Appendix D

Improvement Options Report

Old Highway 312 Corridor Study

Improvement Options Report

January 2016

DOWL

MDT

Contents

Figures

Tables

Attachments

Attachment 1	Intersection Exhibits
Attachment 2	Operational Analysis Worksheets
Attachment 3	Cost Estimate Spreadsheets

Abbreviations and Acronyms

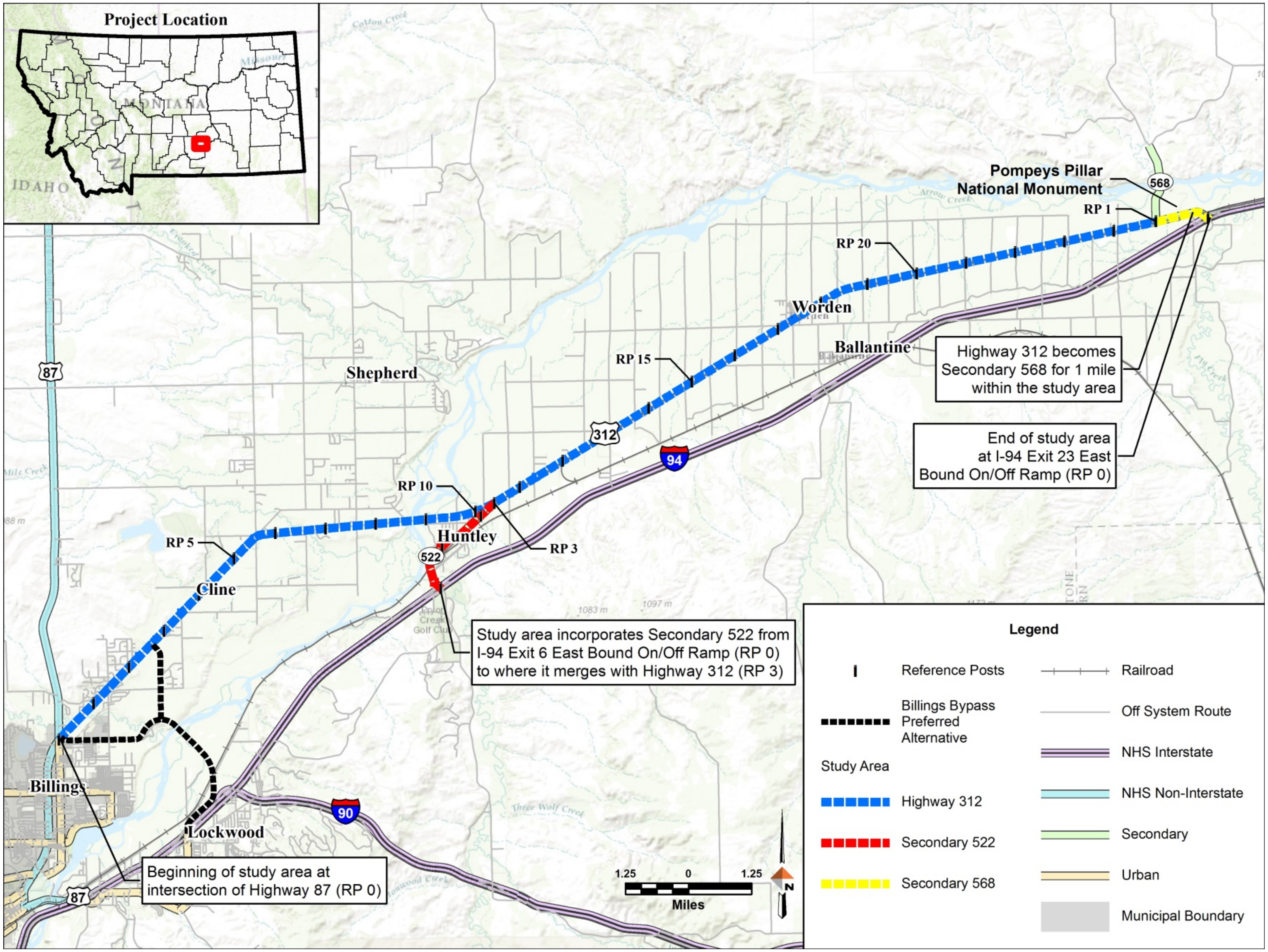
AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
EB	Eastbound
ETW	Edge of Traveled Way
FHWA	Federal Highway Administration
ft	foot/feet
HCM	Highway Capacity Manual
LOS	Level of Service
LOSS	Level of Service of Safety
MDT	Montana Department of Transportation
mph	miles per hour
MUTCD	Manual on Uniform Traffic Control Devices
NBL/NBT/NBR	Northbound Left/Northbound Through/Northbound Right
PROWAG	Public Rights-of-Way Accessibility Guidelines
RDM	Road Design Manual
RP	Reference Point
SBL/SBT/SBR	Southbound Left/Southbound Through/Southbound Right
TWLT	Two-way Left-turn Lane
TWSC	Two-way Stop Control
WBL/WBR	Westbound Left/Westbound Right

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 is 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. This report discusses potential improvements to highways within study area based on analysis conducted for the Existing and Projected Conditions Report and public and agency feedback.

Figure 1 Study Area



2.0 Needs and Objectives

Needs and objectives for the Old Highway 312 Corridor Study were developed based on existing and projected conditions within the corridor (including planned projects), input from the public and resource agencies, and coordination with the study advisory committee. Needs, objectives, and considerations are not listed in order of priority. These statements relate only to the highway corridor (including Highway 312 from RP 0.0 to RP 24.9, Secondary 568 from RP 0.0 to RP 1.0, and Secondary 522 from RP 0.0 to RP 3.0). They do not address the adjacent rail corridor(s).

Need 1: Improve safety within the highway corridor for all roadway users.

Objectives:
To the extent practicable:

- Improve the safety of roadway and structure elements by meeting current design criteria.
- Identify strategies to address locations with high potential for crash reduction and other known safety concerns.

Need 2: Accommodate existing and projected roadway demands and consider operations within the highway corridor.

Objectives:
To the extent practicable:

- Meet desirable levels of service on roadway segments and at intersections through the 2035 planning horizon.
- Consider regional, local, and seasonal travel patterns.

Need 3: Preserve and maintain highway infrastructure.

Objectives:
To the extent practicable:

- Rehabilitate roadway surfacing and structures as needed to accommodate volume and mix of vehicles through the 2035 planning horizon.
- Address areas with inadequate drainage.

Other Considerations

- Local planning efforts, planned projects, and potential future development in the study area.
- Proximity to railroad, utility, irrigation, and other features within the highway corridor.
- Potential adverse impacts to environmental resources that may result from improvement options.
- Funding eligibility and availability.
- Temporary construction impacts.
- Construction feasibility and physical constraints.

2.1 Design Criteria

Improvements to highways within the study area will be designed in accordance with state laws and standards. MDT has generally adopted American Association of State Highway and Transportation Officials (AASHTO) policies and Public Rights-of-Way Accessibility Guidelines (PROWAG) in compliance with the Americans with Disabilities Act (ADA). MDT design criteria and guidelines consulted for this study include the *Road Design Manual* (RDM), *Traffic Engineering Manual*, and *Environmental Manual*, among others.

Highway 312 is currently classified as an off-system (i.e., "X route") minor arterial from the Highway 312 and US 87 intersection to approximately reference point (RP) 1.75 and a 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 major collectors.

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.

3.0 Individual Improvement Options

This chapter presents individual improvement options. Unless otherwise noted, each option (and its associated cost estimate) only includes the elements listed in the option description.

In some cases, options could be grouped together to form a more comprehensive future project within the corridor. Chapter 6 discusses potential option combinations within corridor segments.

3.1 Curve Improvements

The alignment of a highway is composed of vertical and horizontal elements. The vertical alignment shows the profile, or elevation of the roadway, which includes the straight (tangent) highway grades and the parabolic curves that connect these grades. The horizontal alignment is the bird's eye view of the roadway, which includes the straight (tangent) sections of the roadway and the circular curves that connect their change in direction. The design of horizontal curves directly impacts the ability of vehicles, especially large trucks, to maneuver successfully through the curve. Design criteria for horizontal and vertical curves are largely determined by the design speed of the roadway in addition to other limiting factors.

Option 1 Curve Improvements

A total of four horizontal curves and eleven vertical curves within the study area do not meet current MDT design criteria for horizontal and/or vertical alignment. Where an existing roadway does not meet current MDT design criteria, it may not be cost effective to reconstruct the roadway to address geometric issues unless there are documented safety issues. The Level of Service of Safety (LOSS) analysis conducted for this study indicates deviations from the normal expected safety performance, with LOSS I indicating a low potential for crash reduction and LOSS IV indicating a high potential for crash reduction. Six curve locations that do not meet current MDT design criteria are located in an area identified as LOSS IV. These curves along with the corresponding MDT design criteria are shown in Table 1.

Table 1 Curves Not Meeting Current Design Criteria Located in LOSS IV Area

Approximate Location		Horizontal		Vertical	
		Current Radius (ft)	Minimum Radius (ft)	Current K-value	Minimum K-value
Secondary 568	RP 0.1*	1008	1200	-	-
Secondary 522	RP 0.2	674	1200	-	-
	RP 1.3	193	1200	-	-
	RP 1.4	193	1200	-	-
	RP 3.0	-	-	16	151
	RP 3.1	-	-	94	136

Source: MDT and DOWL, 2015.
Listed curves are located within a LOSS IV roadway segment (for total crashes and/or crash severity).
*This curve was designed for and meets criteria for 45 mph design speed.

The remaining nine curves located on Highway 312 that do not meet current MDT design criteria are identified as LOSS II, which indicates a low to moderate potential for crash reduction.

Table 2 Curves Not Meeting Current Design Criteria Located in LOSS II Area

Approximate Location		Vertical	
		Current K-value	Minimum K-value
Highway 312	RP 4.7	31	151
	RP 4.7	95	136
	RP 5.1	60	151
	RP 5.2	48	151
	RP 5.4	59	136
	RP 5.5	62	136
	RP 5.6	53	151
	RP 24.7	104	136
	RP 24.8	146	151

Source: MDT and DOWL, 2015.
Listed curves are located within a LOSS II roadway segment (for total crashes and/or crash severity).

The curve improvement option would involve reconstruction and realignment of the roadway to comply with current MDT design criteria for horizontal and vertical curves listed in the tables above. It would improve the horizontal curves listed in the Table 1 to meet MDT's design criteria of a minimum 1200-foot curve radius and recommended minimum 900-foot curve length. The curve radii and lengths would be increased to provide more sight distance around the curves, allowing motorists to detect potential hazards from a farther distance. As approximately 20.5% of the total number of crashes involved a fixed object within the corridor, improving these curves to allow for more sight distance could potentially reduce fixed-object crashes in these areas.

Additionally, this option would reconstruct vertical curves listed in Tables 1 and 2 to meet MDT design criteria for minimum K-value. K-value is the horizontal distance needed to produce a one percent change in gradient, which is the difference in slope between the two grades, and is directly correlated to the design speed and stopping sight distance.

Using the information from Tables 1 and 2, MDT could elect to nominate a project to address one or multiple curve locations through a corridor segment, with priority given to areas identified as LOSS IV. Curves in proximity were grouped for the purpose of estimating costs for this option,

Planning-level Cost Estimate

The following estimates assume obliteration of existing road and construction of new road at the existing roadway width.

Highway 312
- 1.a (RP 4.7 to RP 5.6): Approximately $1,960,000 to $2,130,000
- 1.b (RP 24.7 to RP 24.8): Approximately $760,000 to $820,000

Secondary 522
- 1.c (RP 0.2): Approximately $570,000 to $620,000
- 1.d (RP 1.3 to RP 1.4): Approximately $760,000 to $820,000
- 1.e (RP 3.0 to RP 3.1): Approximately $760,000 to $820,000

Secondary 568
- 1.f (RP 0.1): Approximately $570,000 to $620,000

Recommended Implementation Timeframe

Mid-term to long-term

Potentially-impacted Resources /Anticipated Right-of-Way

Potential impacts to streams, wetlands, floodplains, protected species, cultural resources, protected farmlands, and utilities may result from this option. The need for additional right-of-way is anticipated.

3.2 Segment Capacity Improvements

Capacity reflects the maximum number of vehicles which can reasonably be expected to traverse a point or uniform roadway section during a given time period under prevailing roadway, geometric, environmental, traffic, and control conditions. The highway mainline or intersection should be designed to accommodate the selected design hourly volume at the selected level of service (LOS). Six LOS categories ranging from a rating of A to F are used to describe traffic operations for roadways. LOS A indicates that the traffic is free-flowing whereas LOS F indicates poor flowing and congested traffic conditions. Detailed calculations, factors, and methodologies are presented in the *Highway Capacity Manual* (HCM).

Capacity improvement options were evaluated for roadway segments 2A (Barry Drive to Five Mile Road), 2B (Five Mile Road to Hoskins Road), and 3 (Hoskins Road to Shepherd Road). Improvement options included widening the shoulder, increasing the passing zone, adding one mile of passing lane in a single direction, and expanding to a five-lane roadway section (with passing lanes in both directions and a center turn lane). These options were evaluated to determine the effects on capacity and then compared with the no-build alternative for each segment. The no-build alternative represents the analyzed LOS for the roadway if no action was taken to improve roadway capacity.

Figure 2 Highway 312 Segments 1, 2A, 2B, and 3

<u>Option 2.a Shoulder Widening</u>

MDT geometric design criteria listed in the RDM specify 12-foot travel lanes for rural minor arterials. The AASHTO *Policy on Geometric Design of Highways and Streets* recommends a minimum usable shoulder width of 8 feet on rural arterials with AADT volumes over 2000.

For rural collectors, MDT geometric design criteria for roadway width vary according to traffic volumes. The RDM recommends a total roadway width (including travel lanes and shoulders) of 40 feet for average annual daily traffic (AADT) volumes over 3000, which corresponds to the majority of the Highway 312 corridor. Segment 7 from Worden to the Pompeys Pillar Interchange exhibits AADT volumes that fall into the RDM range from 300 to 999, corresponding to a total recommended roadway width of 28 feet. For all roadway types, AASHTO recommends consideration of a minimum continuous usable shoulder width of four feet on both sides of roadways where bicyclists and pedestrians are to be accommodated. Additional width may be appropriate based on vehicle speeds, traffic composition, and the presence of obstructions such as guardrail.

There is generally zero feet of shoulder width within Highway 312 segments 2 and 3. As the roadway is currently lacking in shoulder width, non-motorized users such as bicyclists must share the travel lane with vehicles. Non-motorized users decrease the roadway capacity under these circumstances where there is only one non-passing travel lane in each direction.

Widening the shoulders along this portion of the corridor to eight feet on both sides of the road would allow non-motorized users to travel via shoulders. Capacity is anticipated to increase as vehicles would no longer be hindered by slower-moving users. Capacity in the year 2035 for roadway segments 2 and 3 on Highway 312 was analyzed and is presented in Table 3. LOS for westbound traffic in segments 2A, 2B, and 3 is anticipated to improve by one letter ranking, while LOS is expected to remain constant for eastbound traffic with the additional shoulder width.

Table 3 Capacity Analysis for Widened Shoulders (2035 with Billings Bypass)

Segment	Direction	No-build LOS	Widen Shoulders LOS
2A (Barry Dr. to 5 Mile Rd.)	Eastbound	D	D
	Westbound	D	C
2B (5 Mile Rd. to Hoskins Rd.)	Eastbound	E	E
	Westbound	D	C
3 (Hoskins Rd. to Shepherd Rd.)	Eastbound	D	D
	Westbound	D	C

Source: DOWL 2015.
Note: Capacity analysis was performed for the year 2035 and assumes construction of the Billing Bypass project.

In addition to segments 2 and 3, shoulder widening could be considered throughout the entire Highway 312 corridor. AASHTO recommends provision of continuous shoulders to offer refuge for drivers and bicyclists at all points along the traveled way. A continuous shoulder would provide the full safety and operational benefit throughout the corridor.

Slope flattening could also be considered in conjunction with shoulder widening to increase roadside safety. Side slopes within the entire corridor are currently non-compliant with MDT design criteria. A slope flattening project could be cost effectively addressed at the time of shoulder widening (as opposed to a separate, stand-alone project).

Planning-level Cost Estimate
The following estimates assume the addition of eight-foot shoulders to the existing highway alignment and slope flattening where appropriate. Bridge widening is not included; shoulder tapering would need to be provided at bridge approaches.

Highway 312 Segment 2: Approximately $440,000 to $480,000

Highway 312 Segment 3: Approximately $250,000 to $280,000

Highway 312 Entire Corridor (RP 0.0 to 24.9): Approximately $3,140,000 to $3,410,000

Recommended Implementation Timeframe
Mid-term to long-term

Potentially-impacted Resources /Anticipated Right-of-Way
Potential impacts to streams, wetlands, floodplains, protected species, cultural resources, protected farmlands, and utilities may result from this option. Additional right-of-way may be needed.

Option 2.b Three-lane Section (Single-direction Passing Lane)
Highway 312 segments 2 and 3 have select areas striped as passing zones where crossing into the opposite lane to pass slow-moving vehicles is allowed. The addition of a designated passing lane within these areas would allow vehicles an opportunity to pass slower vehicles without crossing into the opposing lane, thereby increasing roadway capacity. Passing lane lengths can vary from less than one mile long to several miles long. A one-mile passing lane provides adequate distance for faster vehicle to pass slower moving vehicles. As such, the addition of a one-mile passing lane was analyzed for each direction of each segment for this planning-level analysis.

Table 4 presents the results of the passing lane analysis for segments 2 and 3. LOS is expected to increase to an acceptable LOS C or better, when compared to the no-build alternative, for both directions of segments 2 and 3 with the addition of one-mile-long passing lanes for each direction in each segment. However, modifications to roadway geometrics, reducing the number of access points, and roadway widening would be required to accommodate the increased passing lanes. Because some segments are still anticipated to operate at LOS C in 2035, this option may not be cost effective.

Table 4 Capacity Analysis for One Mile Passing Lane (2035 with Billings Bypass)

Segment	Direction	No-build LOS	1-Mile Passing Lane LOS
2A (Barry Dr. to 5 Mile Rd.)	Eastbound	D	B
	Westbound	D	B
2B (5 Mile Rd. to Hoskins Rd.)	Eastbound	E	C
	Westbound	D	C
3 (Hoskins Rd. to Shepherd Rd.)	Eastbound	D	C
	Westbound	D	C

Source: DOWL 2015.
Note: Capacity analysis was performed for the year 2035 and assumes construction of the Billing Bypass project.

At high-volume access points within the segments, a four-lane section with one travel lane in each direction, a single passing lane, and a center TWLT lane could be considered to improve the safety of left-turn maneuvers and avoid left-turning vehicles stopped in the passing lane. MDT could consider the need for a center turn lane at the time of a future project in consideration of access point volumes and speeds.

Planning-level Cost Estimate
Segment 2
Approximately $3,200,000 to $3,500,000 to add one 12-foot lane to the existing highway alignment for segment 2. The addition of a one-mile passing lane in each direction with tapers will nearly consume the full segment length of 3.5 miles. This estimate includes replacement of the Seven Mile Creek Bridge.

Segment 3
Approximately $3,600,000 to $3,900,000 to add one 12-foot lane to the existing highway alignment for segment 3. The addition of a one-mile passing lane a one-mile passing lane in each direction with tapers will consume the full segment length of 2.0 miles. This estimate includes the replacement of the Twelve Mile Creek Bridge.

Recommended Implementation Timeframe
Mid-term to long-term

Potentially-impacted Resources /Anticipated Right-of-Way
Potential impacts to streams, wetlands, floodplains, protected species, cultural resources, protected farmlands, and utilities may result from this option. Additional right-of-way may be needed.

Option 2.c Five-lane Section (Dual-direction Passing Lane and Center Turn Lane)
Highway 312 segments 2 and 3 are currently configured with a single travel lane in each direction, and limited areas striped as passing zones. Reconstructing these highway segments to provide two travel lanes in each direction would increase the roadway capacity. In addition to supplementing mainline travel lanes, a roadway reconstruction project would address elements such as bridge replacement, curve geometry, shoulder widening, and any needed intersection improvements occurring within the defined widening limits.

Table 5 presents the results of the analysis of a four-lane section. LOS A is expected for all directions and segments analyzed in comparison to the no-build alternative.

Table 5 Capacity Analysis for Four-lane Expansion (2035 with Billings Bypass)

Segment	Direction	No-build LOS	4- Lane LOS
2A (Barry Dr. to 5 Mile Rd.)	Eastbound	D	A
	Westbound	D	A
2B (5 Mile Rd. to Hoskins Rd.)	Eastbound	E	A
	Westbound	D	A
3 (Hoskins Rd. to Shepherd Rd.)	Eastbound	D	A
	Westbound	D	A

Source: DOWL 2015.
Note: Capacity analysis was performed for the year 2035 and assumes construction of the Billing Bypass project.

A five-lane section with two travel lanes in each direction and a center TWLT lane at higher-volume approach roadways is recommended to improve the safety of left-turn maneuvers and avoid left-turning vehicles stopped in the travel lane. A five-lane roadway section for segments 2 and 3 would be consistent with the five-lane section currently provided in segment 1.

Planning-level Cost Estimate
Segment 2
Approximately $7,000,000 to $7,600,000 to add two 12-foot travel lanes and a 14-foot center turn lane to the existing highway alignment for Segment 2. This estimate includes replacement of the Seven Mile Creek Bridge.

Segment 3
Approximately $5,700,000 to $6,100,000 to add two 12-foot travel lanes and a 14-foot center turn lane to the existing highway alignment for Segment 3. This estimate includes the replacement of the Twelve Mile Creek Bridge.

Recommended Implementation Timeframe
Mid-term to long-term

Potentially-impacted Resources /Anticipated Right-of-Way
Potential impacts to streams, wetlands, floodplains, protected species, cultural resources, protected farmlands, and utilities may result from this option. The need for additional right-of-way is anticipated.

3.3 Intersection Improvements

A variety of options can be considered to improve safety and operations at intersections.

Signs, signals, channelization, and physical geometric layout are options generally used to control intersections. Cost and operating efficiency of the intersection influence the type of intersection control selected, ranging from uncontrolled intersections to yield control, two-way stop control, and traffic control signals, and roundabout configuration. Operating efficiency is determined through a series of traffic analyses.

Current MDT design criteria note roadways should intersect at or as close to 90° as practicable. Skewed intersections are undesirable for several reasons:

- vehicular turning movements and sight distance are restricted;
- additional pavement and channelization may be required to accommodate large vehicle turning movements; and
- the exposure time for vehicles and pedestrians crossing the main traffic flow is increased.

Crash potential at an intersection can be reduced by providing appropriate sight distance to allow drivers an unobstructed view of the entire intersection at a distance great enough to permit control of the vehicle.

Warning signs may be used to inform drivers in advance of upcoming intersections and lane transitions. Flashing warning beacons can supplement warning or regulatory signs or markers. For example, where a minor side street intersects a highway, a circular yellow flashing indication is sometimes installed prior to the intersection on the minor roadway with an enhanced intersection warning sign and a supplemental name plaque on the major roadway. The need for warning beacons and warning signs is determined on a case-by-case basis.

Additionally, turn lanes can be considered to provide a protected location for left-turning vehicles to wait for an acceptable gap in the opposing traffic stream, and remove decelerating right-turning vehicles from the through traffic lane to reduce the potential for collisions. Turn lanes may be appropriate at unsignalized intersections on two-lane highways that meet MDT guidelines for opposing volumes and/or advancing volumes and percentage of turn movements, or where a crash trend involves turning vehicles.

