CUSTER AVENUE—HELENA

Preliminary Traffic Engineering Report

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TABLE OF CONTENTS

List of Tables

List of Figures

Technical Appendix

Preliminary Traffic Engineering Report

1.0. INTRODUCTION

Custer Avenue is located along the northern part of Helena's city limits. Recent development, coupled with construction of the Custer Avenue Interchange in 2012 (exit 194), have resulted in increased traffic demands and deteriorating travel conditions. The area is expected to continue to grow in the future due to anticipated development activities and continued local area growth. Traffic along portions of the corridor are at, or near, capacity levels resulting in congestion issues and vehicle delay. If remained unchanged, vehicle delay, congestion, and safety issues are likely to increase in the future.

The *Greater Helena Area Long Range Transportation Plan – 2014 Update* (LRTP) identified Custer Avenue between Montana Avenue and Green Meadow Drive as recommended major street network project. The recommendation involved widening the corridor to a five-lane urban arterial and recommended including on-street bicycle lanes in addition to the already existing shared use path. A corridor study was also completed for Custer Avenue and Henderson Street in 2005 by master's degree candidates affiliated with George Mason University. The study recognized the potential for traffic volumes on Custer Avenue to continue to grow and ultimately recommended that the corridor be reconstructed to increase capacity.

It is the intent of this *Preliminary Traffic Engineering Report* to identify and evaluate feasible improvement options to improve traffic operations and safety for the study corridor. Included in this report is an assessment of existing conditions, projection of future conditions, safety review, and evaluation of intersection and corridor improvement options. Recommendations made in this report will be vetted through the public involvement process and refined through the remainder of the project development process.

1.1. Study Area

Custer Avenue is an east/west route and begins at Henderson Street to the west (reference post [RP] 0.00) and ends at York Road to the east (RP 3.07). For the purposes of this report, the study area is broken into two areas: the project area, and the evaluation area. The project area includes the portion of Custer Avenue under evaluation for improvements. This area extends from Henderson Street to North Montana Avenue (RP 1.59). The evaluation area includes a larger area to evaluate the affects improvement options may have on corridor traffic conditions. The evaluation area extends east from North Montana Avenue to include the Custer Avenue Interchange and surrounding major intersections. The extended area is included for informational purposes only and was not evaluated for improvements.

The land use adjacent to Custer Avenue consists of a mixture of commercial, residential, and park lands. Capital High School is situated on the south side of the roadway between Henderson Street and Green Meadow/Valley Drive. Four Georgians Elementary School is located on the south side of Custer Avenue between Cooney Drive and McHugh Lane. Bill Roberts Golf Course is the primary land parcel on the south side of Custer Avenue between Benton Avenue and McHugh Lane. The Lewis and Clark County Fairgrounds is accessed along the north and west approaches at the intersection with Henderson Street. A map of the study area, which designates the project and evaluation areas, is shown in **Figure 1.1**.

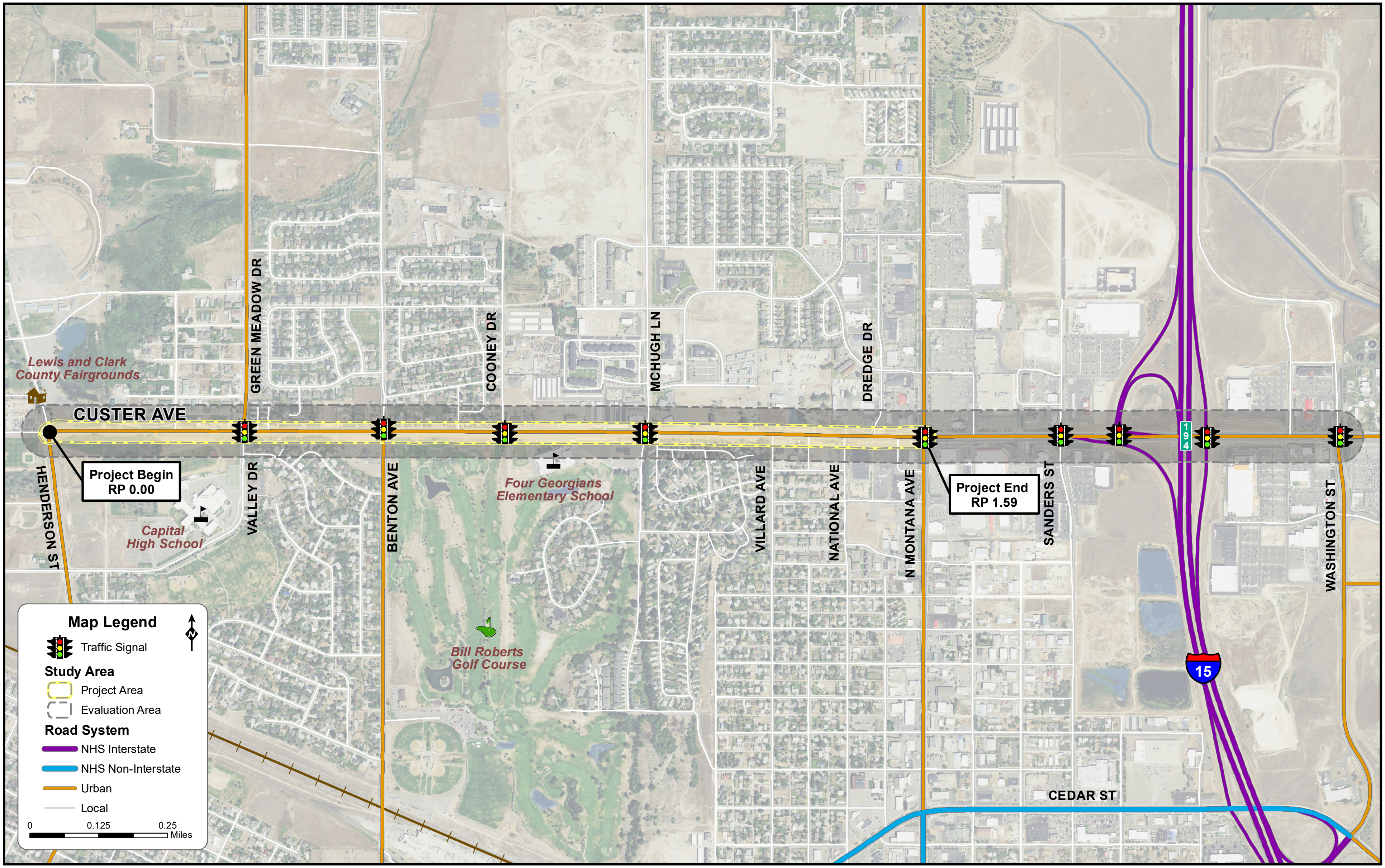


Figure 1.1: Study Area

2.0. EXISTING CONDITIONS

Custer Avenue was originally built as a two-lane roadway in 1955 on the northern edge of the Helena City Limits. In 2010, the roadway was reconstructed and widened between Green Meadow Drive and National Avenue as part of the American Recovery and Reinvestment Act (ARRA). A new interchange was built in 2012 to connect Custer Avenue to Interstate 15 (I-15). As part of the interchange project, Custer Avenue was reconstructed between Montana Avenue and Washington Street. Today, Custer Avenue is a highly trafficked corridor and is used as a major east/west route across the northern part of Helena City Limits. The following sections provide a detailed analysis of the existing conditions for the study corridor. A summary of existing traffic volumes and operations are shown in **Figure 2.1**.

2.1. Physical Features

Custer Avenue is an urban route (U-5802) and is functionally classified as minor arterial. The typical section for Custer Avenue varies through the study area. Between Henderson Street and Green Meadow Drive, Custer Avenue has one lane in each direction, narrow shoulders, and drainage ditches on either side. The roadway was reconstructed in 2010 between Green Meadow Drive and National Avenue to include a center two-way left-turn lane (TWLTL), widened shoulders, and turn lanes at major intersections. The roadway transitions to include curb, gutter, and sidewalks on both sides of the roadway at National Avenue. A second eastbound lane is also provided east of National Avenue. Custer Avenue was reconstructed with the Custer Avenue interchange project to include two travel lanes in each direction, center raised median, on-street bike lanes, and sidewalks on both sides of the roadway between Montana Avenue and Washington Street. The speed limit of Custer Avenue is 40 miles per hour (mph), with a special school speed zone between Cooney Drive and McHugh Lane where the speed limit is normally 35 mph with a reduction to 25 mph during school hours.

There are seven major intersections within the project area. Five of the intersections (Green Meadow Drive, Benton Avenue, Cooney Drive, McHugh Lane, and Montana Avenue) are signalized. The major intersections with Henderson Street and with Villard Avenue have stop control on the minor legs. The signalized intersections with Sanders Street, the I-15 Interchange Ramps, and Washington Street are included within the evaluation area but are outside of the project area.

A shared-use path parallels the south side of the roadway from Henderson Street to National Avenue. The shared-use path accommodates pedestrians and bicyclists. On the north side of the roadway, there are no sidewalks west of McHugh Lane. Sidewalks are provided intermittently on the north side of the roadway between McHugh Lane and National Avenue. There are sidewalks on both sides of the roadway east of National Avenue. Crosswalks are typically provided at the major intersections, however, many lack curb ramps and facilities that meet current standards. Crosswalks are not provided along the following legs of the major intersections: the east leg of Custer Avenue at Henderson Street; the north leg of Benton Avenue; the east leg of Custer Avenue and north leg of Cooney Drive; and the east and west legs of Custer Avenue at Villard and the I-15 Interchange Ramps. More discussion about non-motorized traffic is provided in **Section 2.2.2**.

2.2. Data Collection

In order to supplement existing information, a detailed traffic data collection effort was conducted in October 2017. The data collection effort consisted of intersection turning movement counts, field observations, vehicle classification counts, and travel times. Intersection turning movement counts were collected at the seven major intersections within the project area. Twenty-four-hour counts were performed at the intersections with Montana Avenue, McHugh Lane, and Green Meadows Drive. For the remaining intersections, count data were collected for the 12-hour period between 7:00 AM and 7:00 PM. Vehicle classification data were also collected with the turning movement counts. The data were then used to establish base traffic conditions and to develop a microsimulation model of the corridor. To ensure that all network effects are accounted for, data were also collected at four intersections to the east of the study corridor within the evaluation area: Sanders Street, I-15 SB Ramps, I-15 NB Ramps, and Washington Street. Detailed traffic data collected for the study area is included in **Appendix A**.

2.2.1. Roadway Traffic Volumes

MDT's Data and Statistics Bureau provided Average Annual Daily Traffic (AADT) counts for the study area. The counts are typically conducted annually and adjusted to represent average daily traffic conditions. Historic counts were also available at these locations and were used to evaluate historic growth trends (see **Section 3** for more detail). The existing AADT and percentage of commercial trucks at locations within the study area are shown in **Table 2.1**.

Table 2.1: Existing Average Annual Daily Traffic

Site ID	Location on Custer Ave	2017 AADT	Commercial Trucks
Project Area			
25-7C-025	East of Henderson St	8,672	2%
25-7C-026	Between Green Meadow Dr and Benton Ave	10,622	2%
25-7C-027	Between Cooney Dr and McHugh Ln	16,310	2%
25-7C-028	West of Montana Ave	17,778	3%
Evaluation Area			
25-7C-029	East of Montana Ave	23,384	3%
25-7C-030	Between Frontage Rd and Washington St	18,366	3%

2.2.2. Turning Movement Counts

Turning movement count data were evaluated to define peaks in traffic volumes during the 12-hour collection period. The number of vehicles traveling through each intersection was summed for 15-minute intervals throughout the 12-hour collection period. **Figure 2.1** shows the result of this exercise. As can be seen in the figure, there are distinct peaks that align with morning commute times, school release times, and evening commute times. It is common to assess the functionality of an intersection or corridor during the peak hour, or the time when the most traffic is present. Based on the traffic volumes and corridor conditions, it was determined that traffic operations would be evaluated during three peak hours; AM (7:30 AM – 8:30 AM); School (3:00 PM to 4:00 PM); and PM (4:45 PM – 5:45 PM).

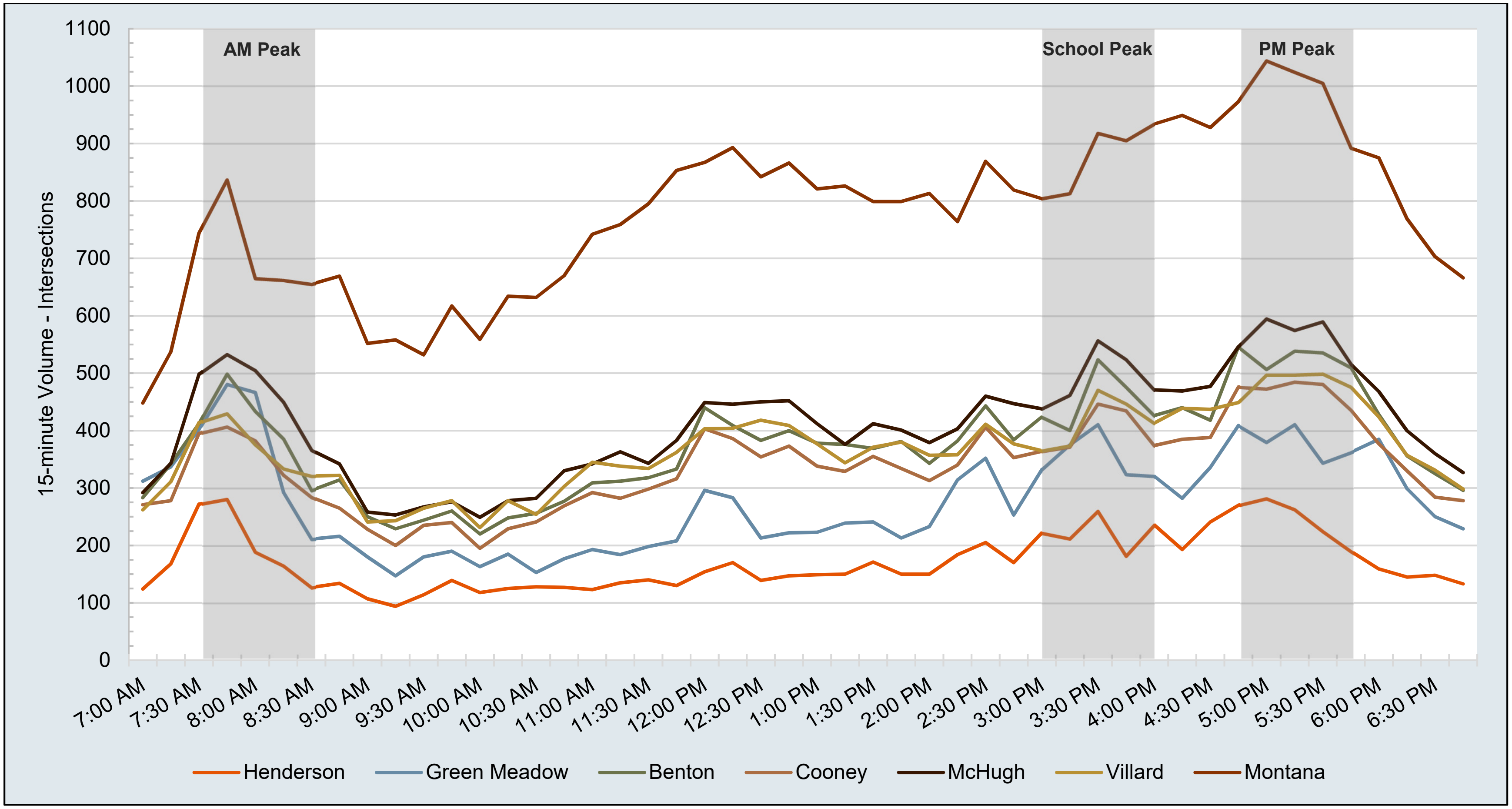


Figure 2.1: Traffic Volumes and Peaks

2.2.3. Non-Motorized Activity

Pedestrian and bicycle traffic data were collected along with the vehicle turning movement counts. The turning movement counts provide data for non-motorists using the crosswalks, along with on-street bicyclists. Supplemented information was also collected along the shared use path to capture non-motorized traffic not recorded by the turning movement counts at Cooney Drive, at Benton Avenue, and at the crossing along Benton Avenue just south of Custer Avenue. A summary of total crossings within the crosswalks along with on-street bicycle counts between Henderson Street and Montana Avenue is provided in **Figure 2.2**. As can be seen in the figure, the vast majority of non-motorized activity occurs during the school peak hours. Most of the crossing activity occurs at the intersections with Cooney Drive and McHugh Lane and is associated with school children crossing to and from Four Georgians Elementary School. During the AM and school peak hours, school crossing guards are present at Cooney Drive and McHugh Lane. A summary of non-motorized activity during the peak hours is shown in **Figure 2.3**.

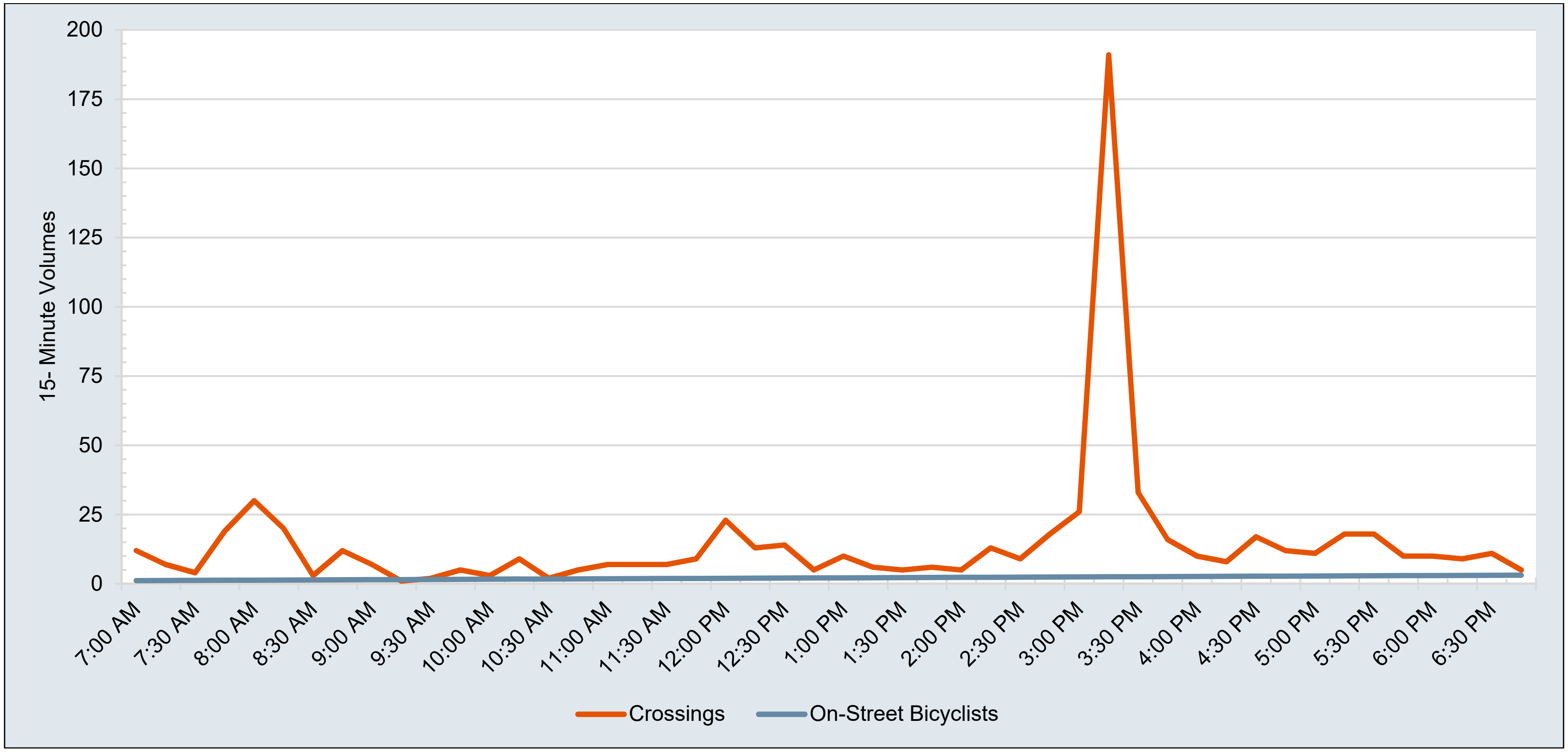


Figure 2.2: Non-Motorized Traffic

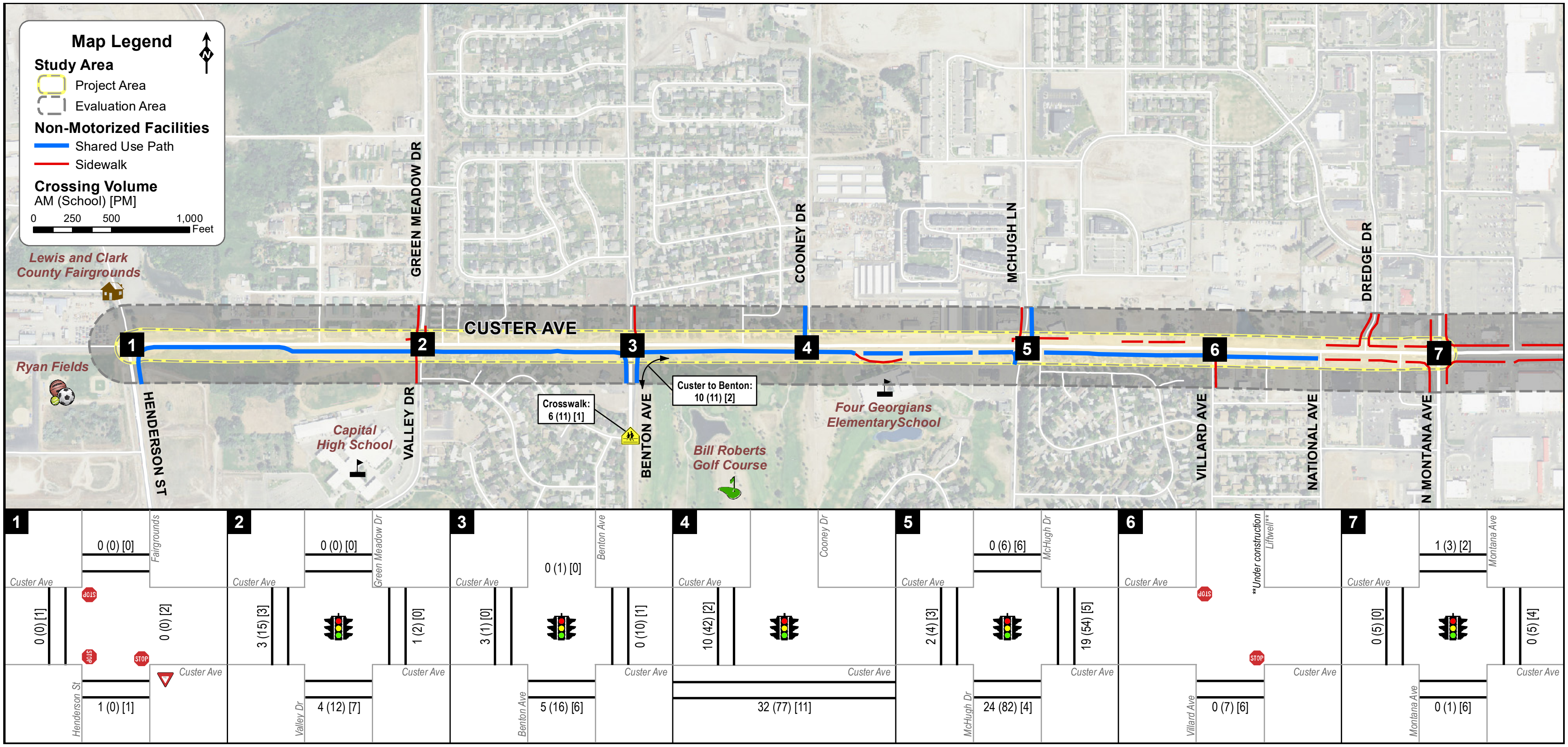


Figure 2.3: Existing Crossing Volume

2.2.4. Travel Time

Travel times between each intersection along the study corridor were collected via the floating car method for the AM and PM peak hours in October 2017. With the floating car method, a vehicle is driven at the same general pace as other traffic on the roadway. A passenger in the car uses a stop watch to measure the amount of time elapsed between each consecutive intersection. Travel times were measured from the approximate center of the intersection. The stop watch was allowed to run at all times, including when the vehicle was stopped or slowed in a queue. Approximately 9 trips along the corridor in each direction were performed across the peak hours. The average travel times are presented in **Table 2.2**.

Table 2.2: Field Collected Travel Times (2017)

Segment	Distance (ft)	AM		School		PM	
		Time (s)	Speed (mph)	Time (s)	Speed (mph)	Time (s)	Speed (mph)
Eastbound							
Henderson St to Green Meadow Dr	1,850	67.0	18.8	60.9	20.7	50.7	24.9
Green Meadow Dr to Benton Ave	1,360	27.6	33.7	53.3	17.4	40.0	23.2
Benton Ave to Cooney Dr	1,125	42.7	18.0	43.2	17.7	43.8	17.5
Cooney Dr to McHugh Ln	1,370	70.7	13.2	58.7	15.9	58.6	16.0
McHugh Ln to Villard Ave	1,210	27.3	30.2	28.1	29.3	29.3	28.1
Villard Ave to Montana Ave	1,450	56.4	17.5	77.4	12.8	77.9	12.7
Montana Ave to Sanders St	1,325	44.9	20.1	78.1	11.6	85.6	10.6
Sanders St to I-15 SB Ramps	530	12.9	28.0	15.0	24.1	12.6	28.8
I-15 SB Ramps to I-15 NB Ramps	850	16.4	35.2	27.2	21.3	21.7	26.7
I-15 NB Ramps to Washington Ave	1,210	63.9	12.9	31.3	26.3	27.4	30.1
Eastbound Corridor Total	**12,280**	**429.8**	**19.5**	**473.3**	**17.7**	**447.4**	**18.7**
Westbound							
Washington Ave to I-15 NB Ramps	1,210	34.9	23.6	27.4	30.1	27.0	30.6
I-15 NB Ramps to I-15 SB Ramps	850	33.3	17.4	43.3	13.4	25.4	22.8
I-15 SB Ramps to Sanders St	530	14.1	25.6	63.3	5.7	57.3	6.3
Sanders St to Montana Ave	1,325	69.0	13.1	66.0	13.7	84.1	10.7
Montana Ave to Villard Ave	1,450	38.2	25.9	37.3	26.5	49.8	19.9
Villard Ave to McHugh Ln	1,210	56.2	14.7	64.2	12.8	89.9	9.2
McHugh Ln to Cooney Dr	1,370	34.8	26.9	34.8	26.9	37.1	25.2
Cooney Dr to Benton Ave	1,125	26.8	28.6	27.3	28.1	28.6	26.9
Benton Ave to Green Meadow Dr	1,360	32.8	28.3	41.8	22.2	37.7	24.6
Green Meadow Dr to Henderson St	1,850	36.8	34.3	37.7	33.5	36.8	34.3
Westbound Corridor Total	**12,280**	**376.9**	**22.2**	**443.2**	**18.9**	**473.7**	**17.7**

2.2.5. Corridor Characteristics and Land Use

Custer Avenue serves as the only contiguous east/west route across the north end of Helena. The corridor is an essential connection to I-15 and a mixture of area land uses. Traffic from the north valley feeds into Custer Avenue via Green Meadow Drive, McHugh Lane, Montana Avenue, and I-15. Fort Harrison, which includes a Veteran's Administration hospital and National Guard facility, is located two miles west of the study corridor. The Custer Avenue corridor serves as a secondary route for military vehicles traveling to/from Fort Harrison. At times, large military trucks, transport vehicles, and convoys utilize the corridor.

