	-	-	-
Follow-up Hdwy	3.527	4.027	3.327	2.227	-	-	2.227	-	-
Pot Cap-1 Maneuver	714	630	950	1442	-	-	1484	-	-
Stage 1	884	779	-	-	-	-	-	-	-
Stage 2	891	782	-	-	-	-	-	-	-
Platoon blocked, %					-	-		-	-
Mov Cap-1 Maneuver	704	0	950	1442	-	-	1484	-	-
Mov Cap-2 Maneuver	704	0	-	-	-	-	-	-	-
Stage 1	872	0	-	-	-	-	-	-	-
Stage 2	891	0	-	-	-	-	-	-	-

Approach	EB	SE	NW
HCM Control Delay, s	23.8	1.2	0
HCM LOS	C		

Minor Lane/Major Mvmt	NWL	NWT	NWR	EBLn1	SEL	SET	SER
Capacity (veh/h)	1484	-	-	747	1442	-	-
HCM Lane V/C Ratio	-	-	-	0.767	0.013	-	-
HCM Control Delay (s)	0	-	-	23.8	7.5	0	-
HCM Lane LOS	A	-	-	C	A	A	-
HCM 95th %tile Q(veh)	0	-	-	7.4	0	-	-

Intersection	
Int Delay, s/veh	4.8

Movement	EBT	EBR	WBL	WBT	NEL	NER
Traffic Vol, veh/h	144	0	82	99	0	174
Future Vol, veh/h	144	0	82	99	0	174
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	3	3	3	3	3	3
Mvmt Flow	152	0	86	104	0	183

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	152	0	429	152
Stage 1	-	-	-	-	152	-
Stage 2	-	-	-	-	277	-
Critical Hdwy	-	-	4.13	-	6.43	6.23
Critical Hdwy Stg 1	-	-	-	-	5.43	-
Critical Hdwy Stg 2	-	-	-	-	5.43	-
Follow-up Hdwy	-	-	2.227	-	3.527	3.327
Pot Cap-1 Maneuver	-	-	1423	-	581	892
Stage 1	-	-	-	-	874	-
Stage 2	-	-	-	-	767	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1423	-	544	892
Mov Cap-2 Maneuver	-	-	-	-	544	-
Stage 1	-	-	-	-	874	-
Stage 2	-	-	-	-	718	-

Approach	EB	WB	NE
HCM Control Delay, s	0	3.5	10.1
HCM LOS			B

Minor Lane/Major Mvmt	NELn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	892	-	-	1423	-
HCM Lane V/C Ratio	0.205	-	-	0.061	-
HCM Control Delay (s)	10.1	-	-	7.7	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	0.8	-	-	0.2	-

Intersection	
Int Delay, s/veh	5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Vol, veh/h	29	65	21	18	55	12	22	33	5	14	25	9
Future Vol, veh/h	29	65	21	18	55	12	22	33	5	14	25	9
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	32	71	23	20	60	13	24	36	5	15	27	10

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	73	0	0	93	0	0	269	257	82	271	262	66
Stage 1	-	-	-	-	-	-	145	145	-	105	105	-
Stage 2	-	-	-	-	-	-	124	112	-	166	157	-
Critical Hdwy	4.13	-	-	4.13	-	-	7.13	6.53	6.23	7.13	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Follow-up Hdwy	2.227	-	-	2.227	-	-	3.527	4.027	3.327	3.527	4.027	3.327
Pot Cap-1 Maneuver	1520	-	-	1495	-	-	682	645	975	679	641	995
Stage 1	-	-	-	-	-	-	855	775	-	898	806	-
Stage 2	-	-	-	-	-	-	878	801	-	834	766	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1520	-	-	1495	-	-	635	622	975	628	618	995
Mov Cap-2 Maneuver	-	-	-	-	-	-	635	622	-	628	618	-
Stage 1	-	-	-	-	-	-	836	758	-	878	795	-
Stage 2	-	-	-	-	-	-	828	790	-	773	749	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	1.9	1.6	11.2	10.8
HCM LOS			B	B

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	646	1520	-	-	1495	-	-	669
HCM Lane V/C Ratio	0.101	0.021	-	-	0.013	-	-	0.078
HCM Control Delay (s)	11.2	7.4	0	-	7.4	0	-	10.8
HCM Lane LOS	B	A	A	-	A	A	-	B
HCM 95th %tile Q(veh)	0.3	0.1	-	-	0	-	-	0.3

Intersection	
Int Delay, s/veh	4.8

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Traffic Vol, veh/h	17	10	8	5	14	5	0	0	0	5	5	20
Future Vol, veh/h	17	10	8	5	14	5	0	0	0	5	5	20
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	74	74	74	74	74	74	74	74	74	74	74	74
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	23	14	11	7	19	7	0	0	0	7	7	27

Major/Minor	Major1			Major2			Minor2		
Conflicting Flow All	26	0	0	24	0	0	101	106	22
Stage 1	-	-	-	-	-	-	36	36	-
Stage 2	-	-	-	-	-	-	65	70	-
Critical Hdwy	4.13	-	-	4.13	-	-	6.43	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	5.43	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	5.43	5.53	-
Follow-up Hdwy	2.227	-	-	2.227	-	-	3.527	4.027	3.327
Pot Cap-1 Maneuver	1582	-	-	1584	-	-	895	782	1052
Stage 1	-	-	-	-	-	-	984	863	-
Stage 2	-	-	-	-	-	-	955	835	-
Platoon blocked, %		-	-		-	-			
Mov Cap-1 Maneuver	1582	-	-	1584	-	-	878	0	1052
Mov Cap-2 Maneuver	-	-	-	-	-	-	878	0	-
Stage 1	-	-	-	-	-	-	980	0	-
Stage 2	-	-	-	-	-	-	941	0	-