Overhead lighting can improve visibility for motorists and provide a more comfortable environment for nighttime drivers. Providing overhead lighting for all highways facilities is not practical or cost effective. It is generally MDT practice to only provide overhead highway lighting where justified based on engineering judgment and the criteria, recommendations, and principals presented in the AASHTO publication *Roadway Lighting Design Guide*. Overhead lighting for streets and highways is dependent upon the considerations of vehicular and pedestrian traffic volumes, intersections, turning movements, signalization, channelization, and varying geometrics.

Option 3.a Intersection Control

Three Highway 312 intersections are anticipated to operate at LOS D by the year 2035 (assuming construction of the Billings Bypass project). 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. LOS C or better is typically desired for optimal traffic flow. The following three locations were analyzed for alternative intersection control.

- Intersection 1 – Highway 312 and Dover Road (RP 1.3)
- Intersection 2 – Highway 312 and Hoskins Road (RP 5.6)
- Intersection 3 – Highway 312 and Shepherd Road (RP 7.6)

Intersection capacities were analyzed using Synchro Studio 9 software based on HCM 2010 methodologies. For each intersection, no-build, traffic signal, and roundabout alternatives were analyzed.

To enable compatibility with Option 2.d which would provide a four-lane section on Highway 312, intersection improvement options include both two-lane and four-lane scenarios for stop-controlled and roundabout conditions. Attachment 1 illustrates the intersection alternatives at the Dover Road, Hoskins Road, and Shepherd Road intersections.

Analysis results for all alternatives are shown in Table 6. Under the no-build alternative, all three intersections are expected to operate at LOS D or worse. Under the traffic signal and roundabout alternatives, all intersections are expected to operate at LOS A.

Table 6 Intersection Control Improvement Alternative

Intersection	Location	Alternative	Control Type	Worst Movement	Delay (sec)	LOS
[1] Dover Road & Highway 312	RP 1.3	No-build	TWSC	NBL/NBR	25.7	D
		Signal	Signal	WBL/WBR	5.0	A
		Roundabout (2-Lane)	Yield	WBL/WBR	7.0	A
[2] Hoskins Road & Highway 312	RP 5.6	No-build	TWSC	NBL/NBT/NBR	25.0	D
		Signal*	Signal	SBL/SBT/SBR	5.0	A
		Roundabout (1-Lane)	Yield	EB	9.9	A
		Roundabout (2-Lane)	Yield	EB	6.0	A
[3] Shepherd Road & Highway 312	RP 7.6	No-build	TWSC	SBT/SBL	41.9	E
		Signal*	Signal	SBR	5.4	A
		Roundabout (1-Lane)	Yield	EB	9.4	A
		Roundabout (2-Lane)	Yield	EB	6.1	A

Source: DOWL 2015. TWSC: two-way stop control; NBL/NBT/NBR: Northbound left/Northbound through/Northbound right; WBL/WBR: Westbound left/Westbound right; SBL/SBT/SBR: Southbound left/Southbound through/Southbound right; EB: Eastbound
* Speed limit = 55 mph so HCM 2010 methodologies could be used
Note: For 1-lane roundabout, all approaches have one lane for each direction. For 2-lane roundabout, major road approaches have two lanes for each direction, and minor road approaches have one lane for each direction.

As shown above, both signalized and roundabout configurations are viable intersection control solutions to meet the target LOS C based on 2035 peak-hour traffic volumes. These options would alter Highway 312 traffic flows, which are currently uninterrupted.

A roundabout configuration could be expected to operate with slightly less delay during peak periods, and reduced severity and frequency of crashes compared to a signalized configuration. However, a roundabout would create undesirable delay for through traffic on Highway 312 during off-peak periods whereas a signalized intersection could rest in green for mainline through traffic during off-peak periods. A traffic signal at this location could offer more flexibility in the intersection operation by allowing more green time to the Highway 312 movements that are higher in priority for regional traffic and less green time to minor-leg movements that are lower in priority.

MDT considers installation of advance warning flashers (AWFs) at signalized intersections to assist motorists in making safer driving decisions when approaching traffic signals in select locations. AWFs are installed based on demonstrated addressable need in locations with limited sight distance, operating speeds in excess of 60 mph, and other safety or operational factors. MDT could consider providing AWFs at the time a traffic signal is installed in accordance with MUTCD and MDT Traffic Engineering Manual guidelines if warranted based on an engineering study.

The need for a traffic signal would require an analysis of applicable warrants contained in the *Manual on Uniform Traffic Control Devices* (MUTCD) and other factors relating to intersection safety and operation. Assuming construction of the Billings Bypass project, projected 2035 traffic volumes for the three intersections listed in Table 6 are anticipated to approach the threshold for the peak-hour warrant. An engineering and traffic study would need to consider the site's physical characteristics and traffic conditions to determine if a traffic signal, roundabout, or AWF is justified at these locations.

Planning-level Cost Estimate

The following estimates assume installation of the specified control at each existing intersection with no other geometric improvements or AWFs. Roundabout estimates include cost for approach legs.

Traffic Signal: Approximately $370,000 to $400,000
Roundabout (1-Lane): Approximately $1,200,000 to $1,300,000
Roundabout (2-Lane): Approximately $1,300,000 to $1,500,000

Recommended Implementation Timeframe

Mid-term to long-term

Potentially-impacted Resources/Anticipated Right-of-Way

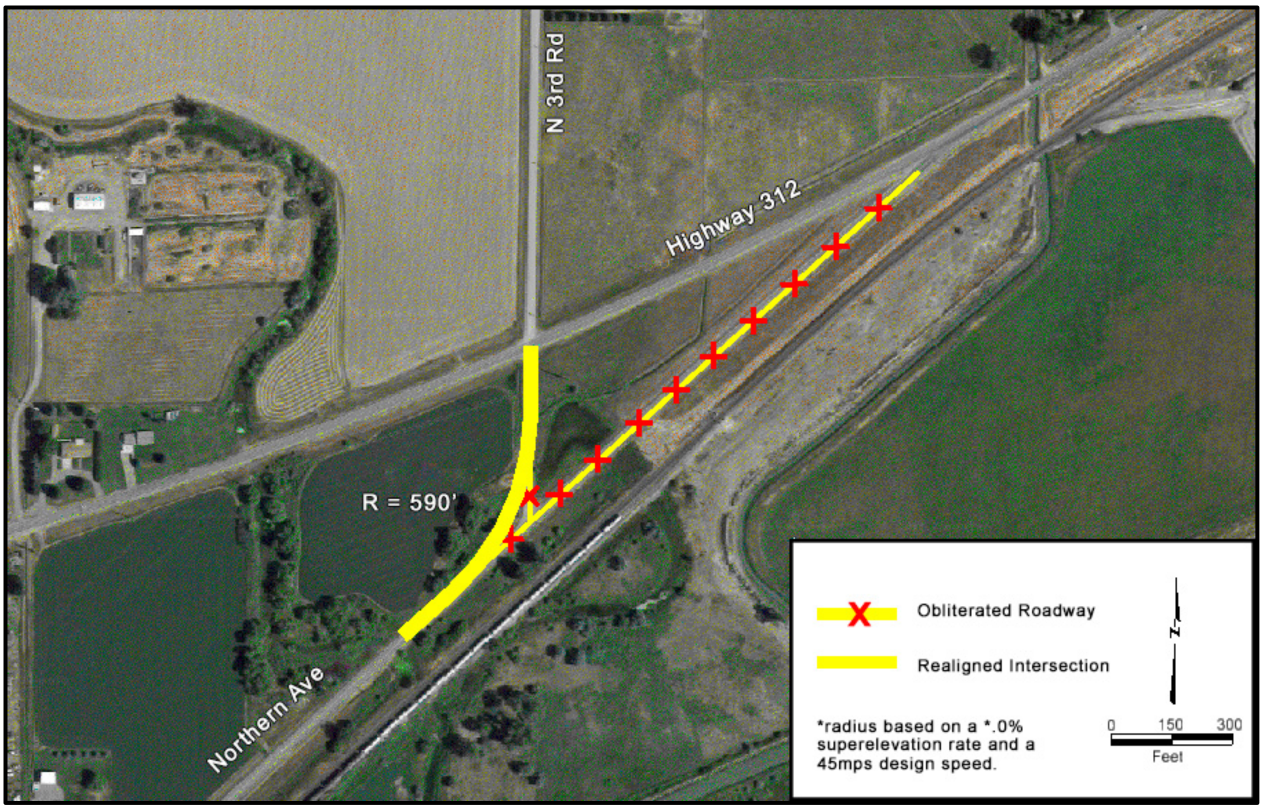
Potential impacts to streams, wetlands, floodplains, protected species, cultural resources, protected farmlands, and utilities may result from this option. The need for additional right-of-way is anticipated.

Option 3.b Intersection Realignment

MDT design guidance notes intersection angles should not exceed 30° from perpendicular at maximum. Intersections with a skew greater than 30° may require geometric improvements, including realignment. The best alignment for an at-grade intersection is when the intersecting roads meet at right or nearly right angles (90°). Right angle intersection alignments require less pavement area at the intersection for turning maneuvers, there is a lower exposure time for vehicles crossing the main traffic flow, and visibility limitations (particularly for trucks) are not as serious as those at acute-angle intersections.

Northern Avenue at RP 10.4 is aligned to Old Highway 312 at an angle greater than 30° from perpendicular. Realignment of this intersection is recommended to improve sight distance and accommodate passenger vehicle and large vehicle turning movements. Realigning the intersection at Northern Avenue to a T-intersection at the existing N. 3rd Avenue intersection as illustrated in Figure 3 could improve safety performance associated with visibility limitations.

Figure 3 Northern Avenue Realignment



Source: DOWL, 2016.

The intersection at Northern Avenue is currently operating at LOS B, with a delay of 10.1 seconds on the worst approach (northbound lane). This indicates that the quality of traffic operations at this intersection is generally free-flowing. A traffic analysis performed using Synchro Studio 9 software shows that LOS is anticipated to remain unchanged with the realignment of this intersection assuming the same intersection control method, two-way stop control on Northern Avenue/N 3rd Road, is utilized. Intersection analysis results comparing the no-build and realigned intersection alternative are shown in Table 7.

Table 7 Intersection Realignment Improvement Alternative

Intersection	Location	Alternative	Intersection Control	Worst Approach	Delay (s)	Level of Service
Northern Ave & Highway 312	RP 10.4	No-build	TWSC	Northbound	10.1	B
		T-intersection*	TWSC	Northbound	10.3	B

Source: DOWL, 2015. TWSC: two-way stop control.
* Assumed 5 vehicles per hour for both northbound and eastbound lanes.

Planning-level Cost Estimate
Approximately $670,000 to $770,000 to realign Secondary 522 to intersect Highway 312 at the current intersection of Highway 312 and North 3rd Road.

Recommended Implementation Timeframe
Short-term to mid-term

Potentially-impacted Resources/Anticipated Right-of-Way
Potential impacts to streams, wetlands, floodplains, protected species, cultural resources, protected farmlands, and utilities may result from this option. The need for additional right-of-way is anticipated.

Option 3.c Intersection Turn Lanes

Turn lanes can improve traffic congestion, operating efficiency, and safety at intersections by separating turning vehicles from through movements. MDT follows guidelines for right-turn and left-turn lanes outlined in the MDT *Traffic Engineering Manual*. Based on these guidelines, exclusive turn lanes may be considered for public intersections on multi-lane highways, on the major roadway at any signalized intersection, on the major roadway at unsignalized intersections on two-lane highways with volumes that meet specified criteria, at any intersection where a capacity analysis determines a turn lane is necessary to meet the target LOS, and where a crash trend or sight distance restrictions involve turning vehicles.

Three of the 12 intersections analyzed for this study are projected to operate at LOS D in 2035 with construction of the Billings Bypass project. Of these, Intersection 2 (Hoskins Road at RP 5.6) and Intersection 3 (Shepherd Road at RP 7.6) already provide mainline left-turn lanes on Highway 312. Additional lanes on Highway 312 at Intersection 1 (Dover Road at RP 1.3) were not considered for safety reasons due to this location’s close proximity to Independent Lane. Turn lanes on minor legs are not anticipated to sufficiently improve operations to meet the target LOS C at these intersections. Accordingly, turn lanes on the minor legs of these three intersections are not considered viable stand-alone improvements. The need for turn lanes should be reconsidered if MDT installs a traffic signal or widens Highway 312 in these locations.

Members of the public requested consideration of turn lanes at several additional intersections with Highway 312, including Northern Avenue (Secondary 522), N 3rd Road, N 15th Road, N 16th Road, McIntyre Drive, and N 4th Road. These locations were not defined as study intersections for this effort (and therefore traffic volumes and operational analysis results are not available). The intersections of Northern Avenue, N 7th Road, N 10th Road, N 12th Road, N 15th Road, and McIntyre Drive with Highway 312 are classified as LOSS III or IV for total crash and/or crash severity.

It is recommended that MDT consider turn lanes at public intersections within the corridor as warranted based on continued observation of safety performance, traffic operations, and adjacent development, and in accordance with the turn-lane guidelines provided in the MDT *Traffic Engineering Manual*. Turn lane widening in segments 2 and 3 conducted in the short- to mid-term could be incorporated into future roadway widening projects.

Planning-level Cost Estimate
Approximately $540,000 to $590,000 to construct left-turn lanes in both directions at each existing intersection with minor geometric improvements to the intersecting road to achieve a perpendicular intersection. Turn lane mitigation needed to serve future development may be the responsibility of the developer.

Recommended Implementation Timeframe
Short-term to mid-term

Potentially-impacted Resources/Anticipated Right-of-Way
Potential impacts to streams, wetlands, floodplains, protected species, cultural resources, protected farmlands, and utilities may result from this option. The need for additional right-of-way is anticipated.

Option 3.d Overhead Lighting
The MDT Traffic Engineering Manual recommends consideration of overhead lighting in locations with high vehicle-to-vehicle interactions, including roadways with numerous driveways, substantial commercial or residential development, and a high percentage of large vehicles. Extending overhead lighting outside community limits in the corridor to select public intersections would help improve visibility in these locations.

The percent of total crashes due to areas without lighting was 25.8% during the years 2005 to 2014. For a highway facility to be considered for lighting, the lighting system must be both economically feasible and justified based on applicable criteria. Installation of lighting at intersections could be justified by one or more of the following conditions:

- the intersection design incorporates raised channelization;
- within a three-year period, the intersection exhibits five or more correctable crashes attributable to lack of lighting during the hours of darkness;
- the intersection meets at least one-half of the requirements necessary to warrant signalization; and/or
- the intersection is located in an unlighted area within 1,000 feet of an existing lighted area.

Select public approaches where LOSS, or crash reduction potential, is high may fulfill one or more of the conditions mentioned above. Three intersections along Highway 312 that may warrant overhead lighting include Nahmis Avenue, Northern Avenue, and Custer Frontage Road, which occur in areas identified as LOSS IV.

Planning-level Cost Estimate
Approximately $220,000 to $250,000 per intersection to construct overhead lighting at the existing intersection without any other geometric improvements. Approximately an additional $50,000 would be needed at the Custer Frontage Road to energize a lighting circuit since the nearest power supply is approximately 300 feet from the intersection and

across the railroad right-of-way. MDT could consider alternative sources of power (such as solar panels) and associated limitations (including storage capacity, cost, and design life).

Recommended Implementation Timeframe
Short-term to mid-term

Potentially-impacted Resources/Anticipated Right-of-Way
No impacts to resources are anticipated to result from this option. The need for additional right-of-way is not anticipated.

3.4 Pavement Preservation

An efficient and cost-effective option to maintaining the condition of existing roadways and preventing future road work is pavement preservation. The applicable treatment is applied to pavement that is still in good condition before the roadway begins to deteriorate. The type of pavement treatment, such as crack sealing, depends on the roadway and current condition of the roadway. Treatments types are typically decided on a case-by-case basis. Preserving pavement will extend the service life of roadways, improve safety and mobility, and reduce future costs by preventing major rehabilitation or reconstruction in the future.

Option 4 Pavement Preservation
Rutting occurs in the wheel paths of Highway 312, Secondary 522, and Secondary 568. Within the two-lane sections of Highway 312, rutting was generally observed to be worse compared to the three- and five-lane sections. The rutting in the roadway was estimated to be between ¼-inch and ½-inch in depth. Transverse cracking consistently occurs along the entire corridor. The transverse cracking is spaced sporadically (150- to 200-foot intervals) on Highway 312 and Secondary 568, while on Secondary 522, transverse cracking averages approximately every 75 to 100 feet. The ride index for Secondary 568, 522, and the first 2.3 miles of Highway 312 are considered fair. The ride index is used to measure ride experience and characteristics for the traveling public.

A pavement overlay would strengthen the pavement in areas where the ride index is considered fair. An overlay of a roadway involves laying a specified thickness of either Portland cement or asphalt over an existing pavement. For this corridor, the estimated overlay thickness would be approximately 0.2 feet (2.4 inches) based on the characteristics of the roadway within the corridor. Overlays should typically be applied to pavements that are still in good condition (and do not require milling) as the overlay needs to be able to bind to the existing pavement. Because the roadways within the corridor are generally in good condition, an overlay would be a good option to preserve and extend their service life.

Planning-level Cost Estimate
The following estimates assume overlay of the existing roadway with a 0.2-foot lift.

Highway 312 (RP 0.0-2.3): Approximately $1,800,000 to $2,000,000
Secondary 568 (RP 0.0-1.0): Approximately $470,000 to $510,000
Secondary 522 (RP 0.0-3.0): Approximately $1,400,000 to $1,600,000

Recommended Implementation Timeframe
Short-term to long-term

Potentially-impacted Resources/Anticipated Right-of-Way
No impacts to resources are anticipated to result from this option. The need for additional right-of-way is not anticipated.

3.5 Roadside Safety Improvements

The safest roadside is flat and free of obstructions or steep slopes. The RDM specifies an offset distance from the edge of the 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, AADT, and the slope and offset of cut/fill sections from the ETW.

Roadside ditches can present a hazard if an errant vehicle cannot easily travel its slopes, regain control, and return to the traveled way. An errant vehicle leaving the roadway may not be able to safely negotiate a critical slope (also called a non-traversable slope). Depending on encroachment conditions, a vehicle on a critical slope may overturn. For most embankment heights, fill slopes steeper than 3:1 are considered critical. A non-recoverable slope can be safely traversed, although an errant vehicle may not be able to return to the roadway. Slopes greater than or equal to 3:1 and less than 4:1 are considered traversable but non-recoverable.

When steep side slopes occur adjacent to a roadway, the hazardous condition ideally should be eliminated by providing slopes and dimensions specified in current MDT design criteria. Oftentimes, this is not practicable due to economic, environmental, or drainage conditions.

If steep side slopes cannot be flattened due to these reasons, it may be necessary to shield the hazard with a roadway barrier such as guardrail, depending on the fill section height. Cut slopes and blunt objects also present a hazard, and may warrant protection.

Slope flattening is addressed as part of option 2.a (shoulder widening).

Option 5 Guardrail
Guardrail is a longitudinal barrier placed on the outside of sharp curves and in locations with steep slopes. Its main function is to prevent vehicles from leaving the roadway and to offer protection against hazards within the clear zone. Guardrail placement is evaluated where embankments are higher than 8 feet and where shoulder slopes are greater than 4:1. Shapes commonly used include the W beam, cable rail, and the box beam. The weak post system provides for the post to collapse on impact, with the rail deflecting and absorbing the energy due to impact. Installation of compliant guardrail is recommended as needed throughout the corridor.

Side slopes along the roadway throughout the entire corridor are currently noncompliant with MDT design criteria. Although the slopes are noncompliant, placement of guardrail along the entire corridor is impracticable and not economically feasible.

Specific locations within the corridor where new guardrail may be warranted are listed in Table 8. Locations recommended for improvements to existing guardrail (associated with bridges) are included in Option 8.

Table 8 Guardrail Locations

Guardrail Location (RP)		Side	Feature Requiring Protection
Highway 312	10.5	RT & LT	Creek
	13.2	RT & LT	Creek
	16.6	RT & LT	Creek
	18.8	RT & LT	Creek
	20.2	RT & LT	Creek
	21.5	RT & LT	Creek
Secondary 522	0.2	RT & LT	Bridge/Creek

Source: DOWL 2015. RT: right; LT: left.

The features requiring protection are potentially hazardous obstacles within the clear zone of the roadway. The clear zone is the distance which should adequately provide a clear recovery space for the majority of drivers who run off the road. Installing guardrail in these areas where warranted would provide protection against the hazardous obstacles.

Planning-level Cost Estimate

Approximately $20,000 per location (given unit cost of $40 per linear foot for standard W-beam guardrail including bridge approach sections and terminal sections, with a typical obstruction in the study corridor requiring approximately 500 feet of guardrail per location).

Recommended Implementation Timeframe

Short-term to mid-term

Potentially-impacted Resources/Anticipated Right-of-Way

No impacts to resources are anticipated to result from this option. The need for additional right-of-way is not anticipated.

3.6 Pedestrian/Bicycle Improvements

In Montana, bicycles may be used on all public roadways subject to MCA Title 61, Chapter 8, Part 6. Paved shoulders can improve comfort and safety for bicyclists on rural highways. Please refer to Option 2.a for discussion on widened shoulders.

In urban areas, sidewalks can be used to accommodate pedestrians. Per PROWAG, sidewalks should be a minimum of 4 feet in width and have a cross slope of no more than 2 percent. Any curb ramp crossing locations or private approach locations should adhere to all applicable guidelines for ramp and landing slopes and cross slopes as found in PROWAG.

Option 6 Pedestrian/Bicycle Improvements

An option to widen and pave shoulders along the corridor is discussed in Option 2.a. Please refer to Option 2.a for further discussion regarding the widening and paving of roadway shoulders.

Construction of sidewalk and ADA improvements is recommended in two locations along the corridor. The first location is along Secondary 522 in Huntley. This option would consist of installing sidewalk along the north side of Secondary 522 in the most concentrated area of residential development in Huntley spanning from southwest of the intersection of Secondary 522 and Shopis Avenue to the intersection of Secondary 522 and Noopis Avenue. There is some existing sidewalk on the north side of Secondary 522 in Huntley. These facilities should be evaluated to ensure existing sidewalks and any new improvements are continuous and meet PROWAG requirements. Sidewalk intersections with existing approaches would need to be reconstructed with PROWAG-compliant curb ramps, and cross-slope and running-slope requirements would be met on all portions of newly-constructed sidewalk. The construction of additional sidewalk in these areas is recommended to improve pedestrian safety and provide continuous pedestrian access.

The second location for sidewalk improvements is an existing road/rail crossing in Worden. The crossing is located at the intersection of Highway 312 and Main Street (becoming South 15th Street south of Highway 312). The current sidewalk ends at the corner of the southern-most building located on the west side of Main Street. The improvement option would extend sidewalk and crossing facilities across Highway 312 and the railroad and intersect with the park located on the south side of Worden. Sidewalk and crossing improvements would be constructed in accordance with PROWAG. The construction of additional sidewalk and crossing improvements in this area is recommended to improve pedestrian safety and provide easier access to existing park facilities.

Planning-level Cost Estimate
Secondary 522 – Huntley
Approximately $200,000 to $220,000 to install missing sidewalk and replace damaged/inaccessible sidewalk. This estimate is based on a cursory survey of the existing sidewalk within the defined limits. Additional investigation would be needed to develop a more accurate cost estimate.

Highway 312 – Worden, Main Street to South 15th Street crossing
Approximately $290,000 to $320,000 to install sidewalk and crossing features within the defined limits. This estimate is based on a cursory survey of the existing sidewalk within the defined limits. Additional investigation would be needed to develop a more accurate cost estimate. A partnership with the county may be appropriate to fund this improvement.

Recommended Implementation Timeframe
Mid-term to long-term

Potentially-impacted Resources/Anticipated Right-of-Way
No impacts to resources are anticipated to result from this option. Additional right-of-way may be needed.