Land use on the west end of the corridor consists of a mixture of residential, light commercial, park, and school lands. Capital High School, Four Georgians Elementary School, and the Bill Roberts Golf Course are located along Custer Avenue west of McHugh Lane. The Lewis and Clark County Fairgrounds and Ryan Park are located on the west end of the corridor off Henderson Street. East of Villard Avenue, adjacent land use is primarily light commercial, becoming denser east of Montana Avenue. The construction of the Custer Avenue Interchange spurred commercial development along the corridor between Montana Avenue and Washington Street.

Portions of the corridor commonly operate at full, or over-saturated conditions. During the AM peak hour, the corridor begins to experience congestion by 7:45 AM. Heavy congestion and fully saturated conditions continue until approximately 8:30 AM. Traffic conditions during the AM are heavily influenced by student arrivals and parent drop-offs at Capital High School and Four Georgians Elementary School. Heavy school and commuter traffic at Green Meadow Drive results in long queues in the southbound direction during the AM peak hour. The intersection at McHugh Lane also experiences congestion and long queues due to school and commuter traffic.

After the AM peak period, congestion along the corridor is typically much lower until the influence of school traffic begins around 2:30 PM. Some congestion can occur during the lunch hour; however, most delay and queuing issues occur on the eastern end near the denser commercial developments. During the school release period, rolling queues start to build along Custer Avenue around 3:00 PM, with peak queuing and congestion lasting for approximately 30 minutes. During this period, long queues are primarily in the eastbound direction between Benton Avenue and McHugh Lane. Queues also build on the minor approaches of Green Meadow Drive, Valley Drive, Benton Avenue, and McHugh Lane during the school release period.

Following the school peak period, general congestion remains in both directions and continues to build up to the PM peak period. During the PM peak period, the most noticeable congestion occurs from 5:00 PM to 6:00 PM. During this period, the corridor is fully saturated between Benton Avenue and east of the I-15 interchange. Queues and vehicle congestion at times overflow into through the major intersections, particularly in the westbound direction. Traffic volumes decrease, and operations typically begin to improve around 6:00 PM.

Outside of normal workdays, the corridor is influenced by a variety of other activities. Special events at the Lewis & Clark Fairgrounds, sporting events at Ryan Fields, and school programs can all create periods of over saturation and congestion. Weekend traffic can also create periods of congestion, particularly on the eastern end near the denser commercial development.

2.3. Traffic Operations

Traffic conditions were primarily assessed using two methods: an intersection level operational analysis, and a corridor wide microsimulation analysis. The intersection level analysis was conducted to gain an understanding of the operational conditions of each intersection along the corridor using industry-standard Highway Capacity Manual (HCM) evaluations. This evaluation is conducted on an individual intersection basis and was adjusted to account calibration parameters to adjust to existing field-measured conditions. The microsimulation evaluation uses a variety of data to simulate the driver behavior for every vehicle in the corridor. For this method, the field collected turning movement volumes were used as inputs for the microsimulation and were adjusted to model the “typical day”. The microsimulation model was used to perform a corridor wide analysis that takes into account all network effects. The following sections discuss the development of the microsimulation model, the corridor operational analysis, and the intersection operational analysis.

2.3.1. Model Development and Calibration

Analyzing traffic conditions when a corridor experiences high levels of congestion can be complex. Situations were one intersection is unable to process the traffic demand can result in traffic queues that extend to a previous intersection. This, in turn, can lead to a cascading failure through the corridor or network. Traditional intersection operations evaluation methods, such as the HCM method, do not have a good mechanism to account for these situations. Microsimulation, however, can be used to analyze these types of situations.

Microsimulation in a traffic engineering context refers to computer models that simulate every vehicle in a given roadway network. Many aspects of driver behavior are simulated, including acceleration rates, following distances, gap acceptance, and many others. Additionally, roadway geometry and traffic control devices are also simulated. With a microsimulation model, it is possible to evaluate existing and projected operations of a corridor while accounting for the interactions between the intersections.

For this report, a base model was created to represent existing conditions and to aid in calibrating the model to reflect actual operating conditions. All modeling was completed using *Simtraffic 10.1.2.20* software. Additional modeling was conducted using PTV Vision’s *VISSIM* software. The *VISSIM* model is more visually advanced and will be used to convey the recommended configuration for public involvement purposes. The following sections present the methodology for creating and utilizing the *Simtraffic* microsimulation model.

Data Collection

A variety of data are needed to accurately develop the microsimulation model. These data include traffic volumes, geometrics, traffic control information, and signal timings. This information is needed to ensure that the model correctly represents the existing configuration of the network. Traffic data consisting of traffic volumes, turning movement counts, travel times, and queue length observations were collected in October 2017 and are discussed in more detail in **Section 2.2**.

Turning movement counts were used to define vehicle inputs and routing decisions. Travel time and queue lengths were used in the model calibration step and are ultimately used to make adjustments to driver behavior parameters. Roadway and intersection geometrics were collected in the form of aerial photographs and field visits. A scaled aerial photograph provides the lane configurations at each intersection along with the roadway links between the intersections. By using an accurately scaled image, roadway geometry can be directly overlaid on the image. Field visit information was used to confirm the accuracy of the aerial photography. Traffic signal timing data was also collected to allow for the proper coding of signal timing and coordination between signals.

Base Model Development

Simtraffic uses base files developed in *Synchro* as inputs. The *Synchro* network was developed to establish existing conditions as the starting point for the microsimulation model. The base model utilizes existing traffic volumes, geometrics, and signal timings to establish existing conditions. The model includes the entire Custer Avenue corridor and major intersections between Henderson Street and Washington Street. While not part of the project corridor, the intersections east of Montana Avenue were included in the model to ensure reasonable platooning of vehicles entering into the study area. Vehicles traveling eastbound past Montana Avenue may not directly affect the traffic flow along the study corridor, but they will affect the signal timing of the intersections to the east of Montana Avenue.

Error Checking

After the base model was been created, the model was run to evaluate if errors were present. Errors can be present with any of the network characteristics. Network geometry errors can include improper number of lanes, missing turning movements, or turn bays, to name a few. These errors can be identified through the inspections of network results. One potential issue that was noted during this process was the eastbound left-turn movement at Washington Street. This movement caused a cascading failure of the network under future traffic volumes. It was determined that by omitting growth on this movement, the queuing in the turn bay would not cause lane starvation of the through movements. Given the location of the intersection in the simulation network, eastbound vehicles at this intersection should have little effect on the study area. As such, no growth was applied to the eastbound left-turn movement at Washington Street. More discussion on projected conditions is provided in **Section 3**. No additional errors were noted with the model.

Calibration

Calibrating the model to actual observed conditions is an iterative process. Calibration is intended to evaluate and document that the model accurately represents existing real-world conditions. To ensure a properly calibrated model, ten simulation runs were performed with different random seeds. The simulated model volumes, travel times, and queue lengths were averaged between the simulations and compared to field collected data. Adjustments to the saturation flow rates were made to calibrate the model to most closely match existing conditions. Adjustments to the saturation flow rates were made on a consistent basis per direction. After adjustments were made, another series of simulations were run and the results compared again. When the model and real-world data agree to an acceptable level, the microsimulation model was considered calibrated. The following factors were compared between the simulation and field collected data:

Vehicle Volumes

Vehicles were input into a *Simtraffic* model at the edges of the network. The volumes in between intersections were automatically adjusted by removing or adding vehicles mid-link. If a traffic queue is present, no additional vehicle could be added. A comparison of intersection volumes collected to the simulation volumes was made. During all peak hours, the model shows less than a two percent margin of error compared to field collected data. **Table 2.3** presents a comparison of total entering volumes at each major intersection in the simulation for the AM, School, and PM peak hours.

Table 2.3: Traffic Volume Calibration

Intersection	AM			School			PM		
	Field Volume	Simulation Volume	Percent Difference	Field Volume	Simulation Volume	Percent Difference	Field Volume	Simulation Volume	Percent Difference
Washington Street	2,039	2,099	2.9%	2,390	2,578	7.9%	3,048	3,173	4.1%
I-15 Northbound	1,789	1,824	2.0%	2,466	2,495	1.2%	2,988	2,985	-0.1%
I-15 Southbound	2,257	2,282	1.1%	2,670	2,721	1.9%	3,174	3,189	0.5%
Sanders Street	2,238	2,270	1.4%	2,952	2,984	1.1%	3,528	3,553	0.7%
Montana Avenue	2,908	3,028	4.1%	3,440	3,573	3.9%	4,046	4,086	1.0%
Villard Avenue	1,614	1,624	0.6%	1,717	1,713	-0.2%	2,001	1,983	-0.9%
McHugh Lane	1,986	2,058	3.6%	1,981	2,000	1.0%	2,306	2,330	1.0%
Cooney Drive	1,508	1,522	0.9%	1,618	1,626	0.5%	1,915	1,909	-0.3%
Benton Avenue	1,731	1,722	-0.5%	1,825	1,815	-0.5%	2,128	2,131	0.1%
Green Meadow Drive	1,643	1,652	0.5%	1,443	1,431	-0.8%	1,544	1,555	0.7%
Henderson Street	907	915	0.9%	876	886	1.1%	1,040	1,056	1.5%
Corridor Total	**20,620**	**20,996**	**1.8%**	**23,378**	**23,822**	**1.9%**	**27,718**	**27,950**	**0.8%**

Travel Times

Simulation travel times were compared against the field collected travel times. The field travel time were collected over the course of the AM, School, and PM peak hours and varied throughout the peak period. Using the field measured travel times, a 95 percent confidence interval was calculated. To determine the high and low travel time targets, half of the 95 percent confidence interval was applied to the average travel time.

Table 2.4 presents the target travel times, average recorded travel times, and the simulated travel times for each peak period. As shown in the table, the majority of simulated travel times fall between the high and low targets and are generally close to the averages. While there are a few locations where the simulation times fall outside the parameters, calibration of the model was focused on the entire network. That being said, an effort was made to ensure that as many links were within the target range as possible. Overall corridor simulation times fall well within the bounds and closely align with averages measured in the field.

Table 2.4: Simulation Travel Time Calibration

Segment	AM Peak Hour				School Peak Hour				PM Peak Hour			
	Field Collected Time (s)			Simulation Time (s)	Field Collected Time (s)			Simulation Time (s)	Field Collected Time (s)			Simulation Time (s)
	High	Low	Average		High	Low	Average		High	Low	Average	
Eastbound												
Henderson St to Green Meadow Dr	89	45	67	57	73	48	61	55	63	39	51	52
Green Meadow Dr to Benton Ave	29	26	28	43	79	28	53	46	59	21	40	51
Benton Ave to Cooney Dr	75	10	43	31	64	23	43	33	62	26	44	34
Cooney Dr to McHugh Ln	98	43	71	82	84	34	59	65	87	30	59	64
McHugh Ln to Villard Ave	29	25	27	36	32	25	28	34	32	27	29	36
Villard Ave to Montana Ave	80	33	56	61	108	47	77	69	113	42	78	82
Montana Ave to Sanders St	57	33	45	46	90	66	78	60	100	71	86	80
Sanders St to I-15 Southbound Ramps	19	7	13	21	21	9	15	19	13	12	13	20
I-15 Southbound to I-15 Northbound Ramps	20	13	16	24	34	20	27	24	30	14	22	31
I-15 Northbound Ramps to Washington Ave	91	37	64	41	45	17	31	53	31	24	27	57
Eastbound Corridor Total	**514**	**346**	**430**	**441**	**564**	**383**	**473**	**458**	**513**	**382**	**447**	**509**
Westbound												
Washington Ave to I-15 Northbound Ramps	45	25	35	34	30	25	27	41	30	24	27	59
I-15 Northbound to I-15 Southbound Ramps	60	7	33	35	63	24	43	27	34	16	25	66
I-15 Southbound Ramps to Sanders St	21	8	14	25	76	50	63	37	76	38	57	63
Sanders St to Montana Ave	99	39	69	65	110	22	66	67	135	34	84	83
Montana Ave to Villard Ave	51	25	38	36	47	28	37	36	80	19	50	39
Villard Ave to McHugh Ln	90	22	56	54	91	38	64	56	139	41	90	105
McHugh Ln to Cooney Dr	41	29	35	36	38	31	35	49	47	28	37	40
Cooney Dr to Benton Ave	31	22	27	37	33	22	27	41	36	21	29	43
Benton Ave to Green Meadow Dr	43	22	33	42	61	22	42	41	56	19	38	43
Green Meadow Dr to Henderson St	39	34	37	41	42	34	38	41	39	35	37	42
Westbound Corridor Total	**443**	**311**	**377**	**406**	**530**	**356**	**443**	**436**	**566**	**382**	**474**	**583**

Vehicle Queue Lengths

Using the traffic simulation model, 95th percentile traffic queue lengths were determined. Note that the 95th percentile queues do not represent the maximum queue lengths, rather, it is the length at which queues are at, or less than, 95 percent of the time during the simulation period. The queues in the simulation model are determined by the point when vehicle speeds drop below 10 feet per second (6.8 miles per hour). If vehicle speeds exceed that limit, such as in a rolling queue scenario, they are not included as part of the reported queues in the model. The queue lengths reported from the simulation were compared to the field observed queues along the corridor to help with the calibration process. Emphasis was placed when calibrating the model to ensure queue lengths along the project corridor most closely aligned with actual conditions.

Calibration Conclusions

The calibration process resulted in some modifications to eastbound and westbound headway factors for each peak hour. These factors modify the distance between consecutive vehicles and result in a modification to the saturation flow rate of the roadway. A higher headway factor results in a lower saturation flow rate because vehicles are spaced further apart. The default headway factor in *Simtraffic* is calculated based on the saturation flow rate entered into *Synchro*. For this work, that initial value was 1,750 vehicles per hour per lane, or a headway factor of 1.11. Modifications to the headway factor were made to only the eastbound and westbound directions. For the eastbound direction, headway factors of 1.30 and 1.50 were determined for the AM and PM peak hours. For the westbound direction, headway factors of 1.55 were used for both peak hours. These factors were kept consistent across the whole network for each peak hour period and were used for all subsequent modeling scenarios.

The calibration process resulted in modification to the eastbound and westbound saturation flow rates for each peak hour. The saturation flow rate effects the rate at which an intersection can process vehicles. *Synchro* defaults to a saturation flow rate of 1,900 vehicles per hour (vph), while MDT recommends using 1,750 vph. Using MDT’s recommended rate resulted in shorter travel times, shorter queues, and lower delay than was experienced in the field. This is likely the result of the closely spaced and overly saturated signalized intersections along the corridor.

An iterative calibration process was used which resulted in adjustments to the saturation flow rates to more accurately reflect existing conditions. For the AM peak period, the saturation flow rates were decreased to 1,400 vph and 1,500 vph in the eastbound and westbound directions, respectively. The saturation flow rates for the School peak period were reduced to 1,350 vph and 1,500 vph in the eastbound and westbound directions, respectively. During the PM peak hour, the saturation flow rates were decreased to 1,400 vph and 1,500 vph in the eastbound and westbound directions, respectively. For all peak periods the saturation flow rates in the north and southbound directions were reduced to 1,500 vph. These factors were kept consistent across the whole network for each peak period for all subsequent modeling scenarios.

2.3.2. Corridor Operational Analysis

The existing conditions microsimulation model was used to assess the operations of the entire corridor. The model presents results for average delay per vehicle, average number of strops per vehicle, average vehicle speed, total fuel used, and travel times and queue lengths in both the eastbound and westbound directions. The modeling results for the project area are presented in **Table 2.5**. Note that the network average values are calculated for all intersection legs and all vehicle movements. These values are intended for comparison purposes only and may not be representative of true driver experiences.

The results of the existing conditions modeling show that the corridor generally operates under poor conditions during the peak hours. Average speed along the corridor is shown to be 17 mph or lower, with an average of 15 or more stops per vehicle. During the AM peak hour, long queues and extended travel times are shown in the eastbound direction, particularly west of McHugh Lane. During the school peak hour, long queues and travel times are shown in both directions along Cuter Avenue at McHugh. The PM peak hour shows excessive queuing and delay in the westbound direction from McHugh to the east. The results of the modeling effort indicate that existing traffic volumes exceed available capacity along Custer Avenue between McHugh and Montana Avenue.

Table 2.5: Existing Corridor Operations (2017)

Performance Measure			2017 AM	2017 School	2017 PM
Network Average		Delay per Vehicle (s/veh)	789	863	1,240
		Stops per Vehicle	15	16	19
		Average Speed (mph)	17	17	15
		Fuel Used (gal)	122	127	155
Travel Time (s) (95th Percentile Queue [ft])	Eastbound	Henderson St to Green Meadow Dr	57 (200)	55 (194)	52 (178)
		Green Meadow Dr to Benton Ave	43 (236)	46 (274)	51 (317)
		Benton Ave to Cooney Dr	31 (179)	33 (173)	34 (207)
		Cooney Dr to McHugh Ln	82 (844)	65 (582)	64 (595)
		McHugh Ln to Villard Ave	36 (24)	34 (26)	36 (25)
		Villard Ave to Montana Ave	61 (261)	69 (320)	82 (463)
		Eastbound Total	**310**	**302**	**319**
	Westbound	Montana Ave to Villard Ave	36 (77)	36 (50)	39 (136)
		Villard Ave to McHugh Ln	54 (460)	56 (534)	105 (1103)
		McHugh Ln to Cooney Dr	36 (206)	49 (311)	40 (294)
		Cooney Dr to Benton Ave	37 (236)	41 (208)	43 (294)
		Benton Ave to Green Meadow Dr	42 (198)	41 (215)	43 (278)
		Green Meadow Dr to Henderson St	41 (20)	41 (27)	42 (49)
		Westbound Total	**246**	**264**	**312**

2.3.3. Intersection Operational Analysis

An existing conditions intersection operational analysis was performed using *Synchro 10* software. The analysis utilized methodologies contained in the *Highway Capacity Manual 6th Edition* which does not directly account for network effects and influence from adjacent intersections. Rather, adjustments to the saturation flow rates and vehicle platoon ratios are needed to more accurately reflect existing conditions. Adjustments to these factors were done as part of the modeling calibration process as discussed in **Section 2.3.1**. The calibrated intersection models used existing signal timings and turning movement counts to reflect existing conditions. The operational conditions of the intersections are characterized by Level of Service (LOS) and average vehicle delay. The results of the operational analysis are shown in **Table 2.6** and summarized in **Figure 2.4**. More detailed data is contained in **Appendix B**. The individual intersections are discussed in detail in **Section 5**.

Table 2.6: Existing Intersection Operations (2017)

ID	Intersection	AM Peak Hour		School Peak Hour		PM Peak Hour	
		Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS
	Project Area						
1	**Henderson Street***	**77.7**	**F**	**30.3**	**D**	**48.2**	**E**
	Northbound	*11.4*	*B*	*12.4*	*B*	*12.6*	*B*
	Southbound	*77.7*	*F*	*30.3*	*D*	*48.2*	*E*
	Eastbound	*0.0*	*A*	*0.7*	*A*	*0.3*	*A*
	Westbound	*8.4*	*A*	*7.5*	*A*	*7.2*	*A*
2	**Green Meadows Drive**	**74.3**	**E**	**32.7**	**C**	**23.3**	**C**
	Northbound	*69.1*	*E*	*75.4*	*E*	*62.8*	*E*
	Southbound	*171.0*	*F*	*37.9*	*D*	*44.8*	*D*
	Eastbound	*20.5*	*C*	*22.7*	*C*	*15.3*	*B*
	Westbound	*13.4*	*B*	*21.7*	*C*	*14.4*	*B*
3	**Benton Avenue**	**23.7**	**C**	**31.0**	**C**	**35.6**	**D**
	Northbound	*45.8*	*D*	*39.9*	*D*	*60.5*	*E*
	Southbound	*47.4*	*D*	*37.5*	*D*	*38.1*	*D*
	Eastbound	*12.9*	*B*	*27.9*	*C*	*23.7*	*C*
	Westbound	*15.9*	*B*	*26.8*	*C*	*23.4*	*C*
4	**Cooney Drive**	**9.2**	**A**	**10.9**	**B**	**11.4**	**B**
	Southbound	*68.7*	*E*	*68.1*	*E*	*67.5*	*E*
	Eastbound	*6.1*	*A*	*9.6*	*A*	*11.1*	*B*
	Westbound	*5.2*	*A*	*5.2*	*A*	*5.1*	*A*
5	**McHugh Lane**	**57.4**	**E**	**49.9**	**D**	**61.1**	**E**
	Northbound	*47.1*	*D*	*54.3*	*D*	*49.4*	*D*
	Southbound	*95.4*	*F*	*57.2*	*E*	*64.9*	*E*
	Eastbound	*58.2*	*E*	*59.3*	*E*	*62.4*	*E*
	Westbound	*31.4*	*C*	*33.4*	*C*	*60.6*	*E*
6	**Villard Avenue***	**59.6**	**F**	**113.7**	**F**	**123.1**	**F**
	Northbound	*56.2*	*F*	*113.7*	*F*	*109.7*	*F*
	Southbound	*59.6*	*F*	*84.6*	*F*	*123.1*	*F*
	Eastbound	*0.1*	*A*	*0.1*	*A*	*0.1*	*A*
	Westbound	*0.8*	*A*	*0.6*	*A*	*1.0*	*A*
7	**Montana Avenue**	**48.2**	**D**	**50.2**	**D**	**58.0**	**E**
	Northbound	*34.0*	*C*	*43.9*	*D*	*56.7*	*E*
	Southbound	*40.3*	*D*	*55.7*	*E*	*67.4*	*E*
	Eastbound	*41.1*	*D*	*50.1*	*D*	*56.9*	*E*
	Westbound	*68.0*	*E*	*51.7*	*D*	*54.2*	*D*

ID	Intersection	AM Peak Hour		School Peak Hour		PM Peak Hour	
		Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS
	Evaluation Area						
8	**Sanders Street**	**23.0**	**C**	**49.0**	**D**	**64.0**	**E**
	Northbound	*56.1*	*E*	*37.7*	*D*	*40.9*	*D*
	Southbound	*57.9*	*E*	*53.5*	*D*	*74.4*	*E*
	Eastbound	*16.8*	*B*	*46.8*	*D*	*52.0*	*D*
	Westbound	*18.4*	*B*	*52.8*	*D*	*79.8*	*E*
9	**I-15 SB Ramps**	**20.1**	**C**	**17.2**	**B**	**16.1**	**B**
	Southbound	60.1	E	81.3	F	*76.1*	*E*
	Eastbound	11.2	B	13.7	B	*12.6*	*B*
	Westbound	16.2	B	13.0	B	*13.1*	*B*
10	**I-15 NB Ramps**	**19.1**	**B**	**13.3**	**B**	**14.2**	**B**
	Northbound	*57.2*	*E*	*64.7*	*E*	*63.4*	*E*
	Eastbound	*9.1*	*A*	*1.2*	*A*	*1.0*	*A*
	Westbound	*11.9*	*B*	*0.5*	*A*	*0.4*	*A*
11	**Washington Street**	**25.7**	**C**	**49.9**	**D**	**47.5**	**D**
	Northbound	*41.8*	*D*	*99.6*	*F*	*85.4*	*F*
	Southbound	*56.0*	*E*	*66.4*	*E*	*67.3*	*E*
	Eastbound	*23.6*	*C*	*25.9*	*C*	*26.6*	*C*
	Westbound	*15.7*	*B*	*23.6*	*C*	*23.6*	*C*

**Intersection delay represents the delay of the worst movement, not the average.*

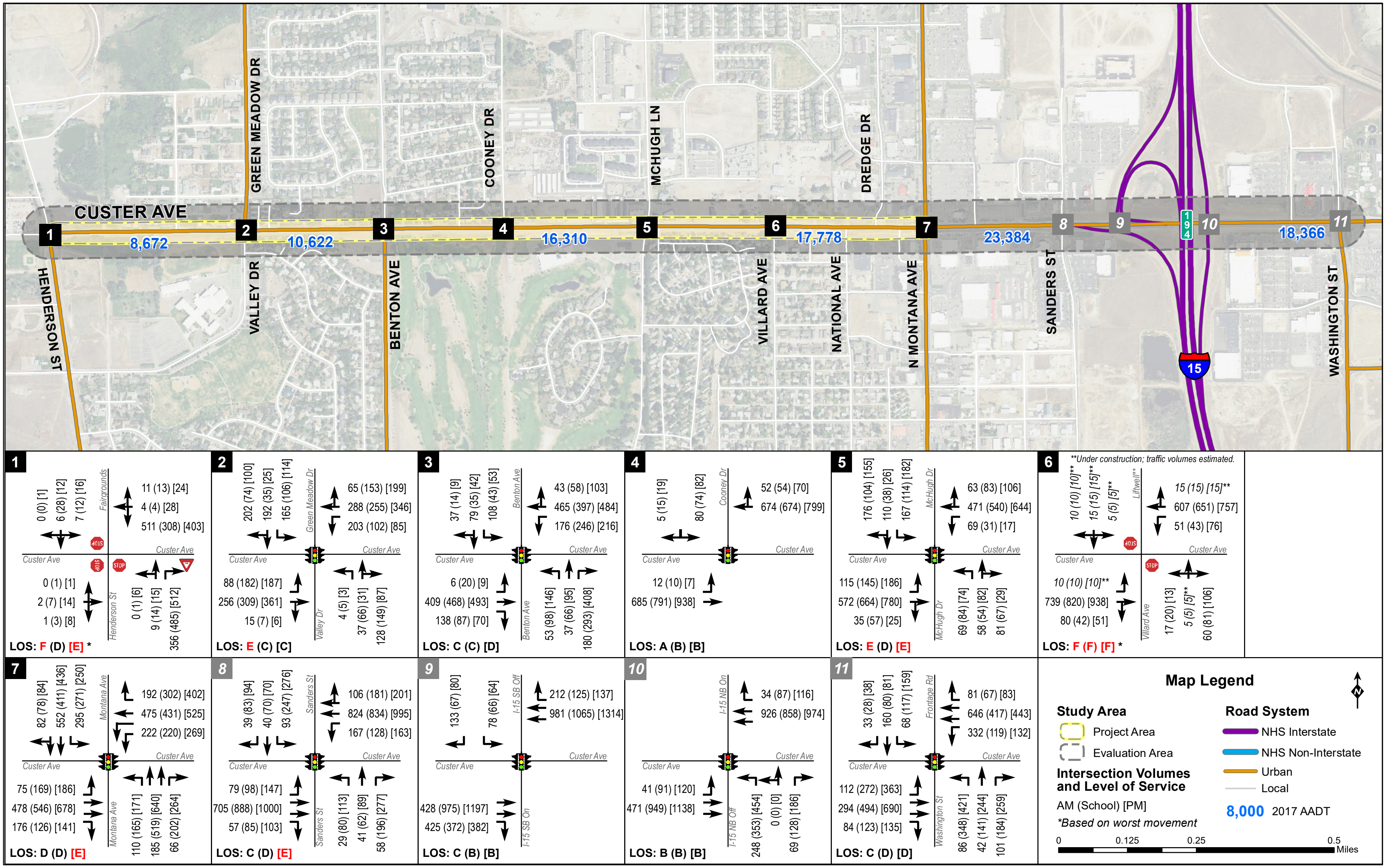


Figure 2.4: Existing Traffic Conditions (2017)

3.0. PROJECTED CONDITIONS

The study corridor area has historically experienced steady traffic growth. In recent years, there has been an influx of new residential and commercial development in the area. Commercial development in particular has increased east of Montana Avenue since the opening of the Custer Interchange in 2012. The new interchange also likely resulted in some shifting in travel patterns in the area. New residential development has occurred over the past 10 years north of Custer Avenue between Green Meadow Drive and McHugh Lane. The study area is expected to continue to grow over the foreseeable future. The following sections provide an evaluation of projected conditions for the study area out to the design year of 2042.