Approach	SE	NW	SW
HCM Control Delay, s	3.6	1.5	8.7
HCM LOS			A

Minor Lane/Major Mvmt	NWL	NWT	NWR	SEL	SET	SER	SWLn1
Capacity (veh/h)	1584	-	-	1582	-	-	1012
HCM Lane V/C Ratio	0.004	-	-	0.015	-	-	0.04
HCM Control Delay (s)	7.3	0	-	7.3	0	-	8.7
HCM Lane LOS	A	A	-	A	A	-	A
HCM 95th %tile Q(veh)	0	-	-	0	-	-	0.1

Intersection	
Int Delay, s/veh	6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Traffic Vol, veh/h	25	5	8	0	0	0	5	5	0	0	9	5
Future Vol, veh/h	25	5	8	0	0	0	5	5	0	0	9	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	77	77	77	77	77	77	77	77	77	77	77	77
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	32	6	10	0	0	0	6	6	0	0	12	6

Major/Minor	Minor1			Major1			Major2		
Conflicting Flow All	34	37	6	18	0	0	6	0	0
Stage 1	19	19	-	-	-	-	-	-	-
Stage 2	15	18	-	-	-	-	-	-	-
Critical Hdwy	6.43	6.53	6.23	4.13	-	-	4.13	-	-
Critical Hdwy Stg 1	5.43	5.53	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.43	5.53	-	-	-	-	-	-	-
Follow-up Hdwy	3.527	4.027	3.327	2.227	-	-	2.227	-	-
Pot Cap-1 Maneuver	977	853	1074	1592	-	-	1608	-	-
Stage 1	1001	878	-	-	-	-	-	-	-
Stage 2	1005	878	-	-	-	-	-	-	-
Platoon blocked, %					-	-		-	-
Mov Cap-1 Maneuver	973	0	1074	1592	-	-	1608	-	-
Mov Cap-2 Maneuver	973	0	-	-	-	-	-	-	-
Stage 1	997	0	-	-	-	-	-	-	-
Stage 2	1005	0	-	-	-	-	-	-	-

Approach	EB	SE	NW
HCM Control Delay, s	8.8	3.6	0
HCM LOS	A		

Minor Lane/Major Mvmt	NWL	NWT	NWR	EBLn1	SEL	SET	SER
Capacity (veh/h)	1608	-	-	996	1592	-	-
HCM Lane V/C Ratio	-	-	-	0.05	0.004	-	-
HCM Control Delay (s)	0	-	-	8.8	7.3	0	-
HCM Lane LOS	A	-	-	A	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0.2	0	-	-

Intersection	
Int Delay, s/veh	3

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Traffic Vol, veh/h	22	0	0	10	12	5
Future Vol, veh/h	22	0	0	10	12	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	25
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	77	77	77	77	77	77
Heavy Vehicles, %	3	3	3	3	3	3
Mvmt Flow	29	0	0	13	16	6

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	29	0	42	29
Stage 1	-	-	-	-	29	-
Stage 2	-	-	-	-	13	-
Critical Hdwy	-	-	4.13	-	6.43	6.23
Critical Hdwy Stg 1	-	-	-	-	5.43	-
Critical Hdwy Stg 2	-	-	-	-	5.43	-
Follow-up Hdwy	-	-	2.227	-	3.527	3.327
Pot Cap-1 Maneuver	-	-	1578	-	967	1043
Stage 1	-	-	-	-	991	-
Stage 2	-	-	-	-	1007	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1578	-	967	1043
Mov Cap-2 Maneuver	-	-	-	-	967	-
Stage 1	-	-	-	-	991	-
Stage 2	-	-	-	-	1007	-

Approach	EB	WB	NW
HCM Control Delay, s	0	0	8.7
HCM LOS			A

Minor Lane/Major Mvmt	NWLn1	NWLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	967	1043	-	-	1578	-
HCM Lane V/C Ratio	0.016	0.006	-	-	-	-
HCM Control Delay (s)	8.8	8.5	-	-	0	-
HCM Lane LOS	A	A	-	-	A	-
HCM 95th %tile Q(veh)	0	0	-	-	0	-

Intersection Analysis

2035 With Billings Bypass

Intersection	
Int Delay, s/veh	2.5

Movement	NWL	NWR	NET	NER	SWL	SWT
Traffic Vol, veh/h	63	42	671	85	22	306
Future Vol, veh/h	63	42	671	85	22	306
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	100	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	88	88	88	88	88	88
Heavy Vehicles, %	3	3	3	3	3	3
Mvmt Flow	72	48	763	97	25	348

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1035	430	0	0	859	0
Stage 1	811	-	-	-	-	-
Stage 2	224	-	-	-	-	-
Critical Hdwy	6.86	6.96	-	-	4.16	-
Critical Hdwy Stg 1	5.86	-	-	-	-	-
Critical Hdwy Stg 2	5.86	-	-	-	-	-
Follow-up Hdwy	3.53	3.33	-	-	2.23	-
Pot Cap-1 Maneuver	226	571	-	-	772	-
Stage 1	395	-	-	-	-	-
Stage 2	789	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	219	571	-	-	772	-
Mov Cap-2 Maneuver	219	-	-	-	-	-
Stage 1	395	-	-	-	-	-
Stage 2	763	-	-	-	-	-