3.7 Traffic Control Devices and Safety/Warning Features

Traffic control devices, such as signing and delineators, are used to notify drivers of regulations and provide warning and guidance to promote efficient operation and minimize crash occurrences. Road signs are installed only where warranted by the MUTCD. Special regulations, obscure hazards, and destinations are examples of information that signs provide. Delineators are retro-reflective signs positioned on the side of the road typically along tangent sections of major roadways, sharp horizontal and short vertical curves, and other appropriate areas. Light from motorists' headlights reflects from the delineators directly back towards the driver to guide them safely along the roadway. Pavement markings complement traffic control devices by conveying additional information in a manner that does not distract drivers.

Shoulder and centerline rumble strips are continuous or intermittent roughened surfaces placed on roadways as safety and warning devices. Shoulder rumble strips help alert sleepy, distracted, and negligent motorists from driving off the roadway, and centerline rumble strips help prevent head-on and sideswipe crashes. Although rumble strips are useful safety and warning features, they impact pavement life, maintenance operations, and initial construction costs. Additionally, bicyclists need to be taken into account before constructing shoulder rumble strips if there are no designated bicycle facilities.

Option 7.a Delineation

Throughout the corridor, delineators are generally in good condition and appear 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 the delineator Design D. These approaches include the intersections shown in Table 9.

Table 9 Intersections without Appropriate Delineators

Location		RP
Highway 312	Lone Tree Trail	4.9
	Shining Mountain Drive	7.2
	Ivy Street, Sunrise Road	9.8
	1st Street (Worden, MT)	17.5
	1st Street (Nibble, MT)	23.9
	Main Street (Nibble, MT)	24.0
Secondary 522	Creekmore Road	0.1
	North Canal Drive	0.3
	South Canal Drive	0.3
	Canal Drive Access Road	0.4

Source: DOWL 2015.

Planning-level Cost Estimate

Approximately $60 per approach (at a unit cost of approximately $30 per delineator)

Recommended Implementation Timeframe

Short-term to mid-term

Potentially-impacted Resources/Anticipated Right-of-Way

No impacts to resources are anticipated to result from this option. The need for additional right-of-way is not anticipated.

Option 7.b Signing

Specialty guide signs and route marker signs are used to inform motorists of intersecting routes, direct them to cities/towns or destinations, and generally provide information that will assist travel along highways.

Members of the public noted that the intersection of Highway 312 and US 87 (Highway 312 RP 0.0) and the Pompeys Pillar Interchange (Highway 568 RP 0.0) are confusing to motorists. Drivers unfamiliar with these areas may miss the appropriate turnoff to their intended destination of Roundup, Interstate 94, or the Pompeys Pillar National Monument. Warning signs could also be placed in advance of higher-volume intersections to notify motorists of upcoming approach roadways. Improved signage could be used to assist and inform drivers in these locations.

Planning-level Cost Estimate

Route Marker Assembly: $550 per assembly (including sheet aluminum sign panel(s), wood or perforated steel post, breakaway devices, concrete foundation)

Guide Sign Assembly: $3,500 per assembly (including sheet aluminum increment sign panel(s), structural steel posts, breakaway devices, concrete foundation)

Recommended Implementation Timeframe

Short-term to mid-term

Potentially-impacted Resources/Anticipated Right-of-Way

No impacts to resources are anticipated to result from this option. The need for additional right-of-way is not anticipated.

Option 7.c Shoulder/Centerline Rumble Strips

Shoulder and centerline rumble strips are not present within the study area. Constructing shoulder and/or centerline rumble strips along highways in the study area could help prevent run-off the road, fixed object, roll-over, and crossover crashes as rumble strips. The audible sound and physical vibration resulting from rumble strips alerts drivers, improves driver reaction, and increases the likelihood for a safe return to the travel lane. To reduce initial construction costs, rumble strips could be placed in select areas classified as LOSS IV including areas near RP 4, 6, 9, 12, and 15 on Highway 312; RP 0.5 on Secondary 568; and RP 0, 1, and 2 on Secondary 522. The rumble strips would be constructed to standards as shown in the MDT Detailed Drawing numbers 411-02 and 411-05. MDT could consider combining installation of rumble strips with shoulder widening as described in option 2.a. Consideration of rumble strips in areas with less than four-foot shoulders would require coordination with the MDT rumble strip committee.

Planning-level Cost Estimate

Shoulder rumble strips are approximately $1,600 per mile ($800 per strip per mile), and centerline rumble strips are $2,700 per mile. Prices shown for each segment include shoulder and centerline rumble strips between the reference posts.

Highway 312 - RP 4.0 to RP 15.0: Approximately $77,500 to $84,600
Secondary 568 RP 0.0 to RP 1.0: Approximately $7,100 to $7,800
Secondary 522 RP 0.0 to 2.0: Approximately $14,200 to $15,500

Recommended Implementation Timeframe

Short-term to mid-term

Potentially-impacted Resources/Anticipated Right-of-Way

The need for additional right-of-way is not anticipated. Noise analysis would need to be conducted for rumble strip placement near noise receptors.

3.8 Bridge Improvements

Bridge repairs are intended to address bridge elements that are in fair condition (as identified by MDT condition assessments) and where field review indicated localized failures in order to extend the life of the structures and improve safety.

Option 8 Bridge Improvements

Minor rehabilitation is recommended as a stand-alone improvement for the five bridge locations listed below. Full bridge replacement would be addressed if MDT pursued roadway reconstruction (as described in option 2.c).

- Seven Mile Creek (Highway 312 RP 2.70) – This structure was built in 1947 and is rated in fair condition. Recommendations for the structure include removal of existing guardrail and installation of new guardrail to meet current design criteria. Additionally, this improvement would include a mill and overlay on the bridge deck.

- Twelve Mile Creek (Highway 312 RP 6.57) – This structure was built in 1947 and is rated in fair condition. Recommendations for the structure include removal of existing guardrail and installation of new guardrail to meet current design criteria. Additionally, this improvement would include a mill and overlay on the bridge deck.

- Yellowstone River (Highway 312 RP 8.78) – This super-span structure was built in 1949 and is rated in fair condition. Recommendations for the structure include removal of existing approach/departure guardrail, installation of new guardrail before and after the bridge to meet current design criteria, and replacement of existing barrier rail. Additionally, this improvement would include bridge deck surface improvements.

- Custer Coulee (Highway 312 RP 12.15) – This structure was built in 1928, reconstructed in 1939, and is rated in fair condition. Recommendations for the structure include reconstructing the Custer Coulee railing as there are multiple areas where cracking is observable in addition to noticeable erosion on the structure.

- Huntley Canal (Secondary 522 RP 0.36) – This structure was built in 1967 and is rated in fair condition. Recommendations for the structure include removal of existing guardrail and installation of new guardrail to meet current design criteria. Additionally, this improvement would include bridge deck surface improvements.

Planning-level Cost Estimate

Seven Mile Creek (Highway 312 RP 2.70): Approximately $60,000 to $65,000
Twelve Mile Creek (Highway 312 RP 6.57): Approximately $260,000 to $290,000
Yellowstone River (Highway 312 RP 8.78): Approximately $3,200,000 to $3,400,000
Custer Coulee (Highway 312 RP 12.15): Approximately $60,000 to $70,000
Huntley Canal (Secondary 522 RP 0.36): Approximately $290,000 to $310,000

Recommended Implementation Timeframe

Mid-term to long-term

Potentially-impacted Resources/Anticipated Right-of-Way

Potential impacts to streams, wetlands, floodplains, protected species, cultural resources, and utilities may result from this option. The need for additional right-of-way is not anticipated.

3.9 Drainage Improvements

Drainage is an important aspect of road design. If water is unable to drain and standing water results, the freeze-thaw cycle can damage the roadway, causing premature deterioration. Freeze-thaw refers to the expansion of water within the ground when freezing and contraction when thawing. The freezing of the ground below the pavement can cause frost heave, which is a phenomenon where the ground is strong enough to lift up and damage roads, bridges, and buildings. Proper drainage is needed to minimize the potential effects of frost heave.

Option 9 Drainage Improvements

Minor drainage issues currently occur on Secondary 522. The most severe drainage issues were observed near the intersection of Nahmis Road near Barkemeyer Park at approximately RP 0.9. Standing water was observed in the roadway ditch adjacent to the roadway in this area. A motor grader or skid steer loader is sufficient to effectively reshape the shoulder promote positive drainage away from the road surface and subgrade.

Planning-level Cost Estimate

Approximately $1,000 (assuming hourly rates for equipment and operator of $250 per hour, for a 4-hour period including mobilization)

Recommended Implementation Timeframe

Short-term to mid-term

Potentially-impacted Resources/Anticipated Right-of-Way

Potential impacts to Barkemeyer Park (a potential Section 4(f) resource) may result from this option. The need for additional right-of-way is not anticipated.

4.0 Options Considered But Not Forwarded

Increased Passing Zones

The available amount of roadway striped as a passing zone within segments 2 and 3 ranges from 36% to 69%. Additional passing zones would provide more opportunities for vehicles to pass slower vehicles, resulting in increased roadway capacity. An iterative process was used to determine the percentage of additional passing zone required to increase the capacity of the road so that it would operate at an acceptable LOS C or better. The passing zone percentage for each study segment was increased by small increments until the passing zone occupied the full segment or LOS C was achieved. Some segments would require as little as a 13 percent increase in passing zone length to meet desired LOS, while other segments are still anticipated to operate below LOS C with full-length passing zones.

Table 10 Capacity Analysis for Increased Passing Zones (2035 with Billings Bypass)

Segment	Direction	Existing Passing (%)	No-build LOS	Increased Passing (%)	Build LOS
2A (Barry Dr. to 5 Mile Rd.)	Eastbound	69	D	82	C
	Westbound	53	D	100	C
2B (5 Mile Rd. to Hoskins Rd.)	Eastbound	51	E	100	D
	Westbound	51	D	100	C
3 (Hoskins Rd. to Shepherd Rd.)	Eastbound	41	D	88	C
	Westbound	36	D	100	C

Source: DOWL 2015. Note: Capacity analysis was performed for the year 2035 and assumes construction of the Billings Bypass project.

LOS is expected to increase by one level for both directions of segments 2 and 3 when compared to the no-build alternative, with the additional passing zone percentages shown in Table 10. However, modifications to roadway geometrics and a reduction in the number of access points would be required to accommodate increased passing zones. As a result, this alternative is not considered viable as a stand-alone alternative.

Shared Use Path

A shared use path is physically separated from motorized vehicular traffic, and provides an alternative to on-road facilities. Users are generally non-motorized and may include bicyclists, pedestrians, and other recreational activity users. A shared use path may be placed within highway right-of-way or within an independent right-of-way. Since the majority of shared use paths are used by pedestrians, any path located in the public right-of-way must be designed in compliance with ADA requirements as provided in PROWAG.

The option of a shared use path adjacent to Highway 312 was mentioned in multiple written comments submitted for this study. Comments noted the recreational benefits of bicycle/pedestrian connectivity between Billings and the Pompeys Pillar area.

Based on recent projects, it was estimated that construction of a shared use path could cost upwards of $250,000 per mile if constructed within the existing MDT right-of-way. Construction of a shared use path outside of the existing MDT right-of-way would provide a facility physically separated from motorized vehicle traffic. Resource impacts resulting from construction of a separated shared use path could be substantial. Impacts to wetlands and other natural resources would be likely, requiring mitigation and permitting through natural resource agencies. Right-of-way acquisition would be another constraining element. Construction of a separated path would require coordination with numerous land owners within the corridor, and long-term maintenance agreements. Due to cost, resource impacts, maintenance, and right-of-way factors, and in consideration of MDT's primary mission to serve transportation needs (as opposed to recreational needs), the construction of a shared use path within the corridor is not recommended as a potential improvement option for MDT to pursue at this time. A recreational shared use path could be pursued by community members using public-private partnerships and alternative sources of funding.

5.0 Summary of Individual Improvement Options

This report outlines a range of improvement options MDT may consider for future implementation in the Highway 312 corridor. Improvement options are intended to address corridor needs and objectives, which were identified through a review of existing and projected conditions within the corridor, input from the public and resource agencies, and coordination with the study advisory committee. Table 11 and Figure 4 summarize individual improvement options within the Highway 312 corridor.

Table 11 Summary of Individual Improvement Options

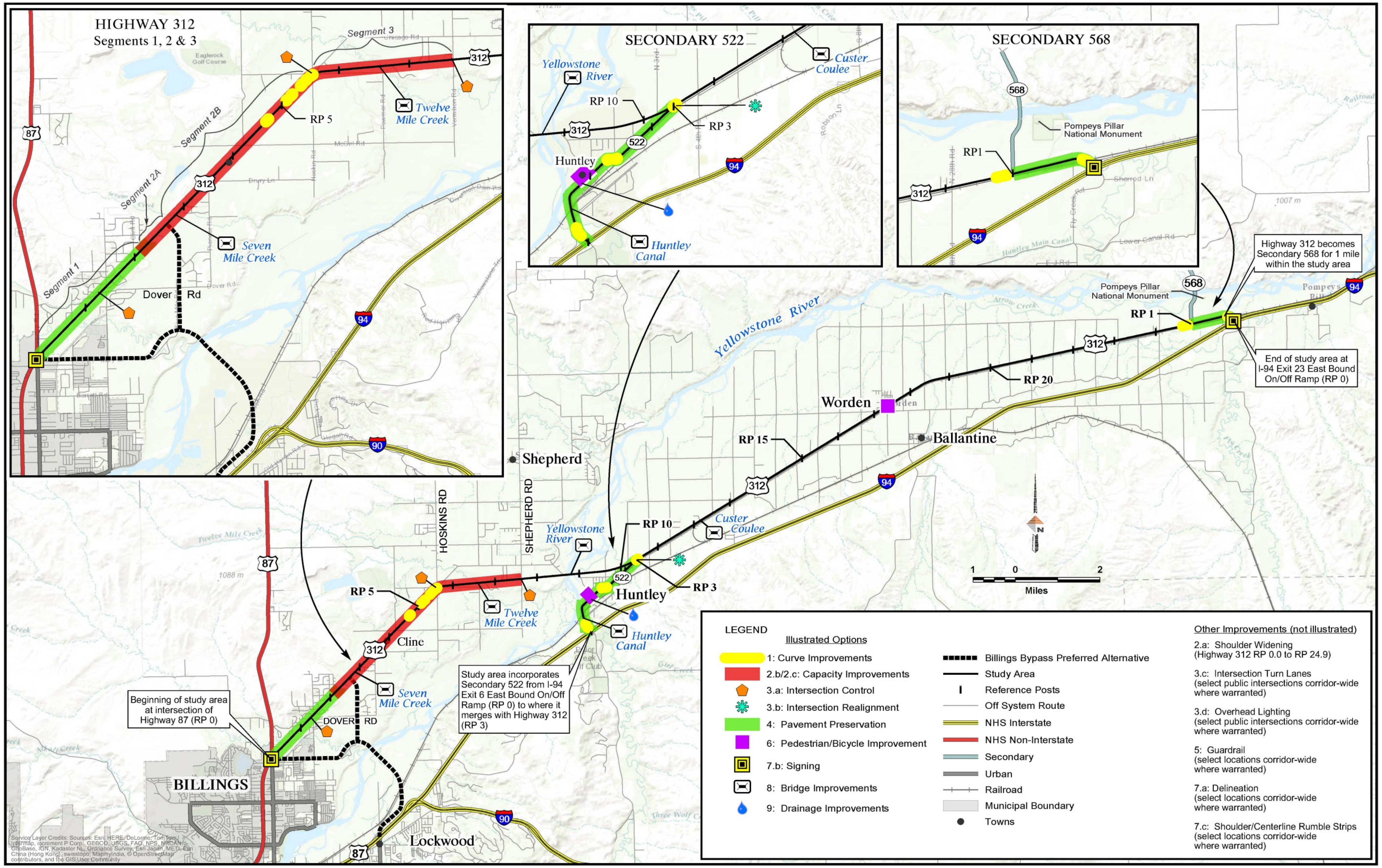
<table>
<tr><th colspan="2">Option Category</th><th>Option ID</th><th>Potential Locations</th><th>Planning Cost Estimate[1]</th><th>Potential Timeframe[2]</th><th>Potentially Impacted Resources & Anticipated ROW/Permitting</th></tr>
<tr><td colspan="2">Curve Improvements</td><td>Option 1</td><td><u>Highway 312</u>
1.a: RP 4.7, 5.1, 5.2, 5.4, 5.5, 5.6
1.b: RP 24.7, 24.8
<u>Secondary 522</u>
1.c: RP 0.2
1.d: RP 1.3, 1.4
1.e: RP 3.0, 3.1
<u>Secondary 568</u>
1.f: RP 0.1</td><td>1.a: $1,960,000 to $2,130,000
1.b: $760,000 to $820,000
1.c: $570,000 to $620,000
1.d: $760,000 to $820,000
1.e: $760,000 to $820,000
1.f: $570,000 to $620,000</td><td>Mid-term to Long-term</td><td>Yes</td></tr>
<tr><td rowspan="3">Capacity Improvements</td><td>Shoulder Widening</td><td>Option 2.a</td><td>Highway 312 Segments 2 and 3
Entire Highway 312 Corridor (RP 0.0 to 24.9)</td><td>Segment 2: $440,000 to $480,000
Segment 3: $250,000 to $280,000
Entire Corridor: $3,140,000 to $3,410,000</td><td>Mid-term to Long-term</td><td>Yes</td></tr>
<tr><td>Three-lane Section</td><td>Option 2.b</td><td rowspan="2">Segment 2: Highway 312 RP 2.1 to 5.6, including bridge replacement at Seven Mile Creek (RP 2.70)
Segment 3: Highway 312 RP 5.6 to 7.4, including bridge replacement at Twelve Mile Creek (RP 6.57)</td><td>Segment 2: $3,200,000 to $3,500,000
Segment 3: $3,600,000 to $3,900,000</td><td>Mid-term to Long-term</td><td>Yes</td></tr>
<tr><td>Five-lane Section</td><td>Option 2.c</td><td>Segment 2: $7,000,000 to $7,600,000
Segment 3: $5,700,000 to $6,100,000</td><td>Mid-term to Long-term</td><td>Yes</td></tr>
<tr><td>Intersection Improvements</td><td>Intersection Control</td><td>Option 3.a</td><td>Dover Road (Highway 312 RP 1.3)
Hoskins Road (Highway 312 RP 5.6)
Shepherd Rd (Highway 312 RP 7.6)</td><td>Traffic Signal: $370,000 to $400,000 per intersection
Roundabout (1-Lane): $1,200,000 to $1,300,000 per intersection
Roundabout (2-Lane): $1,300,000 to $1,500,000 per intersection</td><td>Mid-term to Long-term</td><td>Yes</td></tr>
</table>

Option Category		Option ID	Potential Locations	Planning Cost Estimate[1]	Potential Timeframe[2]	Potentially Impacted Resources & Anticipated ROW/Permitting
Intersection Improvements	**Intersection Realignment**	**Option 3.b**	Northern Ave (Highway 312 RP 10.4)	$670,000 to $770,000	Short-term to Mid-term	Yes
Intersection Improvements	**Intersection Turn Lanes**	**Option 3.c**	Select public intersections, potentially including: McIntyre Dr, Northern Ave, N 7th Rd, N 10th Rd, N 12th Rd, and N 15th Rd.	$540,000 to $590,000 per intersection	Short-term to Mid-term	Yes
Intersection Improvements	**Overhead Lighting**	**Option 3.d**	Select public intersections where warranted, potentially including: Nahmis Ave, Northern Ave, and Custer Frontage Rd	$220,000 to $250,000 per intersection	Short-term to Mid-term	No
Pavement Preservation		**Option 4**	Highway 312 (RP 0.0 to 2.3) Secondary 568 (RP 0.0 to 1.0) Secondary 522 (RP 0.0 to 3.0)	Highway 312: $1,800,000 to $2,000,000 Secondary 568: $470,000 to $510,000 Secondary 522: $1,400,000 to $1,600,000	Short-term to Long-term	No
Roadside Safety Improvements	**Guardrail**	**5**	Select locations corridor-wide where warranted, including: Highway 312 RP 10.5, 12.2, 13.2, 16.6, 18.8, 20.2, 21.5 Secondary 522 RP 0.2	$20,000 per location	Short-term to Mid-term	No
Pedestrian/Bicycle Improvements		**Option 6**	Secondary 522 – Huntley Highway 312 – Worden	Secondary 522 – Huntley: $200,000 to $220,000 Highway 312 – Worden: $290,000 to $320,000	Mid-term to Long-term	No
Traffic Control Devices and Safety/Warning Features	**Delineation**	**Option 7.a**	Select locations corridor-wide where warranted, including: Highway 312 RP 4.9, 7.2, 9.8, 17.5, 23.9, 24.0 Secondary 522 RP 0.1, 0.3, 0.4	$60 per approach	Short-term to Mid-term	No

Option Category		Option ID	Potential Locations	Planning Cost Estimate[1]	Potential Timeframe[2]	Potentially Impacted Resources & Anticipated ROW/Permitting
Traffic Control Devices and Safety/Warning Features	**Signing**	**7.b**	US 87 (Highway 312 RP 0.0) Pompeys Pillar Intchg (RP S568 RP 0.0)	$550 to $3,500 per assembly	Short-term to Mid-term	No
	Shoulder/ Centerline Rumble Strips	**Option 7.c**	Select locations corridor-wide where warranted, including LOSS III/IV areas: Highway 312 RP 4-15 Secondary 522 RP 0-2 Secondary 568 RP 0.5	Highway 312: $77,500 to $84,600 Secondary 568: $7,100 to $7,800 Secondary 522: $14,200 to $15,500	Short-term to Mid-term	No
Bridge Improvements		**Option 8**	<u>Highway 312</u> Seven Mile Creek (RP 2.70) Twelve Mile Creek (RP 6.57) Yellowstone River (RP 8.78) Custer Coulee (RP 12.15) <u>Secondary 522</u> Huntley Canal (RP 0.36)	Seven Mile Creek: $60,000 to $65,000 Twelve Mile Creek: $260,000 to $290,000 Yellowstone River: $3,200,000 to $3,400,000 Custer Coulee: $60,000 to $70,000 Huntley Canal: $290,000 to $310,000	Mid-term to Long-term	Yes
Drainage Improvements		**Option 9**	Barkemeyer Park (S522 RP 0.9)	$1,000	Short-term to Mid-term	Yes

[1] Cost estimates are provided in 2015 dollars and are rounded for planning purposes. Cost estimates reflect contingency ranges to account for the high degree of unknown factors at the planning level. Costs associated with right-of-way acquisition, utilities, preliminary engineering, and construction engineering/inspection are included where appropriate.
[2] Potential timeframe does not indicate when projects will be programmed or implemented. Project programming is based on available funding, the complexity and urgency of potential improvements, and other system priorities. Timeframes are defined as follows. Immediate: Implementation is currently ongoing or will be initiated in 2015; Short-term: Implementation could occur within a 1- to 3-year period; Mid-term: Implementation could occur within a 3- to 6-year period; Long-term: Implementation could occur within a 6- to 20-year period.

Figure 4 **Summary of Individual Improvement Options**



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6.0 Combined Options for Future Project Development

Individual options presented in Chapter 3 are concentrated on Highway 312 within segments 2 and 3, and on Secondary 522. MDT could consider combining individual improvement options in these locations to develop future projects addressing multiple elements. This method would save time and money by reducing mobilization efforts and address capacity and safety deficiencies simultaneously. The following sections describe potential project development considerations and associated costs.

Segment 2

A future reconstruction project within Highway 312 segment 2 could widen the roadway to a five-lane section (with two travel lanes in each direction and a continuous center turn lane), provide widened shoulders and side slopes meeting current design criteria, address vertical curve issues west of Hoskins Road, replace the Seven Mile Creek bridge, and address intersection control at the Highway 312/Hoskins Road intersection. Safety measures such as segment-wide rumble strips and roadway lighting at major approaches could also be included.