3.1. Projected Traffic Growth

Historic and projected conditions were evaluated to help identify appropriate growth characteristics for the study area. The identification of an appropriate growth rate is important for forecasting future traffic conditions and to help identify corridor needs. This section presents two methodologies for determining projected traffic conditions. The first approach utilizes available historic traffic data to evaluate how traffic has changed in the past. The second approach uses a travel demand model to project how changes to area land use and potential reconstruction of the project corridor might affect traffic conditions in the future. The following sections discuss these methodologies in more detail.

Historic Traffic and Growth Rates

Historic AADT traffic counts for Custer Avenue were provided by MDT. There are four count sites along Custer Avenue within the project area, and two additional sites east of Montana Avenue within the evaluation area. The historic growth rates were used to help project future traffic conditions as past growth is typically used as an indicator for future growth. Since traffic volumes can vary greatly over short periods of time, an analysis of multiple years of historic data was conducted to more accurately project future conditions. The historic compound annual growth rates for the Custer Avenue sites are shown in **Table 3.1**. The historic AADT volumes for the project area are plotted in **Figure 3.1**.

Table 3.1: Historic Traffic Compound Annual Growth Rates

Site ID	Location on Custer Ave	2017 AADT	Past 20 Years 1998-2017	Past 10 Years 2008-2017	Past 5 Years 2012-2017
Project Area					
25-7C-025	East of Henderson St	8,672	2.41%	2.76%	-3.84%
25-7C-026	Between Green Meadow Dr and Benton Ave	10,622	0.60%	0.64%	-4.78%
25-7C-027	Between Cooney Dr and McHugh Ln	16,310	0.84%	1.98%	-1.60%
25-7C-028	West of Montana Ave	17,778	1.39%	3.44%	-0.94%
	Weighted Average	**13,346**	**1.23%**	**2.33%**	**-2.38%**
Evaluation Area					
25-7C-029	East of Montana Ave	23,384	5.04%	5.16%	-0.39%
25-7C-030	Between Frontage Rd and Washington St	18,366	3.25%	2.53%	-1.84%
	Weighted Average	**20,875**	**4.26%**	**4.00%**	**-1.03%**

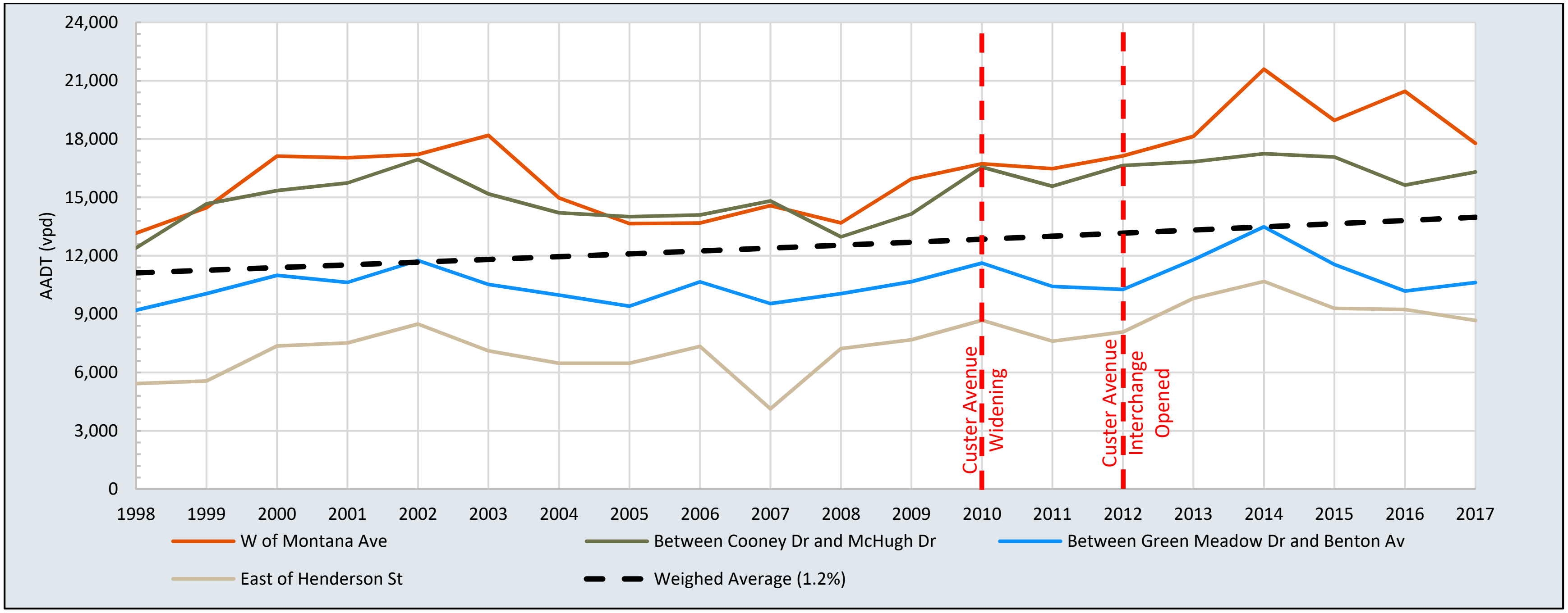


Figure 3.1 Custer Avenue Project Area Historic AADT

Over the past 20 years, traffic volumes have generally experienced a steady increase along Custer Avenue. The project corridor has grown at a rate of approximately 1.2 percent per year over that time. East of Montana Avenue, growth rates have typically been higher. This is likely a result of commercial development that has occurred around the Custer Avenue Interchange and along Sanders and Washington Streets. Between Montana Avenue and Washington Street, Custer Avenue traffic has grown at a rate of approximately 4.2 percent per year over the past 20 years. Volumes along Custer Avenue generally peaked shortly after the interchange opened. Some reduction in volumes have occurred in the past two to three years. It is expected that volumes will increase again particularly with development planned in the study area.

3.1.1. Travel Demand Model

A travel demand model was developed for the *Greater Helena Area Long Range Transportation Plan 2014 Update*. The model uses the transportation network and land use assignments to estimate traffic volumes for roadway segments. The model was initially developed and calibrated to existing conditions for the year 2013. To project future conditions, anticipated growth and land use changes were completed using a combination of socioeconomic data, census projections, and economic projections. Future projections were made out to the year 2035 and were vetted through a workshop with staff from MDT, the City of Helena, and Lewis and Clark County.

Future traffic volumes were estimated by applying the projected land use changes to the existing conditions model. An alternative scenario for Custer Avenue was evaluated with the travel demand model. The scenario modeled Custer Avenue as a five-lane minor arterial roadway with increased capacity between Montana Avenue and Green Meadow Drive. This scenario was compared to the future conditions assuming no changes to Custer Avenue were made. The increased capacity scenario resulted in higher projected traffic volumes along the project corridor.

A review of the two scenarios shows that traffic volumes exceed roadway capacities along the project corridor with the existing configuration. As a result, future traffic demand in the area is being diverted onto alternate routes due to capacity constraints of the existing facility. The rerouting of traffic results in a lower growth rate than future demand might project. The increased capacity scenario results in higher projected traffic volumes along the project corridor as a result of having available capacity to meet future demands. The compound annual growth rates from the travel demand model are shown in **Table 3.2**.

Table 3.2: Travel Demand Model Compound Annual Growth Rates

Location on Custer Ave	2017 AADT	Existing Configuration	Increased Capacity
Project Area			
East of Henderson St	8,672	0.49%	2.15%
Between Green Meadow Dr and Benton Ave	10,622	0.65%	2.04%
Between Cooney Dr and McHugh Ln	16,310	0.79%	2.59%
West of Montana Ave	17,778	0.69%	2.62%
Weighted Average	**13,346**	**0.68%**	**2.42%**
Evaluation Area			
East of Montana Ave	23,384	1.28%	1.44%
Between Frontage Rd and Washington St	18,366	1.35%	1.30%
Weighted Average	**20,875**	**1.31%**	**1.38%**

3.1.2. Projected Growth Summary

Traffic conditions on Custer Avenue have changed considerably over the past 20 years. The corridor has particularly experienced rapid growth over the past 10 years due to commercial developments east of Montana Avenue and residential development north of Custer Avenue between Green Meadow Drive and McHugh Lane. The recent develop, coupled with the opening of the Custer Avenue Interchange, have resulted in traffic volumes near, or exceeding roadway capacity levels. It is anticipated that the corridor will continue to experience traffic growth into the future due to planned and anticipated future development.

The conditions and land use along Custer Avenue varies throughout the study area. As such, a single growth rate for the corridor may not be appropriate. To address this concern, the growth rates identified by the travel demand model are expected to be the best tool to project future conditions. The travel demand model was developed by assigning future anticipated land uses. The results of the model suggest that the true demand for Custer Avenue is higher than historic growth rates. **Table 3.3** shows the projected AADT for Custer Avenue along the project and evaluation areas based on the travel demand model.

Table 3.3: Projected Average Annual Daily Traffic (2042)

Location on Custer Ave	2017 AADT	Growth Rate	2042 Projected AADT
Project Area			
East of Henderson St	8,672	2.15%	14,754
Between Green Meadow Dr and Benton Ave	10,622	2.04%	17,593
Between Cooney Dr and McHugh Ln	16,310	2.59%	30,884
West of Montana Ave	17,778	2.62%	33,951
Evaluation Area			
East of Montana Ave	23,384	1.44%	33,407
Between Frontage Rd and Washington St	18,366	1.30%	25,352

The results of the travel demand model were used to help project future traffic conditions. Growth rates predicted in the model were applied to existing turning movement volumes using the growth of the origin and destination legs. The sum of traffic volume from the turning movement count on a given leg was increased by the growth rate on that leg. The total increased traffic was then redistributed based on the growth rates of the destination leg. This method helps to account for possible changes in traffic distribution due to the expansion of Custer Avenue. Additional adjustments were made to balance flows between intersections and to account for minor approaches and intersections not included in the model. The volumes between the major intersections were generally balanced to keep proportions similar to those under existing conditions.

Figure 3.2 shows the growth rates used for the intersection approach legs. Note that due to the somewhat dated nature of the model, some adjustments are necessary to account for growth already occurring since the model was developed. The following adjustments to the model outputs were made:

- **Benton Avenue:** The travel demand model projected low growth along the south leg under the expanded Custer Avenue scenario. This is likely the result of traffic shifting from Benton Avenue to other routes due to the increased capacity along Custer Avenue. It is expected that traffic along Benton Avenue will continue to grow in the future, particularly with development occurring north of the intersection. As such, the growth predicted in the model was increased to be more reflective of expected area growth.
- **McHugh Lane:** During the model development, future residential development anticipated for a planned apartment complex north of Custer Avenue and west of McHugh Lane. This development has occurred since the base year of the model (2013) and when then data collection occurred (2017). As such, the model growth was reduced to account for the already constructed development.
- **Villard Avenue:** Construction of a new commercial business north of Custer Avenue at Villard Avenue have made the inclusion of a southbound leg necessary. Since this leg was not completed at the time of data collection, traffic volumes were added both into and out of the new development area. It is anticipated that the site will only generate minimal traffic volumes.
- **Montana Avenue:** New development has occurred along McHugh Lane and east of Montana Avenue since 2013. It is anticipated that future traffic projected in the model accounts for the recent development. The growth along the eastbound leg was therefore reduced from that projected in the model to account for the recent development.
- **Sanders Street:** The travel demand model did not include any volume on the southbound leg of Sanders Street. As such, no growth was predicted by the TDM. Future growth for the southbound leg was estimated based on adjacent growth projections.

- **<u>Washington Street:</u>** High levels of growth were predicted on the eastbound left-turn movement at Washington Street. These high volumes of traffic caused cascading issues when microsimulation models of the corridor were run. Since Washington Street is not part of the project corridor, and the fact that the projected eastbound left-turn volumes appear to be overestimated, future growth for the movement was reduced from that predicted in the model.

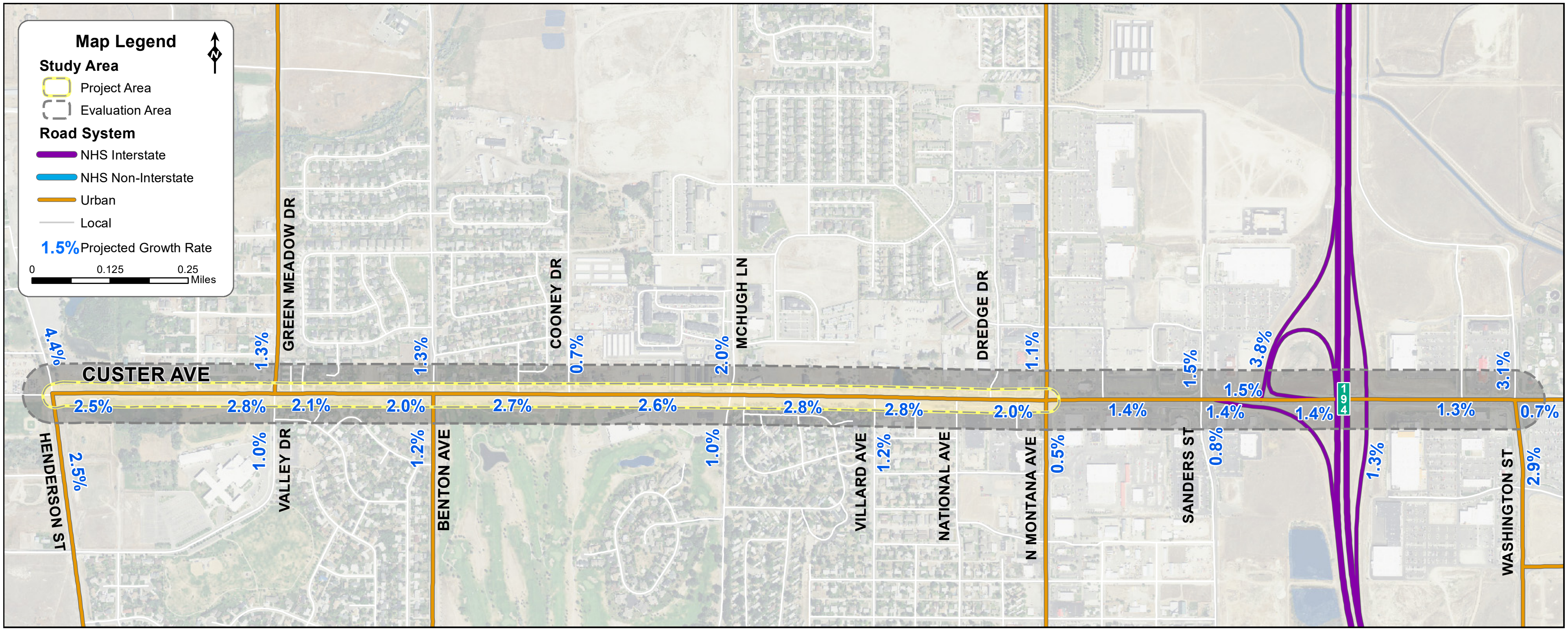


Figure 3.2: Projected Growth Rates

3.2. Traffic Operations

3.2.1. Corridor Operational Analysis

The future growth rates were applied to the calibrated base conditions microsimulation model discussed previously. The projected conditions model represents the corridor under future year 2042 conditions, should no improvements be made to the corridor. The results of the model show a severely congested and oversaturated corridor, with high amounts of vehicle delay and low travel speeds. The model shows queues across the entire model which extend through the major intersections creating grid-lock conditions. The results of the projected conditions model are shown in **Table 3.4**. A discussion of corridor alternatives in comparison to the no action model is provided in **Section 6**.

Table 3.4: Projected Corridor Operations (2042)

Performance Measure			2042		
			AM	School	PM
Network Average		Delay per Vehicle (s/veh)	1,899	2,141	2,604
		Stops per Vehicle	11	9	9
		Average Speed (mph)	5	4	3
		Fuel Used (gal)	323	402	521
Travel Time (s) (95th Percentile Queue [ft])	Eastbound	Henderson St to Green Meadow Dr	569 (2439)	727 (2223)	935 (2203)
		Green Meadow Dr to Benton Ave	337 (1543)	526 (1385)	652 (1334)
		Benton Ave to Cooney Dr	237 (1161)	224 (1134)	256 (1209)
		Cooney Dr to McHugh Ln	211 (1299)	273 (1360)	277 (1423)
		McHugh Ln to Villard Ave	36 (23)	143 (1542)	210 (1681)
		Villard Ave to Montana Ave	60 (293)	223 (1822)	359 (1848)
		Eastbound Total	**1,450**	**2,116**	**2,689**
	Westbound	Montana Ave to Villard Ave	82 (1164)	219 (1701)	266 (1597)
		Villard Ave to McHugh Ln	163 (1386)	182 (1272)	177 (1333)
		McHugh Ln to Cooney Dr	42 (324)	55 (478)	45 (367)
		Cooney Dr to Benton Ave	50 (428)	54 (356)	47 (360)
		Benton Ave to Green Meadow Dr	57 (361)	66 (476)	58 (432)
		Green Meadow Dr to Henderson St	45 (93)	44 (50)	44 (52)
		Westbound Total	**439**	**620**	**637**

3.2.2. Intersection Operational Analysis

Intersection turning movement volumes were projected to estimate future year conditions. The growth rates discussed previously were applied to the existing turning movement volumes from **Section 2.2**. The analysis assumes that no geometric modifications, or changes to signal conditions would be made to the intersections. The analysis also utilizes the calibration parameters discussed previously. **Table 3.4** presents the results of the projected intersection operational analysis. The projected intersection turning movements and roadway AADT volumes are shown graphically in **Figure 3.3**. More detailed information is provided in **Appendix C**.

Table 3.5: Projected Intersection Operations (2042)

ID	Intersection	AM Peak Hour		School		PM Peak Hour	
		Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS
	Project Area						
1	**Henderson Street***	*****	**F**	*****	**F**	*****	**F**
	Northbound	*109.7*	*F*	***	*F*	*85.3*	*F*
	Southbound	***	*F*	*22,987.3*	*F*	***	*F*
	Eastbound	*0.0*	*A*	*1.2*	*A*	*0.6*	*A*
	Westbound	*12.5*	*A*	*8.3*	*A*	*8.5*	*A*
2	**Green Meadows Drive**	**164.9**	**F**	**175.3**	**F**	**144.3**	**F**
	Northbound	*76.7*	*E*	*106.2*	*F*	*63.7*	*E*
	Southbound	*286.8*	*F*	*48.4*	*D*	*50.9*	*D*
	Eastbound	*63.3*	*E*	*232.9*	*F*	*159.0*	*F*
	Westbound	*157.6*	*F*	*180.5*	*F*	*171.2*	*F*
3	**Benton Avenue**	**71.3**	**E**	**143.8**	**F**	**131.1**	**F**
	Northbound	*38.8*	*D*	*68.7*	*E*	*128.1*	*F*
	Southbound	*43.6*	*D*	*39.1*	*D*	*41.6*	*D*
	Eastbound	*73.6*	*E*	*206.5*	*F*	*165.3*	*F*
	Westbound	*87.0*	*F*	*143.0*	*F*	*117.4*	*F*
4	**Cooney Drive**	**53.3**	**D**	**115.4**	**F**	**141.3**	**F**
	Southbound	*66.8*	*E*	*66.1*	*E*	*65.8*	*E*
	Eastbound	*49.3*	*D*	*175.3*	*F*	*183.9*	*F*
	Westbound	*55.9*	*E*	*53.0*	*D*	*101.0*	*F*
5	**McHugh Lane**	**246.1**	**F**	**316.5**	**F**	**331.5**	**F**
	Northbound	*51.0*	*D*	*46.2*	*D*	*44.0*	*D*
	Southbound	*251.3*	*F*	*74.2*	*E*	*129.4*	*F*
	Eastbound	*296.7*	*F*	*419.4*	*F*	*387.0*	*F*
	Westbound	*235.8*	*F*	*343.5*	*F*	*411.9*	*F*
6	**Villard Avenue***	*****	**F**	*****	**F**	*****	**F**
	Northbound	***	*F*	***	*F*	***	*F*
	Southbound	*1,299.7*	*F*	***	*F*	***	*F*
	Eastbound	*0.1*	*A*	*0.1*	*A*	*0.1*	*A*
	Westbound	*0.8*	*A*	*0.7*	*A*	*1.1*	*A*
7	**Montana Avenue**	**152.1**	**F**	**137.2**	**F**	**173.5**	**F**
	Northbound	*56.9*	*E*	*56.7*	*E*	*68.0*	*E*
	Southbound	*75.4*	*E*	*163.7*	*F*	*158.3*	*F*
	Eastbound	*127.7*	*F*	*166.9*	*F*	*238.2*	*F*
	Westbound	*271.1*	*F*	*146.4*	*F*	*194.5*	*F*

ID	Intersection	AM Peak Hour		School		PM Peak Hour	
		Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS
	Evaluation Area						
8	**Sanders Street**	**39.3**	**D**	**186.5**	**F**	**241.6**	**F**
	Northbound	*51.6*	*D*	*39.8*	*D*	*46.7*	*D*
	Southbound	*55.2*	*E*	*150.9*	*F*	*226.0*	*F*
	Eastbound	*31.9*	*C*	*208.8*	*F*	*244.8*	*F*
	Westbound	*41.7*	*D*	*213.4*	*F*	*303.2*	*F*
9	**I-15 SB Ramps**	**48.5**	**D**	**31.4**	**C**	**29.6**	**C**
	Southbound	162.5	F	*67.8*	*E*	*66.3*	*E*
	Eastbound	20.9	C	*32.1*	*C*	*28.6*	*C*
	Westbound	31.1	C	*25.3*	*C*	*25.3*	*C*
10	**I-15 NB Ramps**	**52.7**	**D**	**13.5**	**B**	**13.6**	**B**
	Northbound	*53.8*	*D*	*63.7*	*E*	*63.0*	*E*
	Eastbound	*14.5*	*B*	*4.2*	*A*	*2.3*	*A*
	Westbound	*74.7*	*E*	*0.3*	*A*	*0.2*	*A*
11	**Washington Street**	**90.3**	**F**	**205.2**	**F**	**219.0**	**F**
	Northbound	*42.1*	*D*	*281.9*	*F*	*265.2*	*F*
	Southbound	*116.5*	*F*	*126.4*	*F*	*196.5*	*F*
	Eastbound	*89.3*	*F*	*246.1*	*F*	*260.9*	*F*
	Westbound	*96.0*	*F*	*42.9*	*D*	*42.0*	*D*

**Unable to calculate due to computational limits*
***Intersection delay represents the delay of the worst movement, not the average.*

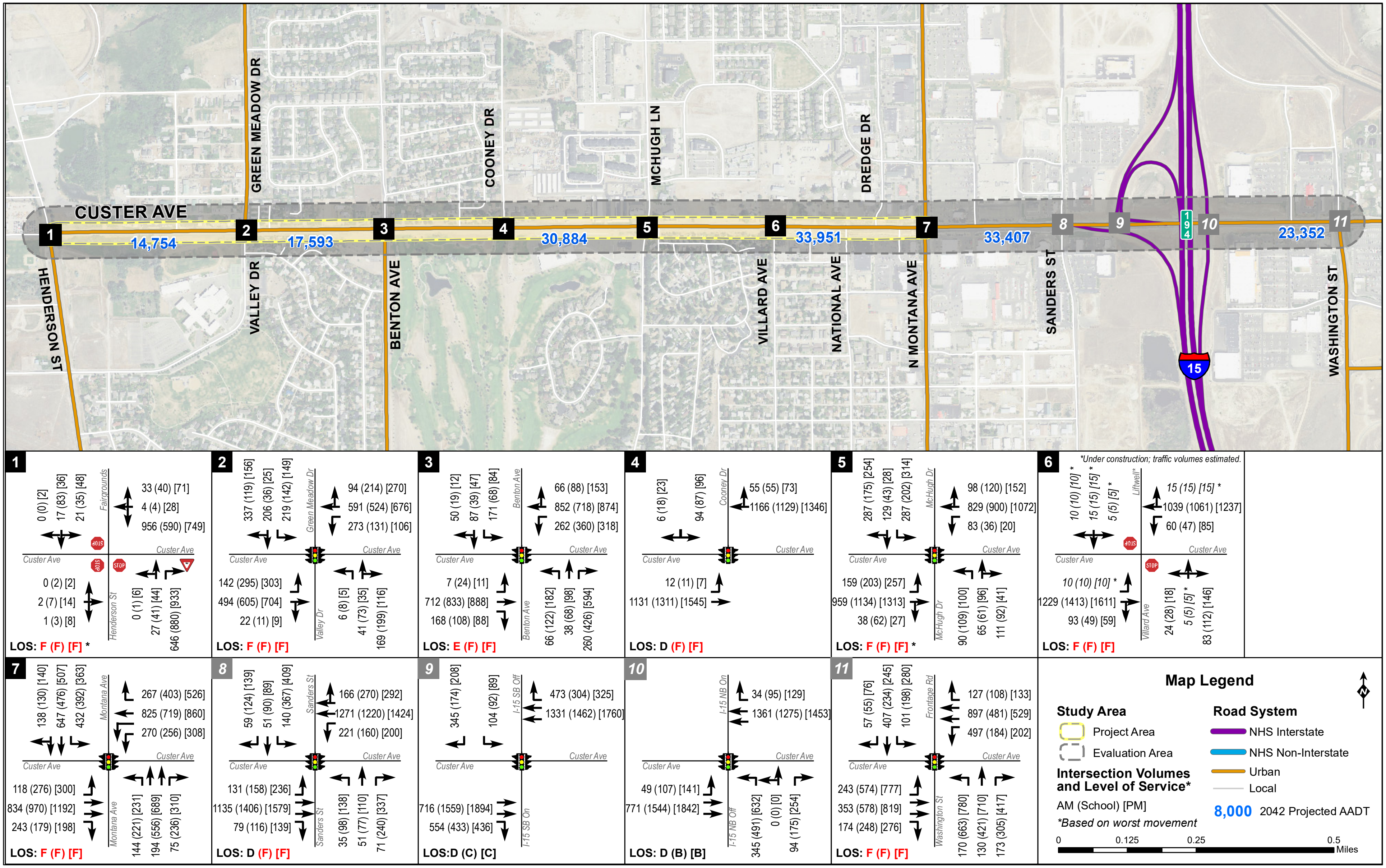


Figure 3.3: Projected (2042) Traffic Operations

4.0. SAFETY

MDT provided crash data for the project area for the ten-year period between January 2007 to December 2016. The crash data included type, frequency, location, and severity of each crash. A total of 665 crashes were reported to have occurred within the project area during this time period. Of the 665 crashes, there was one crash that resulted in a fatality and three crashes that resulted in incapacitating injuries.