Approach	NW	NE	SW
HCM Control Delay, s	25.7	0	0.7
HCM LOS	D		

Minor Lane/Major Mvmt	NET	NER	NWLn1	SWL	SWT
Capacity (veh/h)	-	-	291	772	-
HCM Lane V/C Ratio	-	-	0.41	0.032	-
HCM Control Delay (s)	-	-	25.7	9.8	-
HCM Lane LOS	-	-	D	A	-
HCM 95th %tile Q(veh)	-	-	1.9	0.1	-

Intersection	
Int Delay, s/veh	3.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Vol, veh/h	183	423	7	5	214	46	1	4	1	19	3	70
Future Vol, veh/h	183	423	7	5	214	46	1	4	1	19	3	70
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	320	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	94	94	94	94	94	94	94	94	94	94	94	94
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	195	450	7	5	228	49	1	4	1	20	3	74

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	277	0	0	457	0	0	1145	1130	454	1109	1110	252
Stage 1	-	-	-	-	-	-	843	843	-	263	263	-
Stage 2	-	-	-	-	-	-	302	287	-	846	847	-
Critical Hdwy	4.13	-	-	4.13	-	-	7.13	6.53	6.23	7.13	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Follow-up Hdwy	2.227	-	-	2.227	-	-	3.527	4.027	3.327	3.527	4.027	3.327
Pot Cap-1 Maneuver	1280	-	-	1099	-	-	176	203	604	186	208	784
Stage 1	-	-	-	-	-	-	357	378	-	740	689	-
Stage 2	-	-	-	-	-	-	705	673	-	356	377	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1280	-	-	1099	-	-	138	171	604	160	175	784
Mov Cap-2 Maneuver	-	-	-	-	-	-	138	171	-	160	175	-
Stage 1	-	-	-	-	-	-	303	320	-	627	686	-
Stage 2	-	-	-	-	-	-	632	670	-	297	320	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2.5	0.2	25	16.5
HCM LOS			D	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	186	1280	-	-	1099	-	-	409
HCM Lane V/C Ratio	0.034	0.152	-	-	0.005	-	-	0.239
HCM Control Delay (s)	25	8.3	-	-	8.3	0	-	16.5
HCM Lane LOS	D	A	-	-	A	A	-	C
HCM 95th %tile Q(veh)	0.1	0.5	-	-	0	-	-	0.9

Intersection	
Int Delay, s/veh	6.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Vol, veh/h	258	255	5	10	113	86	5	7	10	41	4	81
Future Vol, veh/h	258	255	5	10	113	86	5	7	10	41	4	81
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	510	-	-	510	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	87	87	87	87	87	87	87	87	87	87	87	87
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	297	293	6	11	130	99	6	8	11	47	5	93

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	229	0	0	299	0	0	1140	1141	296	1101	1094	179
Stage 1	-	-	-	-	-	-	889	889	-	202	202	-
Stage 2	-	-	-	-	-	-	251	252	-	899	892	-
Critical Hdwy	4.13	-	-	4.13	-	-	7.13	6.53	6.23	7.13	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Follow-up Hdwy	2.227	-	-	2.227	-	-	3.527	4.027	3.327	3.527	4.027	3.327
Pot Cap-1 Maneuver	1333	-	-	1256	-	-	177	200	741	188	213	861
Stage 1	-	-	-	-	-	-	336	360	-	798	732	-
Stage 2	-	-	-	-	-	-	751	697	-	332	359	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1333	-	-	1256	-	-	127	154	741	147	164	861
Mov Cap-2 Maneuver	-	-	-	-	-	-	127	154	-	147	164	-
Stage 1	-	-	-	-	-	-	261	280	-	620	726	-
Stage 2	-	-	-	-	-	-	660	691	-	247	279	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	4.2	0.4	23.1	25.6
HCM LOS			C	D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	224	1333	-	-	1256	-	-	317
HCM Lane V/C Ratio	0.113	0.222	-	-	0.009	-	-	0.457
HCM Control Delay (s)	23.1	8.5	-	-	7.9	-	-	25.6
HCM Lane LOS	C	A	-	-	A	-	-	D
HCM 95th %tile Q(veh)	0.4	0.9	-	-	0	-	-	2.3

Intersection	
Int Delay, s/veh	5

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Traffic Vol, veh/h	117	114	13	71	184	14
Future Vol, veh/h	117	114	13	71	184	14
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	3	3	3	3	3	3
Mvmt Flow	126	123	14	76	198	15

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	248	0	291	187
Stage 1	-	-	-	-	187	-
Stage 2	-	-	-	-	104	-
Critical Hdwy	-	-	4.13	-	6.43	6.23
Critical Hdwy Stg 1	-	-	-	-	5.43	-
Critical Hdwy Stg 2	-	-	-	-	5.43	-
Follow-up Hdwy	-	-	2.227	-	3.527	3.327
Pot Cap-1 Maneuver	-	-	1312	-	698	852
Stage 1	-	-	-	-	843	-
Stage 2	-	-	-	-	918	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1312	-	690	852
Mov Cap-2 Maneuver	-	-	-	-	690	-
Stage 1	-	-	-	-	843	-
Stage 2	-	-	-	-	908	-