The combined planning-level cost estimate for this project ranges from $12,900,000 to $14,000,000.

Segment 3

A future reconstruction project within Highway 312 segment 3 could widen the roadway to a five-lane section (with two travel lanes in each direction and a center turn lane at major approaches), provide widened shoulders and side slopes meeting current design criteria, replace the Twelve Mile Creek bridge, and address intersection control at the Highway 312/Hoskins Road intersection and the Highway 312/Shepherd Road intersection. Safety measures such as segment-wide rumble strips and roadway lighting at major approaches could also be included.

The combined planning-level cost estimate for this project ranges from $10,700,000 to $11,600,000.

Secondary 522

A future reconstruction project on Secondary 522 could address pavement condition, provide sidewalks in Huntley, address horizontal and vertical curve issues, widen shoulders, and realign the Northern Avenue intersection with Highway 312.

The combined planning-level cost estimate for this project ranges from $12,100,000 to $13,100,000.

Phasing Considerations

The first phase of the Billings Bypass project is anticipated to be constructed in 2018 and includes the extension of Five Mile Creek Road to connect with Highway 312 near RP 2.6 within segment 2 of the study area. Improvements in segment 2 would essentially extend the current five-lane roadway configuration within segment 1, and could be completed in conjunction or cooperation with the first phase of the Billings Bypass project. The first half mile of segment 2 could be completed with the first phase of the Billings Bypass Project since the Billings Bypass project will likely include intersection improvements to Highway 312.

A major reconstruction of segment 2 is the logical first project to be considered because of the existing and anticipated growth in the Billings Heights and forecasted demand on Highway 312. The reconstruction of segment 3 could follow reconstruction of segment 2. Reconstruction of Secondary 522 could be completed independently from improvements on Highway 312.

7.0 References

AASHTO. (2011). A Policy on Geometric Design of Highways and Streets. Section 4.4.2 Width of Shoulders; Table 7-3 Minimum Width of Traveled Way and Usable Shoulder for Rural Arterials.

AASHTO. (2012). Guide for the Development of Bicycle Facilities.

FHWA. (2009). Manual on Uniform Traffic Control Devices for Streets and Highways.

Montana Department of Transportation. (2004). Road Design Manual. Retrieved December 2014 from: http://www.mdt.mt.gov/publications/manuals.shtml

Montana Department of Transportation. (2007). Traffic Engineering Manual. Retrieved December 2014 from: http://www.mdt.mt.gov/publications/manuals.shtml

Montana Department of Transportation. (2013). Advance Warning Flashers at Signalized Intersections.

Montana Department of Transportation. (2015). Commercial Plant Mix Guidance Memorandum.

Transportation Research Board. (2010). Highway Capacity Manual.

ATTACHMENT 1

Intersection Exhibits

Option 3.a Intersection Control

Exhibit 1

Dover Road

No-Build Alternative

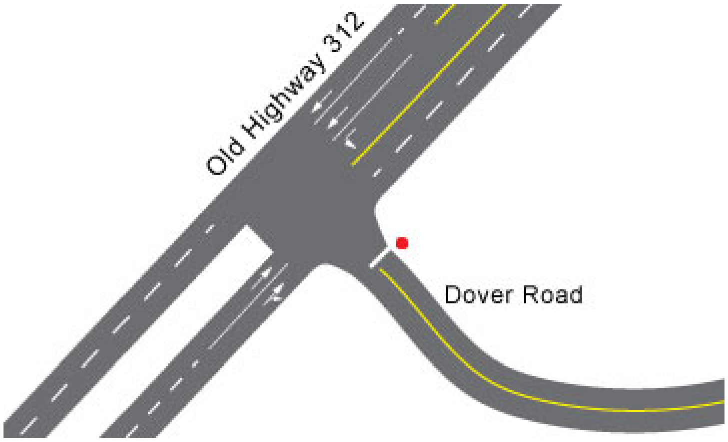


Exhibit 2

Dover Road

Traffic Signal Alternative

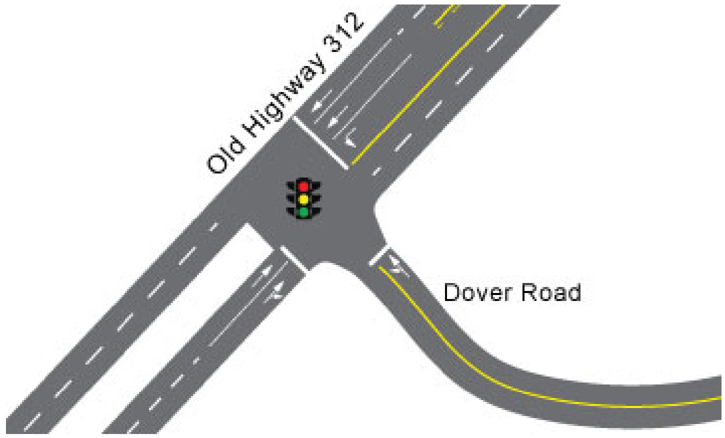


Exhibit 3

Dover Road

2-lane Roundabout Alternative

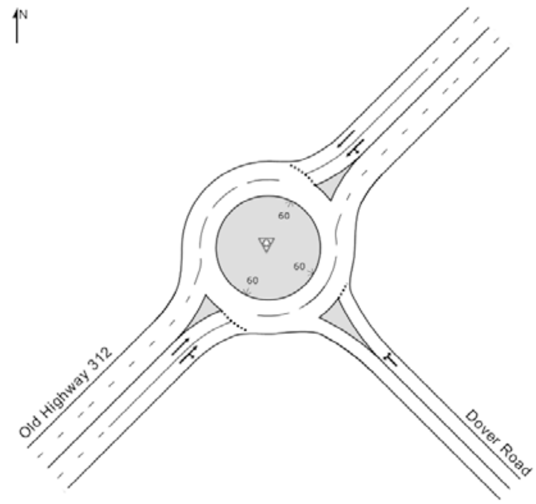


Exhibit 4

Hoskins Road

No-Build Alternative

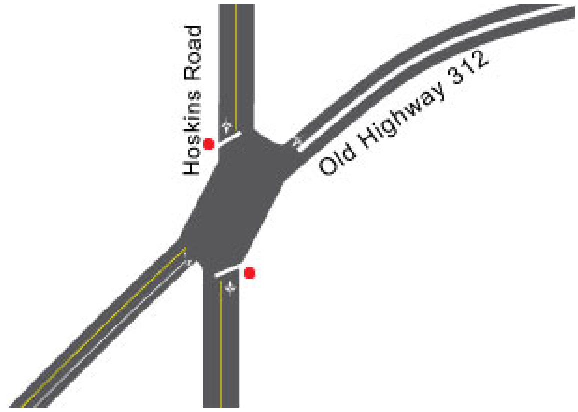


Exhibit 5

Hoskins Road

Traffic Signal Alternative

Exhibit 6

Hoskins Road

1-lane Roundabout Alternative

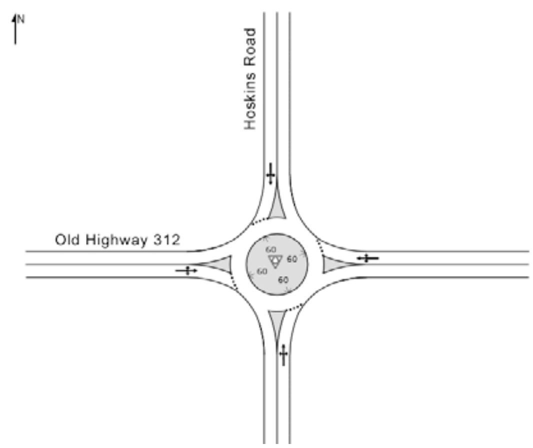


Figure 7

Hoskins Road

2-lane Roundabout Alternative

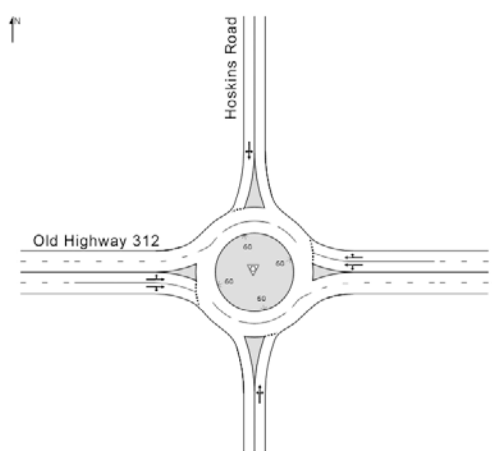


Exhibit 8

Shepherd Road

No-Build Alternative

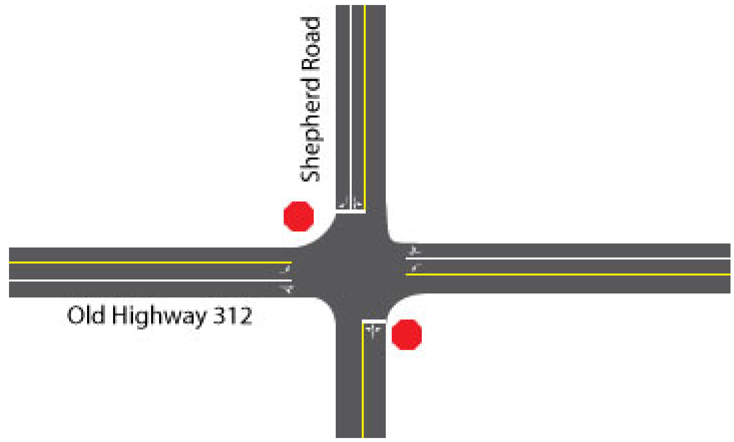


Exhibit 9

Shepherd Road

Traffic Signal Alternative

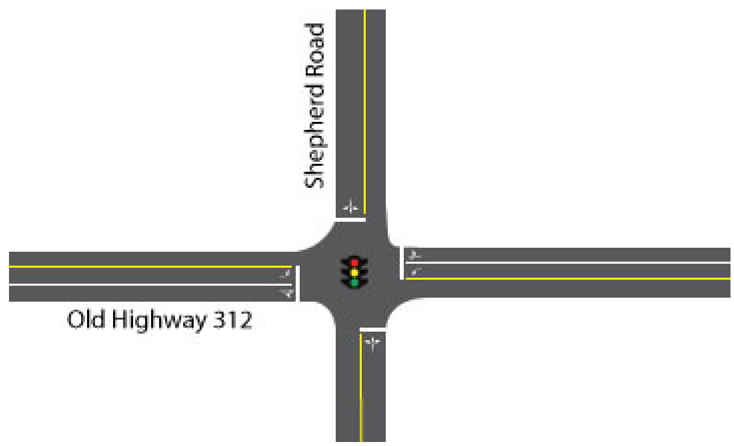


Exhibit 10

Shepherd Road

1-lane Roundabout Alternative

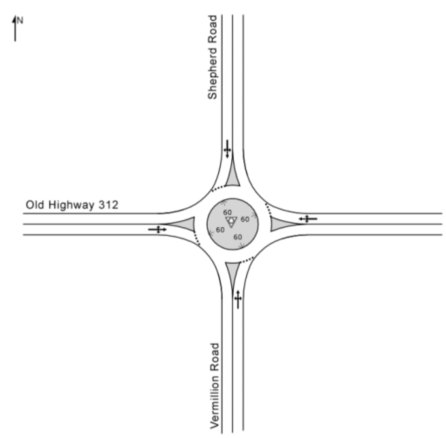
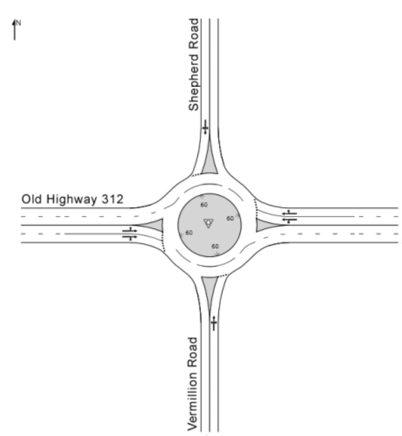


Exhibit 11

Shepherd Road

2-lane Roundabout Alternative



ATTACHMENT 2

Operational Analysis Worksheets

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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 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.

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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 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.

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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	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.

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	JSP
Agency/Co.	DOWL
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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:
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	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.

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	8.0	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	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	56.8	mi/h
Adjustment for no-passing zones, fnp	2.0	mi/h
Average travel speed, ATSd	48.5	mi/h
Percent Free Flow Speed, PFFS	85.5	%

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	9.6	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	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)	48.5	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	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.27
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	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	8.0	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	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	56.8	mi/h
Adjustment for no-passing zones, fnp	1.6	mi/h
Average travel speed, ATSd	48.9	mi/h
Percent Free Flow Speed, PFFS	86.2	%

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	C	
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	4.9	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)	48.9	mi/h
Percent time-spent-following, PTSFd (from above)	45.7	
Level of service, LOSd (from above)	C	

Average Travel Speed with Passing Lane

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

Percent Time-Spent-Following with Passing Lane

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

Level of Service and Other Performance Measures with Passing Lane

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

Bicycle Level of Service

Posted speed limit, Sp	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	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	0.94
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	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	8.0	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	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	56.8	mi/h
Adjustment for no-passing zones, fnp	2.1	mi/h
Average travel speed, ATSd	45.2	mi/h
Percent Free Flow Speed, PFFS	79.6	%

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	15.5	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)	45.2	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	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.48
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.

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	8.0	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	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	56.8	mi/h
Adjustment for no-passing zones, fnp	0.9	mi/h
Average travel speed, ATSd	46.4	mi/h
Percent Free Flow Speed, PFFS	81.7	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.0	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	1.000		1.000	
Grade adjustment factor,(note-1) fg	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	C	
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	7.9	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)	46.4	mi/h
Percent time-spent-following, PTSFd (from above)	57.9	
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	416.5
Effective width of outside lane, We	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.15
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.

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	8.0	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	0.0	mi/h
Adj. for access point density,(note-3) fA	4.3	mi/h
Free-flow speed, FFSd	55.8	mi/h
Adjustment for no-passing zones, fnp	2.5	mi/h
Average travel speed, ATSd	46.0	mi/h
Percent Free Flow Speed, PFFS	82.5	%

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                6.0     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                          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)                       46.0    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	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.08
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.

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	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.90	
Shoulder width	8.0	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	0.0	mi/h
Adj. for access point density,(note-3) fA	4.3	mi/h
Free-flow speed, FFSd	55.8	mi/h
Adjustment for no-passing zones, fnp	1.8	mi/h
Average travel speed, ATSd	46.6	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	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	C	
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	4.1	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)	46.6	mi/h
Percent time-spent-following, PTSFd (from above)	59.4	
Level of service, LOSd (from above)	C	

Average Travel Speed with Passing Lane

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

Percent Time-Spent-Following with Passing Lane

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

Level of Service and Other Performance Measures with Passing Lane

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

Bicycle Level of Service

Posted speed limit, Sp	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	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.11
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 6.70

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	8.0	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	18	%
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	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	56.8	mi/h
Adjustment for no-passing zones, fnp	1.5	mi/h
Average travel speed, ATSd	49.0	mi/h
Percent Free Flow Speed, PFFS	86.3	%

```
_________________________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              0.999
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               24.0
Percent time-spent-following, PTSFd                65.0   %

________________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         465     veh-mi
Peak-hour vehicle-miles of travel, VMT60           1803    veh-mi
Peak 15-min total travel time, TT15                9.5     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)                      49.0    mi/h
Percent time-spent-following, PTSFd (from above)             65.0
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	530.9
Effective width of outside lane, We	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.27
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.

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	8.0	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	0	%
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	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	56.8	mi/h
Adjustment for no-passing zones, fnp	1.1	mi/h
Average travel speed, ATSd	49.4	mi/h
Percent Free Flow Speed, PFFS	87.0	%

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	11.6	
Percent time-spent-following, PTSFd	38.7	%

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.16	
Peak 15-min vehicle-miles of travel, VMT15	241	veh-mi
Peak-hour vehicle-miles of travel, VMT60	935	veh-mi
Peak 15-min total travel time, TT15	4.9	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)	49.4	mi/h
Percent time-spent-following, PTSFd (from above)	38.7	
Level of service, LOSd (from above)	C	

Average Travel Speed with Passing Lane

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

Percent Time-Spent-Following with Passing Lane

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

Level of Service and Other Performance Measures with Passing Lane

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

Bicycle Level of Service

Posted speed limit, Sp	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	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	0.94
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 6.70

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	8.0	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	0	%
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	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	56.8	mi/h
Adjustment for no-passing zones, fnp	1.3	mi/h
Average travel speed, ATSd	46.0	mi/h
Percent Free Flow Speed, PFFS	81.0	%

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	10.2			
Percent time-spent-following, PTSFd	72.5	%		

Level of Service and Other Performance Measures

Level of service, LOS	D	
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	15.3	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)	46.0	mi/h
Percent time-spent-following, PTSFd (from above)	72.5	
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	802.1
Effective width of outside lane, We	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.48
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.

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	8.0	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	0	%
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	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	56.8	mi/h
Adjustment for no-passing zones, fnp	0.5	mi/h
Average travel speed, ATSd	46.7	mi/h
Percent Free Flow Speed, PFFS	82.4	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.0	
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	10.2	
Percent time-spent-following, PTSFd	53.0	%

Level of Service and Other Performance Measures

Level of service, LOS	C	
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	7.8	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)	46.7	mi/h
Percent time-spent-following, PTSFd (from above)	53.0	
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	416.5
Effective width of outside lane, We	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.15
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.

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	8.0	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	12	%
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	0.0	mi/h
Adj. for access point density,(note-3) fA	4.3	mi/h
Free-flow speed, FFSd	55.8	mi/h
Adjustment for no-passing zones, fnp	1.3	mi/h
Average travel speed, ATSd	47.1	mi/h
Percent Free Flow Speed, PFFS	84.5	%

```
_________________________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                       21.2
Percent time-spent-following, PTSFd                        64.6   %

________________Level of Service and Other Performance Measures________________

Level of service, LOS                                      C
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                        5.9     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)                              47.1    mi/h
Percent time-spent-following, PTSFd (from above)                     64.6
Level of service, LOSd (from above)                                  C

___________________Average Travel Speed  with Passing Lane____________________

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

________________Percent Time-Spent-Following with Passing Lane________________

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

______Level of Service and Other Performance Measures with Passing Lane ______

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

__________________________ Bicycle Level of Service ___________________________
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Posted speed limit, Sp	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	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.08
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.

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	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.90	
Shoulder width	8.0	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	0	%
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	0.0	mi/h
Adj. for access point density,(note-3) fA	4.3	mi/h
Free-flow speed, FFSd	55.8	mi/h
Adjustment for no-passing zones, fnp	1.0	mi/h
Average travel speed, ATSd	47.4	mi/h
Percent Free Flow Speed, PFFS	85.1	%

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	13.3	
Percent time-spent-following, PTSFd	50.0	%

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.23	
Peak 15-min vehicle-miles of travel, VMT15	192	veh-mi
Peak-hour vehicle-miles of travel, VMT60	692	veh-mi
Peak 15-min total travel time, TT15	4.0	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	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)	47.4	mi/h
Percent time-spent-following, PTSFd (from above)	50.0	
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	384.4
Effective width of outside lane, We	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.11
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 6.70

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	8.0	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	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	56.8	mi/h
Adjustment for no-passing zones, fnp	2.0	mi/h
Average travel speed, ATSd	48.5	mi/h
Percent Free Flow Speed, PFFS	85.5	%

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	9.6	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	3.5	mi
Length of two-lane highway upstream of the passing lane, Lu	0.0	mi
Length of passing lane including tapers, Lpl	1.0	mi
Average travel speed, ATSd (from above)	48.5	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	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	0.80	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.10	
Average travel speed including passing lane, ATSpl	51.0	
Percent free flow speed including passing lane, PFFSpl	89.9	%

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	7.05	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-4.55	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.61	
Percent time-spent-following including passing lane, PTSFpl	44.6	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	B	
Peak 15-min total travel time, TT15	9.1	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	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.27
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.

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	8.0	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	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	56.8	mi/h
Adjustment for no-passing zones, fnp	1.6	mi/h
Average travel speed, ATSd	48.9	mi/h
Percent Free Flow Speed, PFFS	86.2	%

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	C	
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	4.9	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	0.0	mi
Length of passing lane including tapers, Lpl	1.0	mi
Average travel speed, ATSd (from above)	48.9	mi/h
Percent time-spent-following, PTSFd (from above)	45.7	
Level of service, LOSd (from above)	C	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	0.80	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.09	
Average travel speed including passing lane, ATSpl	51.2	
Percent free flow speed including passing lane, PFFSpl	90.2	%

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	11.94	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-9.44	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.59	
Percent time-spent-following including passing lane, PTSFpl	28.4	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	B	
Peak 15-min total travel time, TT15	4.7	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	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	0.94
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.

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	8.0	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	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	56.8	mi/h
Adjustment for no-passing zones, fnp	2.1	mi/h
Average travel speed, ATSd	45.2	mi/h
Percent Free Flow Speed, PFFS	79.6	%

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	15.5	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	0.0	mi
Length of passing lane including tapers, Lpl	1.0	mi
Average travel speed, ATSd (from above)	45.2	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	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	0.80	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.11	
Average travel speed including passing lane, ATSpl	47.7	
Percent free flow speed including passing lane, PFFSpl	84.1	%

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	4.99	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-2.49	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.62	
Percent time-spent-following including passing lane, PTSFpl	56.4	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	C	
Peak 15-min total travel time, TT15	14.7	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	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.48
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.

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	8.0	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	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	56.8	mi/h
Adjustment for no-passing zones, fnp	0.9	mi/h
Average travel speed, ATSd	46.4	mi/h
Percent Free Flow Speed, PFFS	81.7	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.0	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	1.000		1.000	
Grade adjustment factor,(note-1) fg	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	C	
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	7.9	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	0.0	mi
Length of passing lane including tapers, Lpl	1.0	mi
Average travel speed, ATSd (from above)	46.4	mi/h
Percent time-spent-following, PTSFd (from above)	57.9	
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	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	0.80	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.10	
Average travel speed including passing lane, ATSpl	48.8	
Percent free flow speed including passing lane, PFFSpl	85.9	%

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	7.97	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-5.47	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.61	
Percent time-spent-following including passing lane, PTSFpl	37.8	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	C	
Peak 15-min total travel time, TT15	7.5	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	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.15
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.