Note that Custer Avenue between Montana Avenue and Green Meadow Drive was expanded to a three-lane facility in 2010. Additional changes to traffic signal phasing and timing occurred in 2014. These changes may have affected the crash characteristics of the project area.

The crash reports obtained from MDT are a summation of information collected at the scene of the crash provided by the responding officers. Some of the information contained in the crash reports may be subjective. Any crash records from other law enforcement agencies that were not reported to or by the Montana Highway Patrol were not contained in the database and are not included in this analysis.

4.1. Crash Location

Crash location data were plotted based on the reported location of the crashes. In an urban environment such as the Custer Avenue corridor, crashes generally occur at intersections or are directly related to the operation of the intersection. As such the number of crashes occurring at major intersections and those occurring between were summed. **Figure 4.1** presents a plot of the number of crashes at each of the major intersections on the corridor along with the number of crashes occurring between the intersections. Of the 665 total crashes, 441 crashes (about 66 percent) occurred at an intersection. This distribution of crashes is expected in an urban environment. Crash trend analyses for each intersection is given in **Section 4.8** of this report.

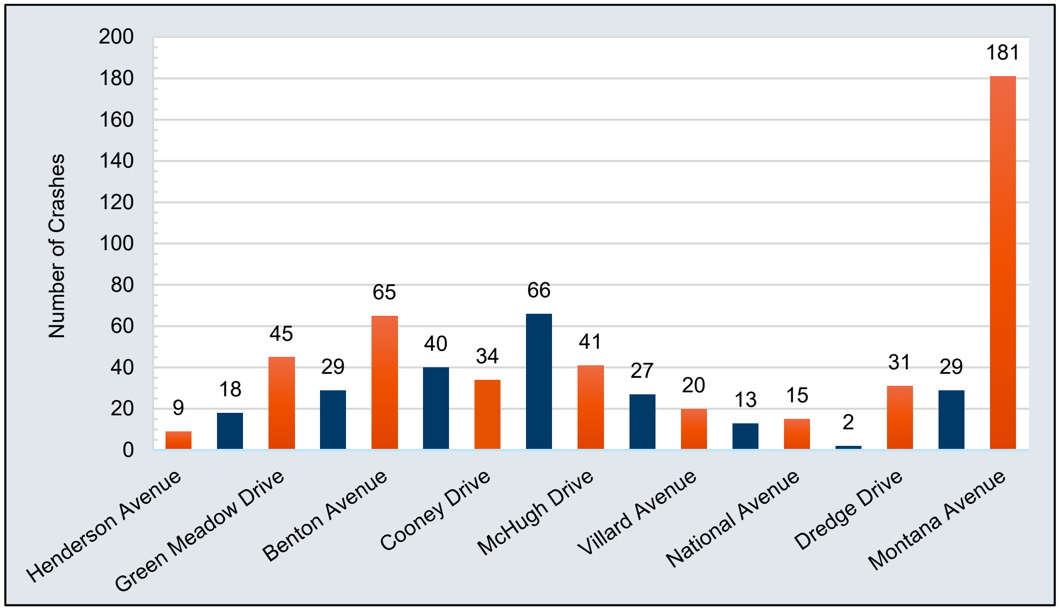


Figure 4.1: Crash Location

4.2. Crash Period

Crash data for the project area was evaluated based on the period of time when the crash occurred. Temporal trends such as crashes per year, month, and day of week were identified. **Figure 4.2** presents the crash period details.

On average, there have been approximately 67 crashes per year along the project corridor over the past 10 years. Two peaks occurred during this time period, one in 2010 and one in 2014. The peak in 2010 coincides with the expansion of the project area to a three-lane facility. The 2014 peak corresponds to the opening of the Custer Avenue Interchange and subsequent increase in traffic volumes.

Plotting the number of crashes occurring in a given month can help to identify seasonal trends that may affect the project area. Seasonal changes such as weather, school sessions, and tourism may drive changes in crash trends. Peaks are shown during the winter months when inclement weather conditions are more common. Another peak occurs in September which corresponds to when school begins.

The day of the week in which crashes occurred was plotted. Trends in these data can be attributed to traffic changes throughout the week. Generally, there is more traffic on weekdays, Monday through Friday, as compared to the weekend, Saturday and Sunday. As such, weekday crashes are expected to be more common. Crashes occurred most commonly on Fridays, with a lower number of crashes on the weekend.

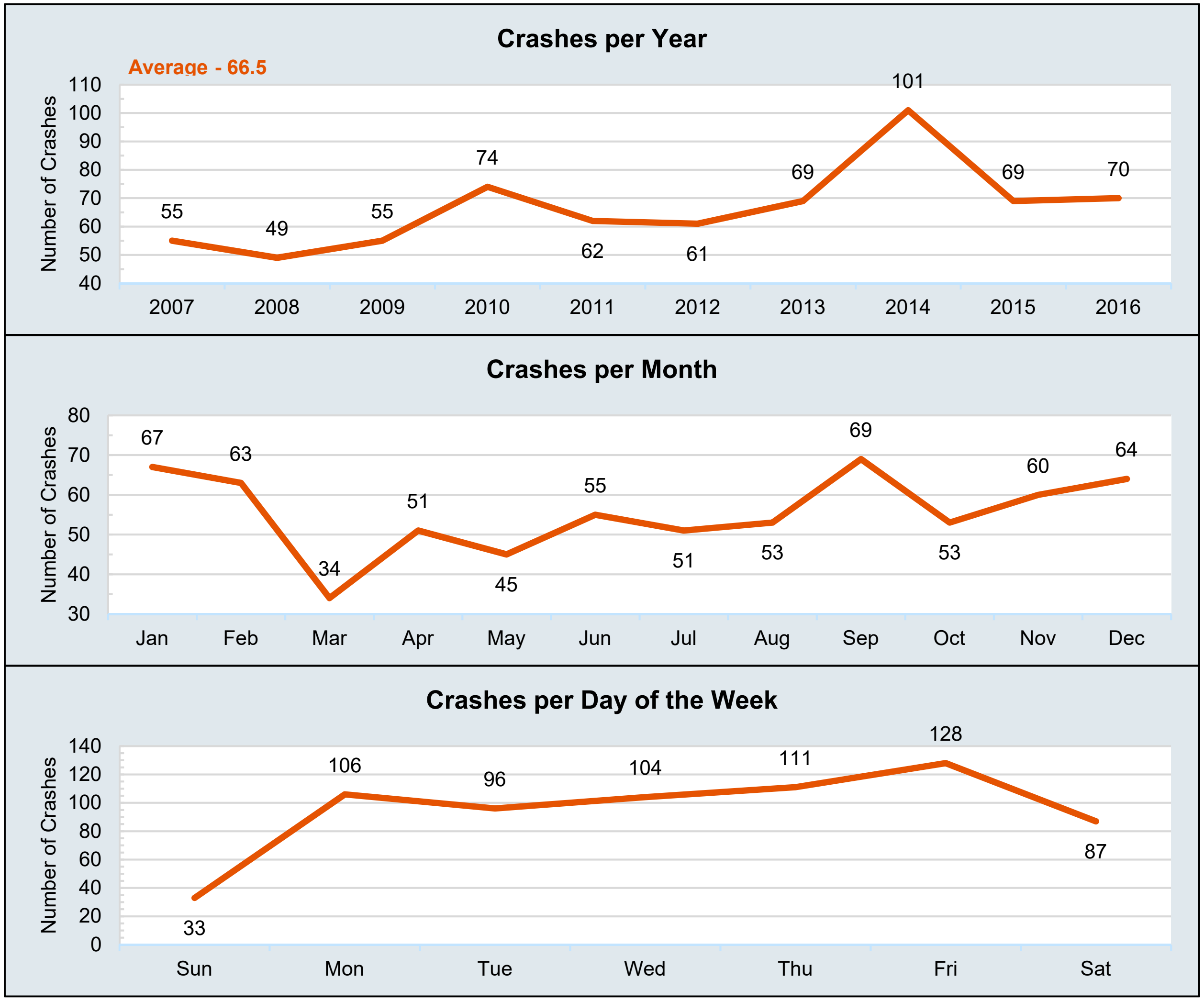


Figure 4.2: Crash Period Details

4.3. Environmental Factors

Crash data were reviewed to evaluate trends related to environmental factors such as weather, roadway surfacing, and lighting conditions. Approximately 57 percent of crashes occurred under clear weather conditions, while approximately 74 percent occurred on dry roads. Overall, approximately 12 percent occurred during times of inclement weather and 26 percent on non-dry road conditions. **Figure 4.3** presents the distributions of weather, road surface, and lighting conditions. **Table 4.1** presents the relationship between these three conditions.

Table 4.1: Environmental Conditions Relationship

Weather Condition	Road Surface Condition					
Lighting Condition	Dry	Ice or Frost	Snow	Wet	Other	Total
Clear	**346**	**10**	**15**	**7**	**3**	**382**
Daylight	*300*	*6*	*12*	*3*	*3*	*325*
Dark-Lighted	*29*	*3*	*2*	*3*		*37*
Dark-Not Lighted	*9*		*1*	*1*		*11*
Dusk	*7*					*7*
Dawn	*1*	*1*				*2*
Cloudy	**134**	**19**	**15**	**19**	**1**	**189**
Daylight	*110*	*16*	*12*	*14*	*1*	*154*
Dark-Lighted	*21*	*1*	*3*	*4*		*29*
Dark-Not Lighted	*2*	*1*		*1*		*4*
Dusk	*1*					*1*
Dawn		*1*				*1*
Snow		**22**	**20**	**2**		**44**
Daylight		*12*	*15*	*1*		*28*
Dark-Lighted		*4*	*3*	*1*		*8*
Dark-Not Lighted		*4*	*1*			*5*
Dusk		*1*				*1*
Dawn		*1*	*1*			*2*
Rain	**5**			**22**		**27**
Daylight	*4*			*15*		*19*
Dark-Lighted	*1*			*4*		*5*
Dark-Not Lighted				*2*		*2*
Dawn				*1*		*1*
Blowing snow		**10**	**2**			**12**
Daylight		*7*	*2*			*9*
Dark-Lighted		*2*				*2*
Dark-Not Lighted		*1*				*1*
Other or Unknown*	**10**	**1**	**1**		**1**	**13**
Daylight	*8*		*1*			*9*
Dark-Lighted	*1*	*1*				*2*
Unknown	*1*				*1*	*2*
Total	**495**	**62**	**53**	**50**	**5**	**665**

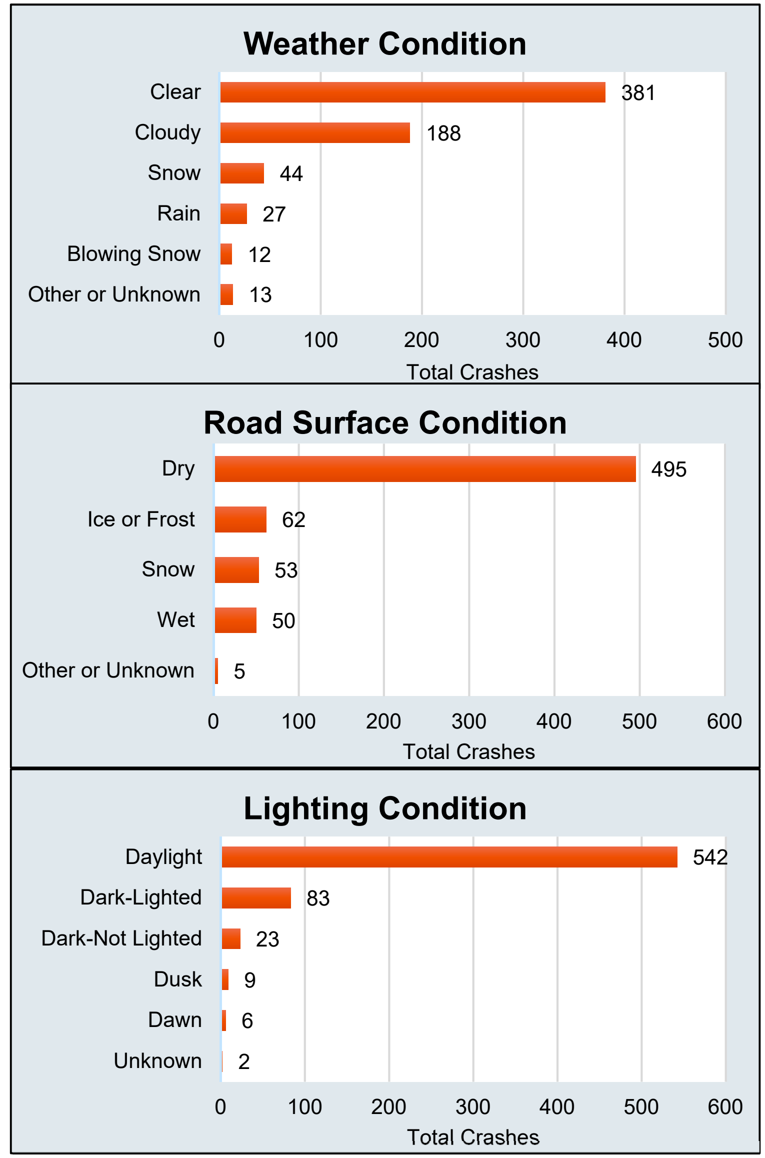


Figure 4.3: Environmental Conditions

4.4. Crash Type

The reported crash type was reviewed to identify if any trends exist. It was found that rear end and right-angle crashes were the most commonly report crash type. Rear end crashes accounted for approximately 70 percent of all crashes, while right-angle crashes accounted for approximately nine percent of all crashes. **Figure 4.4** presents the distribution of reported crash types.

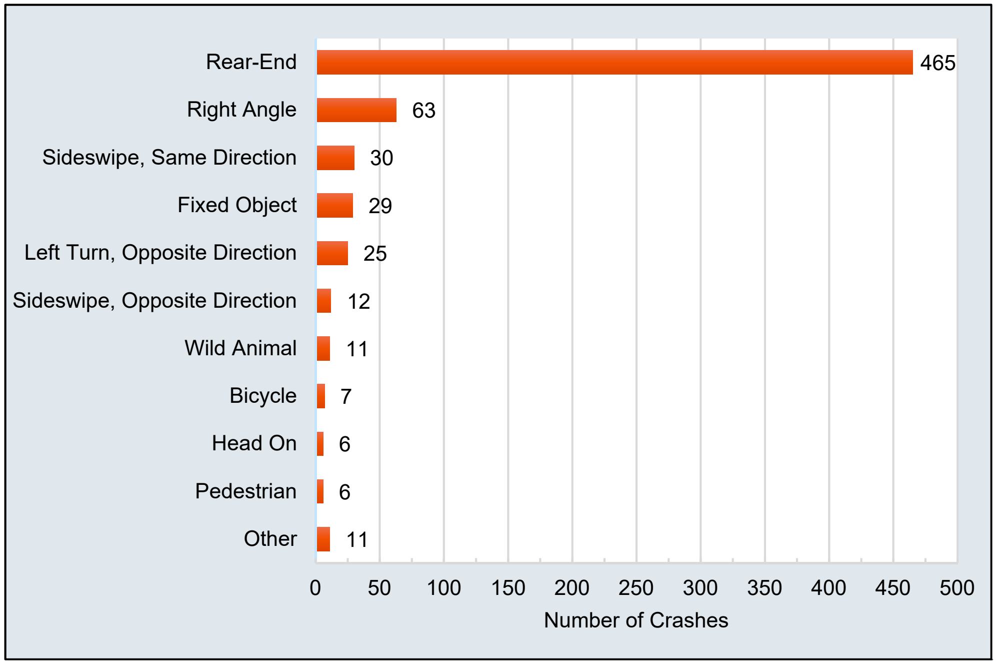


Figure 4.4: Crash Type

4.5. Crash Severity

Crash severity can range from property damage only (PDO) to fatal injury crashes. The reported crash severity is the most severe injury that occurred during the crash. For example, if a crash results in a non-incapacitating evident injury and an incapacitating injury, the crash will be reported as an incapacitating injury crash. Analysis of the crash data found that PDO crashes were the most common, accounting for approximately 75 percent of all crashes. A combined 23 percent of crashes were listed as non-incapacitating injury or possible injury. Severe crashes, those with fatal or incapacitating injuries, accounted for less than 1 percent of all crashes. Over the ten-year period, there was one fatality and three incapacitating injuries. The fatality was a pedestrian at the intersection of National Avenue.

4.6. Vehicle Details

A total of 1,370 vehicles were involved in the 665 reported crashes. Of the 1,370 vehicles involved in crashes, passenger vehicles accounted for approximately 97 percent of vehicles. There were ten heavy vehicles involved in crashes (less than one percent) and two school buses. Bicycles were involved in seven crashes and pedestrians were involved in six crashes.

4.7. Driver Demographics

Driver gender and age were analyzed to identify any trends that may be present in the data set. A total of 1,363 drivers were involved in the 665 reported crashes. Gender was generally evenly split between male and female with males accounting for about 48 percent of drivers and females accounting for about 49 percent of drivers. The remaining 3 percent of drivers were reported as unknown gender.

With respect to driver's age, it was found that the average age of drivers was 38 years. The youngest and oldest drivers were reported as 15 and 88 years, respectively. Drivers aged 15 to 19 years accounted for 297 (21.8 percent) of the drivers. Capital High School is located along the corridor which may contribute to a higher proportion of young drivers. The age distribution and gender of drivers involved in the reported crashes is shown in **Figure 4.5**.

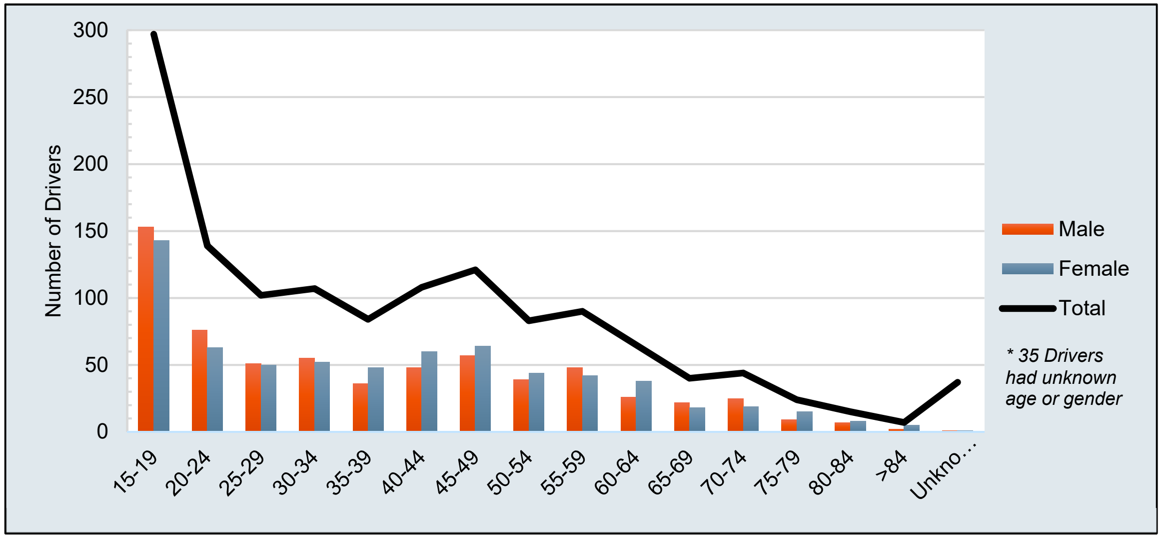


Figure 4.5: Driver's Gender and Age

4.8. Intersection Crash Analyses

The following subsections give an in-depth analysis of each of the major intersections within the study corridor. Data at each intersection were analyzed for crash type and direction of travel. Traffic data were used to determine the intersection crash rate, severity index, and severity rate; all of which are quantitative rates that can be used to compare intersections to one another (see **Table 4.2**). Intersection crash diagrams are presented in **Appendix B**.

- **Montana Avenue:** Montana Avenue had 181 reported crashes. This is the highest number of crashes at any intersection in the study area. Montana Avenue also has the highest traffic volumes. No fatal or incapacitating injury crashes were reported at the intersection. With respect to crash type, rear end crashes accounted for the majority of crashes reported at Montana Avenue with a total of 130 reported crashes. The second most common reported crash type was left-turn, opposite direction crashes, accounting for 15 crashes total. Three crashes involving bicycles were reported at Montana Avenue. Each of the three crashes involved a bicyclist wishing to travel straight ahead and a vehicle making a right turn. Three pedestrian related crashes were reported and each one involved a vehicle making a right turn.
- **Dredge Drive:** Dredge Drive had 31 reported crashes. Right angle crashes accounted for the majority of crashes reported at Dredge Drive with a total of 16 crashes. As a stop-controlled intersection on a busy roadway, it is not uncommon to see a large number of right angle crashes. The second most common reported crash type was rear end crashes with a total of 11.

- **National Avenue:** National Avenue had 15 reported crashes. Rear end crashes accounted for the majority of crashes reported at National Avenue with a total of six crashes. Crashes reported as "other" accounted for three of the reported crashes. The "other" crash type is reported when the crash does not fit the description of any other crash types available to the responding officer. One pedestrian crash was reported at the intersection. This pedestrian crash resulted in a fatal injury of the pedestrian. A westbound vehicle struck the pedestrian.
- **Villard Avenue:** Villard Avenue had 20 reported crashes. The majority of traffic entering the intersection is in the east and westbound direction on Custer Avenue. Rear end crashes accounted for nine of the reported crashes. Five of those nine crashes were reported in the eastbound direction. The second most common crash type was right-angle crashes with three reported crashes.
- **McHugh Lane:** McHugh Lane had 41 reported crashes. Traffic volumes entering the intersection are the second highest for the study area. The majority of crashes were rear end crashes, accounting for 36 crashes. Of the rear end crashes, 16 and 17 of the crashes were in the east and westbound directions, respectively. Given the close proximity of the intersection to the Four Georgians Elementary School, pedestrian and bicycle related crashes are of interest. No pedestrian or bicycle related crashes were reported at the intersection.
- **Cooney Drive:** Cooney Drive had 34 reported crashes. The majority of crashes were reported as rear end crashes, accounting for 32 of the crashes. All of the rear end crashes were in the east or westbound directions. The remaining two crashes were a right angle and a fixed object crash.
- **Benton Avenue:** Benton Avenue had 65 reported crashes. The majority of crashes were reported as rear end crashes, accounting for 45 of the crashes. Of the rear end crashes, 21 of them were reported to have occurred in the northbound direction. Three bicycle related crashes were reported. Two of the bicycle related crashes involved a bicyclist traveling westbound and getting struck by a turning vehicle. The remaining bicycle crash was a bicyclist traveling northbound and getting struck by a vehicle traveling westbound. Two pedestrian related crashes occurred at the intersection.
- **Green Meadow Drive:** Green Meadow Drive had 45 reported crashes. The majority of crashes were reported as rear end crashes, accounting for 27 of the crashes. Nine right angle crashes were reported at the intersection.
- **Henderson Street:** Henderson Street had 9 reported crashes. The most common crash types were right angle and fixed object crashes, with three crashes each.

4.8.1. Intersection Crash Summary

Of the 665 reported crashes in the project area, 441 (66 percent) occurred within 150 feet of an intersection. This distribution of crashes is expected in an urban environment with a large number of intersections and approaches. Of the 441 crashes reported near intersections, rear end crashes were the most commonly reported crashes, accounting for approximately 67 percent of the intersection crashes. Right angle crashes were the second most commonly reported crash type, accounting for 11 percent of the intersection crashes. Stop controlled intersections appeared to have a higher rate of right angle crashes as compared to signalized intersections.

Pedestrian and bicycle related crashes were noted at three intersections: Montana Avenue (three bike and three pedestrian crashes), National Avenue (one pedestrian crash), and Benton Avenue (three bike and two pedestrian crashes). For the bicycle related crashes, many of them appear to be "right hook" type crashes. Right hook crashes occur when a motor vehicle makes a right-hand turn across the path of a bicyclist. Of the seven reported bicycle crashes, five crashes resulted in injuries and the remaining two crashes were reported as PDO. No fatal or incapacitating injury crashes were reported for bicycle related crashes. Six pedestrian related crashes were reported within the project area, all of which occurred near an intersection. One of those crashes, at National Avenue, resulted in a pedestrian fatality, three crashes resulted in non-severe injuries, and the remaining two crashes were reported as PDO. The pedestrian fatality was the only fatality reported within the project area.

Crash rates were used to compare the number of crashes to the daily traffic volume. The rate is expressed as the number of crashes per million entering vehicles. **Equation 1** was used to calculated crash rate. The severity index was calculated by applying multipliers to crashes based on severity. For the severity index, crashes were broken into three categories of severity: property damage only (PDO), non-incapacitating injury, and fatal or incapacitating injury crashes. Each of these three types was given a different multiplier: 1.0 for PDO, 3.0 for injury, and 8.0 for fatal or incapacitating injury crashes. **Equation 2** was used to calculate the severity index. The severity rate is calculated by multiplying the crash rate by the severity index. **Table 4.2** presents the crash rates and severity indices for the major intersections within the project area.

Equation 1:

$$\frac{Total\ Number\ of\ Crashes\ \times 1{,}000{,}000\ Vehicles}{Vehicles\ per\ day\ \times Number\ of\ Years\ \times 365\ days\ per\ year} = Crash\ Rate$$

Equation 2:

$$\frac{(\#PDO \times 1.0) + (\#Injury \times 3.0) + (\#Fatal\ or\ Incap. \times 8.0)}{Total\ Number\ of\ Crashes} = Severity\ Index$$

The severity rate was found to exceed 1.00 for three intersections: Montana Avenue, Benton Avenue, and Green Meadow Drive. Montana Avenue has the highest traffic volumes within the project area. As such, a higher number of crashes is expected to occur. The severity rate at Montana Avenue is also the highest of all the intersections. Benton Avenue has the third highest traffic volumes within the project area but has the second highest number of reported crashes. The high number of crashes coupled with 13 injury crashes, makes the severity index and resulting severity rate at Benton Avenue high. Green Meadow Drive has the third highest total number of crashes. The volume at this intersection is lower than others. Given the proximity to Capital High School, a higher proportion of young drivers are likely to use the intersection. High school aged drivers were found to be involved in more crashes than any other age group.