Approach	EB	WB	NW
HCM Control Delay, s	0	1.2	12.4
HCM LOS			B

Minor Lane/Major Mvmt	NWLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	699	-	-	1312	-
HCM Lane V/C Ratio	0.305	-	-	0.011	-
HCM Control Delay (s)	12.4	-	-	7.8	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	1.3	-	-	0	-

Intersection	
Int Delay, s/veh	6.5

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Traffic Vol, veh/h	47	7	82	5	9	3	224	167	2	3	110	54
Future Vol, veh/h	47	7	82	5	9	3	224	167	2	3	110	54
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	91	91	91	91	91	91	91	91	91	91	91	91
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	52	8	90	5	10	3	246	184	2	3	121	59

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	841	835	151	883	864	185	180	0	0	186	0	0
Stage 1	157	157	-	677	677	-	-	-	-	-	-	-
Stage 2	684	678	-	206	187	-	-	-	-	-	-	-
Critical Hdwy	7.13	6.53	6.23	7.13	6.53	6.23	4.13	-	-	4.13	-	-
Critical Hdwy Stg 1	6.13	5.53	-	6.13	5.53	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.13	5.53	-	6.13	5.53	-	-	-	-	-	-	-
Follow-up Hdwy	3.527	4.027	3.327	3.527	4.027	3.327	2.227	-	-	2.227	-	-
Pot Cap-1 Maneuver	283	302	893	265	291	855	1389	-	-	1382	-	-
Stage 1	843	766	-	441	451	-	-	-	-	-	-	-
Stage 2	437	450	-	794	743	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	231	242	893	197	233	855	1389	-	-	1382	-	-
Mov Cap-2 Maneuver	231	242	-	197	233	-	-	-	-	-	-	-
Stage 1	676	764	-	354	362	-	-	-	-	-	-	-
Stage 2	340	361	-	705	742	-	-	-	-	-	-	-

Approach	SE	NW	NE	SW
HCM Control Delay, s	18.3	20.4	4.6	0.1
HCM LOS	C	C		

Minor Lane/Major Mvmt	NEL	NET	NER	NWLn1	SELn1	SWL	SWT	SWR
Capacity (veh/h)	1389	-	-	252	419	1382	-	-
HCM Lane V/C Ratio	0.177	-	-	0.074	0.357	0.002	-	-
HCM Control Delay (s)	8.1	0	-	20.4	18.3	7.6	0	-
HCM Lane LOS	A	A	-	C	C	A	A	-
HCM 95th %tile Q(veh)	0.6	-	-	0.2	1.6	0	-	-

Intersection	
Int Delay, s/veh	0.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Traffic Vol, veh/h	0	0	0	5	5	6	0	102	111	31	452	0
Future Vol, veh/h	0	0	0	5	5	6	0	102	111	31	452	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	88	88	88	88	88	88	88	88	88	88	88	88
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	0	0	0	6	6	7	0	116	126	35	514	0

Major/Minor	Minor2			Major1			Major2		
Conflicting Flow All	763	826	514	514	0	0	242	0	0
Stage 1	584	584	-	-	-	-	-	-	-
Stage 2	179	242	-	-	-	-	-	-	-
Critical Hdwy	6.43	6.53	6.23	4.13	-	-	4.13	-	-
Critical Hdwy Stg 1	5.43	5.53	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.43	5.53	-	-	-	-	-	-	-
Follow-up Hdwy	3.527	4.027	3.327	2.227	-	-	2.227	-	-
Pot Cap-1 Maneuver	371	306	558	1046	-	-	1319	-	-
Stage 1	555	496	-	-	-	-	-	-	-
Stage 2	850	704	-	-	-	-	-	-	-
Platoon blocked, %					-	-		-	-
Mov Cap-1 Maneuver	357	0	558	1046	-	-	1319	-	-
Mov Cap-2 Maneuver	357	0	-	-	-	-	-	-	-
Stage 1	534	0	-	-	-	-	-	-	-
Stage 2	850	0	-	-	-	-	-	-	-

Approach	WB	SE	NW
HCM Control Delay, s	13.5	0	0.5
HCM LOS	B		

Minor Lane/Major Mvmt	NWL	NWT	NWR	WBLn1	SEL	SET	SER
Capacity (veh/h)	1319	-	-	444	1046	-	-
HCM Lane V/C Ratio	0.027	-	-	0.041	-	-	-
HCM Control Delay (s)	7.8	0	-	13.5	0	-	-
HCM Lane LOS	A	A	-	B	A	-	-
HCM 95th %tile Q(veh)	0.1	-	-	0.1	0	-	-

Intersection	
Int Delay, s/veh	9.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Traffic Vol, veh/h	270	5	78	0	0	0	16	87	0	0	110	6
Future Vol, veh/h	270	5	78	0	0	0	16	87	0	0	110	6
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	85	85	85	85	85	85	85	85	85	85	85	85
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	318	6	92	0	0	0	19	102	0	0	129	7

Major/Minor	Minor1			Major1			Major2		
Conflicting Flow All	273	276	102	136	0	0	102	0	0
Stage 1	140	140	-	-	-	-	-	-	-
Stage 2	133	136	-	-	-	-	-	-	-
Critical Hdwy	6.43	6.53	6.23	4.13	-	-	4.13	-	-
Critical Hdwy Stg 1	5.43	5.53	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.43	5.53	-	-	-	-	-	-	-
Follow-up Hdwy	3.527	4.027	3.327	2.227	-	-	2.227	-	-
Pot Cap-1 Maneuver	714	630	950	1442	-	-	1484	-	-
Stage 1	884	779	-	-	-	-	-	-	-
Stage 2	891	782	-	-	-	-	-	-	-
Platoon blocked, %					-	-		-	-
Mov Cap-1 Maneuver	704	0	950	1442	-	-	1484	-	-
Mov Cap-2 Maneuver	704	0	-	-	-	-	-	-	-
Stage 1	872	0	-	-	-	-	-	-	-
Stage 2	891	0	-	-	-	-	-	-	-