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	8.0	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	0.0	mi/h
Adj. for access point density,(note-3) fA	4.3	mi/h
Free-flow speed, FFSd	55.8	mi/h
Adjustment for no-passing zones, fnp	2.5	mi/h
Average travel speed, ATSd	46.0	mi/h
Percent Free Flow Speed, PFFS	82.5	%

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	6.0	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	2.0	mi
Length of two-lane highway upstream of the passing lane, Lu	0.0	mi
Length of passing lane including tapers, Lpl	1.0	mi
Average travel speed, ATSd (from above)	46.0	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	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-0.70	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.10	
Average travel speed including passing lane, ATSpl	49.9	
Percent free flow speed including passing lane, PFFSpl	89.5	%

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	6.85	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-5.85	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.61	
Percent time-spent-following including passing lane, PTSFpl	45.7	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	C	
Peak 15-min total travel time, TT15	5.6	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	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.08
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 6.70

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	Westbound Traffic

Input Data

Highway class	Class 1		Peak hour factor, PHF	0.90	
Shoulder width	8.0	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	0.0	mi/h
Adj. for access point density,(note-3) fA	4.3	mi/h
Free-flow speed, FFSd	55.8	mi/h
Adjustment for no-passing zones, fnp	1.8	mi/h
Average travel speed, ATSd	46.6	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	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	C	
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	4.1	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	0.0	mi
Length of passing lane including tapers, Lpl	1.0	mi
Average travel speed, ATSd (from above)	46.6	mi/h
Percent time-spent-following, PTSFd (from above)	59.4	
Level of service, LOSd (from above)	C	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-0.70	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.10	
Average travel speed including passing lane, ATSpl	50.6	
Percent free flow speed including passing lane, PFFSpl	90.7	%

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	8.63	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-7.63	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.60	
Percent time-spent-following including passing lane, PTSFpl	36.3	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	B	
Peak 15-min total travel time, TT15	3.8	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	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.11
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: Multilane Highways Release 6.70

Phone: Fax:
E-mail:

OPERATIONAL ANALYSIS

Analyst: JSP
Agency/Co: DOWL
Date: 11/19/2015
Analysis 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
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	Undivided		Undivided	
Free-flow speed:	Base		Base	
FFS or BFFS	60.0	mph	60.0	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	1.6	mph	1.6	mph
Access points adjustment, FA	3.3	mph	3.3	mph
Free-flow speed	55.2	mph	55.2	mph

VOLUME

Direction	1		2	
Volume, V	515	vph	267	vph
Peak-hour factor, PHF	0.97		0.97	
Peak 15-minute volume, v15	133		69	
Trucks and buses	1	%	1	%
Recreational vehicles	0	%	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	0.995		0.993	
Flow rate, vp	266	pcphpl	138	pcphpl

RESULTS

Direction	1		2	
Flow rate, vp	266	pcphpl	138	pcphpl
Free-flow speed, FFS	55.2	mph	55.2	mph
Avg. passenger-car travel speed, S	55.0	mph	55.0	mph
Level of service, LOS	A		A	
Density, D	4.8	pc/mi/ln	2.5	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	265.5	137.6
Effective width of outside lane, We	24.00	24.00
Effective speed factor, St	4.79	4.79
Bicycle LOS Score, BLOS	1.96	1.63
Bicycle LOS	B	B

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

HCS 2010: Multilane Highways Release 6.70

Phone: Fax:
E-mail:

OPERATIONAL ANALYSIS

Analyst: JSP
Agency/Co: DOWL
Date: 11/19/2015
Analysis 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
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	Undivided		Undivided	
Free-flow speed:	Base		Base	
FFS or BFFS	60.0	mph	60.0	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	1.6	mph	1.6	mph
Access points adjustment, FA	3.3	mph	3.3	mph
Free-flow speed	55.2	mph	55.2	mph

VOLUME

Direction	1		2	
Volume, V	778	vph	404	vph
Peak-hour factor, PHF	0.97		0.97	
Peak 15-minute volume, v15	201		104	
Trucks and buses	1	%	1	%
Recreational vehicles	0	%	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	0.995		0.993	
Flow rate, vp	403	pcphpl	209	pcphpl

RESULTS

Direction	1		2	
Flow rate, vp	403	pcphpl	209	pcphpl
Free-flow speed, FFS	55.2	mph	55.2	mph
Avg. passenger-car travel speed, S	55.0	mph	55.0	mph
Level of service, LOS	A		A	
Density, D	7.3	pc/mi/ln	3.8	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	401.0	208.2
Effective width of outside lane, We	24.00	24.00
Effective speed factor, St	4.79	4.79
Bicycle LOS Score, BLOS	2.17	1.84
Bicycle LOS	B	B

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

HCS 2010: Multilane Highways Release 6.70

Phone: Fax:
E-mail:

OPERATIONAL ANALYSIS

Analyst: JSP
Agency/Co: DOWL
Date: 11/19/2015
Analysis 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
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	17		17	
Median type	Undivided		Undivided	
Free-flow speed:	Base		Base	
FFS or BFFS	60.0	mph	60.0	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	1.6	mph	1.6	mph
Access points adjustment, FA	4.3	mph	4.3	mph
Free-flow speed	54.2	mph	54.2	mph

VOLUME

Direction	1		2	
Volume, V	500	vph	346	vph
Peak-hour factor, PHF	0.90		0.90	
Peak 15-minute volume, v15	139		96	
Trucks and buses	0	%	1	%
Recreational vehicles	0	%	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	1.000		0.993	
Flow rate, vp	277	pcphpl	193	pcphpl

RESULTS

Direction	1		2	
Flow rate, vp	277	pcphpl	193	pcphpl
Free-flow speed, FFS	54.2	mph	54.2	mph
Avg. passenger-car travel speed, S	55.0	mph	55.0	mph
Level of service, LOS	A		A	
Density, D	5.0	pc/mi/ln	3.5	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	277.8	192.2
Effective width of outside lane, We	24.00	24.00
Effective speed factor, St	4.79	4.79
Bicycle LOS Score, BLOS	1.77	1.79
Bicycle LOS	B	B

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

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	-

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Traffic Volume (veh/h)	63	42	671	85	22	306
Future Volume (veh/h)	63	42	671	85	22	306
Number	5	12	4	14	3	8
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1650	1700	1650	1700	1717	1650
Adj Flow Rate, veh/h	72	48	762	97	25	348
Adj No. of Lanes	0	0	2	0	1	2
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	0	0	3	3	3	3
Cap, veh/h	151	101	1379	175	504	1545
Arrive On Green	0.17	0.17	0.49	0.49	0.49	0.49
Sat Flow, veh/h	893	595	2882	356	660	3218
Grp Volume(v), veh/h	121	0	427	432	25	348
Grp Sat Flow(s),veh/h/ln	1501	0	1568	1588	660	1568
Q Serve(g_s), s	1.7	0.0	4.5	4.5	0.6	1.5
Cycle Q Clear(g_c), s	1.7	0.0	4.5	4.5	5.1	1.5
Prop In Lane	0.60	0.40		0.22	1.00	
Lane Grp Cap(c), veh/h	254	0	772	782	504	1545
V/C Ratio(X)	0.48	0.00	0.55	0.55	0.05	0.23
Avail Cap(c_a), veh/h	1015	0	1061	1074	626	2122
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	8.9	0.0	4.2	4.2	6.0	3.4
Incr Delay (d2), s/veh	1.4	0.0	0.6	0.6	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.8	0.0	2.0	2.1	0.1	0.6
LnGrp Delay(d),s/veh	10.3	0.0	4.8	4.8	6.0	3.5
LnGrp LOS	B		A	A	A	A
Approach Vol, veh/h	121		859			373
Approach Delay, s/veh	10.3		4.8			3.7
Approach LOS	B		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4				8
Phs Duration (G+Y+Rc), s		8.0		15.7				15.7
Change Period (Y+Rc), s		4.0		4.0				4.0
Max Green Setting (Gmax), s		16.0		16.0				16.0
Max Q Clear Time (g_c+I1), s		3.7		6.5				7.1
Green Ext Time (p_c), s		0.2		4.7				4.5

Intersection Summary		
HCM 2010 Ctrl Delay		5.0
HCM 2010 LOS		A

Notes
User approved volume balancing among the lanes for turning movement.

DELAY (CONTROL)

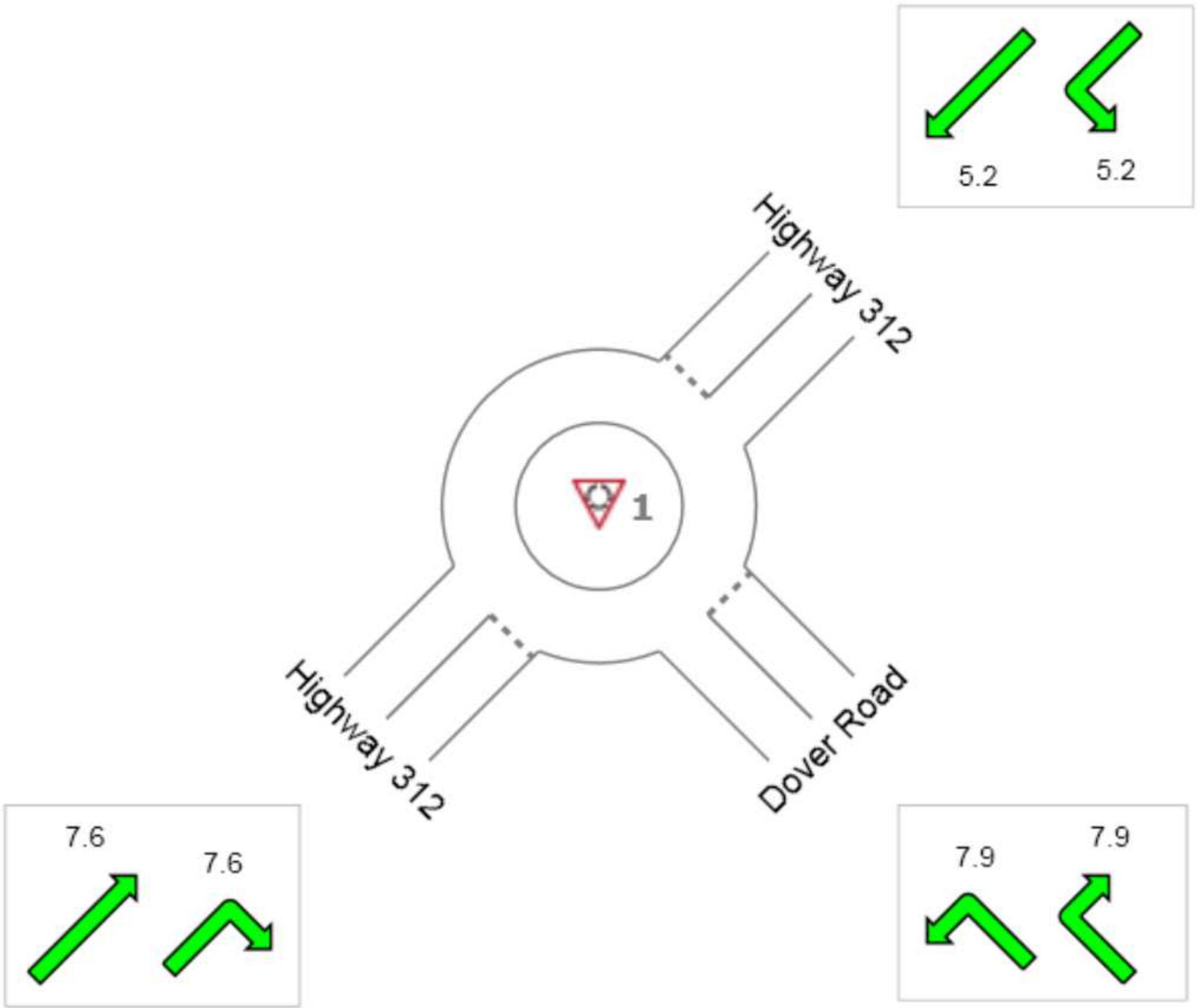
Average control delay per vehicle, or average pedestrian delay (seconds)

Site: Intersection #1, 2-Lane Roundabout

New Site
Roundabout

All Movement Classes

	Southeast	Northeast	Southwest	Intersection
	7.9	5.2	7.6	7.0
LOS	A	A	A	A



Colour code based on Level of Service

LOS A LOS B LOS C LOS D LOS E LOS F Continuous

Level of Service Method: Delay & v/c (HCM 2010)
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Roundabout Level of Service Method: Same as Sign Control
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

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

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	183	423	7	5	214	46	1	4	1	19	3	70
Future Volume (veh/h)	183	423	7	5	214	46	1	4	1	19	3	70
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1650	1650	1700	1700	1650	1700	1700	1650	1700	1700	1650	1700
Adj Flow Rate, veh/h	195	450	7	5	228	49	1	4	1	20	3	74
Adj No. of Lanes	1	1	0	0	1	0	0	1	0	0	1	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	3	3	3	3	3	3	3	3	3	3	3	3
Cap, veh/h	877	733	11	171	592	125	217	214	48	236	24	198
Arrive On Green	0.45	0.45	0.45	0.45	0.45	0.45	0.18	0.18	0.18	0.18	0.18	0.18
Sat Flow, veh/h	1087	1621	25	8	1310	277	137	1170	261	204	133	1084
Grp Volume(v), veh/h	195	0	457	282	0	0	6	0	0	97	0	0
Grp Sat Flow(s),veh/h/ln	1087	0	1646	1595	0	0	1568	0	0	1421	0	0
Q Serve(g_s), s	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Cycle Q Clear(g_c), s	1.7	0.0	4.6	2.6	0.0	0.0	0.1	0.0	0.0	1.3	0.0	0.0
Prop In Lane	1.00		0.02	0.02		0.17	0.17		0.17	0.21		0.76
Lane Grp Cap(c), veh/h	877	0	744	888	0	0	478	0	0	458	0	0
V/C Ratio(X)	0.22	0.00	0.61	0.32	0.00	0.00	0.01	0.00	0.00	0.21	0.00	0.00
Avail Cap(c_a), veh/h	1180	0	1203	1329	0	0	1321	0	0	1229	0	0
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00
Uniform Delay (d), s/veh	3.8	0.0	4.6	4.0	0.0	0.0	7.3	0.0	0.0	7.8	0.0	0.0
Incr Delay (d2), s/veh	0.1	0.0	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.7	0.0	2.2	1.1	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
LnGrp Delay(d),s/veh	3.9	0.0	5.4	4.2	0.0	0.0	7.4	0.0	0.0	8.1	0.0	0.0
LnGrp LOS	A		A	A			A			A		
Approach Vol, veh/h		652			282			6			97	
Approach Delay, s/veh		4.9			4.2			7.4			8.1	
Approach LOS		A			A			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		8.0		13.9		8.0		13.9
Change Period (Y+Rc), s		4.0		4.0		4.0		4.0
Max Green Setting (Gmax), s		16.0		16.0		16.0		16.0
Max Q Clear Time (g_c+I1), s		2.1		6.6		3.3		4.6
Green Ext Time (p_c), s		0.3		3.3		0.3		3.7

Intersection Summary	
HCM 2010 Ctrl Delay	5.0
HCM 2010 LOS	A

DELAY (CONTROL)

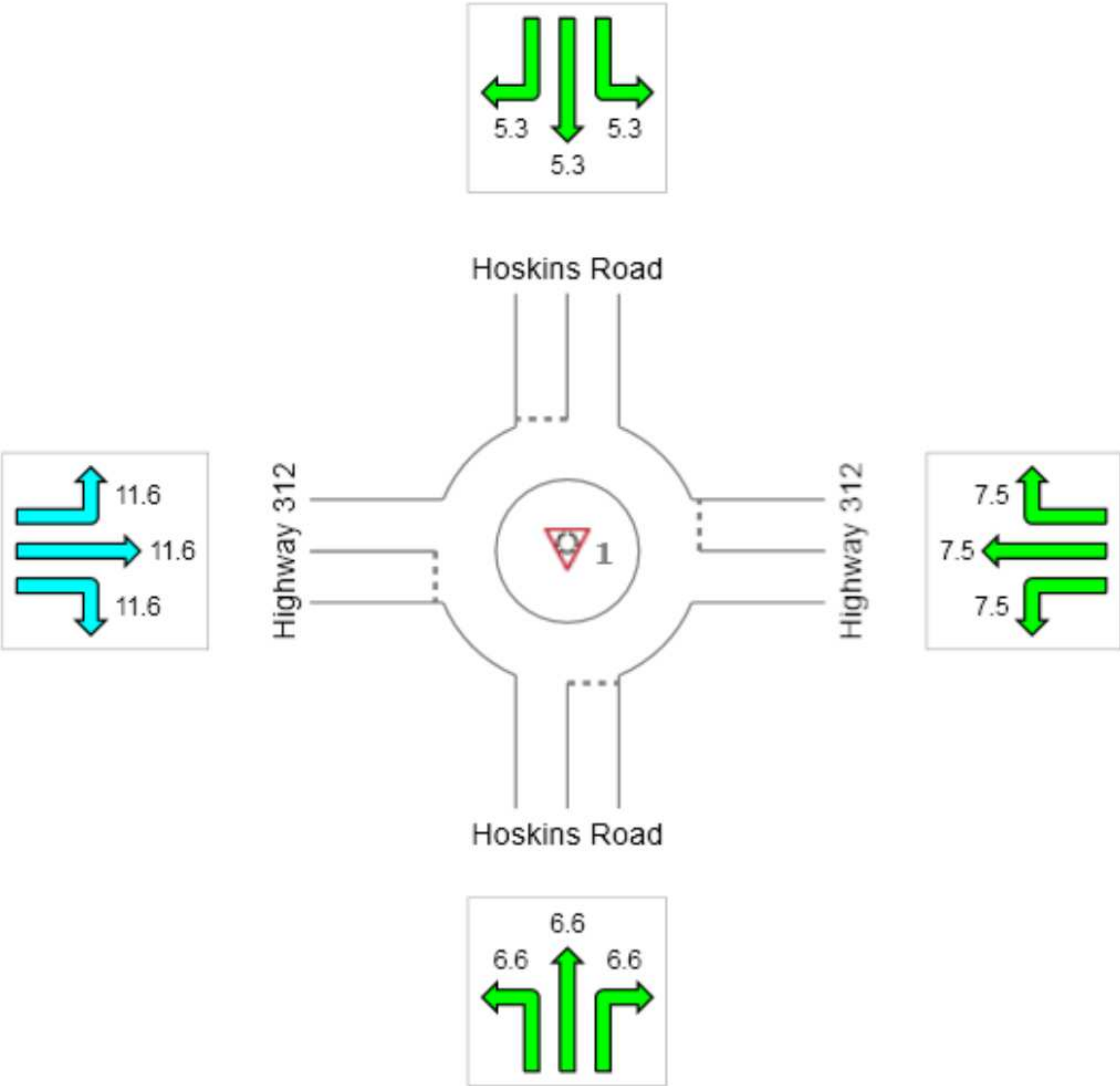
Average control delay per vehicle, or average pedestrian delay (seconds)

Site: Intersection #2, 1-Lane Roundabout

New Site
Roundabout

All Movement Classes

	South	East	North	West	Intersection
	6.6	7.5	5.3	11.6	9.9
LOS	A	A	A	B	A



Colour code based on Level of Service

LOS A LOS B LOS C LOS D LOS E LOS F Continuous

Level of Service Method: Delay & v/c (HCM 2010)
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Roundabout Level of Service Method: Same as Sign Control
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

DELAY (CONTROL)

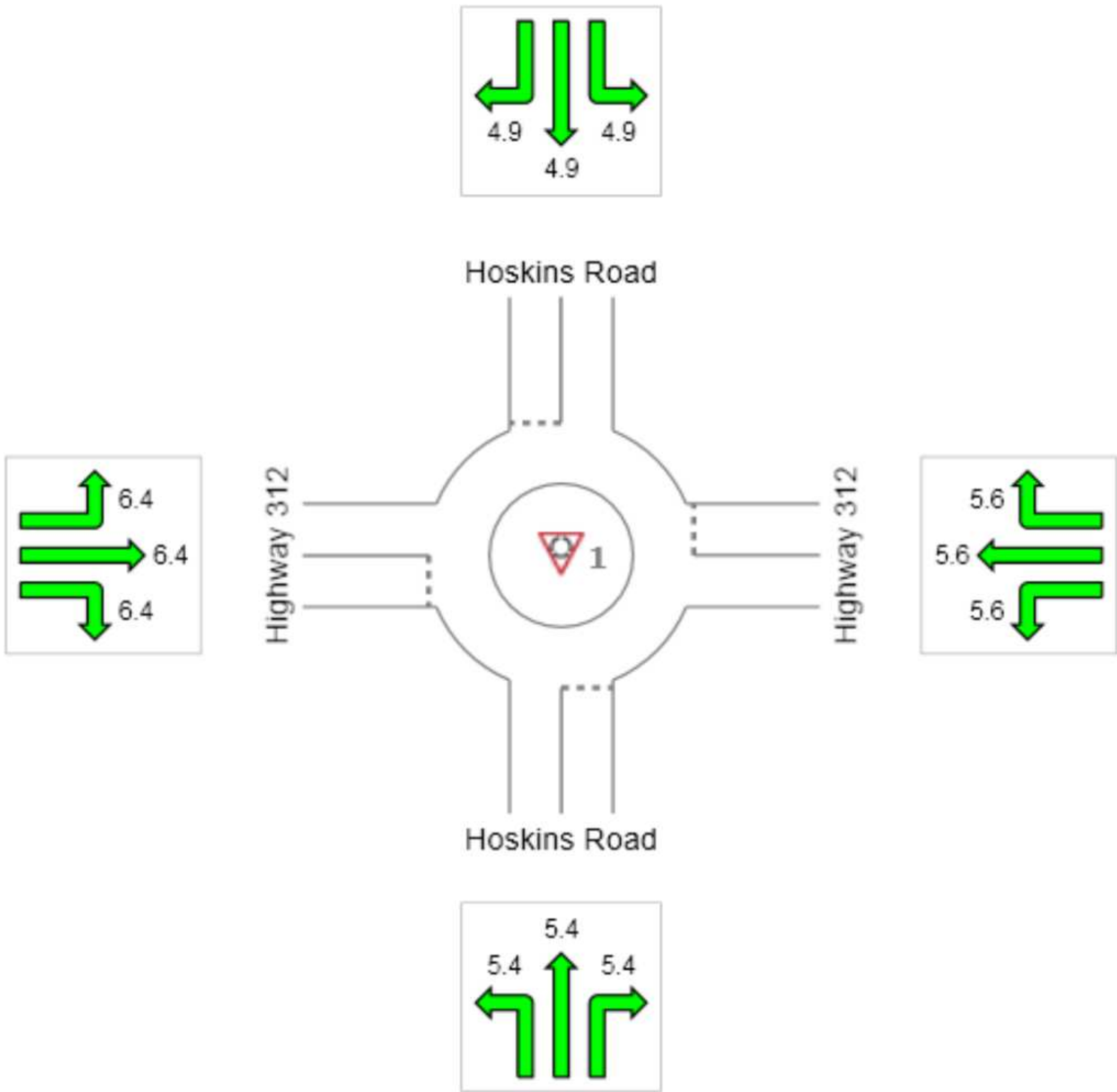
Average control delay per vehicle, or average pedestrian delay (seconds)

Site: Intersection #2, 2-Lane Roundabout

New Site
Roundabout

All Movement Classes

	South	East	North	West	Intersection
	5.4	5.6	4.9	6.4	6.0
LOS	A	A	A	A	A



Colour code based on Level of Service

LOS A | LOS B | LOS C | LOS D | LOS E | LOS F | Continuous

Level of Service Method: Delay & v/c (HCM 2010)
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Roundabout Level of Service Method: Same as Sign Control
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