Table 4.2: Intersection Crash Severity Summary

Intersection	Total Crashes	Crash Rate (Crashes per million Vehicles)	Severity Index	Severity Rate
Montana Avenue	181	1.26	1.46	1.85
Dredge Drive*	31	0.58	1.32	0.77
National Avenue*	15	0.33	1.87	0.62
Villard Avenue	20	0.29	1.50	0.43
McHugh Lane	41	0.50	1.54	0.77
Cooney Drive	34	0.50	1.35	0.68
Benton Avenue	65	0.86	1.40	1.21
Green Meadow Drive	45	0.82	1.58	1.30
Henderson Street	9	0.24	1.00	0.24

**Crash rate and severity rate estimated based on volumes in the travel demand model.*

5.0. INTERSECTION IMPROVEMENT OPTIONS

A list of improvement options was developed for the major intersections along the project corridor. The options were identified based on the needs of the intersection, right-of-way constraints, and corridor consistency. For each improvement option, planning-level layouts were developed. The layouts are based on assumptions and are for evaluation purposes only. Modifications to the layouts are likely should they advance into design. Traffic operations for each intersection were evaluated individually for existing and projected years. Basic assumptions with regards to geometrics, signal timing, etc., were made. Detailed data from the intersection operation analysis is contained in **Appendix C**. In addition to the traffic operations analysis, a list of identified advantages, disadvantages, and potential barriers and constraints to project development are noted.

5.1. HENDERSON STREET

The intersection of Henderson Street and Custer Avenue is a four-legged intersection with stop control along the eastbound, southbound, and the northbound through/left-turn lane. The westbound leg operates as free-flow. There is a northbound channelized right-turn lane with yield control that essentially operates as free-flow. The north approach is the main entrance into the Lewis and Clark County Fairgrounds. The west approach connects to Ryan Fields and provides additional access to the Fairgrounds.

The dominate traffic flow is in the northbound to eastbound (right-turn) and westbound to southbound (left-turn) directions. The intersection general operates with little vehicle delay in the primary movements during the peak hours. The intersection does not currently meet warrants for installation of a traffic signal.

While the intersection generally operates at an acceptable LOS for the primary movements, movements from the minor approaches can experience excessive delay due to high volumes on Custer Avenue/Henderson Street. During special events at the Fairgrounds and Ryan Fields, the intersection can experience significant vehicle delay, resulting in long queues along all legs. When major events take place, such as the Last Chance Stampede, traffic control at the intersection is modified to all-way stop to allow for better traffic operations along the southbound and eastbound approaches. At times, traffic cops are utilized to control traffic flow.

Table 5.1: Henderson Street Intersection Traffic Operations

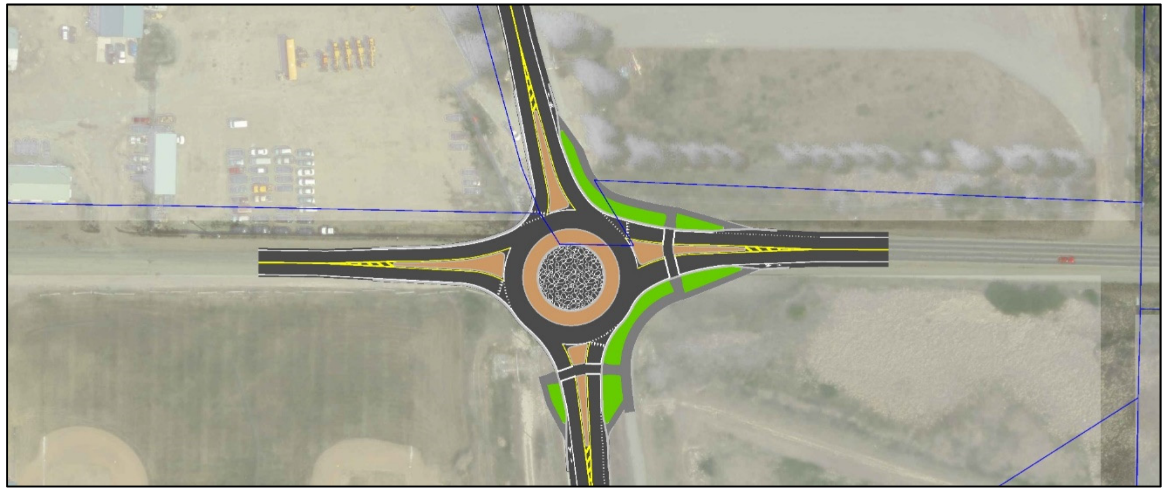
	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total**	**77.7**	**F**	**30.3**	**D**	**48.2**	**E**	*	**F**	*	**F**	*	**F**
Northbound	*11.4*	*B*	*12.4*	*B*	*12.6*	*B*	*109.7*	*F*	*	*F*	*85.3*	*F*
Southbound	*77.7*	*F*	*30.3*	*D*	*48.2*	*E*	*	*F*	*22,987.3*	*F*	*	*F*
Eastbound	*0.0*	*A*	*0.7*	*A*	*0.3*	*A*	*0.0*	*A*	*1.2*	*A*	*0.6*	*A*
Westbound	*8.4*	*A*	*7.5*	*A*	*7.2*	*A*	*12.5*	*A*	*8.3*	*A*	*8.5*	*A*

** Unable to calculate due to computational limits.*
*** Intersection delay represents the delay of the worst movement, not the average.*

5.1.1. Henderson Street Alternative #1 (HEN-1)

Description:

Henderson Street Alternative #1 calls for the construction of a four-legged roundabout with a single circulation lane. This configuration would provide improvements to accommodating movements from the minor approach legs. The primary movements of westbound left-turn and northbound right-turn would continue to operate unopposed under this configuration. Additional consideration for the entrance to the Fairgrounds along the north approach leg as well as accommodations for special event traffic may be necessary. An alternative as a mini roundabout may also be considered at this intersection, however, special consideration may be needed for large trucks associated with Fort Harrison and operations at the Fairgrounds.



Traffic Operations:

A single-lane roundabout is shown to operate at a LOS C or better for all peak hours under existing and projected conditions. At this location, the dominate movements do not conflict with one another, making a roundabout a prime candidate for this intersection. This configuration is shown to significantly improve operations for minor movements while still accommodating the primary movements under existing and projected conditions.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Intersection	**6.9**	**A**	**6.2**	**A**	**6.5**	**A**	**23.0**	**C**	**15.0**	**C**	**16.5**	**C**
Northbound	*5.7*	*A*	*7.1*	*A*	*7.0*	*A*	*10.3*	*B*	*19.7*	*C*	*20.2*	*C*
Southbound	*6.0*	*A*	*4.3*	*A*	*4.5*	*A*	*12.4*	*B*	*7.9*	*A*	*8.1*	*A*
Eastbound	*5.1*	*A*	*4.5*	*A*	*4.4*	*A*	*9.4*	*A*	*7.0*	*A*	*7.3*	*A*
Westbound	*7.7*	*A*	*5.3*	*A*	*6.1*	*A*	*32.1*	*D*	*9.6*	*A*	*13.5*	*B*

Advantages:

- Accommodates existing and projected traffic volumes
- Improves operations of minor traffic movements
- Adjusts to changes in traffic patterns due to events
- Provides a "gateway" opportunity for the Fairgrounds

Disadvantages

- Impacts to all quadrants
- May impact Fairgrounds entrance gate
- High construction cost
- Impacts to utilities

Potential Barriers/Constraints:

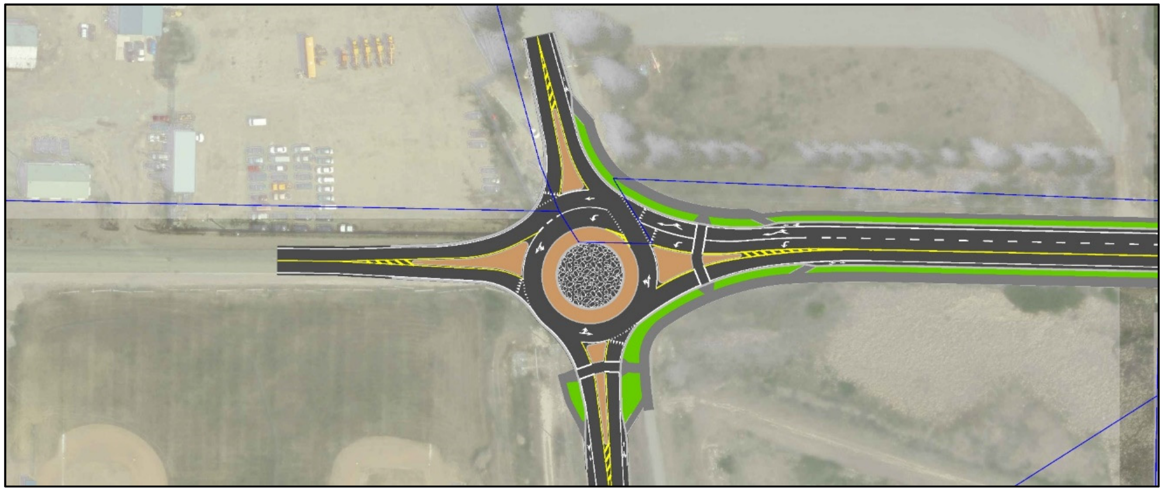
- Potential impacts to 4(f)/6(f) property
- Possible impact to nearby wetlands
- Proximity to Fairgrounds entry gate
- Accommodations for large vehicles
- May experience congestion issues during special events

Conclusion:

- **ADVANCED** – Included in Corridor options 1, 2, 3

5.1.2. Henderson Street Alternative #2 (HEN-2)

Description:
Henderson Street Alternative #2 is a modification of the single lane roundabout described previously. This configuration includes two westbound lanes into the intersection. The inside lane would accommodate the dominate movement of left-turning traffic. The outside lane would be used to access Ryan Park and the Fairgrounds. During normal conditions, this alternative would operate similarly to HEN-1. When events occur at Ryan Park or the Fairgrounds, the additional lane would provide increased capacity.



Traffic Operations:
This roundabout configuration is shown to operate similarly to HEN-1 during the peak hours. As with HEN-1, the dominate movements do not conflict with one another, making a roundabout a prime candidate for this intersection. This configuration is shown to significantly improve operations compared to the existing configuration under existing and projected conditions.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**6.6**	**A**	**6.1**	**A**	**6.1**	**A**	**18.9**	**C**	**14.4**	**B**	**15.0**	**C**
Northbound	*5.7*	*A*	*7.1*	*A*	*7.0*	*A*	*10.3*	*B*	*19.7*	*C*	*20.2*	*C*
Southbound	*5.3*	*A*	*3.9*	*A*	*4.1*	*A*	*9.7*	*A*	*6.7*	*A*	*6.7*	*A*
Eastbound	*5.1*	*A*	*4.5*	*A*	*4.4*	*A*	*9.4*	*A*	*7.0*	*A*	*7.3*	*A*
Westbound	*7.4*	*A*	*5.0*	*A*	*5.3*	*A*	*25.2*	*D*	*8.5*	*A*	*10.0*	*B*

Advantages:
- Accommodates existing and projected traffic volumes
- Improves operations of minor traffic movements
- Adjusts to changes in traffic patterns due to events
- Provides a "gateway" opportunity for the Fairgrounds
- Adds additional capacity and lane storage for special events

Disadvantages
- Larger impacts than HEN-1
- May impact Fairgrounds entrance gate
- High construction cost
- Impacts to utilities
- Non-traditional configuration may cause some driver confusion

Potential Barriers/Constraints:
- Potential impacts to 4(f)/6(f) property
- Possible impact to nearby wetlands
- Proximity to Fairgrounds entry gate
- Accommodations for large vehicles

Conclusion:
- **ADVANCED** – Included in Corridor options 4, 5

5.2. Green Meadow Drive

The intersection of Green Meadow Drive/Valley Drive and Custer Avenue is a four-legged signal-controlled intersection. Each leg of the intersection consists of a shared through/right lane and a dedicated left-turn lane.

Valley Drive, the south leg, provides access to Capital High School and local residents. The north leg, Green Meadow Drive, is a minor arterial urban route and provides connectivity to Highway 279 (Lincoln Road) to the north and numerous residential areas. Bridger Veterinary Hospital is located on the northwest corner or the intersection. The business has two access points which are close to the intersection and are often blocked by queuing at the intersection. On the east leg of the intersection, there are multiple residential approaches on the north side of Custer Avenue.

During the AM peak hour, the intersection experiences higher traffic volumes in the southbound direction along Green Meadow Drive. The southbound movements are split almost evenly between left-turn, through, and right-turns. Long queues are common in the southbound direction during the AM peak hour. Traffic volumes along Custer Avenue are higher in both directions during the PM peak hour. Under existing traffic volumes, the intersection operates poorly during the AM peak hour due to heavy traffic in the southbound direction. During the School and PM peak hours, the intersection performs at a LOS C with some delay along the minor streets. Under projected conditions, the intersection is expected to fail during the peak hours.

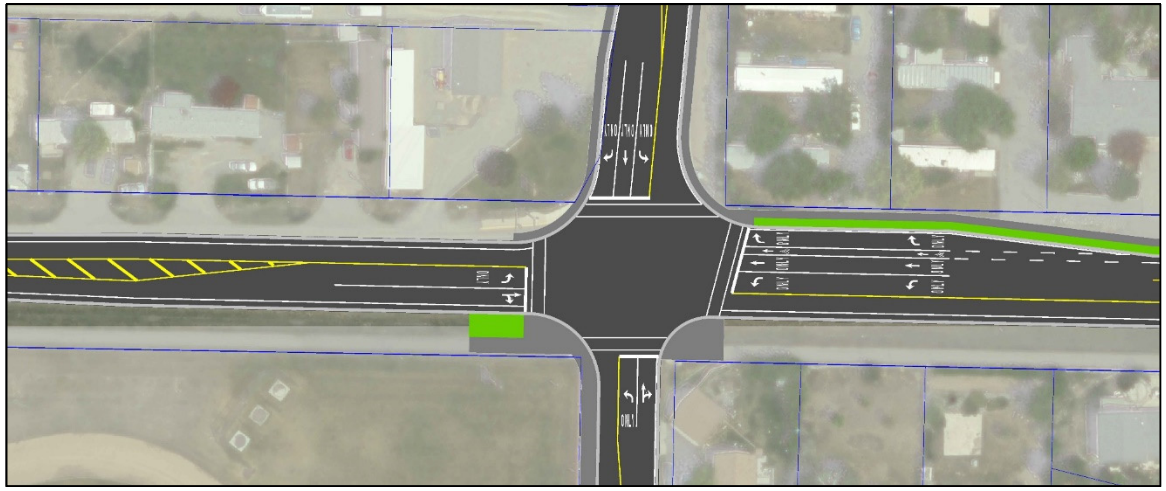
Table 5.2: Green Meadow Drive Intersection Traffic Operations

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**74.3**	**E**	**32.7**	**C**	**23.3**	**C**	**164.9**	**F**	**175.3**	**F**	**144.3**	**F**
Northbound	*69.1*	*E*	*75.4*	*E*	*62.8*	*E*	*76.7*	*E*	*106.2*	*F*	*63.7*	*E*
Southbound	*171.0*	*F*	*37.9*	*D*	*44.8*	*D*	*286.8*	*F*	*48.4*	*D*	*50.9*	*D*
Eastbound	*20.5*	*C*	*22.7*	*C*	*15.3*	*B*	*63.3*	*E*	*232.9*	*F*	*159.0*	*F*
Westbound	*13.4*	*B*	*21.7*	*C*	*14.4*	*B*	*157.6*	*F*	*180.5*	*F*	*171.2*	*F*

5.2.1. Green Meadow Drive Alternative #1 (GM-1)

Description:

This alternative reconfigures the westbound and southbound legs to include dedicated left-turn, right-turn, and through lanes. The eastbound and northbound legs will remain the same as the existing configuration. This alternative would provide additional capacity for the southbound and westbound right-turn movements. This may result in impacts to the Bridger Veterinary Hospital parcel on the northwest quadrant.



Traffic Operations:

This configuration shows some improvement over the existing configuration under existing traffic volumes, particularly in the southbound direction. Under projected traffic conditions, total intersection delay decreases by almost 100 seconds per vehicle during the peak hours. However, the configuration still results in a failing LOS during the projected AM and school peak hours. The northbound leg, in particular, is shown to have high amounts of vehicle delay.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**31.2**	**C**	**28.3**	**C**	**20.2**	**C**	**76.1**	**E**	**80.7**	**F**	**52.8**	**D**
Northbound	*82.1*	*F*	*71.6*	*E*	*68.9*	*E*	*237.4*	*F*	*216.9*	*F*	*120.4*	*F*
Southbound	*36.9*	*D*	*33.3*	*C*	*39.5*	*D*	*76.7*	*E*	*58.3*	*E*	*70.3*	*E*
Eastbound	*24.8*	*C*	*20.4*	*C*	*13.2*	*B*	*58.2*	*E*	*81.4*	*F*	*63.7*	*E*
Westbound	*14.1*	*B*	*15.1*	*B*	*7.7*	*A*	*51.6*	*D*	*43.6*	*D*	*26.6*	*C*

Advantages:

- Maintains existing alignment of the eastbound and northbound legs
- Accommodates existing traffic volumes and improves projected conditions
- Could be accomplishes with minor widening

Disadvantages

- Potential relocation of utilities on the northwest quadrant
- Requires some relocated signal poles and longer mast arms
- Access to the Bridger Veterinary Hospital may be impacted
- Additional right-of-way likely needed along the north approach leg

Potential Barriers/Constraints:

- Impacts to the Bridger Veterinary Hospital parcel and access
- Access to residents to the northeast

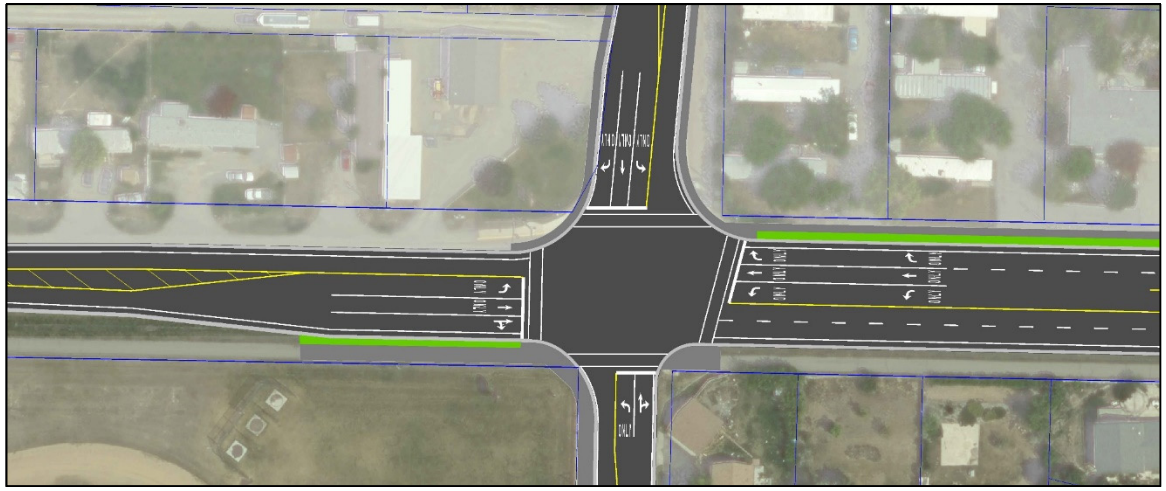
Conclusion:

- **ADVANCED** – Included in Corridor Options 1 and 2

5.2.2. Green Meadow Drive Alternative #2 (GM-2)

Description:

Green Meadow Drive Alternative #2 would expand the southbound and westbound legs similarly to the previous alternative. The eastbound leg would be modified to include an additional through lane. An additional receiving lane east of the intersection would also be needed. The dedicated right-turn lane on the westbound leg is used to drop a travel lane. This configuration would require that Custer Avenue be reconstructed to five lanes east of the intersection.



Traffic Operations:

This configuration operates similarly to the previous alternative. Minor improvements are realized due to the inclusion of an additional eastbound through lane. This alternative experiences the same issue as GM-1 with accommodating traffic along the northbound lane.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**29.9**	**C**	**26.8**	**C**	**18.9**	**B**	**56.4**	**E**	**70.9**	**E**	**47.8**	**D**
Northbound	*79.5*	*E*	*69.9*	*E*	*63.0*	*E*	*163.6*	*F*	*216.9*	*F*	*100.4*	*F*
Southbound	*37.0*	*D*	*33.2*	*C*	*39.5*	*D*	*71.3*	*E*	*58.3*	*E*	*81.4*	*F*
Eastbound	*20.9*	*C*	*17.2*	*B*	*11.1*	*B*	*39.1*	*D*	*65.8*	*E*	*49.0*	*D*
Westbound	*13.6*	*B*	*15.0*	*B*	*7.7*	*A*	*32.2*	*C*	*33.7*	*C*	*28.3*	*C*

Advantages:

- Accommodates existing traffic volumes and improves projected conditions compared to GM-1
- Maintains existing alignment of northbound leg

Disadvantages

- Shifts alignment of Custer Avenue to the south, reducing boulevard width between the road and the shared use path
- Relocation of multiple signal poles and new mast arms required
- More impacts than GM-1 with only minor improvements to operations
- Increased crossing distance for pedestrians

Potential Barriers/Constraints:

- Impacts to the Bridger Veterinary Hospital parcel and access
- Potential drainage impacts due to decreased boulevard size
- Access to residents to the northeast

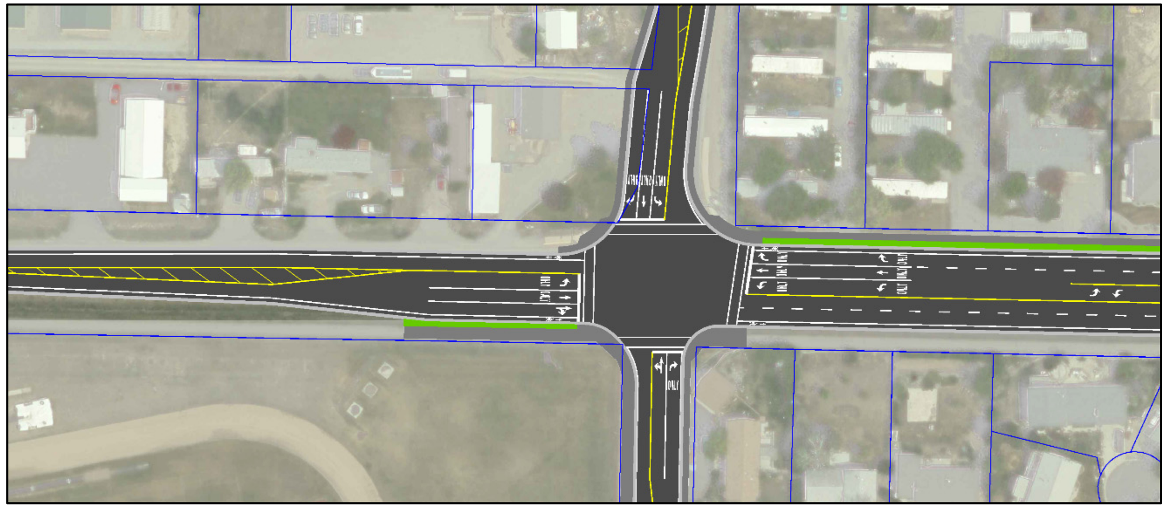
Conclusion:

- **ADVANCED** – Included in Corridor Option 3

5.2.3. Green Meadow Drive Alternative #3 (GM-3)

Description:

Green Meadow Drive Alternative #3 is similar to GM-2, however the northbound leg has been reconfigured to include shared left/through and dedicated right-turn lanes. The dedicated right-turn lane is intended to reduce delay along the northbound leg as shown in the previous alternatives. This configuration requires that the southbound leg be shifted to the west in order to along the northbound through lane with the receiving lane. As with GM-2, this configuration would require that Custer Avenue be reconstructed to five lanes east of the intersection.



Traffic Operations:

This configuration shows improvements over GM-2 due to the addition of a dedicated northbound right-turn lane. The alternative is shown to operate at LOS C or better under existing traffic volumes and a LOS D or better under projected volumes. The northbound leg experiences higher delay than the other legs due to the lack of protected signal phasing.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**24.2**	**C**	**20.7**	**C**	**16.9**	**B**	**33.9**	**C**	**39.5**	**D**	**27.0**	**C**
Northbound	*43.5*	*D*	*48.1*	*D*	*52.2*	*D*	*43.0*	*D*	*69.7*	*E*	*63.5*	*E*
Southbound	*35.3*	*D*	*33.8*	*C*	*39.1*	*D*	*51.8*	*D*	*46.3*	*D*	*63.9*	*E*
Eastbound	*18.0*	*B*	*13.4*	*B*	*9.7*	*A*	*26.6*	*C*	*37.5*	*D*	*24.8*	*C*
Westbound	*11.1*	*B*	*10.5*	*B*	*6.3*	*A*	*22.6*	*C*	*29.6*	*C*	*12.2*	*B*

Advantages:

- Accommodates existing and projected traffic volumes
- Maintains existing alignment of northbound leg

Disadvantages

- Shifts alignment of Custer Avenue to the south, reducing boulevard width between the road and the shared use path
- Southbound leg would shift to the west to ensure proper through lane alignment in the northbound direction
- Relocation of multiple signal poles and new mast arms required
- More impacts than GM-2

Potential Barriers/Constraints:

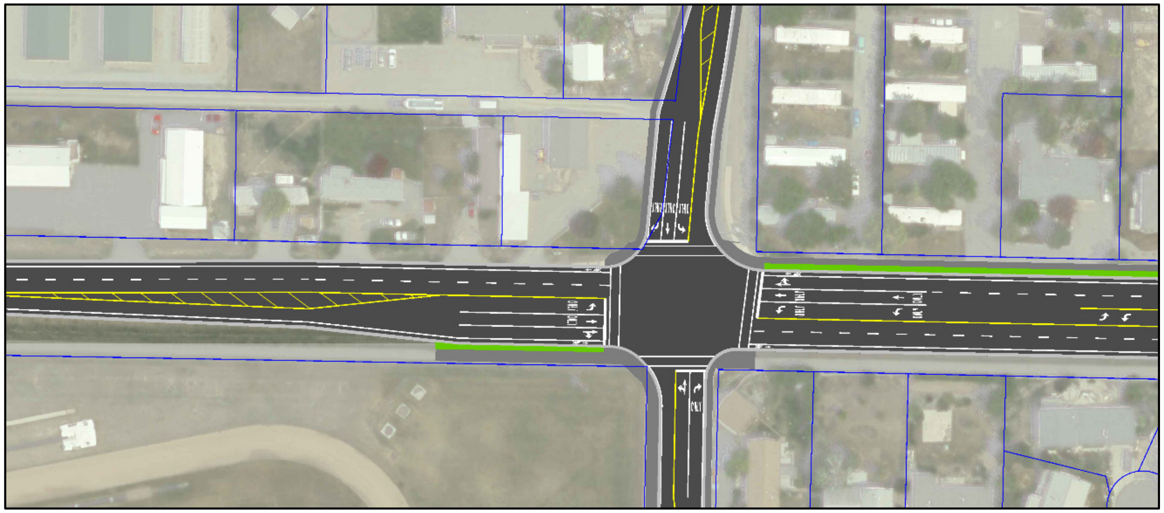
- Impacts to the Bridger Veterinary Hospital parcel and access
- Potential drainage impacts due to decreased boulevard size
- Impacts to residents to the northeast

Conclusion:

- **ADVANCED** – Included in Corridor Option 3

5.2.4. Green Meadow Drive Alternative #4 (GM-4)

Description:
Green Meadow Drive Alternative #4 would accommodate the expansion of Custer Avenue to five lanes west of the intersection. This configuration would increase capacity in the westbound direction. Note that the majority of daily traffic in the westbound direction turns left downstream at Henderson Street. As such, the capacity improvements for this configuration may be reduced due to the likelihood of westbound vehicles choosing the inside through lane in advance of Henderson Street. The additional westbound through lane would help increase capacity and storage for events at Ryan Park and the Fairgrounds, however.