Approach	EB	SE	NW
HCM Control Delay, s	15.7	1.2	0
HCM LOS	C		

Minor Lane/Major Mvmt	NWL	NWT	NWR	EBLn1	SEL	SET	SER
Capacity (veh/h)	1484	-	-	747	1442	-	-
HCM Lane V/C Ratio	-	-	-	0.556	0.013	-	-
HCM Control Delay (s)	0	-	-	15.7	7.5	0	-
HCM Lane LOS	A	-	-	C	A	A	-
HCM 95th %tile Q(veh)	0	-	-	3.5	0	-	-

Intersection	
Int Delay, s/veh	4.8

Movement	EBT	EBR	WBL	WBT	NEL	NER
Traffic Vol, veh/h	144	0	82	99	0	174
Future Vol, veh/h	144	0	82	99	0	174
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	3	3	3	3	3	3
Mvmt Flow	152	0	86	104	0	183

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	152	0	429	152
Stage 1	-	-	-	-	152	-
Stage 2	-	-	-	-	277	-
Critical Hdwy	-	-	4.13	-	6.43	6.23
Critical Hdwy Stg 1	-	-	-	-	5.43	-
Critical Hdwy Stg 2	-	-	-	-	5.43	-
Follow-up Hdwy	-	-	2.227	-	3.527	3.327
Pot Cap-1 Maneuver	-	-	1423	-	581	892
Stage 1	-	-	-	-	874	-
Stage 2	-	-	-	-	767	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1423	-	544	892
Mov Cap-2 Maneuver	-	-	-	-	544	-
Stage 1	-	-	-	-	874	-
Stage 2	-	-	-	-	718	-

Approach	EB	WB	NE
HCM Control Delay, s	0	3.5	10.1
HCM LOS			B

Minor Lane/Major Mvmt	NELn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	892	-	-	1423	-
HCM Lane V/C Ratio	0.205	-	-	0.061	-
HCM Control Delay (s)	10.1	-	-	7.7	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	0.8	-	-	0.2	-

Intersection	
Int Delay, s/veh	5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Vol, veh/h	29	65	21	18	55	12	22	33	5	14	25	9
Future Vol, veh/h	29	65	21	18	55	12	22	33	5	14	25	9
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	32	71	23	20	60	13	24	36	5	15	27	10

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	73	0	0	93	0	0	269	257	82	271	262	66
Stage 1	-	-	-	-	-	-	145	145	-	105	105	-
Stage 2	-	-	-	-	-	-	124	112	-	166	157	-
Critical Hdwy	4.13	-	-	4.13	-	-	7.13	6.53	6.23	7.13	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.13	5.53	-	6.13	5.53	-
Follow-up Hdwy	2.227	-	-	2.227	-	-	3.527	4.027	3.327	3.527	4.027	3.327
Pot Cap-1 Maneuver	1520	-	-	1495	-	-	682	645	975	679	641	995
Stage 1	-	-	-	-	-	-	855	775	-	898	806	-
Stage 2	-	-	-	-	-	-	878	801	-	834	766	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1520	-	-	1495	-	-	635	622	975	628	618	995
Mov Cap-2 Maneuver	-	-	-	-	-	-	635	622	-	628	618	-
Stage 1	-	-	-	-	-	-	836	758	-	878	795	-
Stage 2	-	-	-	-	-	-	828	790	-	773	749	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	1.9	1.6	11.2	10.8
HCM LOS			B	B

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	646	1520	-	-	1495	-	-	669
HCM Lane V/C Ratio	0.101	0.021	-	-	0.013	-	-	0.078
HCM Control Delay (s)	11.2	7.4	0	-	7.4	0	-	10.8
HCM Lane LOS	B	A	A	-	A	A	-	B
HCM 95th %tile Q(veh)	0.3	0.1	-	-	0	-	-	0.3

Intersection	
Int Delay, s/veh	4.8

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Traffic Vol, veh/h	17	10	8	5	14	5	0	0	0	5	5	20
Future Vol, veh/h	17	10	8	5	14	5	0	0	0	5	5	20
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	74	74	74	74	74	74	74	74	74	74	74	74
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	23	14	11	7	19	7	0	0	0	7	7	27

Major/Minor	Major1			Major2			Minor2		
Conflicting Flow All	26	0	0	24	0	0	101	106	22
Stage 1	-	-	-	-	-	-	36	36	-
Stage 2	-	-	-	-	-	-	65	70	-
Critical Hdwy	4.13	-	-	4.13	-	-	6.43	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	5.43	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	5.43	5.53	-
Follow-up Hdwy	2.227	-	-	2.227	-	-	3.527	4.027	3.327
Pot Cap-1 Maneuver	1582	-	-	1584	-	-	895	782	1052
Stage 1	-	-	-	-	-	-	984	863	-
Stage 2	-	-	-	-	-	-	955	835	-
Platoon blocked, %		-	-		-	-			
Mov Cap-1 Maneuver	1582	-	-	1584	-	-	878	0	1052
Mov Cap-2 Maneuver	-	-	-	-	-	-	878	0	-
Stage 1	-	-	-	-	-	-	980	0	-
Stage 2	-	-	-	-	-	-	941	0	-