Intersection	
Int Delay, s/veh	6.2

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	-	-	-	-	-	-	-	150
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	1094	1141	296	1101	1094	179
Stage 1	-	-	-	-	-	-	889	889	-	202	202	-
Stage 2	-	-	-	-	-	-	205	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	-	-	191	200	741	188	213	861
Stage 1	-	-	-	-	-	-	336	360	-	798	732	-
Stage 2	-	-	-	-	-	-	795	697	-	332	359	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1333	-	-	1256	-	-	137	154	741	147	164	861
Mov Cap-2 Maneuver	-	-	-	-	-	-	137	154	-	147	164	-
Stage 1	-	-	-	-	-	-	261	280	-	620	726	-
Stage 2	-	-	-	-	-	-	698	691	-	247	279	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	4.2	0.4	22.6	21.2
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	230	1333	-	-	1256	-	-	148	861
HCM Lane V/C Ratio	0.11	0.222	-	-	0.009	-	-	0.349	0.108
HCM Control Delay (s)	22.6	8.5	-	-	7.9	-	-	41.9	9.7
HCM Lane LOS	C	A	-	-	A	-	-	E	A
HCM 95th %tile Q(veh)	0.4	0.9	-	-	0	-	-	1.4	0.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	258	255	5	10	113	86	5	7	10	41	4	81
Future Volume (veh/h)	258	255	5	10	113	86	5	7	10	41	4	81
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1650	1650	1700	1650	1650	1700	1700	1650	1700	1700	1650	1650
Adj Flow Rate, veh/h	297	293	6	11	130	99	6	8	11	47	5	93
Adj No. of Lanes	1	1	0	1	1	0	0	1	0	0	1	1
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Percent Heavy Veh, %	3	3	3	3	3	3	3	3	3	3	3	3
Cap, veh/h	772	814	17	718	440	335	219	102	107	481	35	231
Arrive On Green	0.51	0.51	0.51	0.51	0.51	0.51	0.16	0.16	0.16	0.16	0.16	0.16
Sat Flow, veh/h	1136	1612	33	1065	871	663	210	616	649	1201	215	1403
Grp Volume(v), veh/h	297	0	299	11	0	229	25	0	0	52	0	93
Grp Sat Flow(s),veh/h/ln	1136	0	1645	1065	0	1533	1475	0	0	1416	0	1403
Q Serve(g_s), s	5.0	0.0	2.7	0.2	0.0	2.1	0.0	0.0	0.0	0.4	0.0	1.4
Cycle Q Clear(g_c), s	7.1	0.0	2.7	2.8	0.0	2.1	0.3	0.0	0.0	0.7	0.0	1.4
Prop In Lane	1.00		0.02	1.00		0.43	0.24		0.44	0.90		1.00
Lane Grp Cap(c), veh/h	772	0	831	718	0	775	427	0	0	516	0	231
V/C Ratio(X)	0.38	0.00	0.36	0.02	0.00	0.30	0.06	0.00	0.00	0.10	0.00	0.40
Avail Cap(c_a), veh/h	1182	0	1425	1103	0	1328	1140	0	0	1208	0	926
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	5.6	0.0	3.6	4.5	0.0	3.5	8.6	0.0	0.0	8.7	0.0	9.1
Incr Delay (d2), s/veh	0.3	0.0	0.3	0.0	0.0	0.2	0.1	0.0	0.0	0.1	0.0	1.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.6	0.0	1.2	0.0	0.0	0.9	0.1	0.0	0.0	0.3	0.0	0.6
LnGrp Delay(d),s/veh	5.9	0.0	3.9	4.5	0.0	3.7	8.6	0.0	0.0	8.8	0.0	10.2
LnGrp LOS	A		A	A		A	A			A		B
Approach Vol, veh/h		596			240			25			145	
Approach Delay, s/veh		4.9			3.7			8.6			9.7	
Approach LOS		A			A			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		8.0		16.2		8.0		16.2
Change Period (Y+Rc), s		4.0		4.0		4.0		4.0
Max Green Setting (Gmax), s		16.0		21.0		16.0		21.0
Max Q Clear Time (g_c+I1), s		2.3		9.1		3.4		4.8
Green Ext Time (p_c), s		0.5		3.2		0.4		3.6

Intersection Summary	
HCM 2010 Ctrl Delay	5.4
HCM 2010 LOS	A

DELAY (CONTROL)

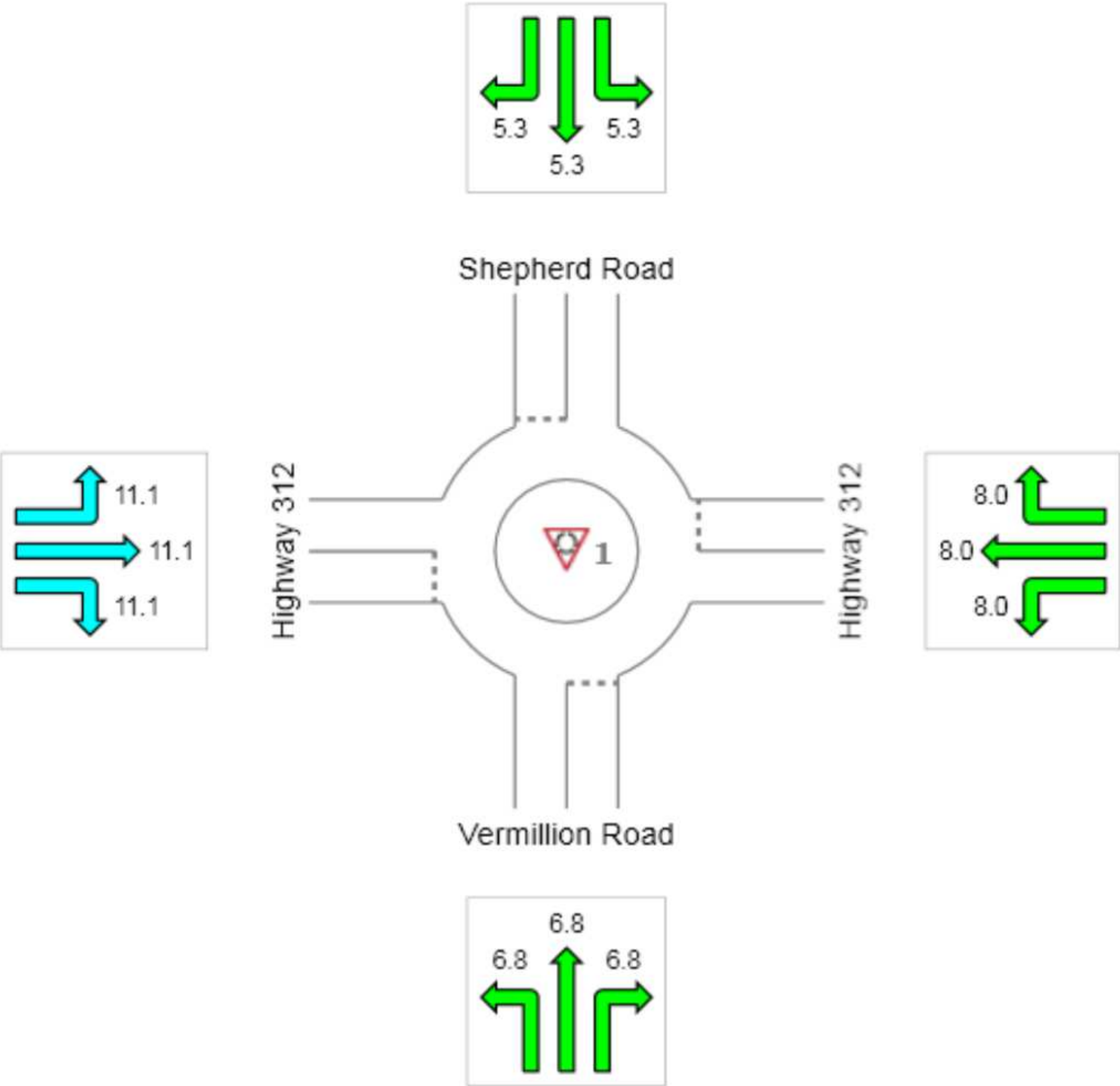
Average control delay per vehicle, or average pedestrian delay (seconds)

Site: Intersection #3, 1-Lane Roundabout

New Site
Roundabout

All Movement Classes

	South	East	North	West	Intersection
	6.8	8.0	5.3	11.1	9.4
LOS	A	A	A	B	A



Colour code based on Level of Service

Level of Service Method: Delay & v/c (HCM 2010)
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Roundabout Level of Service Method: Same as Sign Control
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

DELAY (CONTROL)

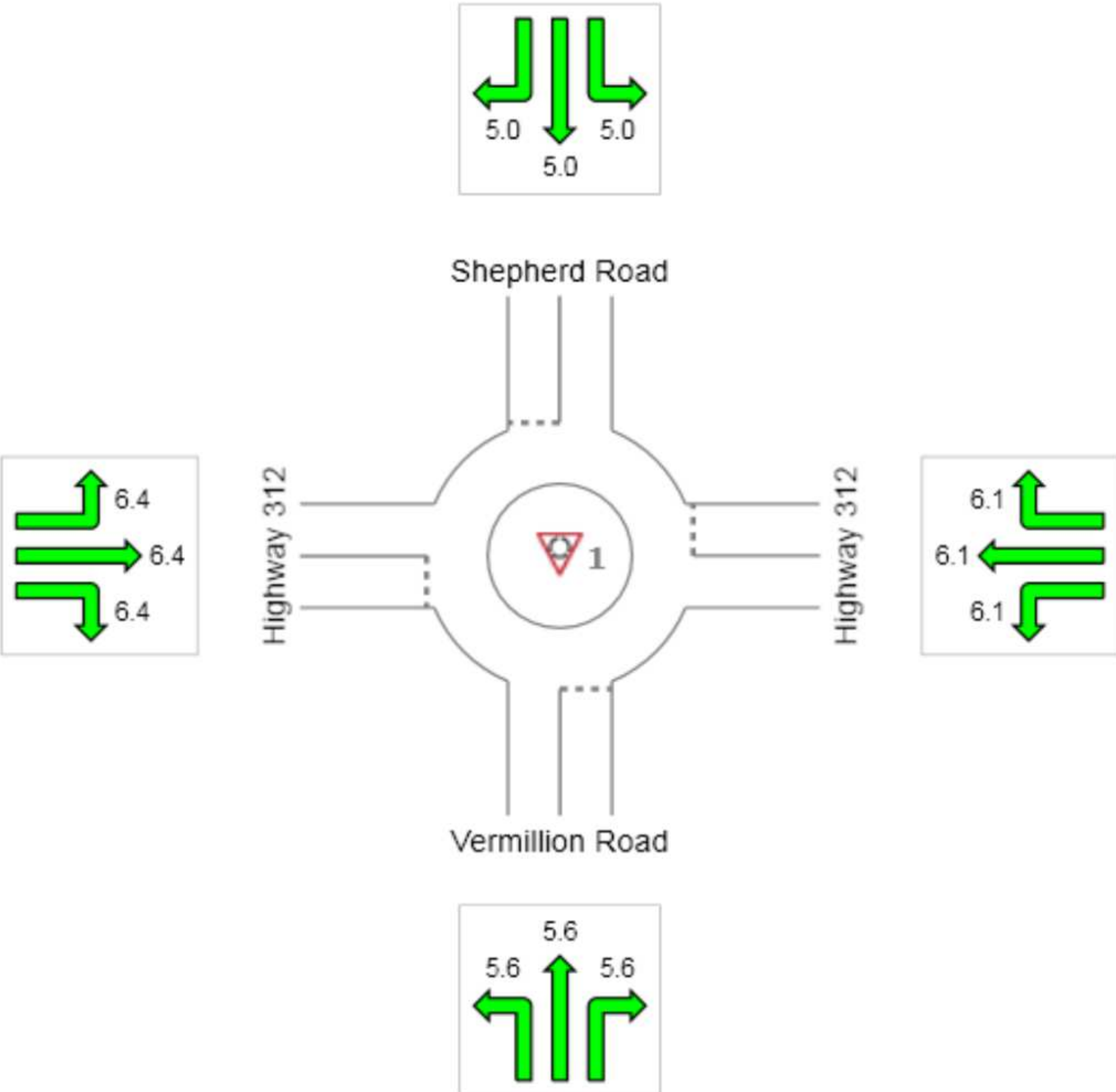
Average control delay per vehicle, or average pedestrian delay (seconds)

Site: Intersection #3, 2-Lane Roundabout

New Site
Roundabout

All Movement Classes

	South	East	North	West	Intersection
	5.6	6.1	5.0	6.4	6.1
LOS	A	A	A	A	A



Colour code based on Level of Service

LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	Continuous

Level of Service Method: Delay & v/c (HCM 2010)
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Roundabout Level of Service Method: Same as Sign Control
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

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	4.9

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Traffic Vol, veh/h	144	5	82	99	5	174
Future Vol, veh/h	144	5	82	99	5	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	-	-	150	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	3	3	3	3	3	3
Mvmt Flow	157	5	89	108	5	189

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	162	0	445	159
Stage 1	-	-	-	-	159	-
Stage 2	-	-	-	-	286	-
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	-	-	1411	-	569	884
Stage 1	-	-	-	-	867	-
Stage 2	-	-	-	-	760	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1411	-	533	884
Mov Cap-2 Maneuver	-	-	-	-	533	-
Stage 1	-	-	-	-	867	-
Stage 2	-	-	-	-	712	-

Approach	EB	WB	NB
HCM Control Delay, s	0	3.5	10.3
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	868	-	-	1411	-
HCM Lane V/C Ratio	0.224	-	-	0.063	-
HCM Control Delay (s)	10.3	-	-	7.7	-
HCM Lane LOS	B	-	-	A	-
HCM 95th %tile Q(veh)	0.9	-	-	0.2	-

ATTACHMENT 3

Cost Estimate Spreadsheets

DOWL

Option 1 - CURVE IMPROVEMENTS
Planning-level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average MDT Bid Prices [1]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
HIGHWAY 312						
1.a: RP 4.7, 5.1, 5.2, 5.4, 5.5, 5.6	**LENGTH (MILE): 1.2**					
PLANT MIX SURF GR S-3/4 IN[3]	5,070	TON	$31.12	$157,778.00	$35.00	$177,450.00
ASPHALT CEMENT PG 70-28	280	TON	$670.09	$187,625.00	$700.00	$196,000.00
EMULSIFIED ASPHALT CRS-2P	4.6	TON	$579.90	$2,673.00	$580.00	$2,673.00
COVER-TYPE 1	19,712	SQYD	$0.61	$12,024.00	$1.00	$19,712.00
CRUSHED AGGREGATE COURSE [3]	7,885	CUYD	$22.12	$174,412.00	$25.00	$197,120.00
ROADWAY OBLITERATION	63.4	STA	$858.58	$54,434.00	$860.00	$54,524.00
EXCAVATION - UNCLASSIFIED [4]	13,141	CUYD	$4.69	$61,633.00	$5.00	$65,707.00
RIGHT OF WAY [10]	5.8	ACRE			$50,000.00	$290,909.00
				Option 1.a SUBTOTAL		$1,004,095
1.b: RP 24.7, 24.8	**LENGTH (MILE): 0.4**					
COMMERCIAL MIX-PG 70-28[3]	1,690	TON	$104.99	$177,433.00	$105.00	$177,450.00
EMULSIFIED ASPHALT CRS-2P	1.5	TON	$579.90	$891.00	$580.00	$891.00
COVER-TYPE 1	6,571	SQYD	$0.61	$4,008.00	$1.00	$6,571.00
CRUSHED AGGREGATE COURSE [3]	2,628	CUYD	$22.12	$58,137.00	$25.00	$65,707.00
ROADWAY OBLITERATION	21.1	STA	$858.58	$18,116.00	$860.00	$18,146.00
EXCAVATION - UNCLASSIFIED [4]	4,380	CUYD	$4.69	$20,544.00	$5.00	$21,902.00
RIGHT OF WAY [10]	1.9	ACRE		$0.00	$50,000.00	$96,970.00
				Option 1.b SUBTOTAL		$387,637
SECONDARY 522						
1.c: RP 0.2	**LENGTH (MILE): 0.3**					
COMMERCIAL MIX-PG 70-28[3]	1,270	TON	$104.99	$133,337.00	$105.00	$133,350.00
EMULSIFIED ASPHALT CRS-2P	1.2	TON	$579.90	$670.00	$580.00	$670.00
COVER-TYPE 1	4,928	SQYD	$0.61	$3,006.00	$1.00	$4,928.00
CRUSHED AGGREGATE COURSE [3]	1,971	CUYD	$22.12	$43,603.00	$25.00	$49,280.00
ROADWAY OBLITERATION	15.8	STA	$858.58	$13,566.00	$860.00	$13,588.00
EXCAVATION - UNCLASSIFIED [4]	3,285	CUYD	$4.69	$15,408.00	$5.00	$16,427.00
RIGHT OF WAY [10]	1.5	ACRE			$50,000.00	$72,727.00
				Option 1.c SUBTOTAL		$290,970
1.d: RP 1.3, 1.4	**LENGTH (MILE): 0.4**					
COMMERCIAL MIX-PG 70-28[3]	1,690	TON	$104.99	$177,433.00	$105.00	$177,450.00
EMULSIFIED ASPHALT CRS-2P	1.5	TON	$579.90	$891.00	$580.00	$891.00
COVER-TYPE 1	6,571	SQYD	$0.61	$4,008.00	$1.00	$6,571.00
CRUSHED AGGREGATE COURSE [3]	2,628	CUYD	$22.12	$58,137.00	$25.00	$65,707.00
ROADWAY OBLITERATION	21.1	STA	$858.58	$18,116.00	$860.00	$18,146.00
EXCAVATION - UNCLASSIFIED [4]	4,380	CUYD	$4.69	$20,544.00	$5.00	$21,902.00
RIGHT OF WAY [10]	1.9	ACRE			$50,000.00	$96,970.00
				Option 1.d SUBTOTAL		$387,637
1.e: RP 3.0, 3.1	**LENGTH (MILE): 0.4**					
COMMERCIAL MIX-PG 70-28[3]	1,690	TON	$104.99	$177,433.00	$105.00	$177,450.00
EMULSIFIED ASPHALT CRS-2P	1.5	TON	$579.90	$891.00	$580.00	$891.00
COVER-TYPE 1	6,571	SQYD	$0.61	$4,008.00	$1.00	$6,571.00
CRUSHED AGGREGATE COURSE [3]	2,628	CUYD	$22.12	$58,137.00	$25.00	$65,707.00
ROADWAY OBLITERATION	21.1	STA	$858.58	$18,116.00	$860.00	$18,146.00
EXCAVATION - UNCLASSIFIED [4]	4,380	CUYD	$4.69	$20,544.00	$5.00	$21,902.00
RIGHT OF WAY [10]	1.9	ACRE			$50,000.00	$96,970.00
				Option 1.e SUBTOTAL		$387,637
SECONDARY 568						
1.f: RP 0.1	**LENGTH (MILE): 0.3**					
COMMERCIAL MIX-PG 70-28[3]	1,270	TON	$104.99	$133,337.00	$105.00	$133,350.00
EMULSIFIED ASPHALT CRS-2P	1.2	TON	$579.90	$670.00	$580.00	$670.00
COVER-TYPE 1	4,928	SQYD	$0.61	$3,006.00	$1.00	$4,928.00
CRUSHED AGGREGATE COURSE [3]	1,971	CUYD	$22.12	$43,603.00	$25.00	$49,280.00
ROADWAY OBLITERATION	15.8	STA	$858.58	$13,566.00	$860.00	$13,588.00
EXCAVATION - UNCLASSIFIED [4]	3,285	CUYD	$4.69	$15,408.00	$5.00	$16,427.00
RIGHT OF WAY [10]	1.5	ACRE			$50,000.00	$72,727.00
				Option 1.f SUBTOTAL		$290,970

Option 1 - CURVE IMPROVEMENTS
Planning-level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average MDT Bid Prices [1]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
ADDITIONAL COSTS						
	Option 1.a	**Option 1.b**	**Option 1.c**	**Option 1.d**	**Option 1.e**	**Option 1.f**
SUBTOTAL 1	**$1,004,095**	**$387,637**	**$290,970**	**$387,637**	**$387,637**	**$290,970**
MISCELLANEOUS ITEMS @ 15% OF SUBTOTAL 1 [5]	$150,600	$58,100	$43,600	$58,100	$58,100	$43,600
MOBILIZATION @ 10% OF SUBTOTAL 1 [6]	$100,400	$38,800	$29,100	$38,800	$38,800	$29,100
SUBTOTAL 2	$1,255,100	$484,500	$363,700	$484,500	$484,500	$363,700
PRELIMINARY ENGINEERING @ 10%	$125,500	$48,500	$36,400	$48,500	$48,500	$36,400
CONSTRUCTION ENGINEERING @ 10%	$125,500	$48,500	$36,400	$48,500	$48,500	$36,400
INDIRECT COST (IDC) @ 10.37% OF SUBTOTAL 2 [7]	$130,200	$50,200	$37,700	$50,200	$50,200	$37,700
TOTAL COST @ 20% CONTINGENCY [8,9]	**$1,960,000**	**$760,000**	**$570,000**	**$760,000**	**$760,000**	**$570,000**
TOTAL COST @ 30% CONTINGENCY [8,9]	**$2,130,000**	**$820,000**	**$620,000**	**$820,000**	**$820,000**	**$620,000**

[1] Average MDT bid prices provided for the period July 2014 to July 2015.
[2] Cost estimates are provided in 2015 dollars. All dollar amounts are rounded for planning purposes.
[3] Paved road typical section includes a top width of 28 ft, 0.4 ft of plant mix, and 1.2 ft of crushed aggregate course.
[4] 2ft average cut depth is assumed.
[5] The Miscellaneous category is estimated at 15 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[7] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[8] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon.
[9] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.
[10] Right of way costs estimated from anticipated impacted area.

Option 2.a - SHOULDER WIDENING
Planning-level Estimate of Costs

Item Description	Approx. Quantity per 0.1 Mile	Unit	Average MDT Bid Prices [1]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
COMMERCIAL MIX-PG 70-28[3]	270	TON	$104.99	$28,347.00	$105.00	$28,350.00
EMULSIFIED ASPHALT CRS-2P	0.2	TON	$579.90	$142.00	$580.00	$142.00
COVER-TYPE 1	821	SQYD	$0.61	$501.00	$1.00	$821.00
CRUSHED AGGREGATE COURSE [3]	329	CUYD	$22.12	$7,267.00	$25.00	$8,213.00
EXCAVATION - UNCLASSIFIED [4]	548	CUYD	$4.69	$2,568.00	$5.00	$2,738.00
RIGHT OF WAY[10]	0.5	ACRE			$50,000.00	$24,242.00
SUBTOTAL PER 0.1 MILE						$64,506

CATEGORY	LENGTH (MILE)	SUBTOTAL 1
Segment 2	3.49	$225,126
Segment 3	2.00	$129,012
Highway 312 Corridor	24.90	$1,606,199

ADDITIONAL COSTS

		Segment 2	Segment 3	Corridor
MISCELLANEOUS ITEMS @ 15% of SUBTOTAL 1 [5]	15%	$33,800	$19,400	$240,900
MOBILIZATION @ 10% OF SUBTOTAL 1 [6]	10%	$22,500	$12,900	$160,600
SUBTOTAL 2		$281,400	$161,300	$2,007,700
PRELIMINARY ENGINEERING	10%	$28,100	$16,100	$200,800
CONSTRUCTION ENGINEERING	10%	$28,100	$16,100	$200,800
INDIRECT COST (IDC) - CONSTRUCTION @ 10.37% OF SUBTOTAL 2 [7]	10.37%	$29,200	$16,700	$208,200
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [8,9]		**$440,000**	**$250,000**	**$3,140,000**
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [8,9]		**$480,000**	**$280,000**	**$3,410,000**

[1] Average MDT bid prices provided for the period July 2014 to July 2015.
[2] Cost estimates are provided in 2015 dollars. All dollar amounts are rounded for planning purposes.
[3] Paved road typical section includes a top width of 18 ft (8-foot shoulders plus one-foot sawcut in travel lane), 0.4 ft of plant mix, and 1.2 ft of crushed aggregate course.
[4] 2ft average cut depth is assumed.
[5] The Miscellaneous category is estimated at 15 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[7] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[8] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon.
[9] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.
[10] Right of way costs estimated from anticipated impacted area.