Traffic Operations:
This configuration results in a LOS C during all existing peak hours and is projected to operate at a LOS D or better under future traffic conditions. The northbound lane is shown to experience some excessive delay due to the lack of protected phasing for the northbound leg.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**28.0**	**C**	**22.5**	**C**	**19.9**	**B**	**30.5**	**C**	**41.1**	**D**	**26.0**	**C**
Northbound	*64.7*	*E*	*55.4*	*E*	*76.4*	*E*	*56.8*	*E*	*66.6*	*E*	*74.4*	*E*
Southbound	*40.0*	*D*	*32.8*	*C*	*50.0*	*D*	*40.6*	*D*	*33.7*	*C*	*49.1*	*D*
Eastbound	*18.6*	*B*	*13.9*	*B*	*9.9*	*A*	*28.2*	*C*	*43.7*	*D*	*23.4*	*C*
Westbound	*10.9*	*B*	*12.3*	*B*	*6.5*	*A*	*18.1*	*B*	*32.7*	*C*	*14.2*	*B*

Advantages:
- Generally accommodates existing and projected traffic volumes
- Maintains existing alignment of northbound leg
- Provides additional capacity and storage for special events

Disadvantages
- Shifts alignment of Custer Avenue to the south, reducing boulevard width between the road and the shared use path
- Southbound leg would shift to the west to ensure proper through lane alignment in the northbound direction
- Relocation of multiple signal poles and new mast arms required
- Increased crossing distance for pedestrians

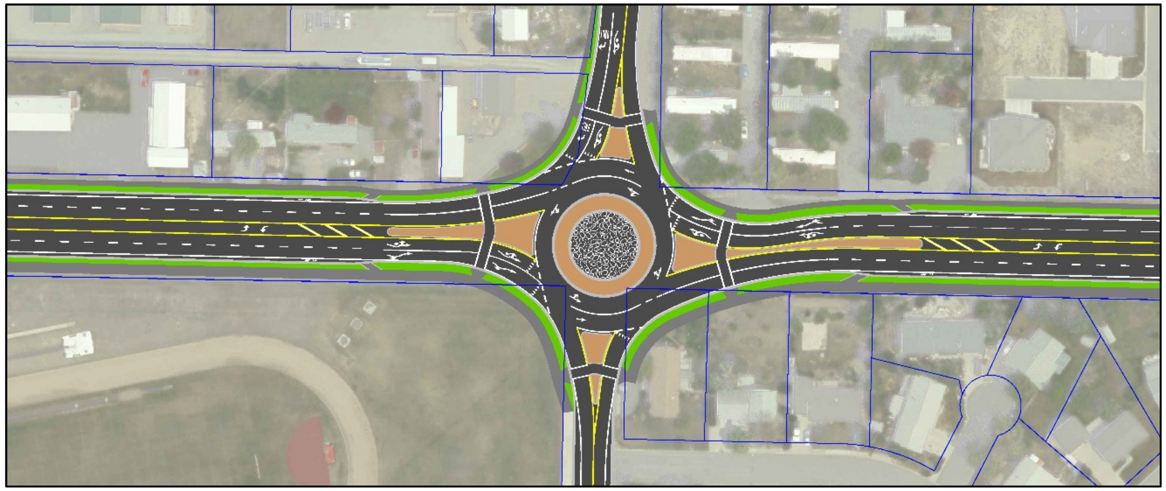
Potential Barriers/Constraints:
- Impacts to the Bridger Veterinary Hospital parcel and access
- Potential drainage impacts due to decreased boulevard size
- Access to residents to the northeast

Conclusion:
- **ADVANCED** – Included in Corridor Option 4

5.2.5. Green Meadow Alternative #5 (GM-5)

Description:

Green Meadow Drive Alternative #5 includes construction of a multi-lane roundabout. The roundabout would include shared left/through and through/right lanes in the eastbound and westbound directions. The southbound direction includes a right-turn and shared through/left-turn lane. The northbound leg has a combined left/through/right lane. This configuration would accommodate reconstruction of Custer Avenue to five lanes both east and west of the intersection.



Traffic Operations:

This configuration is shown to operate at a LOS C or better during the peak hours under existing and projected traffic volumes. The highest amount of delay is shown along the southbound leg during the AM peak hour due to a high amount of southbound left-turns.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**7.8**	**A**	**6.4**	**A**	**6.0**	**A**	**19.1**	**B**	**12.1**	**C**	**10.9**	**B**
Northbound	*6.8*	*A*	*8.2*	*A*	*6.4*	*A*	*12.8*	*B*	*21.0*	*C*	*12.5*	*B*
Southbound	*9.7*	*A*	*5.1*	*A*	*5.3*	*A*	*33.3*	*D*	*8.2*	*A*	*8.9*	*A*
Eastbound	*8.7*	*A*	*6.2*	*A*	*5.9*	*A*	*19.0*	*C*	*10.8*	*B*	*10.1*	*B*
Westbound	*5.7*	*A*	*6.4*	*A*	*6.4*	*A*	*9.4*	*A*	*12.0*	*B*	*12.1*	*B*

Advantages:

- Accommodates existing and projected traffic volumes
- Generally balanced delay along all approach legs
- Improved safety

Disadvantages

- Requires full intersection reconstruction
- Most impactful alternative
- Impacts to all quadrants, including to residential buildings on the northeast and southeast quadrants

Potential Barriers/Constraints:

- Impacts to the Bridger Veterinary Hospital parcel and access
- Impacts to multiple residential buildings
- School playground area in southwest quadrant

Conclusion:

- **ADVANCED** – Included in Corridor Option 5

5.3. Benton Avenue

The intersection of Benton Avenue and Custer Avenue is a four-legged signal-controlled intersection. The northbound and eastbound legs consist of dedicated left-turn, through, and right-turn lanes. The southbound and westbound legs include a shared through/right lane and a dedicated left-turn lane.

The north leg of the intersection is classified as a local road and provides access to residential developments. The south leg is a minor arterial urban route and accesses residential areas to the west and recreational lands to the east. Benton Avenue connects to US Highway 12 (Euclid/Lyndale Avenue) to the south.

During the AM peak hour, southbound left-turn and northbound right-turn are the dominant movements for the minor approaches. Through traffic in the eastbound and westbound directions are relatively balanced. During the school and PM peak hours, volumes on the southbound leg decrease as compared to the AM peak hour. However, volumes on all other legs increase. The northbound right-turn is the most dominate movement on the minor legs. Through movements in the east and westbound directions remain relatively balanced.

The intersection is shown to operate at a LOS C during the AM and School peak hours and at a LOS D during the PM peak hour under existing conditions. Under projected traffic conditions, the intersection is shown to experience increased delay along the eastbound and westbound legs due to high volumes along Custer Avenue. The northbound legs are also projected to experience considerable delay during the school and PM peak hours is primarily due to the high volume of northbound right turning movements.

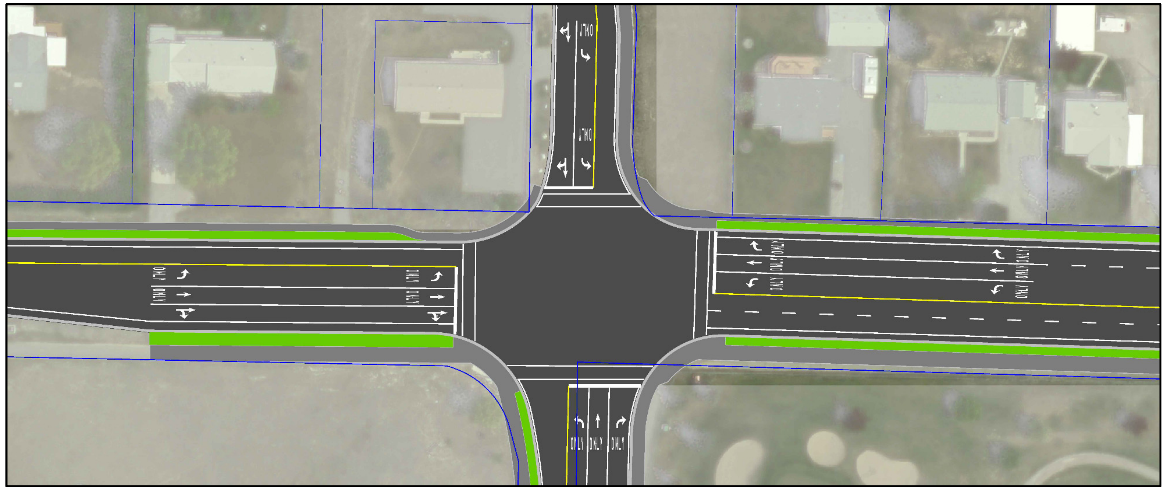
Table 5.3: Benton Avenue Intersection Traffic Operations

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**23.7**	**C**	**31.0**	**C**	**35.6**	**D**	**71.3**	**E**	**143.8**	**F**	**131.1**	**F**
Northbound	*45.8*	*D*	*39.9*	*D*	*60.5*	*E*	*38.8*	*D*	*68.7*	*E*	*128.1*	*F*
Southbound	*47.4*	*D*	*37.5*	*D*	*38.1*	*D*	*43.6*	*D*	*39.1*	*D*	*41.6*	*D*
Eastbound	*12.9*	*B*	*27.9*	*C*	*23.7*	*C*	*73.6*	*E*	*206.5*	*F*	*165.3*	*F*
Westbound	*15.9*	*B*	*26.8*	*C*	*23.4*	*C*	*87.0*	*F*	*143.0*	*F*	*117.4*	*F*

5.3.1. Benton Avenue Alternative #1 (BEN-1)

Description:

This alternative includes using the right-turn lane as a lane drop for the westbound lanes. The eastbound leg consists of a dedicated left-turn, dedicated through, and a shared through/right lane. The shared through/right lane is used to gain the additional travel lane to the east of the intersection. The north and southbound legs are the same as the existing configuration. Reconstruction of Custer Avenue to the east to include five-lanes would be required.



Traffic Operations:

The delay under existing traffic volumes is similar to the existing configuration. Under projected traffic volumes, this alternative shows a minor decrease in the delay for both the School and PM peak hours. During all peak hours, the westbound direction improved over the existing configuration while the other legs degraded. Part of the increase in delay along some lanes is likely the result of adding protected northbound/southbound left-turn phasing. The westbound movement was improved by the addition of a right turn lane, allowing better throughput on the approach.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**27.9**	**C**	**36.5**	**D**	**45.7**	**D**	**74.8**	**E**	**128.3**	**F**	**123.0**	**F**
Northbound	*43.9*	*D*	*60.1*	*E*	*90.8*	*F*	*52.4*	*D*	*105.7*	*F*	*175.6*	*F*
Southbound	*41.6*	*D*	*43.3*	*D*	*41.3*	*D*	*58.6*	*E*	*66.7*	*E*	*64.0*	*E*
Eastbound	*21.9*	*C*	*27.9*	*C*	*27.2*	*C*	*86.5*	*F*	*221.5*	*F*	*190.2*	*F*
Westbound	*22.0*	*C*	*27.2*	*C*	*22.9*	*C*	*77.3*	*E*	*69.7*	*E*	*45.8*	*D*

Advantages:

- Maintains existing alignment on the northbound and southbound legs
- Signal poles could likely remain in place
- Least impactful alternative

Disadvantages

- Does not fully accommodate projected traffic volumes
- Shifts alignment of Custer Avenue to the south, reducing boulevard width between the road and the shared use path
- Potential right-of-way needed in three quadrants
- Increased crossing distance for pedestrians

Potential Barriers/Constraints:

- Potential impacts to 4(f)/6(f) property
- Potential drainage impacts due to decreased boulevard size
- Access to residents on the north side of Custer Avenue

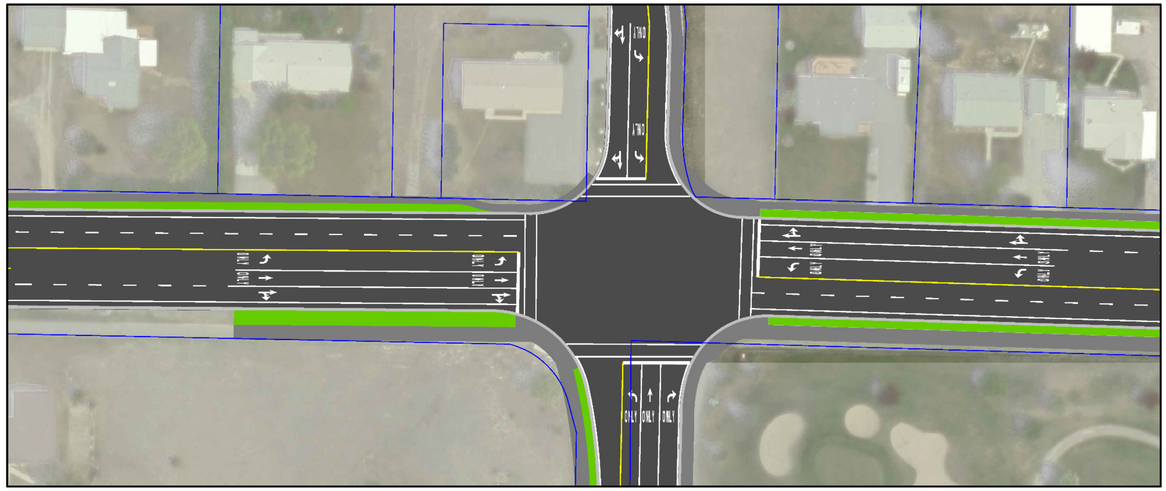
Conclusion:

- **ADVANCED** – Included in Corridor Option 2

5.3.2. Benton Avenue Alternative #2 (BEN-2)

Description:

Benton Avenue Alternative #2 includes additional through lanes in the east/west directions. The westbound leg consists of dedicated left-turn, dedicated through lane, and shared through/right-turn lane. Two receiving lanes in the westbound direction would extend to Green Meadow Drive. The eastbound leg has the same lane configuration as the westbound leg. The north and southbound legs remain the same as under existing conditions.



Traffic Operations:

This alternative is shown to operate similarly to BEN-1 under existing traffic volumes. Under projected conditions, the intersection is shown to operate with substantially less delay during all peak hours. Improvements over the existing configuration and BEN-1 are shown due to the increased capacity for the east/west through movements. The additional through lanes allow for more green time to be allocated to the northbound and southbound directions, thus reducing the delay experienced on those legs.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**24.5**	**C**	**28.9**	**C**	**41.8**	**D**	**33.8**	**C**	**58.4**	**E**	**63.3**	**E**
Northbound	*41.0*	*D*	*48.7*	*D*	*87.8*	*F*	*56.5*	*E*	*76.2*	*E*	*90.5*	*F*
Southbound	*56.9*	*E*	*43.0*	*D*	*43.4*	*D*	*70.3*	*E*	*59.9*	*E*	*48.6*	*D*
Eastbound	*16.0*	*B*	*24.2*	*C*	*21.9*	*C*	*26.0*	*C*	*64.8*	*E*	*71.8*	*E*
Westbound	*14.1*	*B*	*17.9*	*B*	*18.6*	*B*	*23.0*	*C*	*43.7*	*D*	*41.0*	*D*

Advantages:

- Maintains existing alignment on the north and south legs
- Signal poles could likely remain in place
- Mostly accommodates existing and projected traffic volumes

Disadvantages

- More construction impacts than BEN-1
- Shifts alignment of Custer Avenue to the south, reducing boulevard width between the road and the shared use path
- Potential right-of-way needed in three quadrants
- Increased crossing distance for pedestrians
- Some capacity concerns due to high volume of northbound right-turns

Potential Barriers/Constraints:

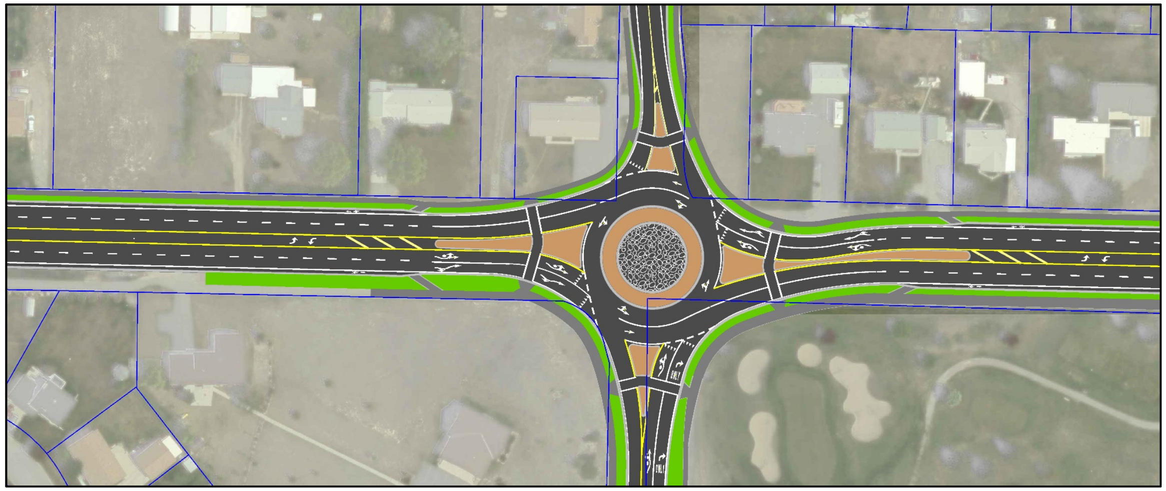
- Potential impacts to 4(f)/6(f) property
- Potential drainage impacts due to decreased boulevard size
- Access to residents on the north side of Custer Avenue

Conclusion:

- **ADVANCED** – Included in Corridor Option 3 and 4

5.3.3. Benton Avenue Alternative #3 (BEN-3)

Description:
Benton Avenue Alternative #3 calls for the construction of a four-legged multi-lane roundabout. The eastbound and westbound legs would include combined left/through and through/right-turn lanes. The northbound leg includes a shared left/through and dedicated right-turn lane. The southbound approach has a combined left/through/right-turn lane. This configuration would require reconstruction of Custer Avenue to five lanes both east and west of the intersection.



Traffic Operations:
This configuration operates at a LOS A under existing conditions and LOS C under projected conditions for all three peak hours. Under projected conditions, the southbound leg experiences higher delay in the AM peak hour, while the northbound approach experiences the highest delay during the School and PM peak hours. This is primarily due to heavy east and westbound through movements on Custer Avenue which reduces the number of acceptable gaps to enter the roundabout from the minor approaches.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**7.3**	**A**	**7.6**	**A**	**7.8**	**A**	**16.8**	**C**	**18.1**	**C**	**23.4**	**C**
Northbound	*6.9*	*A*	*8.6*	*A*	*9.5*	*A*	*14.2*	*B*	*31.3*	*D*	*51.4*	*F*
Southbound	*10.0*	*B*	*7.1*	*A*	*7.2*	*A*	*41.3*	*E*	*14.3*	*B*	*14.7*	*B*
Eastbound	*8.1*	*A*	*7.6*	*A*	*6.5*	*A*	*18.4*	*C*	*17.6*	*C*	*12.7*	*B*
Westbound	*6.1*	*A*	*7.0*	*A*	*7.4*	*A*	*9.9*	*A*	*12.1*	*B*	*14.0*	*B*

Advantages:
- Generally accommodates existing and projected traffic volumes
- Improves operations of minor traffic movements
- Improved safety

Disadvantages
- Shifts alignment of Custer Avenue to the south, reducing boulevard width between the road and the shared use path
- Most impactful alternative
- Likely impacts to residence on northeast quadrant
- Potential right-of-way needed in four quadrants

Potential Barriers/Constraints:
- Potential impacts to 4(f)/6(f) property
- Potential drainage impacts due to decreased boulevard size
- Impacts to residents on the north side of Custer Avenue

Conclusion:
- **ADVANCED** – Included in Corridor Option 5

5.4. Cooney Drive

The intersection of Cooney Drive and Custer Avenue is a three-legged signal-controlled intersection. The southbound leg of the intersection consists of a single lane allowing for left- and right-turn movements. The eastbound leg consists of dedicated through and left-turn lanes. The westbound leg consists of a single shared through/right-turn lane.

The southbound leg has relatively low traffic volumes as it serves residential and light commercial areas to the north of the intersection. It is unlikely that future development will occur on Cooney Drive as the lands accessed by the roadway are already developed. As such, it is expected that the traffic volumes will remain reasonably constant into the future. The land to the south of the intersection is part of the Bill Roberts Golf Course.

Four Georgians Elementary School is located to the east of this intersection. A crossing guard is present during the times when students are walk to and from school. The crossing guard does not control traffic flow, rather it is used to increase the visibility of the students when the traffic signal gives them a walk signal.

The intersection currently operates with little delay along the major approaches. However, at times during the AM and school peak hours, the intersection experience queue spill back from McHugh Lane. Under projected traffic conditions, the intersection is shown to experience significantly increased delay in the eastbound and westbound directions due to high traffic volumes along Custer Avenue.

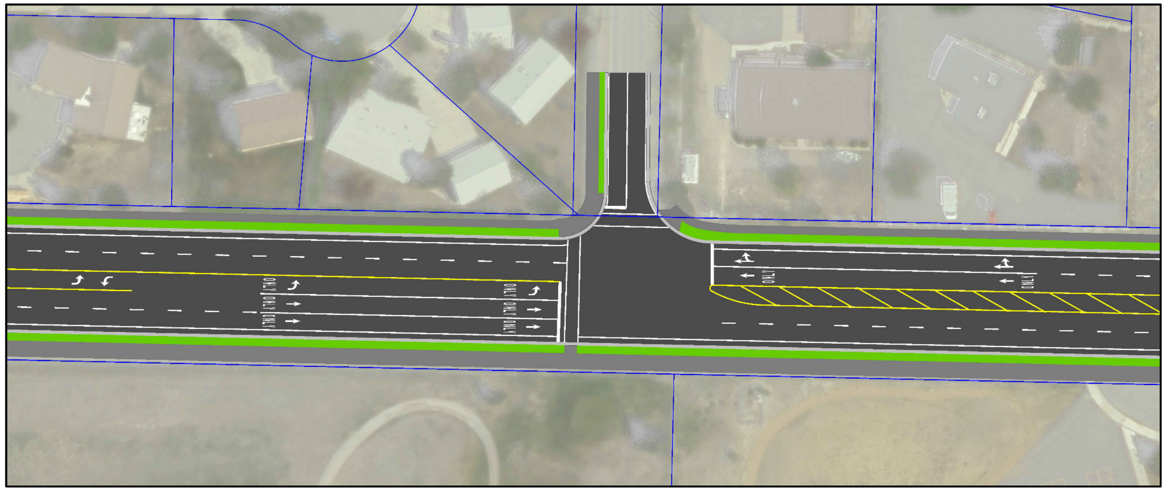
Table 5.4: Cooney Drive Intersection Traffic Operations

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**9.2**	**A**	**10.9**	**B**	**11.4**	**B**	**53.3**	**D**	**115.4**	**F**	**141.3**	**F**
Southbound	*68.7*	*E*	*68.1*	*E*	*67.5*	*E*	*66.8*	*E*	*66.1*	*E*	*65.8*	*E*
Eastbound	*6.1*	*A*	*9.6*	*A*	*11.1*	*B*	*49.3*	*D*	*175.3*	*F*	*183.9*	*F*
Westbound	*5.2*	*A*	*5.2*	*A*	*5.1*	*A*	*55.9*	*E*	*53.0*	*D*	*101.0*	*F*

5.4.1. Cooney Drive Alternative #1 (CD-1)

Description:

Cooney Drive Alternative #1 consists of the addition of east and westbound through lanes at the intersection. These lanes would be needed at the intersection if Custer Avenue were expanded to five-lanes. The southbound leg of the intersection would remain a single lane allowing both left- and right-turns.