Approach	SE	NW	SW
HCM Control Delay, s	3.6	1.5	8.7
HCM LOS			A

Minor Lane/Major Mvmt	NWL	NWT	NWR	SEL	SET	SER	SWLn1
Capacity (veh/h)	1584	-	-	1582	-	-	1012
HCM Lane V/C Ratio	0.004	-	-	0.015	-	-	0.04
HCM Control Delay (s)	7.3	0	-	7.3	0	-	8.7
HCM Lane LOS	A	A	-	A	A	-	A
HCM 95th %tile Q(veh)	0	-	-	0	-	-	0.1

Intersection	
Int Delay, s/veh	6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Traffic Vol, veh/h	25	5	8	0	0	0	5	5	0	0	9	5
Future Vol, veh/h	25	5	8	0	0	0	5	5	0	0	9	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	77	77	77	77	77	77	77	77	77	77	77	77
Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3
Mvmt Flow	32	6	10	0	0	0	6	6	0	0	12	6

Major/Minor	Minor1			Major1			Major2		
Conflicting Flow All	34	37	6	18	0	0	6	0	0
Stage 1	19	19	-	-	-	-	-	-	-
Stage 2	15	18	-	-	-	-	-	-	-
Critical Hdwy	6.43	6.53	6.23	4.13	-	-	4.13	-	-
Critical Hdwy Stg 1	5.43	5.53	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.43	5.53	-	-	-	-	-	-	-
Follow-up Hdwy	3.527	4.027	3.327	2.227	-	-	2.227	-	-
Pot Cap-1 Maneuver	977	853	1074	1592	-	-	1608	-	-
Stage 1	1001	878	-	-	-	-	-	-	-
Stage 2	1005	878	-	-	-	-	-	-	-
Platoon blocked, %					-	-		-	-
Mov Cap-1 Maneuver	973	0	1074	1592	-	-	1608	-	-
Mov Cap-2 Maneuver	973	0	-	-	-	-	-	-	-
Stage 1	997	0	-	-	-	-	-	-	-
Stage 2	1005	0	-	-	-	-	-	-	-

Approach	EB	SE	NW
HCM Control Delay, s	8.8	3.6	0
HCM LOS	A		

Minor Lane/Major Mvmt	NWL	NWT	NWR	EBLn1	SEL	SET	SER
Capacity (veh/h)	1608	-	-	996	1592	-	-
HCM Lane V/C Ratio	-	-	-	0.05	0.004	-	-
HCM Control Delay (s)	0	-	-	8.8	7.3	0	-
HCM Lane LOS	A	-	-	A	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0.2	0	-	-

Intersection	
Int Delay, s/veh	3

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Traffic Vol, veh/h	22	0	0	10	12	5
Future Vol, veh/h	22	0	0	10	12	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	25
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	77	77	77	77	77	77
Heavy Vehicles, %	3	3	3	3	3	3
Mvmt Flow	29	0	0	13	16	6

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	29	0	42	29
Stage 1	-	-	-	-	29	-
Stage 2	-	-	-	-	13	-
Critical Hdwy	-	-	4.13	-	6.43	6.23
Critical Hdwy Stg 1	-	-	-	-	5.43	-
Critical Hdwy Stg 2	-	-	-	-	5.43	-
Follow-up Hdwy	-	-	2.227	-	3.527	3.327
Pot Cap-1 Maneuver	-	-	1578	-	967	1043
Stage 1	-	-	-	-	991	-
Stage 2	-	-	-	-	1007	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1578	-	967	1043
Mov Cap-2 Maneuver	-	-	-	-	967	-
Stage 1	-	-	-	-	991	-
Stage 2	-	-	-	-	1007	-