DOWL

Option 2.b - THREE-LANE SECTION (SINGLE-DIRECTION PASSING LANE)
Planning-level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average MDT Bid Prices [1]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
HIGHWAY 312						
SEGMENT 2 - RP 2.1 TO 5.6						
PLANT MIX SURF GR S-3/4 IN[3]	6,310	TON	$31.12	$196,367.00	$35.00	$220,850.00
ASPHALT CEMENT PG 70-28	350	TON	$670.09	$234,532.00	$700.00	$245,000.00
EMULSIFIED ASPHALT CRS-2P	5.7	TON	$579.90	$3,327.00	$580.00	$3,327.00
COVER-TYPE 1	24,570	SQYD	$0.61	$14,987.00	$1.00	$24,570.00
CRUSHED AGGREGATE COURSE [3]	9,828	CUYD	$22.12	$217,392.00	$25.00	$245,696.00
EXCAVATION - UNCLASSIFIED [4]	16,380	CUYD	$4.69	$76,821.00	$5.00	$81,899.00
SEVEN MILE CREEK BRIDGE REPLACEMENT	1,400	SQFT			$125.00	$175,000.00
SEVEN MILE CREEK BRIDGE REMOVAL	1	LS			$20,000.00	$20,000.00
RIGHT OF WAY[10]	12.7	ACRE			$50,000.00	$634,545.00
SEGMENT 3 - RP 5.6 TO 7.4						
COMMERCIAL MIX-PG 70-28[3]	3,620	TON	$104.99	$380,064.00	$105.00	$380,100.00
EMULSIFIED ASPHALT CRS-2P	3.3	TON	$579.90	$1,908.00	$580.00	$1,909.00
COVER-TYPE 1	14,080	SQYD	$0.61	$8,589.00	$1.00	$14,080.00
CRUSHED AGGREGATE COURSE [3]	5,632	CUYD	$22.12	$124,580.00	$25.00	$140,800.00
EXCAVATION - UNCLASSIFIED [4]	9,387	CUYD	$4.69	$44,023.00	$5.00	$46,933.00
TWELVE MILE CREEK BRIDGE REPLACEMENT	6,720	SQFT			$125.00	$840,000.00
TWELVE MILE CREEK BRIDGE REMOVAL	1	LS			$30,000.00	$30,000.00
RIGHT OF WAY[10]	7.3	ACRE			$50,000.00	$363,636.00

CATEGORY	LENGTH (MILE)	SUBTOTAL 1
SEGMENT 2	3.49	$1,650,887
SEGMENT 3	2.00	$1,817,458

ADDITIONAL COSTS

		Segment 2	Segment 3
MISCELLANEOUS ITEMS @ 15% OF SUBTOTAL 1 [5]	15%	$247,600	$272,600
MOBILIZATION @ 10% OF SUBTOTAL 1 [6]	10%	$165,100	$181,700
SUBTOTAL 2		$2,063,600	$2,271,800
PRELIMINARY ENGINEERING	10%	$206,400	$227,200
CONSTRUCTION ENGINEERING	10%	$206,400	$227,200
INDIRECT COST (IDC) - CONSTRUCTION @ 10.37% OF SUBTOTAL 2 [7]	10.37%	$214,000	$235,600
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [8,9]		**$3,200,000**	**$3,600,000**
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [8,9]		**$3,500,000**	**$3,900,000**

[1] Average MDT bid prices provided for the period July 2014 to July 2015.
[2] Cost estimates are provided in 2015 dollars. All dollar amounts are rounded for planning purposes.
[3] Paved road typical section includes a top width of 12 ft, 0.4 ft of plant mix, 1.2 ft of crushed aggregate course.
[4] 2ft average cut depth is assumed.
[5] The Miscellaneous category is estimated at 15 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[7] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[8] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon.
[9] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.
[10] Right of way costs estimated from anticipated impacted area.

Option 2.c - FIVE-LANE SECTION (DUAL-DIRECTION PASSING LANE AND CENTER TURN LANE)
Planning-level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average MDT Bid Prices [1]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
HIGHWAY 312						
SEGMENT 2 - RP 2.1 TO 5.6						
PLANT MIX SURF GR S-3/4 IN[3]	20,000	TON	$31.12	$622,400.00	$35.00	$700,000.00
ASPHALT CEMENT PG 70-28	1,080	TON	$670.09	$723,697.00	$700.00	$756,000.00
EMULSIFIED ASPHALT CRS-2P	20.0	TON	$579.90	$11,598.00	$580.00	$11,600.00
COVER-TYPE 1	77,804	SQYD	$0.61	$47,460.00	$1.00	$77,804.00
CRUSHED AGGREGATE COURSE [3]	31,121	CUYD	$22.12	$688,407.00	$25.00	$778,037.00
EXCAVATION - UNCLASSIFIED [4]	51,869	CUYD	$4.69	$243,266.00	$5.00	$259,346.00
SEVEN MILE CREEK BRIDGE REPLACEMENT	2,720	SQFT			$125.00	$340,000.00
SEVEN MILE CREEK BRIDGE REMOVAL	1	LS			$20,000.00	$20,000.00
RIGHT OF WAY[10]	12.7	ACRE			$50,000.00	$634,545.00
SEGMENT 3 - RP 5.6 TO 7.4						
PLANT MIX SURF GR S-3/4 IN[3]	11,460	TON	$31.12	$356,635.00	$35.00	$401,100.00
ASPHALT CEMENT PG 70-28	620	TON	$670.09	$415,456.00	$700.00	$434,000.00
EMULSIFIED ASPHALT CRS-2P	10.4	TON	$579.90	$6,042.00	$580.00	$6,043.00
COVER-TYPE 1	44,587	SQYD	$0.61	$27,198.00	$1.00	$44,587.00
CRUSHED AGGREGATE COURSE [3]	17,835	CUYD	$22.12	$394,503.00	$25.00	$445,867.00
EXCAVATION - UNCLASSIFIED [4]	29,724	CUYD	$4.69	$139,408.00	$5.00	$148,622.00
TWELVE MILE CREEK BRIDGE REPLACEMENT	8,160	SQFT			$125.00	$1,020,000.00
TWELVE MILE CREEK BRIDGE REMOVAL	1	LS			$30,000.00	$30,000.00
RIGHT OF WAY[10]	7.3	ACRE			$50,000.00	$363,636.00

CATEGORY	LENGTH (MILE)	SUBTOTAL 1
SEGMENT 2	3.49	$3,577,332
SEGMENT 3	2.00	$2,893,855

ADDITIONAL COSTS

		Segment 2	Segment 3
MISCELLANEOUS ITEMS @ 15% OF SUBTOTAL 1 [5]	15%	$536,600	$434,100
MOBILIZATION @ 10% OF SUBTOTAL 1 [6]	10%	$357,700	$289,400
SUBTOTAL 2		$4,471,600	$3,617,400
PRELIMINARY ENGINEERING	10%	$447,200	$361,700
CONSTRUCTION ENGINEERING	10%	$447,200	$361,700
INDIRECT COST (IDC) - CONSTRUCTION @ 10.37% OF SUBTOTAL 2 [7]	10.37%	$463,700	$375,100
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [8,9]		**$7,000,000**	**$5,700,000**
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [8,9]		**$7,600,000**	**$6,100,000**

[1] Average MDT bid prices provided for the period July 2014 to July 2015.
[2] Cost estimates are provided in 2015 dollars. All dollar amounts are rounded for planning purposes.
[3] Paved road typical section includes a top width of 12 ft, 0.4 ft of plant mix, 1.2 ft of crushed aggregate course.
[4] 2ft average cut depth is assumed.
[5] The Miscellaneous category is estimated at 15 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[7] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[8] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon.
[9] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.
[10] Right of way costs estimated from anticipated impacted area.

Option 3.a - SIGNAL CONTROLLED INTERSECTION
Planning-level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average MDT Bid Prices [1]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
STRIPING-WHITE PAINT	4	GAL	$34.31	$103.00	$1,000.00	$3,000.00
STRIPING-WHITE PLASTIC 24 IN	80	LNFT		$0.00	$110.00	$7,370.00
STRIPING-YELLOW PAINT	4	GAL	$39.70	$79.00	$1,000.00	$2,000.00
CONDUIT-PLASTIC 2 IN	400	LNFT	$8.69	$3,476.00	$10.00	$4,000.00
CONDUIT-PLASTIC 2 1/2 IN	75	LNFT	$6.76	$507.00	$7.00	$525.00
CONDUIT-PLASTIC 4 IN	75	LNFT			$25.00	$1,875.00
PULL BOX-COMPOSITE TYPE 3	5	EACH	$528.78	$2,644.00	$600.00	$3,000.00
FOUNDATION-CONCRETE	10	CUYD	$859.53	$8,595.00	$900.00	$9,000.00
CABLE-COPPER 3AWG14-600V	50	LNFT	$1.05	$53.00	$1.00	$50.00
CABLE-COPPER 7AWG14-600V	800	LNFT	$1.72	$1,376.00	$2.00	$1,600.00
CABLE-COPPER 16AWG14-600V	600	LNFT	$4.50	$2,700.00	$4.50	$2,700.00
CABLE-COPPER COAXIAL-VIDEO	600	LNFT		$0.00	$3.00	$1,800.00
CABLE-COPPER COAXIAL 50 OHM 3/8 IN	50	LNFT	$1.95	$98.00	$2.00	$100.00
CONDUCTOR-COPPER AWG6-600V	600	LNFT	$1.05	$630.00	$1.00	$600.00
CONDUCTOR-COPPER AWG8-600V	800	LNFT	$0.80	$640.00	$1.00	$800.00
CONDUCTOR-COPPER AWG10-600V	600	LNFT	$0.57	$342.00	$1.00	$600.00
PHOTO ELECTRIC CONTROL	1	EACH			$200.00	$200.00
LUMINAIRE ASSEMBLY - 400 W S.V.	4	EACH	$354.00	$1,416.00	$150.00	$600.00
CONTROLLER-CAB PEDESTAL TYPE P	1	EACH	$980.00	$980.00	$1,000.00	$1,000.00
SERV ASSEMB-60 AMP	1	EACH	$1,787.50	$1,788.00	$2,000.00	$2,000.00
SIG-TRAF 3 COL-1 WAY 12-12-12	12	EACH	$838.85	$10,066.00	$1,000.00	$12,000.00
SIG-TRAF-BACKPLATE-REFLECTIVE	12	EACH	$75.00	$900.00	$75.00	$900.00
SIG-PEDESTRIAN TYPE 2	8	EACH	$885.55	$7,084.00	$900.00	$7,200.00
CONTLR/TRAF-ACTUAT TYPE 8-A	1	EACH	$788.00	$788.00	$35,000.00	$35,000.00
SIG STANDARD TYPE 3-A-500-3	4	EACH	$1,331.25	$5,325.00	$10,000.00	$40,000.00
REMOVE AND RESET EXISTING POLE	4	EACH	$350.00	$1,400.00	$350.00	$1,400.00
REMOVE AND SALVAGE MISC ELECTRICAL	1	LS	$2,594.17	$2,594.00	$10,000.00	$10,000.00
PUSH BUTTON/PEDESTRIAN	8	EACH	$1,041.67	$8,333.00	$1,050.00	$8,400.00
YAGI ANTENNA-TYPE D	1	EACH	$1,075.00	$1,075.00	$1,075.00	$1,075.00
GE/MDS SD9 RADIO	1	EACH			$2,000.00	$2,000.00
TRAFFIC CONTROL	1	LS	$15,285.16	$15,285.00	$15,500.00	$15,500.00
SIGNS	8	EACH		$0.00	$500.00	$4,000.00
SUBTOTAL						$180,295
MISCELLANEOUS ITEMS @ 20% OF SUBTOTAL 1 [3]					20%	$36,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [4]					10%	$18,000
SUBTOTAL 2						$230,000
PRELIMINARY ENGINEERING					12%	$27,600
CONSTRUCTION ENGINEERING					10%	$23,000
INDIRECT COST (IDC) - CONSTRUCTION @ 10.37% OF SUBTOTAL 2 [5]					10.37%	$24,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [6,7]					**$370,000**	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [6,7]					**$400,000**	

[1] Average MDT bid prices provided for the period July 2014 to July 2015.
[2] Cost estimates are provided in 2015 dollars. All dollar amounts are rounded for planning purposes.
[3] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[4] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[5] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[6] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon.
[7] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

Option 3.a ONE-LANE ROUNDABOUT INTERSECTION
Planning-level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average MDT Bid Prices [1]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
EXCAVATION-UNCLASSIFIED [4]	500	CUYD	$4.69	$2,345.00	$6.00	$3,000.00
CRUSHED AGGREGATE COURSE [3]	700	CUYD	$22.12	$15,484.00	$25.00	$17,500.00
PORT CEM CONC PAVE 9 IN	2200	SQYD	$145.22	$319,484.00	$150.00	$330,000.00
COMMERCIAL MIX PG 70-28 [3]	50	TON	$103.45	$5,172.50	$125.00	$6,250.00
DECORATIVE CONCRETE	500	SQYD	$95.24	$47,620.00	$100.00	$50,000.00
CURB-CONC MEDIAN TYPE A	800	LNFT	$26.66	$21,328.00	$22.00	$17,600.00
CURB AND GUTTER-CONC	1200	LNFT	$22.16	$26,592.00	$25.00	$30,000.00
TOPSOIL	200	CUYD	$26.40	$5,280.00	$30.00	$6,000.00
SEEDING AREA NO 1	1	ACRE	$379.87	$379.87	$400.00	$400.00
CONDITION SEEDBED SURFACE	1	ACRE	$61.48	$61.48	$70.00	$70.00
LANDSCAPE ROCK	90	CUYD	$88.70	$7,983.00	$50.00	$4,500.00
SIGNS	20	EACH			$500.00	$10,000.00
CURB MARKING-YELLOW PAINT	8	GAL			$70.00	$560.00
CURB MARKING-YELLOW EPOXY	8	GAL	$240.94	$1,927.52	$250.00	$2,000.00
WORDS AND SYMBOLS-WHITE PAINT	8	GAL	$135.06	$1,080.48	$150.00	$1,200.00
WORDS AND SYMBOLS-WHITE EPOXY	8	GAL	$321.55	$2,572.40	$325.00	$2,600.00
STRIPING-WHITE PAINT	63	GAL	$24.82	$1,563.66	$30.00	$1,890.00
STRIPING-WHITE EPOXY	8	GAL	$59.54	$476.32	$60.00	$480.00
STRIPING-YELLOW PAINT	8	GAL	$25.57	$204.56	$30.00	$240.00
STRIPING-YELLOW EPOXY	8	GAL	$60.09	$480.72	$65.00	$520.00
SEPARATION GEOTEXTILE - MOD	500	SQYD	$3.31	$1,655.00	$3.00	$1,500.00
RIGHT OF WAY[10]	1.5	ACRE			$50,000.00	$75,000.00
				SUBTOTAL		$561,310
				MISCELLANEOUS ITEMS @ 20% OF SUBTOTAL 1 [5]	20%	$112,300
				MOBILIZATION @ 10% OF SUBTOTAL 1 [6]	10%	$56,100
				SUBTOTAL 2		$729,700
				PRELIMINARY ENGINEERING	12%	$87,564
				CONSTRUCTION ENGINEERING	10%	$72,970
				INDIRECT COST (IDC) - CONSTRUCTION @ 10.37% OF SUBTOTAL 2 [7]	10.37%	$76,000
				TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [8,9]	**$1,200,000**	
				TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [8,9]	**$1,300,000**	

[1] Average MDT bid prices provided for the period July 2014 to July 2015.
[2] Cost estimates are provided in 2015 dollars. All dollar amounts are rounded for planning purposes.
[3] Paved road typical section includes a top width of 40 ft, 0.4 ft of plant mix and 1.2 ft of crushed aggregate course.
[4] 2 ft average cut depth is assumed.
[5] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[7] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[8] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon.
[9] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.
[10] Right of way costs estimated from anticipated impacted area.

Option 3.a TWO-LANE ROUNDABOUT INTERSECTION
Planning-level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average MDT Bid Prices [1]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
EXCAVATION-UNCLASSIFIED [4]	500	CUYD	$4.69	$2,345.00	$6.00	$3,000.00
CRUSHED AGGREGATE COURSE [3]	700	CUYD	$22.12	$97,512.00	$25.00	$17,500.00
PORT CEM CONC PAVE 9 IN	2200	SQYD	$145.22	$685,293.00	$150.00	$330,000.00
COMMERCIAL MIX PG 70-28 [3]	100	TON	$103.45	$152,002.00	$125.00	$12,500.00
DECORATIVE CONCRETE	750	SQYD	$95.24	$89,684.00	$100.00	$75,000.00
CURB-CONC MEDIAN TYPE A	1000	LNFT	$26.66	$53,267.00	$22.00	$22,000.00
CURB AND GUTTER-CONC	1500	LNFT	$22.16	$51,367.00	$25.00	$37,500.00
TOPSOIL	250	CUYD	$26.40	$21,296.00	$30.00	$7,500.00
SEEDING AREA NO 1	1.5	ACRE	$379.87	$570.00	$400.00	$600.00
CONDITION SEEDBED SURFACE	1.5	ACRE	$61.48	$92.00	$70.00	$105.00
LANDSCAPE ROCK	90	CUYD	$88.70	$14,547.00	$50.00	$4,500.00
SIGNS	20	EACH		$0.00	$500.00	$10,000.00
CURB MARKING-YELLOW PAINT	12	GAL		$0.00	$70.00	$840.00
CURB MARKING-YELLOW EPOXY	12	GAL	$240.94	$3,614.00	$250.00	$3,000.00
WORDS AND SYMBOLS-WHITE PAINT	12	GAL	$135.06	$2,026.00	$150.00	$1,800.00
WORDS AND SYMBOLS-WHITE EPOXY	12	GAL	$321.55	$4,823.00	$325.00	$3,900.00
STRIPING-WHITE PAINT	75	GAL	$24.82	$3,103.00	$30.00	$2,250.00
STRIPING-WHITE EPOXY	12	GAL	$59.54	$7,443.00	$60.00	$720.00
STRIPING-YELLOW PAINT	12	GAL	$25.57	$2,046.00	$30.00	$360.00
STRIPING-YELLOW EPOXY	12	GAL	$60.09	$4,807.00	$65.00	$780.00
SEPARATION GEOTEXTILE - MOD	1000	SQYD	$3.31	$3,254.00	$3.00	$3,000.00
RIGHT OF WAY[10]	2	ACRE			$50,000.00	$100,000.00
				SUBTOTAL		$636,855

ADDITIONAL COSTS		
MISCELLANEOUS ITEMS @ 20% OF SUBTOTAL 1 [5]	20%	$127,400
MOBILIZATION @ 10% OF SUBTOTAL 1 [6]	10%	$63,700
SUBTOTAL 2		$828,000
PRELIMINARY ENGINEERING	12%	$99,360
CONSTRUCTION ENGINEERING	10%	$82,800
INDIRECT COST (IDC) - CONSTRUCTION @ 10.37% OF SUBTOTAL 2 [7]	10.37%	$86,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [8,9]	**$1,300,000**	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [8,9]	**$1,500,000**	

[1] Average MDT bid prices provided for the period July 2014 to July 2015.

[2] Cost estimates are provided in 2015 dollars. All dollar amounts are rounded for planning purposes.

[3] Paved road typical section includes a top width of 40 ft, 0.4 ft of plant mix and 1.2 ft of crushed aggregate course.

[4] 2 ft average cut depth is assumed.

[5] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.

[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.

[7] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.

[8] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon.

[9] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

[10] Right of way costs estimated from anticipated impacted area.

Option 3.b - INTERSECTION REALIGNMENT
Planning-level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average MDT Bid Prices [1]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
Northern Ave						
COMMERCIAL MIX-PG 70-28 [3]	1,060	TON	$104.99	$111,289.00	$105.00	$111,300.00
EMULSIFIED ASPHALT CRS-2P	1.0	TON	$579.90	$559.00	$580.00	$559.00
COVER-TYPE 1	4,107	SQYD	$0.61	$2,505.00	$1.00	$4,107.00
CRUSHED AGGREGATE COURSE [3]	1,369	CUYD	$22.12	$30,280.00	$25.00	$34,222.00
ROADWAY OBLITERATION	20.0	STA	$858.58	$17,172.00	$860.00	$17,200.00
EXCAVATION - UNCLASSIFIED [4]	2,738	CUYD	$4.69	$12,840.00	$5.00	$13,689.00
RIGHT OF WAY [10]	2.4	ACRE			$50,000.00	$121,212.00
				SUBTOTAL		$302,289
LOCATION	**LENGTH (MILE)**					
Northern Ave	0.25				$303,000	
ADDITIONAL COSTS						
MISCELLANEOUS ITEMS @ 20% OF SUBTOTAL 1 [5]					20%	$61,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [6]					10%	$30,000
SUBTOTAL 2						$390,000
PRELIMINARY ENGINEERING					12%	$46,800
CONSTRUCTION ENGINEERING					10%	$39,000
INDIRECT COST (IDC) - CONSTRUCTION @ 10.37% OF SUBTOTAL 2 [7]					10.37%	$40,000
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [8,9]					**$670,000**	
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [8,9]					**$770,000**	

[1] Average MDT bid prices provided for the period July 2014 to July 2015.
[2] Cost estimates are provided in 2015 dollars. All dollar amounts are rounded for planning purposes.
[3] Paved road typical section includes a top width of 40 ft, 0.4 ft of plant mix, 1.2 ft of crushed aggregate course.
[4] 2ft average cut depth is assumed.
[5] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[7] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[8] A contingency range of 30 to 50 percent was used due to the high degree of unknown factors over the planning horizon.
[9] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.
[10] Right of way costs estimated from anticipated impacted area.

Option 3.c - INTERSECTION TURN LANES
Planning-level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average MDT Bid Prices [1] Unit Price Dollars	Average MDT Bid Prices [1] Amount Dollars	Adjusted Unit Prices Unit Price Dollars	Adjusted Unit Prices Amount [2] Dollars
COMMERCIAL MIX-PG 70-28[3]	1690	TON	$31.12	$52,593.00	$35.00	$59,150.00
EMULSIFIED ASPHALT CRS-2P	1.5	TON	$579.90	$891.00	$580.00	$891.00
COVER-TYPE 1	6015	SQYD	$0.61	$3,669.00	$1.00	$6,015.00
CRUSHED AGGREGATE COURSE [3]	2632	CUYD	$22.12	$58,230.00	$25.00	$65,811.00
EXCAVATION - UNCLASSIFIED [4]	4387	CUYD	$4.69	$20,577.00	$5.00	$21,937.00
ROADWAY OBLITERATION	9.0	STA	$858.58	$7,727.00	$860.00	$7,740.00
RIGHT OF WAY[10]	2.3	ACRE			$50,000.00	$117,137.00
TURN LANE SUBTOTAL						$278,681
MISCELLANEOUS ITEMS @ 15% OF SUBTOTAL 1 [5]					15%	$41,800
MOBILIZATION @ 10% OF SUBTOTAL 1 [6]					10%	$27,900
SUBTOTAL 2						$348,400
PRELIMINARY ENGINEERING					10%	$34,800
CONSTRUCTION ENGINEERING					10%	$34,800
INDIRECT COST (IDC) - CONSTRUCTION @ 10.37% OF SUBTOTAL 2 [7]					10.37%	$36,100
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [8,9]					**$540,000**	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [8,9]					**$590,000**	

[1] Average MDT bid prices provided for the period July 2014 to July 2015.
[2] Cost estimates are provided in 2015 dollars. All dollar amounts are rounded for planning purposes.
[3] Paved road typical section includes a top width of 12 ft, 0.4 ft of plant mix, 1.2 ft of crushed aggregate course.
[4] 2ft average cut depth is assumed.
[5] The Miscellaneous category is estimated at 15 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[7] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[8] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon.
[9] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.
[10] Right of way costs estimated from anticipated impacted area.