Traffic Operations:

The existing configuration of this intersection operates at an acceptable LOS for all peak hours. This alternative would improve the projected peak hour operations by increasing east/west capacity, thereby allowing for additional green time for the southbound movements. Delay is shown to occur along the minor approach leg due to the prioritization of signal timing along Custer Avenue.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**6.6**	**A**	**5.4**	**A**	**6.9**	**A**	**7.0**	**A**	**8.1**	**A**	**8.2**	**A**
Southbound	*68.4*	*E*	*68.0*	*E*	*67.4*	*E*	*74.5*	*E*	*82.1*	*F*	*85.3*	*F*
Eastbound	*2.8*	*A*	*0.4*	*A*	*3.5*	*A*	*3.8*	*A*	*5.2*	*A*	*5.6*	*A*
Westbound	*3.1*	*A*	*3.3*	*A*	*3.5*	*A*	*4.4*	*A*	*4.8*	*A*	*4.6*	*A*

Advantages:

- Maintains existing alignment on southbound leg
- Accommodates existing and projected traffic volumes
- Signal poles could likely remain in place

Disadvantages

- Some new right-of-way may be needed
- Shifts alignment of Custer Avenue to the south, reducing boulevard width between the road and the shared use path
- Increased crossing distance for pedestrians

Potential Barriers/Constraints:

- Potential drainage impacts due to decreased boulevard size
- 4(f)/6(f) property to the south

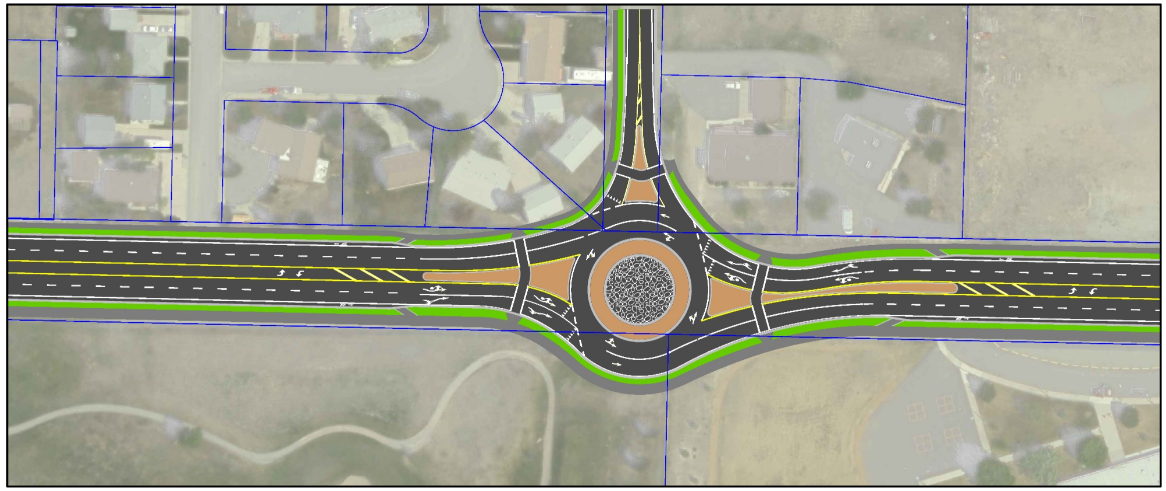
Conclusion:

- **ADVANCED** – Included in Corridor Options 2, 3, and 4

5.4.2. Cooney Drive Alternative #2 (CD-2)

Description:

Cooney Drive Alternative #2 includes construction of a multi-lane roundabout. This configuration would accommodate expansion of Cuter Avenue to five lanes. Shared left/through and through/right-turn lanes in the eastbound and westbound direction would be provided. Similar to CD-1, the eastbound and westbound legs would include two approach lanes with the southbound leg only having one. This configuration allows for continuous east and westbound through movements thereby reducing queues during the peak hours.



Traffic Operations:

This configuration is shown to operate at a LOS B or better along all approached during the existing and projected peak hours. The roundabout configuration substantially improves operations of the southbound leg due to continuous circulation.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**5.5**	**A**	**5.8**	**A**	**6.0**	**A**	**8.2**	**A**	**8.9**	**A**	**9.6**	**A**
Southbound	*6.0*	*A*	*6.3*	*A*	*6.6*	*A*	*10.9*	*B*	*11.1*	*B*	*12.5*	*B*
Eastbound	*5.6*	*A*	*6.2*	*A*	*6.4*	*A*	*8.4*	*A*	*9.9*	*A*	*10.8*	*B*
Westbound	*5.3*	*A*	*5.3*	*A*	*5.5*	*A*	*7.8*	*A*	*7.6*	*A*	*8.2*	*A*

Advantages:

- Accommodates existing and projected traffic volumes
- Improves operations of minor traffic movements
- Generally balanced delay along all approach legs
- Improved safety

Disadvantages

- Shifts alignment of Custer Avenue to the south, reducing boulevard width between the road and the shared use path
- Right-of-way potentially needed in all quadrants
- Most impactful alternative
- May impact residential and commercial developments to the north

Potential Barriers/Constraints:

- Potential drainage impacts due to decreased boulevard size
- 4(f)/6(f) property to the south

Conclusion:

- **ADVANCED** – Included in Corridor Option 5

5.5. McHugh Lane

The intersection of McHugh Lane and Custer Avenue is a four-legged signal-controlled intersection. All four legs consist of a shared through/right-turn lane and a dedicated left-turn lane. The intersection is skewed in the north/south direction.

Both residential and commercial locations are served by the intersection. Meineke Car Care Center is located in the northwest quadrant and has approaches in close proximity to the intersection. Recent residential and commercial development has occurred to the north of the intersection and is expected to continue in the future. Four Georgians Elementary School is located to the southwest of the intersection. A crossing guard is in-place during the times when students are walking to and from school. As with Cooney Drive, the crossing guard is in place to increase the visibility of the students, not direct traffic. Residential development is located southeast of the intersection.

Traffic volumes along the north approach leg have increased rapidly due to recent developments. Adjustments to signal timing and phasing has been necessary to accommodate the additional traffic, which has required some reduction in green time for Custer Avenue. The operational analysis indicates the intersection is operating at a LOS D or E during the peak hours. Long queues are common at multiple times throughout the day in both the eastbound and westbound directions. Queues at this intersection were observed to affect operations at nearby intersections. Under projected traffic conditions, the intersection is expected to experience significant delay and failing operations.

Table 5.5: McHugh Lane Intersection Traffic Operations

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**57.4**	**E**	**49.9**	**D**	**61.1**	**E**	**246.1**	**F**	**316.5**	**F**	**331.5**	**F**
Northbound	*47.1*	*D*	*54.3*	*D*	*49.4*	*D*	*51.0*	*D*	*46.2*	*D*	*44.0*	*D*
Southbound	*95.4*	*F*	*57.2*	*E*	*64.9*	*E*	*251.3*	*F*	*74.2*	*E*	*129.4*	*F*
Eastbound	*58.2*	*E*	*59.3*	*E*	*62.4*	*E*	*296.7*	*F*	*419.4*	*F*	*387.0*	*F*
Westbound	*31.4*	*C*	*33.4*	*C*	*60.6*	*E*	*235.8*	*F*	*343.5*	*F*	*411.9*	*F*

5.5.1. McHugh Lane Alternative #1 (MCH-1)

Description:

This alternative includes reconfiguration of the intersection to include dedicated left-turn, dedicated through, and shared through/right-turn lanes in the eastbound direction. In the westbound direction, dedicated left-turn, through, and right-turn lanes are provided. The dedicated right-turn lane in the westbound direction would act as a lane drop for an expanded typical section of Custer Avenue east of the intersection. The shared through/right lane in the eastbound direction would be added prior to the intersection and carried through the intersection as an additional lane on Custer Avenue. The northbound and southbound legs would remain unchanged.

Traffic Operations:

This alternative results in lower overall delay as compared to the existing configuration. Most of the improvement is on the eastbound and westbound legs. For the eastbound leg, additional through lanes help to decrease delay. On the westbound leg, separating the through and right-turn movements helps to decrease the delay incurred by those wishing to make a right turn. However, under projected traffic conditions the intersection has a failing LOS due to high traffic volumes in the westbound direction. This suggests the need for an additional westbound through lane at the intersection to accommodate projected traffic demands.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**35.5**	**D**	**30.0**	**C**	**34.2**	**C**	**109.4**	**F**	**106.4**	**F**	**140.4**	**F**
Northbound	*47.7*	*D*	*53.5*	*D*	*46.4*	*D*	*87.9*	*F*	*104.7*	*F*	*69.8*	*E*
Southbound	*58.3*	*E*	*66.8*	*E*	*69.9*	*E*	*216.9*	*F*	*222.2*	*F*	*257.9*	*F*
Eastbound	*27.8*	*C*	*21.7*	*C*	*24.4*	*C*	*61.5*	*E*	*59.4*	*E*	*74.2*	*E*
Westbound	*23.4*	*C*	*19.4*	*B*	*27.0*	*C*	*94.8*	*F*	*123.0*	*F*	*182.3*	*F*

Advantages:

- Maintains existing alignment on the north and south legs
- Last impactful alternative
- Improved traffic operations from existing configuration

Disadvantages

- Intersection remains undesirably skewed
- Does not accommodate projected traffic volumes
- Shifts alignment of Custer Avenue to the south, reducing boulevard width between the road and the shared use path
- Increased crossing distance for pedestrians

Potential Barriers/Constraints:

- Potential drainage impacts due to decreased boulevard size

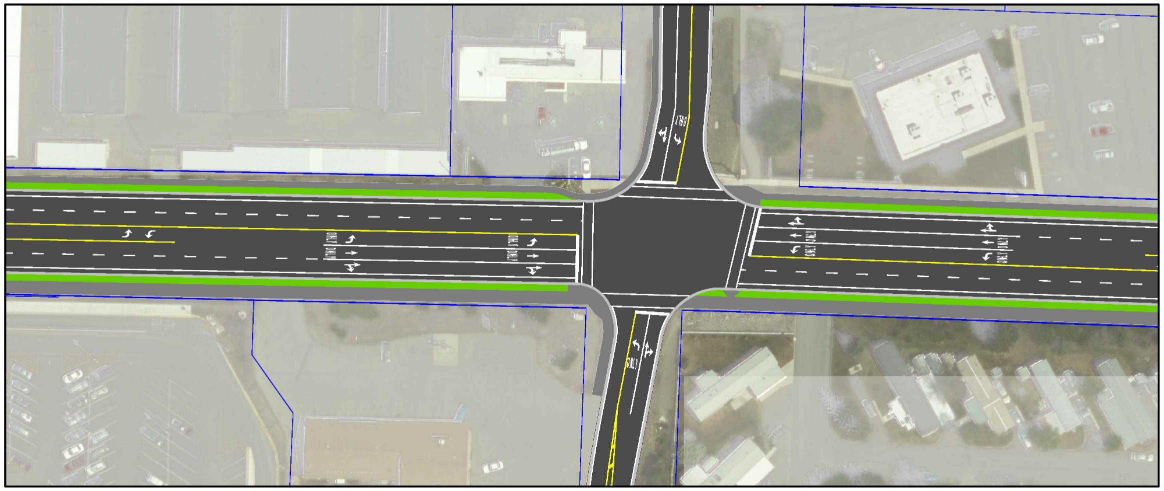
Conclusion:

- **ADVANCED** – Included in Corridor Option 1

5.5.2. McHugh Lane Alternative #2 (MCH-2)

Description:

McHugh Lane Alternative #2 is similar to the existing configuration of the intersection with the addition of one dedicated through lane in both the eastbound and westbound directions. The inclusion of additional through lanes would increase capacity along Custer Avenue. The northbound and southbound lanes would remain unchanged from their current configurations.



Traffic Operations:

Intersection delay under 2017 traffic volumes was reduced by about 20 to 30 seconds per vehicle during the peak hours compared to the existing configuration. This decrease is a result of the increased through capacity in both the eastbound and westbound directions. Under projected 2042 traffic volumes, the intersection delay decreased substantially during the peak hours. Delay in the eastbound and westbound directions are a result of the volume of both through and right-turning vehicles creating congestion with the shared lanes, indicating a need for dedicated right-turn lanes.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**33.7**	**C**	**27.8**	**C**	**29.2**	**C**	**60.3**	**E**	**57.5**	**E**	**77.7**	**E**
Northbound	*44.6*	*D*	*55.0*	*E*	*51.7*	*D*	*87.9*	*F*	*90.4*	*F*	*71.3*	*E*
Southbound	*51.5*	*D*	*50.4*	*D*	*56.1*	*E*	*81.9*	*F*	*101.8*	*F*	*114.6*	*F*
Eastbound	*29.2*	*C*	*23.0*	*C*	*22.8*	*C*	*51.6*	*D*	*52.5*	*D*	*62.5*	*E*
Westbound	*21.8*	*C*	*16.7*	*B*	*19.4*	*B*	*47.9*	*D*	*38.2*	*D*	*80.9*	*F*

Advantages:

- Maintains existing configuration on the northbound and southbound legs
- Minimal new right-of-way needed
- Limited impact to business in northwest quadrant

Disadvantages

- Projected operational issues
- Relocation of multiple signal poles and new mast arms required
- Intersection remains undesirably skewed
- Shifts alignment of Custer Avenue to the south, reducing boulevard width between the road and the shared use path
- Increased crossing distance for pedestrians

Potential Barriers/Constraints:

- Potential drainage impacts due to decreased boulevard size

Conclusion:

- **NOT ADVANCED** – Does not accommodate projected traffic volumes

5.5.3. McHugh Lane Alternative #3 (MCH-3)

Description:

McHugh Lane Alternative #3 is similar to MCH-2 with the addition of dedicated right-turn lanes in the southbound and westbound directions. Inclusion of the dedicated right-turn lanes is intended to accommodate the high volume of right-turning traffic. The additional lanes may result in some impacts to the adjacent businesses, particularly in the southbound direction. Further investigation will be needed to determine the extent of the impacts.

Traffic Operations:

This configuration is shown to generally operate at a LOS C under existing conditions. Under projected conditions, the intersection is shown to operate at a LOS D in the AM and School peak hours and LOS E in the PM peak hour. The inclusion of dedicated right-turn lanes in the southbound and westbound directions results in a reduction in an average intersection delay by more than 15 seconds compared to MCH-2 under projected conditions.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**28.9**	**C**	**25.9**	**C**	**26.6**	**C**	**45.2**	**D**	**48.4**	**D**	**57.1**	**E**
Northbound	*55.8*	*E*	*54.0*	*D*	*55.6*	*E*	*74.5*	*E*	*79.9*	*E*	*75.6*	*E*
Southbound	*41.1*	*D*	*43.5*	*D*	*45.1*	*D*	*48.5*	*D*	*81.5*	*F*	*118.3*	*F*
Eastbound	*24.7*	*C*	*22.9*	*C*	*22.7*	*C*	*47.1*	*D*	*49.1*	*D*	*49.5*	*D*
Westbound	*15.5*	*B*	*14.2*	*B*	*16.0*	*B*	*32.8*	*C*	*26.4*	*C*	*33.9*	*C*

Advantages:

- Generally accommodates existing and projected traffic demands
- Maintains existing alignment of the northbound leg

Disadvantages

- Additional right-of-way likely required
- Relocation of multiple signal poles and new mast arms required
- Intersection remains undesirably skewed
- Shifts alignment of Custer Avenue to the south, reducing boulevard width between the road and the shared use path
- Increased crossing distance for pedestrians

Potential Barriers/Constraints:

- Close proximity of businesses in the northwest and northeast quadrants
- Potential drainage impacts due to decreased boulevard size

Conclusion:

- **ADVANCED** – Included in Corridor Options 2, 3, and 4

5.5.4. McHugh Lane Alternative #4 (MCH-4)

Description:

McHugh Lane Alternative #4 calls for the construction of a four-legged multi-lane roundabout. This configuration would accommodate reconstruction of Custer Avenue to five lanes. The eastbound and westbound legs would include combined left/through and through/right-turn lanes. The southbound leg includes a shared left/through lane and a dedicated right-turn lane. Th northbound leg is a combined left/through/right-turn lane.

Traffic Operations:

This configuration operates at a LOS A during all peak hours under existing conditions. Under projected conditions, the intersection is expected to operate at a LOS C during the AM and School peak hours and LOS D during the PM peak hour. The northbound leg experienced the highest amount of delay due to the high volume of eastbound traffic resulting in limited available gaps.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**8.2**	**A**	**8.2**	**A**	**8.8**	**A**	**21.3**	**C**	**22.0**	**C**	**27.2**	**D**
Northbound	*10.2*	*B*	*12.3*	*B*	*12.8*	*B*	*35.0*	*E*	*69.8*	*F*	*72.5*	*F*
Southbound	*8.6*	*A*	*7.3*	*A*	*8.3*	*A*	*28.4*	*D*	*17.0*	*C*	*25.5*	*D*
Eastbound	*8.6*	*A*	*8.0*	*A*	*8.5*	*A*	*22.6*	*C*	*19.9*	*C*	*27.3*	*D*
Westbound	*6.6*	*A*	*7.6*	*A*	*8.4*	*A*	*11.4*	*B*	*14.9*	*B*	*19.3*	*C*

Advantages:

- Generally accommodates existing and projected traffic volumes
- Improves operations of minor traffic movements
- Improved safety

Disadvantages

- Shifts alignment of Custer Avenue to the south, reducing boulevard width between the road and the shared use path
- Right-of-way potentially needed in all quadrants
- Most impactful alternative
- May impact adjacent business and residential buildings

Potential Barriers/Constraints:

- Substantial site impacts to Meineke Car Care Center
- Residential buildings on southeast quadrant
- Potential drainage impacts due to decreased boulevard size

Conclusion:

- **ADVANCED** – Included in Corridor Option 5

5.6. Villard Avenue

The intersection of Villard Avenue and Custer Avenue is currently a three-legged intersection with stop control along the northbound leg. The northbound leg consists of a single lane allowing for left- and right-turn movements. The eastbound leg consists of a single shared through/right-turn lane. The westbound leg consists of dedicated left-turn and through lanes. A development is under construction that will add a southbound leg. All analysis of this intersection has accounted for this new leg and development.

Villard Avenue is a major collector off-system roadway. The corridor provides access to residential and commercial developments. Villard Avenue connects to Last Chance Gulch to the south.

Existing traffic flows are heavily dominated by through traffic in the eastbound and westbound directions. These movements can cause excessive delay for minor street traffic wishing to turn onto Custer Avenue. At times, particularly during the PM peak hour, this intersection experiences queue spillover from the intersection with McHugh Lane in the westbound direction.

A signal warrant evaluation shows that this intersection meets warrants numbers 1, 2, 6, and 8. The first two warrants are for vehicular volumes. Warrant 6 is for a signal that would be part of a coordinated signal system, of which this intersection would be part of if a signal were installed. Warrant 8 is met because a signal here would help to encourage the use of this intersection over other, possibly less desirable, intersections due to excessive delay incurred at Villard Avenue.

The intersection currently operates at a failing LOS due to the lack of available gaps in the Custer Avenue traffic stream for vehicles along Villard Avenue. As traffic volumes increase, the intersection is projected to continue to experience severe delay and congestion issues along the minor approaches.

Table 5.6: Villard Avenue Intersection Traffic Operations

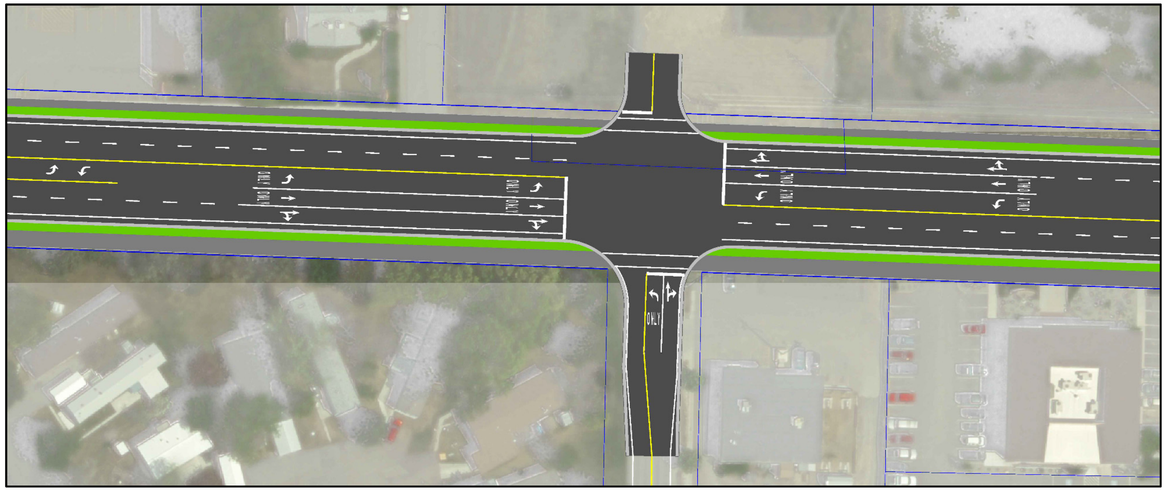
	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total**	**59.6**	**F**	**113.7**	**F**	**123.1**	**F**	*	**F**	*	**F**	*	**F**
Northbound	*56.2*	*F*	*113.7*	*F*	*109.7*	*F*	*	*F*	*	*F*	*	*F*
Southbound	*59.6*	*F*	*84.6*	*F*	*123.1*	*F*	*1,299.7*	*F*	*	*F*	*	*F*
Eastbound	*0.1*	*A*	*0.1*	*A*	*0.1*	*A*	*0.1*	*A*	*0.1*	*A*	*0.1*	*A*
Westbound	*0.8*	*A*	*0.6*	*A*	*1.0*	*A*	*0.8*	*A*	*0.7*	*A*	*1.1*	*A*

** Unable to calculate due to computational limits.*
*** Intersection delay represents the delay of the worst movement, not the average.*

5.6.1. Villard Avenue Alternative #1 (VA-1)

Description:

Villard Avenue Alternative #1 would result in installation of a traffic signal. Additionally, the east and westbound legs will be expanded to include dedicated left-turn, dedicated through, and shared through/right lanes. The additional through lanes would increase capacity along Custer Avenue. The northbound leg would be reconfigured to include a dedicate left-turn lane and a share through/right lane. The southbound leg is a private business approach and would consist of a single lane allowing all movements.



Traffic Operations:

Eastbound and westbound traffic would experience minor increases in delay resulting from installation of a traffic signal. However, both approaches would operate at a LOS A under existing and projected conditions. The northbound and southbound directions would operate considerably better with installation of a traffic signal, although still at a failing LOS under projected conditions due prioritization of signal timing along Custer Avenue. The northbound leg experiences the highest amount of delay due to a high volume of right-turn movements. Adjustments to the signal timing may result in reduced delay for this movement.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**5.8**	**A**	**7.8**	**A**	**7.7**	**A**	**6.3**	**A**	**6.4**	**A**	**7.6**	**A**
Northbound	*62.9*	*E*	*42.9*	*D*	*46.2*	*D*	*72.3*	*E*	*78.6*	*E*	*113.9*	*F*
Southbound	*53.9*	*D*	*38.8*	*D*	*39.5*	*D*	*58.2*	*E*	*59.2*	*E*	*63.4*	*E*
Eastbound	*0.9*	*A*	*2.0*	*A*	*1.7*	*A*	*1.2*	*A*	*2.3*	*A*	*1.3*	*A*
Westbound	*2.7*	*A*	*8.4*	*A*	*8.1*	*A*	*4.2*	*A*	*0.9*	*A*	*0.1*	*A*

Advantages:

- Accommodates existing and projected traffic volumes
- Provides significant traffic improvements along Villard Avenue
- Multiple traffic signal warrants are met at the intersection
- Provides protected crossing opportunity for pedestrians

Disadvantages

- Will create induced delay along Custer Avenue with traffic signal
- May impact business on north side
- Shifts alignment of Custer Avenue to the south, reducing boulevard width between the road and the shared use path

Potential Barriers/Constraints:

- Business on north approach leg
- Potential drainage impacts due to decreased boulevard size

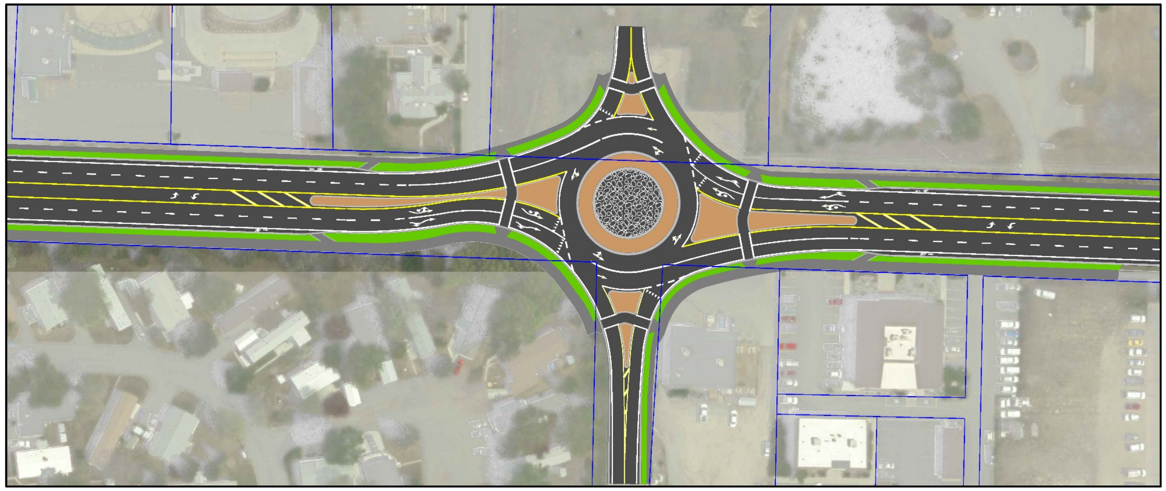
Conclusion:

- **ADVANCED** – Included in Corridor Options 1, 2, 3, and 4

5.6.2. Villard Avenue Alternative #2 (VA-2)

Description:

Villard Avenue Alternative #2 includes construction of a four-leg multi-lane roundabout. Similar to VA-1, the eastbound and westbound legs would include two lanes in each direction. Shared left/through and through/right-turn lanes are provided in the eastbound and westbound directions. A combined left/through/right-turn is provided on the northbound and southbound lanes.



Traffic Operations:

This configuration operates at a LOS B or better under existing and projected peak hour conditions. The eastbound and westbound directions are shown to experience minor increases in delay compared to VA-1, while the north and southbound approaches experience considerable reductions in delay. This is due to slight shifts in priority of entering vehicles in the intersection during the peak hours. The northbound approach experiences the most delay during all peak hours under both existing and projected conditions.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**5.9**	**A**	**6.2**	**A**	**6.5**	**A**	**9.2**	**A**	**10.5**	**B**	**11.5**	**B**
Northbound	*6.6*	*A*	*8.1*	*A*	*8.6*	*A*	*13.0*	*B*	*21.5*	*C*	*24.5*	*C*
Southbound	*5.3*	*A*	*5.6*	*A*	*5.8*	*A*	*8.4*	*A*	*8.8*	*A*	*9.2*	*A*
Eastbound	*6.4*	*A*	*6.6*	*A*	*6.9*	*A*	*10.1*	*B*	*11.5*	*B*	*12.8*	*B*
Westbound	*5.3*	*A*	*5.6*	*A*	*5.6*	*A*	*7.7*	*A*	*8.0*	*A*	*8.2*	*A*

Advantages:

- Accommodates existing and projected traffic volumes
- Improves operations of minor traffic movements

Disadvantages

- Shifts alignment of Custer Avenue to the south, reducing boulevard width between the road and the shared use path
- Right-of-way potentially needed in all quadrants
- Most impactful alternative
- Would likely impact the new business on the north side

Potential Barriers/Constraints:

- Business on north approach leg
- Potential drainage impacts due to decreased boulevard size
- Residential development in southwest quadrant
- Commercial development in southeast quadrant

Conclusion:

- **ADVANCED** – Included in Corridor Option 5

5.7. Montana Avenue

The intersection of Montana Avenue and Custer Avenue is a major high-volume signalized intersection. The eastbound and northbound legs consist of a dedicated left-turn lane, two through lanes, and a dedicated right-turn lane. The westbound leg consists of two dedicated left-turn lanes, a single through lane, and a dedicated right-turn lane that acts to drop a lane. The southbound leg consists of a single left-turn lane, a dedicated through lane, and a shared through/right-turn lane. Dual eastbound left-turn lanes are planned in the near future.

Montana Avenue is an urban minor arterial roadway and is a major north/south commercial corridor. Commercial businesses are located on all quadrants of the intersection. There are business approaches and other intersections located in close proximity to the intersection which are impacted by operations at the intersection.