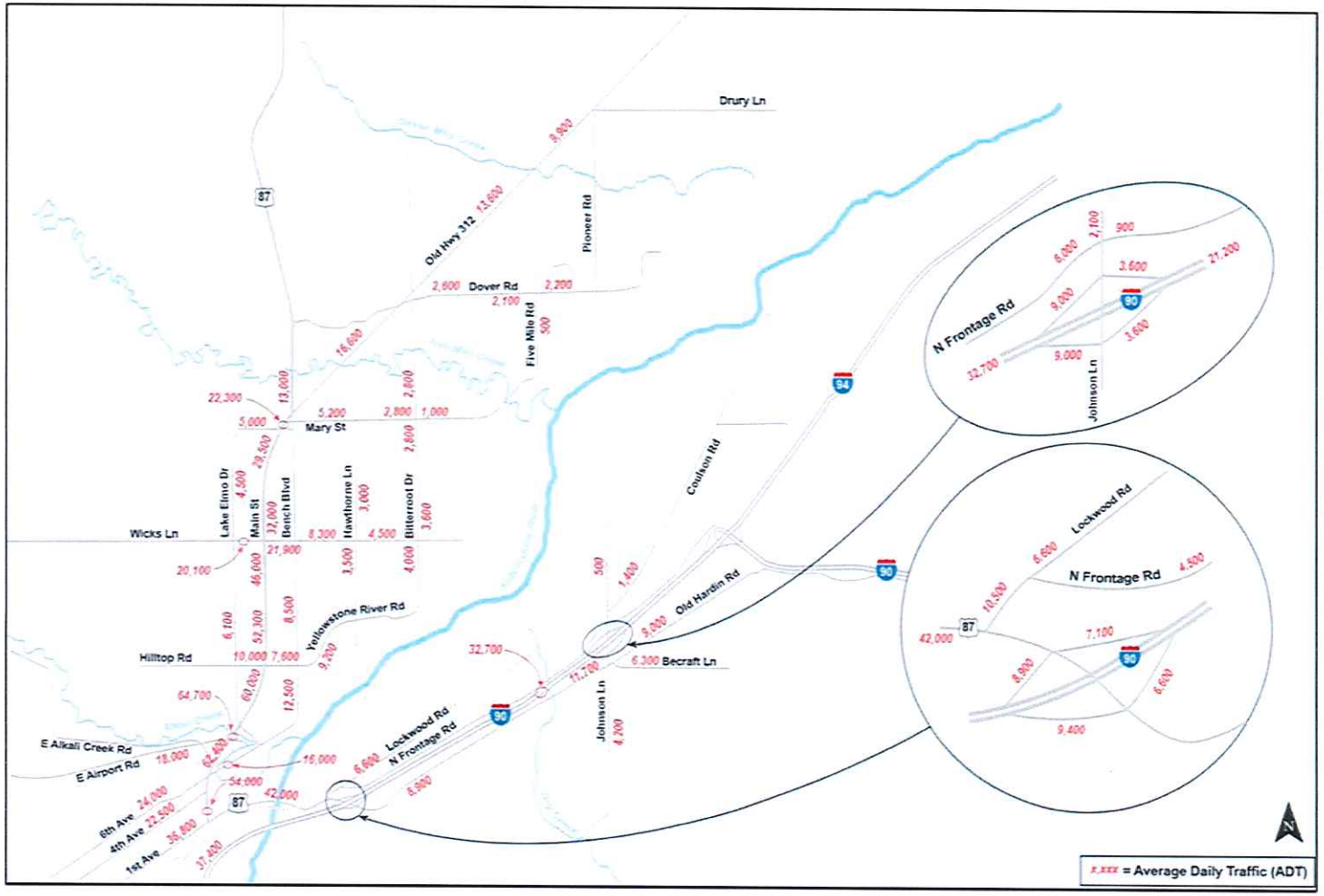
Approach	EB	WB	NW
HCM Control Delay, s	0	0	8.7
HCM LOS			A

Minor Lane/Major Mvmt	NWLn1	NWLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	967	1043	-	-	1578	-
HCM Lane V/C Ratio	0.016	0.006	-	-	-	-
HCM Control Delay (s)	8.8	8.5	-	-	0	-
HCM Lane LOS	A	A	-	-	A	-
HCM 95th %tile Q(veh)	0	0	-	-	0	-