DOWL

Option 3.d - OVERHEAD LIGHTING
Planning-level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average MDT Bid Prices [1]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
CONDUIT-PLASTIC 2 IN	1,500	LNFT	$8.69	$13,035.00	$10.00	$15,000.00
CONDUIT-PLASTIC 2 1/2 IN	50	LNFT	$6.76	$338.00	$7.00	$350.00
CONDUIT-PLASTIC 4 IN	50	LNFT			$25.00	$1,250.00
PULL BOX-COMPOSITE TYPE 3	4	EACH	$528.78	$2,115.00	$600.00	$2,400.00
FOUNDATION-CONCRETE	20	CUYD	$859.53	$17,191.00	$900.00	$18,000.00
CABLE-COPPER 3AWG14-600V	500	LNFT	$1.05	$525.00	$1.00	$500.00
CONDUCTOR-COPPER AWG6-600V	2,500	LNFT	$1.05	$2,625.00	$1.00	$2,500.00
PHOTO ELECTRIC CONTROL	1	EACH			$200.00	$200.00
LUMINAIRE ASSEMBLY-250 W S.V.	12	EACH	$351.23	$4,215.00	$400.00	$4,800.00
ENCLOSURE - NEMA TYPE 3R	1	2457	$2,457.00	$2,457.00	$5,000.00	$5,000.00
SERV ASSEMB-60 AMP	1	EACH	$1,787.50	$1,788.00	$2,000.00	$2,000.00
STANDARD-STL TYPE 10-A-500-6	12	EACH	$2,311.17	$27,734.00	$3,500.00	$42,000.00
TRAFFIC CONTROL	1	LS	$15,285.16	$15,285.00	$15,500.00	$15,500.00
SUBTOTAL						$109,500
MISCELLANEOUS ITEMS @ 20% OF SUBTOTAL 1 [3]					20%	$22,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [4]					10%	$11,000
SUBTOTAL 2						$140,000
PRELIMINARY ENGINEERING					12%	$16,800
CONSTRUCTION ENGINEERING					10%	$14,000
INDIRECT COST (IDC) - CONSTRUCTION @ 10.37% OF SUBTOTAL 2 [5]					10.37%	$15,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [6,7]					**$220,000**	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [6,7]					**$250,000**	

[1] Average MDT bid prices provided for the period July 2014 to July 2015.
[2] Cost estimates are provided in 2015 dollars. All dollar amounts are rounded for planning purposes.
[3] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[4] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[5] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[6] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon.
[7] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

DOWL

Option 4 - PAVEMENT PRESERVATION
Planning-Level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average MDT Bid Prices [1]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
HIGHWAY 312 RP 0.0 TO 2.3						
PLANT MIX SURF GR S-3/4 IN[3]	11,440	TON	$31.12	$356,013.00	$35.00	$400,400.00
ASPHALT CEMENT PG 70-28	620	TON	$670.09	$415,456.00	$700.00	$434,000.00
EMULSIFIED ASPHALT CRS-2P	10.4	TON	$579.90	$6,031.00	$580.00	$6,032.00
COVER-TYPE 1	89,056	SQYD	$0.61	$54,324.00	$1.00	$89,056.00
				HIGHWAY 312 RP 0.0 TO 2.3 SUBTOTAL		$929,488
SECONDARY 568 - RP 0.0 TO 1.0						
COMMERCIAL MIX-PG 70-28[3]	2,110	TON	$104.99	$221,529.00	$105.00	$221,550.00
EMULSIFIED ASPHALT CRS-2P	1.9	TON	$579.90	$1,112.00	$580.00	$1,113.00
COVER-TYPE 1	16,427	SQYD	$0.61	$10,020.00	$1.00	$16,427.00
				SECONDARY 568 - RP 0.0 to 1.0 SUBTOTAL		$239,090
SECONDARY 522 - RP 0.0 TO 3.0						
PLANT MIX SURF GR S-3/4 IN[3]	9,050	TON	$31.12	$281,636.00	$35.00	$316,750.00
ASPHALT CEMENT PG 70-28	490	TON	$670.09	$328,344.00	$700.00	$343,000.00
EMULSIFIED ASPHALT CRS-2P	8.2	TON	$579.90	$4,771.00	$580.00	$4,772.00
COVER-TYPE 1	70,400	SQYD	$0.61	$42,944.00	$1.00	$70,400.00
				SECONDARY 568 - RP 0.0 to 1.0 SUBTOTAL		$734,922

CATEGORY	LENGTH (MILE)
HIGHWAY 312 RP 0.0 TO 2.3	2.3
SECONDARY 568 - RP 0.0 to 1.0	1.0
SECONDARY 522 - RP 0.0 to 3.0	3.0

		HWY 312	S-568	S-522
SUBTOTAL 1		$929,000	$239,000	$735,000
MISCELLANEOUS ITEMS @15 % OF SUBTOTAL 1 [4]	15%	$140,000	$36,000	$111,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [5]	10%	$93,000	$24,000	$74,000
SUBTOTAL 2		$1,162,000	$299,000	$920,000
PRELIMINARY ENGINEERING	10%	$116,200	$29,900	$92,000
CONSTRUCTION ENGINEERING	10%	$116,200	$29,900	$92,000
INDIRECT COST (IDC) - CONSTRUCTION @ 10.37% OF SUBTOTAL 2 [6]	10.37%	$120,499	$31,006	$95,404
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [7,8]		**$1,800,000**	**$470,000**	**$1,400,000**
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [7,8]		**$2,000,000**	**$510,000**	**$1,600,000**

[1] Average MDT bid prices provided for the period July 2014 to July 2015.
[2] Cost estimates are provided in 2015 dollars. All dollar amounts are rounded for planning purposes.
[3] Paved road typical section includes a 0.2 ft overlay
[4] The Miscellaneous category is estimated at 15 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[5] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[6] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[7] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon.
[8] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

Option 6 - PEDESTRIAN/BICYCLE IMPROVEMENTS
Planning-level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average MDT Bid Prices [1] Unit Price Dollars	Average MDT Bid Prices [1] Amount Dollars	Adjusted Unit Prices Unit Price Dollars	Adjusted Unit Prices Amount [2] Dollars
Secondary 522 - Huntley						
EXCAVATION-UNCLASSIFIED [3]	63	CUYD	$4.69	$295.00	$5.00	$315.00
SIDEWALK-CONCRETE 4 IN	189	SQYD	$63.99	$12,087.00	$70.00	$13,222.00
SIDEWALK-CONCRETE 6 IN	56	SQYD	$70.28	$3,904.00	$75.00	$4,167.00
COMMERCIAL MIX-PG 58-28	129	TON	$140.30	$18,029.00	$150.00	$19,275.00
REMOVE SIDEWALK	19	SQYD		$0.00	$10.00	$189.00
DETEC WARNING DEVICES-TYPE 1	90	SQYD	$289.14	$26,023.00	$300.00	$27,000.00
CURB AND GUTTER-CONC	340	LNFT	$22.16	$7,534.00	$25.00	$8,500.00
REMOVE CURB AND GUTTER	68	LNFT		$0.00	$12.00	$816.00
TRAFFIC CONTROL	1	LS	$15,285.16	$15,285.00	$20,000.00	$20,000.00
CURB MARKING-YELLOW EPOXY	5	GAL	$240.94	$1,205.00	$150.00	$750.00
RIGHT OF WAY [9]	0.1	ACRE		$0.00	$100,000.00	$10,000.00
				SUBTOTAL		$104,234
Worden - 312/Main Street Crossing						
EXCAVATION-UNCLASSIFIED [3]	26	CUYD	$4.69	$122.00	$5.00	$130.00
SIDEWALK-CONCRETE 4 IN	78	SQYD	$63.99	$4,977.00	$70.00	$5,444.00
SIDEWALK-CONCRETE 6 IN	11	SQYD	$70.28	$781.00	$75.00	$833.00
COMMERCIAL MIX-PG 58-28	26	TON	$140.30	$3,606.00	$150.00	$3,855.00
REMOVE SIDEWALK	8	SQYD		$0.00	$10.00	$78.00
DETEC WARNING DEVICES-TYPE 1	10	SQYD	$289.14	$2,891.00	$300.00	$3,000.00
CURB AND GUTTER-CONC	200	LNFT	$22.16	$4,432.00	$25.00	$5,000.00
REMOVE CURB AND GUTTER	20	LNFT		$0.00	$12.00	$240.00
TRAFFIC CONTROL	1	LS	$15,285.16	$15,285.00	$20,000.00	$20,000.00
CURB MARKING-YELLOW EPOXY	5	GAL	$240.94	$1,205.00	$150.00	$750.00
RR CROSSING TREATMENT [10]	1	LSUM			$100,000.00	$100,000.00
RIGHT OF WAY [9]	0.1	ACRE		$0.00	$100,000.00	$10,000.00
				SUBTOTAL		$149,330
					S-522 Huntley	**Worden Xing**
MISCELLANEOUS ITEMS @ 15% OF SUBTOTAL 1 [4]				15%	$15,600	$22,400
MOBILIZATION @ 10% OF SUBTOTAL 1 [5]				10%	$10,400	$14,900
SUBTOTAL 2					$130,200	$186,600
PRELIMINARY ENGINEERING				10%	$13,000	$18,700
CONSTRUCTION ENGINEERING				10%	$13,000	$18,700
INDIRECT COST (IDC) - CONSTRUCTION @ 10.37% OF SUBTOTAL 2 [6]				10.37%	$13,500	$19,400
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [7, 8]					**$200,000**	**$290,000**
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [7, 8]					**$220,000**	**$320,000**

[1] Average MDT bid prices provided for the period July 2014 to July 2015.
[2] Cost estimates are provided in 2015 dollars. All dollar amounts are rounded for planning purposes.
[3] Assume an excavation depth of 1 ft under sidewalk locations.
[4] The Miscellaneous category is estimated at 15 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion erosion measures and public relations.
[5] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[6] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[7] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon.
[8] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.
[9] Right of way costs estimated from anticipated impacted
[10] The pedestrian crossing item includes modifications and additions to the crossing arms, and additional length of traversable pads at the tracks.

DOWL

Option 7.c - SHOULDER/CENTERLINE RUMBLE STRIPS
Planning-level Estimate of Costs

Item Description	Approx. Quantity	Unit	Unit Price [1]	Amount [2]
			Dollars	Dollars
HIGHWAY 312 - RP 4.0 TO 15.0				
SHOULDER RUMBLE STRIP	11.0	MILE	$1,600.00	$17,600.00
CENTERLINE RUMBLE STRIP	11.0	MILE	$2,700.00	$29,700.00
HIGHWAY 312 - RP 4.0 TO 15.0 SUBTOTAL				$47,300
SECONDARY 568 - RP 0.0 TO 1.0				
SHOULDER RUMBLE STRIP	1.0	MILE	$1,600.00	$1,600.00
CENTERLINE RUMBLE STRIP	1.0	MILE	$2,700.00	$2,700.00
SECONDARY 568 - RP 0.0 to 1.0 SUBTOTAL				$4,300
SECONDARY 522 - RP 0.0 TO 2.0				
SHOULDER RUMBLE STRIP	2.0	MILE	$1,600.00	$3,200.00
CENTERLINE RUMBLE STRIP	2.0	MILE	$2,700.00	$5,400.00
SECONDARY 522 - RP 0.0 to 2.0 SUBTOTAL				$8,600
		HWY 312	**S-568**	**S-522**
SUBTOTAL 1		$47,000	$4,300	$8,600
MISCELLANEOUS ITEMS @ 5 % OF SUBTOTAL 1 [3]	5%	$2,350	$215	$430
MOBILIZATION @ 10% OF SUBTOTAL 1 [4]	10%	$4,700	$430	$860
SUBTOTAL 2		$54,050	$4,945	$9,890
PRELIMINARY ENGINEERING	10%	$5,405	$495	$989
CONSTRUCTION ENGINEERING	10%	$5,405	$495	$989
INDIRECT COST (IDC) - CONSTRUCTION @ 10.37% OF SUBTOTAL 2 [5]	10.37%	$5,605	$513	$1,026
TOTAL IMPROVEMENT OPTION COST @ 10% CONTINGENCY [6,7]		**$77,500**	**$7,100**	**$14,200**
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [6,7]		**$84,600**	**$7,800**	**$15,500**

[1] Average MDT bid prices provided by MDT Traffic Safety Bureau.
[2] Cost estimates are provided in 2015 dollars. All dollar amounts are rounded for planning purposes.
[3] The Miscellaneous category is estimated at 5 percent due to unknown factors including but not limited to surface preparation, traffic control, temporary water pollution erosion control measures and public relations.
[4] The Mobilization category includes all costs incurred in assembling and transporting equipment and materials to the work site.
[5] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[6] A contingency range of 10 to 20 percent was used due to the unknown factors over the planning horizon.
[7] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

Option 8 - BRIDGE IMPROVEMENTS
Planning-level Estimate of Costs

		Highway 312				S-522
		Seven Mile Creek (RP 2.70)	Twelve Mile Creek (RP 6.57)	Yellowstone River (RP 8.78)	Custer Coulee (RP 12.15)	Huntley Canal (RP 0.36)
BRIDGE DECK WIDTH (FT) [1]		24	26	24	24	40
BRIDGE DECK LENGTH (FT) [1]		25	102	1,022	27	72
BRIDGE DECK AREA (SF)		600	2,652	24,528	648	2,880
BRIDGE COST ESTIMATE (SF) [2]		$50.00	$50.00	$65.00	$50.00	$50.00
BRIDGE IMPROVEMENTS COST SUBTOTAL		$30,000	$132,600	$1,594,320	$32,400	$144,000
MISCELLANEOUS ITEMS SUBTOTAL [3]	**15%**	$4,500	$19,900	$239,100	$4,900	$21,600
MOBILIZATION @ 10% OF SUBTOTAL [4]	**10%**	$3,000	$13,300	$159,400	$3,200	$14,400
SUBTOTAL 2		**$37,500**	**$165,800**	**$1,992,820**	**$40,500**	**$180,000**
PRELIMINARY ENGINEERING	**12%**	$4,500	$19,900	$239,100	$4,900	$21,600
CONSTRUCTION ENGINEERING	**10%**	$3,800	$16,600	$199,300	$4,100	$18,000
INDIRECT COST (IDC) - CONSTRUCTION @ 10.37% OF SUBTOTAL 2 [5]	**10.37%**	$3,900	$17,200	$206,700	$4,200	$18,700
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [6,7]	**20%**	**$60,000**	**$260,000**	**$3,200,000**	**$60,000**	**$290,000**
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [6,7]	**30%**	**$65,000**	**$290,000**	**$3,400,000**	**$70,000**	**$310,000**

[1] Existing bridge width and lengths are from a Bridge Inspection Report Summary provided by the MDT Bridge Bureau.

[2] Unit costs identified in coordination with MDT Bridge Bureau.

[3] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.

[4] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.

[5] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.

[6] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon.

[7] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

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Combined Option - Segment 2
Planning-level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average MDT Bid Prices [1]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
HIGHWAY 312						
SEGMENT 2 - RP 2.1 TO 5.6	**LENGTH (MILE)**	**3.49**				
ROADWAY OBLITERATION	184.3	STA	$858.58	$158,236.00	$860.00	$158,498.00
PLANT MIX SURF GR S-3/4 IN [3]	41,040	TON	$31.12	$1,277,165.00	$35.00	$1,436,400.00
ASPHALT CEMENT PG 70-28	2,100	TON	$670.09	$1,407,189.00	$700.00	$1,470,000.00
EMULSIFIED ASPHALT CRS-2P	37.3	TON	$579.90	$21,636.00	$580.00	$21,639.00
COVER-TYPE 1	159,702	SQYD	$0.61	$97,418.00	$1.00	$159,702.00
CRUSHED AGGREGATE COURSE [3]	63,881	CUYD	$22.12	$1,413,047.00	$25.00	$1,597,024.00
EXCAVATION - UNCLASSIFIED [4]	106,468	CUYD	$4.69	$499,336.00	$5.00	$532,341.00
SEVEN MILE CREEK BRIDGE REPLACEMENT	2,050	SQFT			$125.00	$256,250.00
SEVEN MILE CREEK BRIDGE REMOVAL	1	LS			$20,000.00	$20,000.00
RIGHT OF WAY[10]	12.7	ACRE			$50,000.00	$634,545.00
RUMBLE STRIPS	3.5	MILE			$4,300.00	$15,007.00
HOSKINS RD INTERSECTION (SIGNAL)	1	LS			$181,000.00	$181,000.00
OVERHEAD LIGHTING	1	LS			$110,000.00	$110,000.00
SEGMENT 2 SUBTOTAL						$6,592,406
MISCELLANEOUS ITEMS @ 15% OF SUBTOTAL 1 [5]					15%	$988,900
MOBILIZATION @ 10% OF SUBTOTAL 1 [6]					10%	$659,200
SUBTOTAL 2						$8,240,500
PRELIMINARY ENGINEERING					10%	$824,100
CONSTRUCTION ENGINEERING					10%	$824,100
INDIRECT COST (IDC) - CONSTRUCTION @ 10.37% OF SUBTOTAL 2 [7]					10.37%	$854,500
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [8,9]					**$12,900,000**	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [8,9]					**$14,000,000**	

[1] Average MDT bid prices provided for the period July 2014 to July 2015.

[2] Cost estimates are provided in 2015 dollars. All dollar amounts are rounded for planning purposes.

[3] Paved road typical section includes a top width of 12 ft, 0.4 ft of plant mix, 1.2 ft of crushed aggregate course.

[4] 2ft average cut depth is assumed.

[5] The Miscellaneous category is estimated at 15 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.

[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.

[7] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.

[8] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon.

[9] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

[10] Right of way costs estimated from anticipated impacted area.

Combined Option - Segment 3
Planning-level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average MDT Bid Prices [1]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
HIGHWAY 312						
SEGMENT 3 - RP 5.6 TO 7.4	**LENGTH (MILE)**	**2.00**				
ROADWAY OBLITERATION	105.6	STA	$858.58	$90,666.05	$860.00	$90,816.00
PLANT MIX SURF GR S-3/4 IN[3]	23,520	TON	$31.12	$731,942.00	$35.00	$823,200.00
ASPHALT CEMENT PG 70-28	1,240	TON	$670.09	$830,912.00	$700.00	$868,000.00
EMULSIFIED ASPHALT CRS-2P	21.4	TON	$579.90	$12,399.00	$580.00	$12,401.00
COVER-TYPE 1	91,520	SQYD	$0.61	$55,827.00	$1.00	$91,520.00
CRUSHED AGGREGATE COURSE [3]	36,608	CUYD	$22.12	$809,769.00	$25.00	$915,200.00
EXCAVATION - UNCLASSIFIED [4]	61,013	CUYD	$4.69	$286,153.00	$5.00	$305,067.00
TWELVE MILE CREEK BRIDGE REPLACEMENT	8,364	SQFT			$125.00	$1,045,500.00
TWELVE MILE CREEK BRIDGE REMOVAL	1	LS			$30,000.00	$30,000.00
RIGHT OF WAY[10]	7.3	ACRE			$50,000.00	$363,636.00
RUMBLE STRIPS	2	MILE			$4,300.00	$8,600.00
HOSKINS RD INTERSECTION (SIGNAL)	1	LS				$181,000.00
SHEPHERD RD INTERSECTION (2-LN RNDBT)	1	LS				$637,000.00
OVERHEAD LIGHTING	1	LS				$110,000.00
				SEGMENT 3 SUBTOTAL		$5,481,940
				MISCELLANEOUS ITEMS @ 15% OF SUBTOTAL 1 [5]	15%	$822,300
				MOBILIZATION @ 10% OF SUBTOTAL 1 [6]	10%	$548,200
				SUBTOTAL 2		$6,852,400
				PRELIMINARY ENGINEERING	10%	$685,200
				CONSTRUCTION ENGINEERING	10%	$685,200
				INDIRECT COST (IDC) - CONSTRUCTION @ 10.37% OF SUBTOTAL 2 [7]	10.37%	$710,600
				TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [8,9]	**$10,700,000**	
				TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [8,9]	**$11,600,000**	

[1] Average MDT bid prices provided for the period July 2014 to July 2015.

[2] Cost estimates are provided in 2015 dollars. All dollar amounts are rounded for planning purposes.

[3] Paved road typical section includes a top width of 12 ft, 0.4 ft of plant mix, 1.2 ft of crushed aggregate course.

[4] 2ft average cut depth is assumed.

[5] The Miscellaneous category is estimated at 15 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.

[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.

[7] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.

[8] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon.

[9] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

[10] Right of way costs estimated from anticipated impacted area.

DOWL

Combined Option - Secondary 522
Planning-level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average MDT Bid Prices [1]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
SECONDARY 522						
RP 0.0 TO 3.0	**LENGTH (MILE)**	**3.00**				
ROADWAY OBLITERATION	158.4	STA	$858.58	$135,999.07	$860.00	$136,224.00
PLANT MIX SURF GR S-3/4 IN[3]	35280	TON	$31.12	$1,097,914.00	$35.00	$1,234,800.00
ASPHALT CEMENT PG 70-28	1905	TON	$670.09	$1,276,602.00	$700.00	$1,333,584.00
EMULSIFIED ASPHALT CRS-2P	32	TON	$579.90	$18,599.00	$580.00	$18,602.00
COVER-TYPE 1	137280	SQYD	$0.61	$83,741.00	$1.00	$137,280.00
CRUSHED AGGREGATE COURSE [3]	54912	CUYD	$22.12	$1,214,653.00	$25.00	$1,372,800.00
EXCAVATION - UNCLASSIFIED [4]	91520	CUYD	$4.69	$429,229.00	$5.00	$457,600.00
SIDEWALK-CONCRETE 4 IN	189	SQYD	$63.99	$12,087.00	$70.00	$13,222.00
SIDEWALK-CONCRETE 6 IN	56	SQYD	$70.28	$3,904.00	$75.00	$4,167.00
DETEC WARNING DEVICES TYPE 1	90	SQYD	$289.14	$26,023.00	$300.00	$27,000.00
CURB AND GUTTER-CONC	340	LNFT	$22.16	$7,534.00	$25.00	$8,500.00
CURB MARKING-YELLOW EPOXY	5	GAL	$240.94	$1,205.00	$250.00	$1,250.00
REMOVE SIDEWALK	18.9	SQYD			$10.00	$189.00
REMOVE CURB AND GUTTER	68	LNFT			$12.00	$816.00
HUNTLEY CANAL BRIDGE REPLACEMENT	5904	SQFT			$125.00	$738,000.00
HUNTLEY CANAL BRIDGE REMOVAL	1	LS			$30,000.00	$30,000.00
RIGHT OF WAY[10]	10.9	ACRE			$50,000.00	$545,455.00
RUMBLE STRIPS	2.5	MILE			$4,300.00	$10,750.00
BARKEMEYER PARK DRAINAGE IMPROVEMENT	1	LS				$1,000.00
OVERHEAD LIGHTING	1	LS				$110,000.00
				SEGMENT 3 SUBTOTAL		$6,181,239
				MISCELLANEOUS ITEMS @ 15% OF SUBTOTAL 1 [5]	15%	$927,200
				MOBILIZATION @ 10% OF SUBTOTAL 1 [6]	10%	$618,100
				SUBTOTAL 2		$7,726,500
				PRELIMINARY ENGINEERING	10%	$772,700
				CONSTRUCTION ENGINEERING	10%	$772,700
				INDIRECT COST (IDC) - CONSTRUCTION @ 10.37% OF SUBTOTAL 2 [7]	10.37%	$801,200
				TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [8,9]	**$12,100,000**	
				TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [8,9]	**$13,100,000**	

[1] Average MDT bid prices provided for the period July 2014 to July 2015.

[2] Cost estimates are provided in 2015 dollars. All dollar amounts are rounded for planning purposes.

[3] Paved road typical section includes a top width of 12 ft, 0.4 ft of plant mix, 1.2 ft of crushed aggregate course.

[4] 2ft average cut depth is assumed.

[5] The Miscellaneous category is estimated at 15 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.

[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.

[7] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.

[8] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon.

[9] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning-level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

[10] Right of way costs estimated from anticipated impacted area.