ATTACHMENT 7

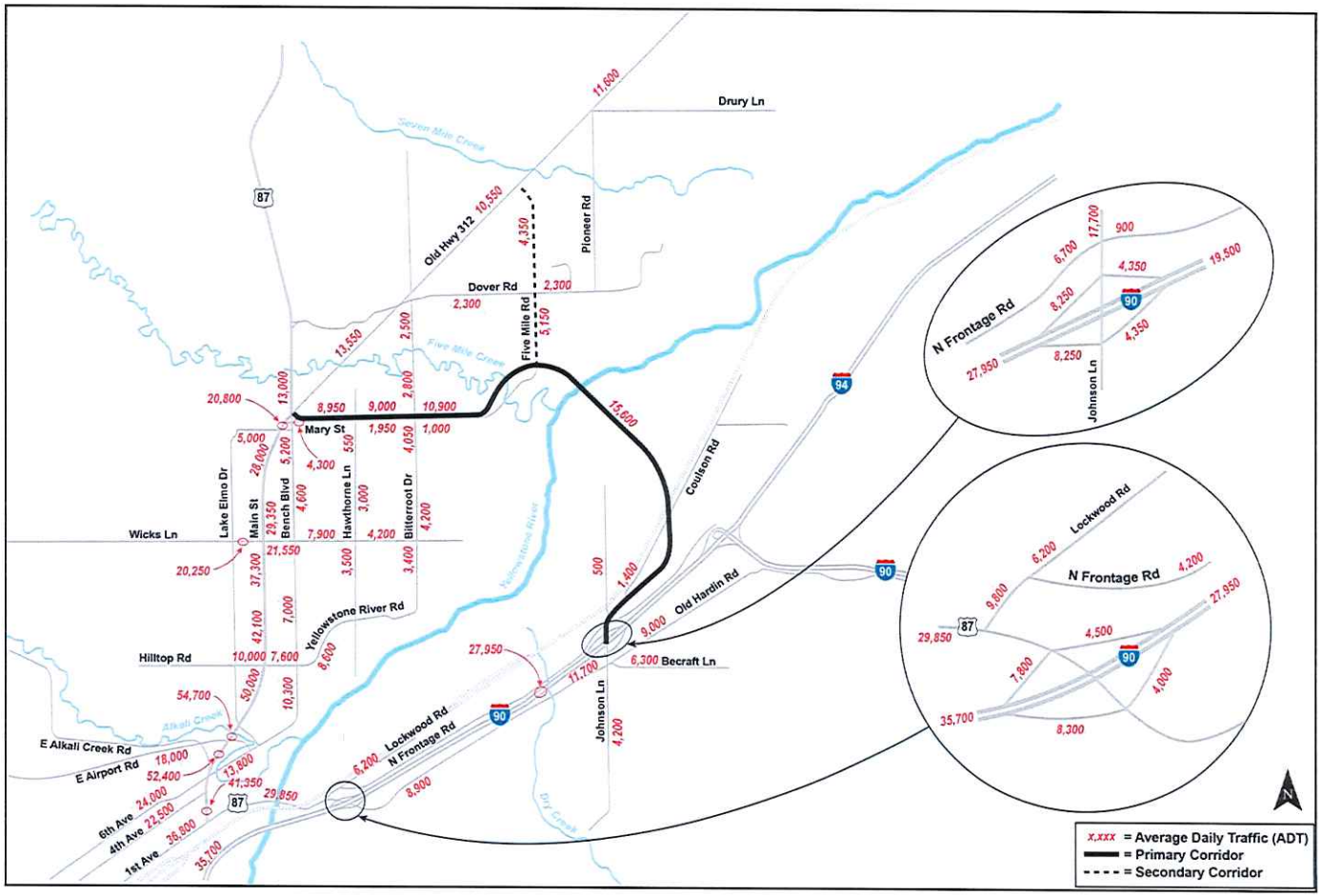
Billings Bypass FEIS
Traffic Volumes

Figure 4.2 2035 No Build Alternative Traffic Volumes



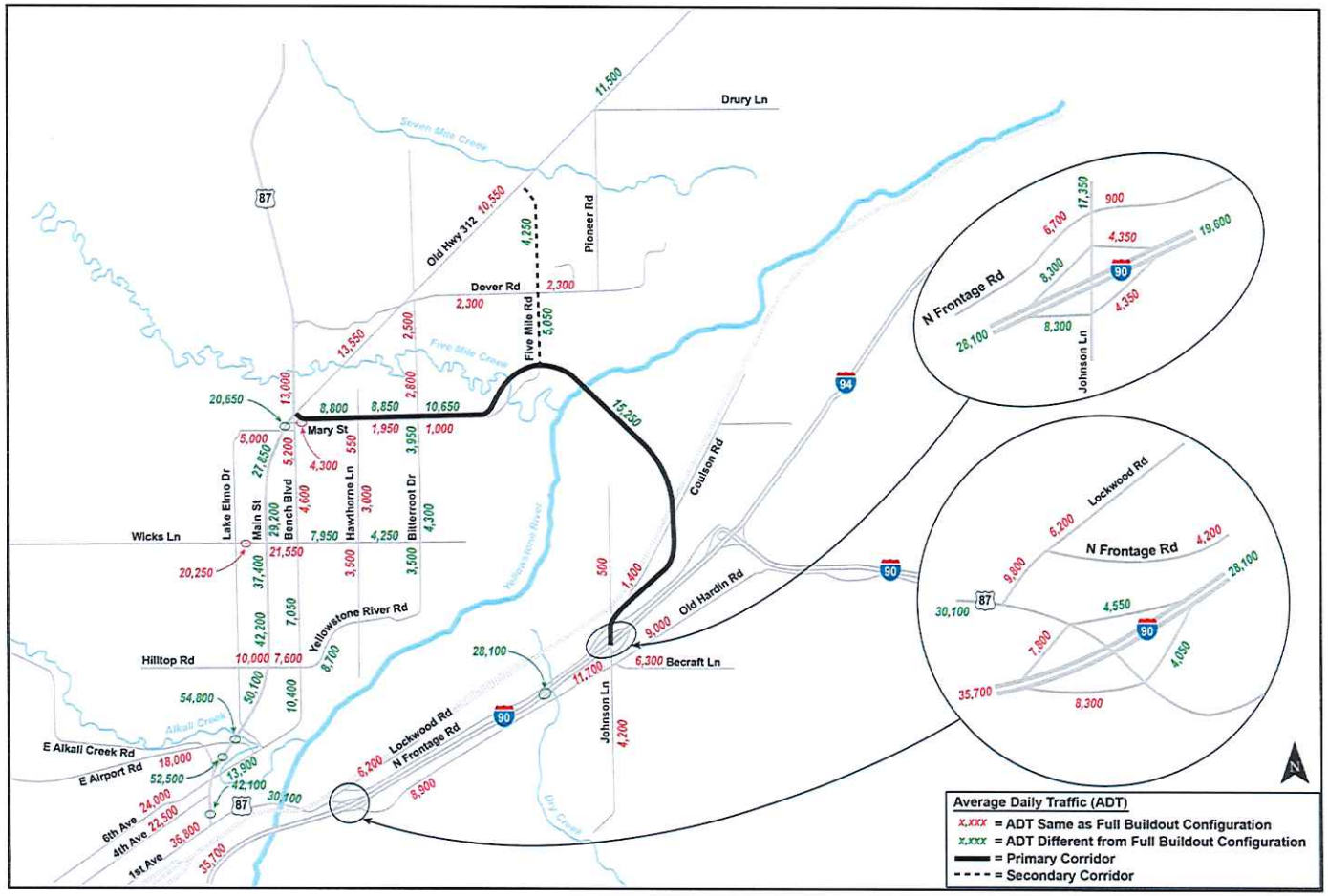
Source: *Billings Bypass Combined Traffic Reports*, August 2013.

Figure 4.7 2035 Mary Street Option 2 Alternative – Full Buildout Traffic Volumes



Source: *Billings Bypass Combined Traffic Reports*, August 2013.

Figure 4.8 2035 Mary Street Option 2 Alternative – Phase 1 Traffic Volumes



Source: *Billings Bypass Combined Traffic Reports*, August 2013.