The intersection experiences a high volume of traffic in almost all directions. The southbound left-turn lane in particular commonly has queue lengths that exceed available capacity. These queues can lead to lane starvation for the dedicated southbound through lane. In the westbound direction, queues in the through lane can block the dual left-turn lanes.

Under existing traffic conditions, the intersection is shown to operate at a LOS D during the AM and School peak hours and LOS E during the PM peak hour. Long queues and vehicle delay has been noted for westbound throughs during the AM, and southbound lefts and eastbound throughs during the PM. The intersection is projected to fail due to anticipated future growth.

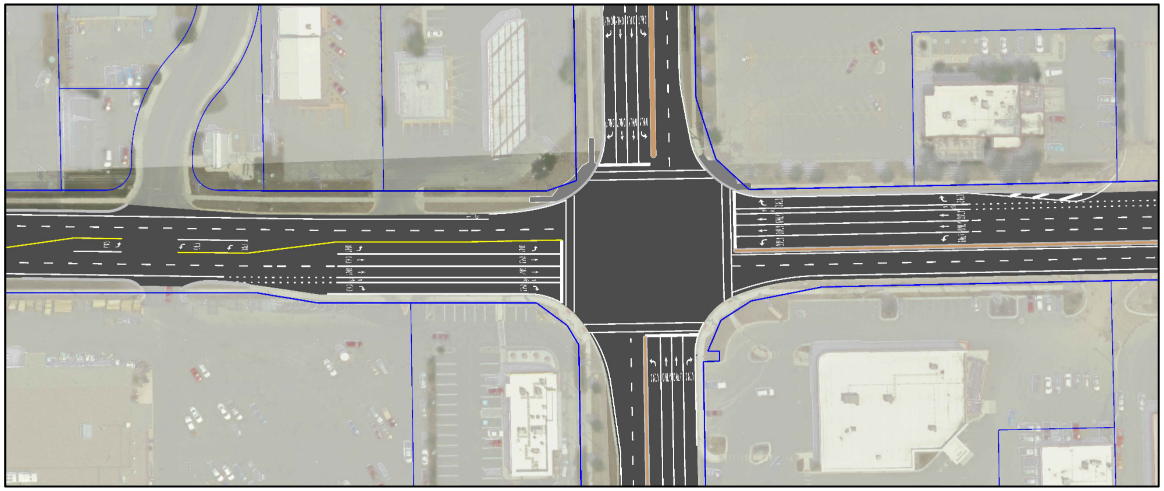
Table 5.7: Montana Avenue Intersection Traffic Operations

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**48.2**	**D**	**50.2**	**D**	**58.0**	**E**	**152.1**	**F**	**137.2**	**F**	**173.5**	**F**
Northbound	*34.0*	*C*	*43.9*	*D*	*56.7*	*E*	*56.9*	*E*	*56.7*	*E*	*68.0*	*E*
Southbound	*40.3*	*D*	*55.7*	*E*	*67.4*	*E*	*75.4*	*E*	*163.7*	*F*	*158.3*	*F*
Eastbound	*41.1*	*D*	*50.1*	*D*	*56.9*	*E*	*127.7*	*F*	*166.9*	*F*	*238.2*	*F*
Westbound	*68.0*	*E*	*51.7*	*D*	*54.2*	*D*	*271.1*	*F*	*146.4*	*F*	*194.5*	*F*

5.7.1. Montana Avenue Alternative #1 (MT-1)

Description:

Montana Avenue Alternative #1 would reconfigure the intersection so that all of the legs consist of dedicated left-turn, dedicated right-turn, and two dedicated through lanes. The signal timing would be modified so that all left-turn phases allow for both protected and permissive movement. All right-turn phases would allow for overlapped operations with the non-conflicting left-turn phases. An additional receiving lane would be required for the westbound traffic. Compared to the existing configuration, this alternative would add a dedicated southbound right-turn lane and would remove the dual westbound left-turn lanes and replace them with a single lane.



Traffic Operations:

This alternative compares similarly to the existing configuration under existing traffic volumes. Under projected conditions, overall delay is reduced by approximately 90 seconds in the AM peak hour and by approximately 50 seconds in the School and PM peak hours. The reduction in delay is primarily due to increased westbound throughput and the inclusion of a southbound right-turn lane. A high volume of left-turning traffic in all directions is shown to result in long queue lengths, likely to exceed available storage length. This alternative would allow for protected/permissive left-turn phasing which is more efficient than protected-only phasing utilized for dual left-turn lanes but would have reduced capacity and storage.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**37.2**	**D**	**44.2**	**D**	**50.3**	**D**	**66.4**	**E**	**92.7**	**F**	**117.1**	**F**
Northbound	*30.7*	*C*	*38.2*	*D*	*47.4*	*D*	*52.1*	*D*	*61.5*	*E*	*80.7*	*F*
Southbound	*31.8*	*C*	*39.3*	*D*	*48.3*	*D*	*60.9*	*E*	*118.1*	*F*	*136.4*	*F*
Eastbound	*53.4*	*D*	*57.3*	*E*	*60.4*	*E*	*84.8*	*F*	*111.7*	*F*	*162.1*	*F*
Westbound	*32.1*	*C*	*42.2*	*D*	*45.7*	*D*	*59.5*	*E*	*77.7*	*E*	*87.3*	*F*

Advantages:

- Least impactful alternative
- Appears to fit within existing right-of-way
- Accommodates existing traffic demands
- Most efficient traffic signal timing

Disadvantages

- Does not fully accommodate projected traffic demands
- May not provide ample left-turn lane storage
- Driveway access to the gas station on the northwest quadrant is on a taper

Potential Barriers/Constraints:

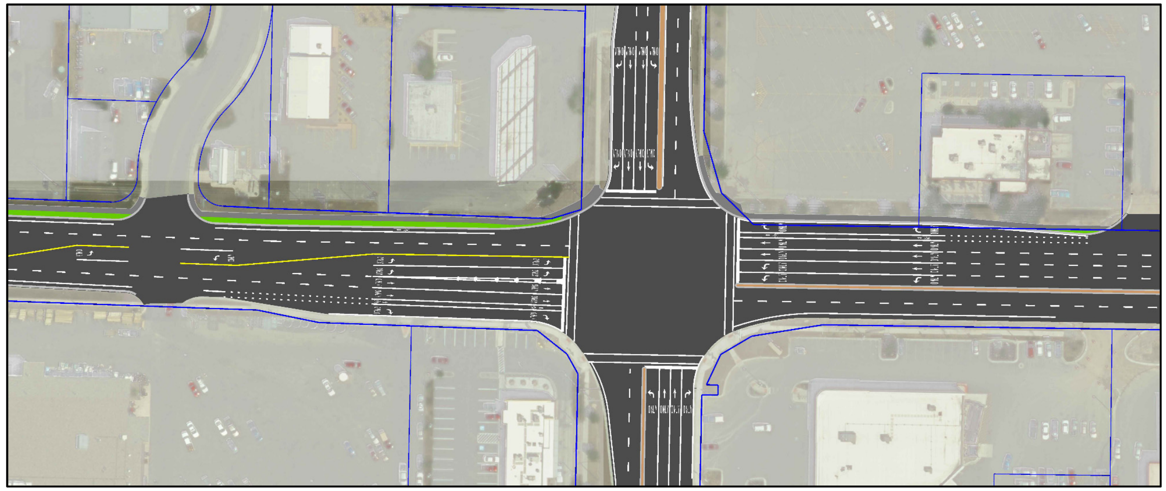
- Potential impacts to business on northwest corner

Conclusion:

- **NOT ADVANCED** – Does not accommodate projected traffic volumes

5.7.2. Montana Avenue Alternative #2 (MT-2)

Description:
Montana Avenue Alternative #2 reconfigures the intersection similarly to MT-1 but includes the addition of dual left-turn lanes in the east and westbound directions. With dual left-turn lanes, it is necessary for the east and westbound left-turn phase to be protected only. This configuration results in a less efficient signal timing plan but would increase capacity for eastbound and westbound left-turning vehicles. As with MT-1, an additional receiving lane would be required for the westbound traffic.



Traffic Operations:
This alternative performs similarly to MT-1 under existing traffic volumes. Some minor improvements to delay are realized due to the increased capacity for eastbound and westbound left-turns. Under projected minor reductions in delay are realized during the AM and school peak hours. Delay is reduced by 55 seconds during the PM peak hour under projected volumes compared to MT-1.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**37.1**	**D**	**43.5**	**D**	**43.2**	**D**	**56.8**	**E**	**82.4**	**F**	**61.2**	**E**
Northbound	*27.8*	*C*	*32.0*	*C*	*34.4*	*C*	*43.6*	*D*	*61.0*	*E*	*38.4*	*D*
Southbound	*28.3*	*C*	*32.7*	*C*	*35.4*	*D*	*56.1*	*E*	*109.9*	*F*	*56.4*	*E*
Eastbound	*51.1*	*D*	*62.5*	*E*	*54.8*	*D*	*79.9*	*E*	*99.5*	*F*	*86.6*	*F*
Westbound	*38.6*	*D*	*46.1*	*D*	*46.4*	*D*	*41.2*	*D*	*60.4*	*E*	*55.3*	*E*

Advantages:
- Accommodates existing traffic demands
- Provides increased capacity and storage for eastbound and westbound left-turns
- Minimal impacts to northwest, southwest, and southeast quadrants

Disadvantages
- More impactful than MT-1
- Some new right-of way may be needed
- Does not fully accommodate projected traffic demands
- May not provide ample storage for southbound left-turns
- Less efficient signal timing

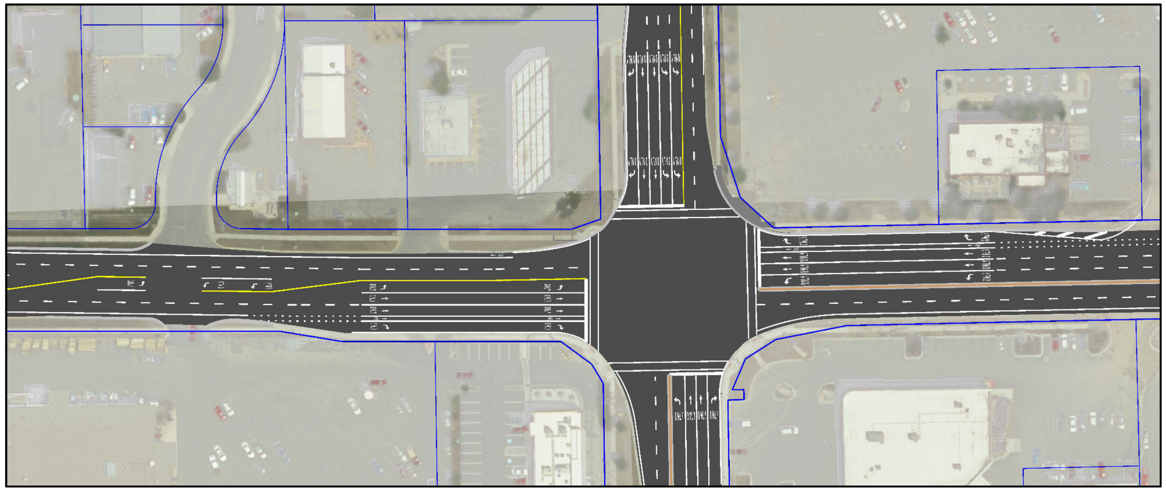
Potential Barriers/Constraints:
- Potential impacts to business on the northeast quadrant

Conclusion:
- **ADVANCED** – Included in Corridor Options 1, 2, 3, 4, and 5

5.7.3. Montana Avenue Alternative #3 (MT-3)

Description:

This alternative is similar to MT-1 but includes dual left-turn lanes in the southbound direction. All other lanes include designated left-turn, dual through, and designated right-turn lanes. This alternative is intended to help accommodate the high volume of southbound left-turning vehicles. The existing southbound left-turn lane often experiences overflow which blocks the inside through lane and creates operational and safety issues.



Traffic Operations:

This alternative operates similarly to the MT-1 and MT-2 alternatives. Average delay is slightly higher than MT-1, with the exception of the school peak hour under projected conditions. The inclusion of the second southbound left-turn lane provides little benefit to overall traffic operations at the intersection. The additional lane would, however, provide additional capacity and storage for the southbound left-turn movement at the expense of some signal timing efficiency.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**43.1**	**D**	**46.3**	**D**	**49.3**	**D**	**76.7**	**E**	**75.4**	**E**	**87.0**	**F**
Northbound	*29.9*	*C*	*36.7*	*D*	*45.7*	*D*	*52.7*	*D*	*76.5*	*E*	*47.8*	*D*
Southbound	*46.3*	*D*	*51.5*	*D*	*57.1*	*E*	*95.4*	*F*	*87.5*	*F*	*113.6*	*F*
Eastbound	*53.9*	*D*	*56.5*	*E*	*58.1*	*E*	*91.6*	*F*	*81.6*	*F*	*113.0*	*F*
Westbound	*36.4*	*D*	*42.2*	*D*	*39.9*	*D*	*54.2*	*D*	*59.4*	*E*	*73.8*	*E*

Advantages:

- Maintains existing roadway on eastbound and westbound legs with only minor curb and paint modifications
- Minor right-of-way needed on northeast and northwest quadrants
- Accommodates existing traffic demands
- Signal poles could likely remain in place
- Additional capacity for southbound left-turns

Disadvantages

- Requires lane shift on westbound leg
- Potential impacts to business and access on northwest quadrant
- May not provide ample left-turn lane storage for eastbound and westbound directions
- Does not fully accommodate projected traffic demands
- Some new right-of-way may be needed

Potential Barriers/Constraints:

- Potential impacts to business on the northeast quadrant

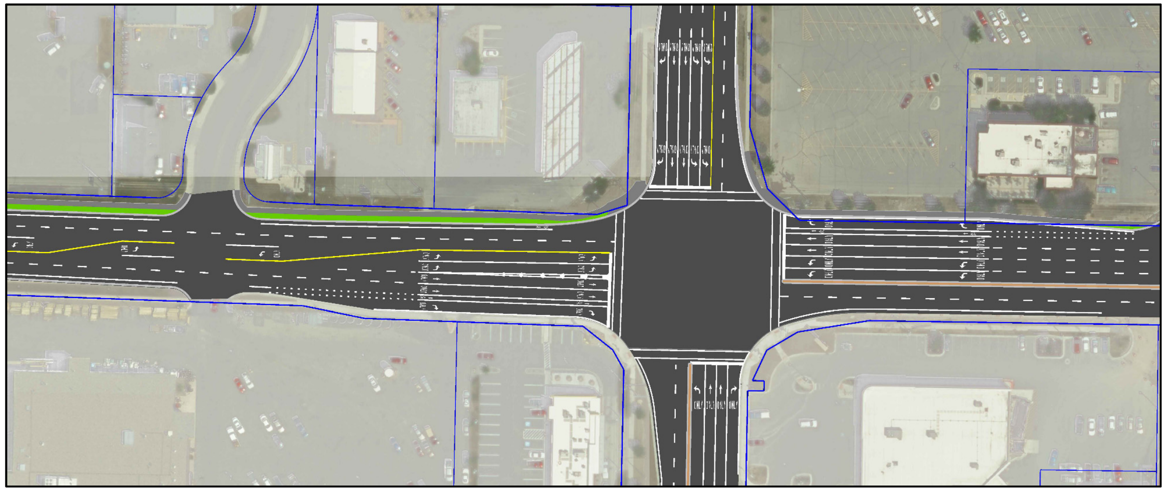
Conclusion:

- **NOT ADVANCED** – More impactful than MT-2 with similar operations

5.7.4. Montana Avenue Alternative #4 (MT-4)

Description:

Montana Avenue Alternative #4 is a combination of MT-2 and MT-3 with dual left-turn lanes in the eastbound, westbound, and southbound directions. As with Alternatives 2 and 3, the signal phasing for the dual left turns must be protected only. As with the other alternatives, an additional receiving lane would be required for the westbound traffic. This additional lane would be extended to the west based on the demands on downstream intersections.



Traffic Operations:

This alternative operates similarly to the other alternatives previously discussed. While this alternative generally performs the best under projected peak hour conditions, there is some increased delay during the other times due to the inefficiencies of protected-only left-turns.

	2017						2042					
	AM		School		PM		AM		School		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Total	**42.3**	**D**	**51.2**	**D**	**51.7**	**D**	**60.7**	**E**	**60.9**	**E**	**62.9**	**E**
Northbound	*67.3*	*E*	*65.6*	*E*	*63.2*	*E*	*92.5*	*F*	*81.2*	*F*	*105.3*	*F*
Southbound	*32.9*	*C*	*40.6*	*D*	*47.1*	*D*	*54.9*	*D*	*26.1*	*C*	*15.0*	*B*
Eastbound	*50.6*	*D*	*60.5*	*E*	*62.1*	*E*	*79.5*	*E*	*85.2*	*F*	*82.9*	*F*
Westbound	*35.2*	*D*	*37.9*	*D*	*35.6*	*D*	*39.7*	*D*	*46.2*	*D*	*40.8*	*D*

Advantages:

- Maintains existing alignment of northbound leg
- Provides additional left-turn capacity for eastbound, westbound, and southbound directions
- Best performing alternative under projected conditions

Disadvantages

- Most impactful alternative
- Some new mast arms and signal poles would be required
- Additional right-of-way likely needed on the westbound leg and in the northwest and northeast quadrants
- Does not fully accommodate projected traffic demands
- Some increase in delay under existing traffic volumes due to signal inefficiencies

Potential Barriers/Constraints:

- Potential impacts to business on the northeast quadrant

Conclusion:

- **NOT ADVANCED** – Most impactful alternative with only minor improvement to operations

5.8. Intersection Improvement Options Summary

A full range of improvement options were developed for analysis based on existing and projected traffic conditions and area needs. The improvement options identified previously were based on corridor needs, existing traffic operations, projected future growth, and identified constraints. **Table 5.8** summarizes the improvement options and identified actions. Those advanced for further consideration are discussed in more detail as part of corridor-wide evaluation in **Section 6**.

Table 5.8: Improvement Options Summary

Intersection	Option	Level of Service (AM/School/PM)		Action
		2017	2042	
Henderson Street	Existing Configuration	F / D / E	F / F / F	NOT ADVANCED
	Alternative #1	A / A / A	C / C / C	ADVANCED – Included in Corridor options 1, 2, 3
	Alternative #2	A / A / A	C / B / C	ADVANCED – Included in Corridor options 4, 5
Green Meadow Drive	Existing Configuration	E / C / C	F / F / F	NOT ADVANCED
	Alternative #1	C / C / C	E / F / D	ADVANCED – Included in Corridor Options 1 and 2
	Alternative #2	C / C / B	E / E / D	NOT ADVANCED
	Alternative #3	C / C / B	C / D / C	ADVANCED – Included in Corridor Option 3
	Alternative #4	C / C / B	C / D / C	ADVANCED – Included in Corridor Option 4
	Alternative #5	A / A / A	C / B / B	ADVANCED – Included in Corridor Option 5
Benton Avenue	Existing Configuration	C / C / D	E / F / F	ADVANCED – Modified and included in Option 1
	Alternative #1	C / D / D	E / F / F	ADVANCED – Included in Corridor Option 2
	Alternative #2	C / C / D	C / E / E	ADVANCED – Included in Corridor Option 3 and 4
	Alternative #3	A / A / A	C / C / C	ADVANCED – Included in Corridor Option 5
Cooney Drive	Existing Configuration	A / B / B	D / F / F	ADVANCED – Included in Corridor Option 1
	Alternative #1	A / A / A	A / A / A	ADVANCED – Included in Corridor Options 2, 3, and 4
	Alternative #2	A / A / A	A / A / A	ADVANCED – Included in Corridor Option 5
McHugh Lane	Existing Configuration	E / D / E	F / F / F	NOT ADVANCED
	Alternative #1	D / C / C	F / F / F	ADVANCED – Included in Corridor Option 1
	Alternative #2	C / C / C	E / E / E	NOT ADVANCED
	Alternative #3	C / C / C	D / D / E	ADVANCED – Included in Corridor Options 2, 3, and 4
	Alternative #4	A / A / A	C / C / D	ADVANCED – Included in Corridor Option 5
Villard Avenue	Existing Configuration	F / F / F	F / F / F	NOT ADVANCED
	Alternative #1	A / A / A	A / A / A	ADVANCED – Included in Corridor Options 1, 2, 3, and 4
	Alternative #2	A / A / A	A / B / B	ADVANCED – Included in Corridor Option 5
Montana Avenue	Existing Configuration	D / D / E	F / F / F	NOT ADVANCED
	Alternative #1	D / D / D	E / F / F	NOT ADVANCED
	Alternative #2	D / D / D	E / F / E	ADVANCED – Included in Corridor Options 1, 2, 3, 4, and 5
	Alternative #3	D / D / D	E / E / F	NOT ADVANCED
	Alternative #4	D / D / D	E / E / E	NOT ADVANCED

6.0. CORRIDOR-WIDE IMPROVEMENT OPTIONS

The improvement options identified for advancement in the previous section were evaluated in more detail as part of a corridor-wide scenario analysis. Traffic models for each corridor option were developed to evaluate network conditions. Each scenario represents an incremental approach to improving the project corridor. While the scenarios were developed as models for the Custer Avenue corridor between Henderson Street and Washington Street, no modifications were made to the intersections to the east of Montana Avenue as they are outside of the project area. Signal timing for all intersections was optimized using *Synchro* for the entire network as a single coordinated network.

A variety of traffic performance metrics were used to compare the scenarios. These metrics allow for a comparison of each scenario. The following sub-sections present an overview of each corridor configuration, the resulting performance metrics, and a comparison of existing and projected traffic volumes. A summary of the options follows with a comparison and discussion of each metric between each scenario.

6.1. Corridor 0 – No Action

Corridor 0 represents the existing geometric configuration of the Custer Avenue corridor with the addition of a southbound leg at Villard Avenue currently under construction. This option represents the "no action" scenario. Traffic control at each intersection is maintained as it currently exists. Existing traffic conditions were used to calibrate this model to ensure that it operates similarly to the real-world conditions seen during data collection. The results for this corridor alternative are presented in **Table 6.1** and serve as a baseline for comparison for all the other corridor alternatives.

Table 6.1: Corridor 0 Network Performance Results

Performance Measure			2017			2042		
			AM	School	PM	AM	School	PM
Network Average		Delay per Vehicle (s/veh)	789	863	1,240	1,899	2,141	2,604
		Stops per Vehicle	15	16	19	11	9	9
		Average Speed (mph)	17	17	15	5	4	3
		Fuel Used (gal)	122	127	155	323	402	521
Travel Time (s) (95th Percentile Queue [ft])	Eastbound	Henderson St to Green Meadow Dr	57 (200)	55 (194)	52 (178)	569 (2439)	727 (2223)	935 (2203)
		Green Meadow Dr to Benton Ave	43 (236)	46 (274)	51 (317)	337 (1543)	526 (1385)	652 (1334)
		Benton Ave to Cooney Dr	31 (179)	33 (173)	34 (207)	237 (1161)	224 (1134)	256 (1209)
		Cooney Dr to McHugh Ln	82 (844)	65 (582)	64 (595)	211 (1299)	273 (1360)	277 (1423)
		McHugh Ln to Villard Ave	36 (24)	34 (26)	36 (25)	36 (23)	143 (1542)	210 (1681)
		Villard Ave to Montana Ave	61 (261)	69 (320)	82 (463)	60 (293)	223 (1822)	359 (1848)
		Eastbound Total	**310**	**302**	**319**	**1,450**	**2,116**	**2,689**
	Westbound	Montana Ave to Villard Ave	36 (77)	36 (50)	39 (136)	82 (1164)	219 (1701)	266 (1597)
		Villard Ave to McHugh Ln	54 (460)	56 (534)	105 (1103)	163 (1386)	182 (1272)	177 (1333)
		McHugh Ln to Cooney Dr	36 (206)	49 (311)	40 (294)	42 (324)	55 (478)	45 (367)
		Cooney Dr to Benton Ave	37 (236)	41 (208)	43 (294)	50 (428)	54 (356)	47 (360)
		Benton Ave to Green Meadow Dr	42 (198)	41 (215)	43 (278)	57 (361)	66 (476)	58 (432)
		Green Meadow Dr to Henderson St	41 (20)	41 (27)	42 (49)	45 (93)	44 (50)	44 (52)
		Westbound Total	**246**	**264**	**312**	**439**	**620**	**637**

Network wide performance is generally poor under the existing traffic and geometric conditions. The capacity of Custer Avenue is limited by the presence of only one through travel lane at all intersections except for Montana Avenue. Under projected conditions, the delay per vehicle more than doubles for both peak hour periods. While the number of stops per vehicle actually decreases between the 2017 and 2042 simulations, this is a result of the vehicles being stopped for longer periods under the projected traffic conditions. This can be confirmed by noting that the average speed decreased, and the fuel used increased. Travel times and 95th percentile queue lengths both increased between every intersection pair in both directions. Both of these results also help to explain the decreased number of stops per vehicle.

6.2. Corridor 1 – Expanded to McHugh Lane

Corridor 1 represents the expansion of Custer Avenue to five lanes between Montana Avenue and McHugh Lane. To facilitate this expansion, Montana Avenue would be configured as shown in MT-2, Villard Avenue would be configured as shown in VA-1, and McHugh Lane would be configured as shown in MCH-1. West of McHugh Lane, Custer Avenue would remain a three-lane facility with a center TWTL. Cooney Drive would remain in its existing configuration. To improve traffic flow at Benton Avenue, a dedicated westbound right-turn lane was added to the existing configuration. At Green Meadow Drive, configuration GM-1 was used. Henderson Street was configured as a roundabout as shown in HEN-1. The results for this alternative are presented in **Table 6.3**.

Table 6.2: Corridor 1 Network Performance Results

Performance Measure			2017			2042		
			AM	School	PM	AM	School	PM
Network Average		Delay per Vehicle (s/veh)	649	780	761	1,273	1,527	1,979
		Stops per Vehicle	14	16	14	13	14	15
		Average Speed (mph)	19	18	17	11	9	7
		Fuel Used (gal)	119	126	148	237	246	356
Travel Time (s) (95th Percentile Queue [ft])	Eastbound	Henderson St to Green Meadow Dr	55 (176)	54 (210)	49 (170)	81 (623)	241 (2333)	291 (2278)
		Green Meadow Dr to Benton Ave	44 (249)	45 (264)	49 (307)	73 (915)	202 (1516)	220 (1391)
		Benton Ave to Cooney Dr	29 (134)	34 (243)	35 (285)	43 (468)	72 (906)	78 (972)
		Cooney Dr to McHugh Ln	49 (194)	50 (166)	49 (185)	72 (342)	69 (286)	63 (302)
		McHugh Ln to Villard Ave	34 (96)	36 (131)	36 (121)	35 (112)	41 (353)	45 (435)
		Villard Ave to Montana Ave	66 (270)	78 (313)	81 (376)	72 (470)	107 (1043)	157 (1447)
		Eastbound Total	**277**	**297**	**299**	**376**	**732**	**854**
	Westbound	Montana Ave to Villard Ave	38 (133)	43 (218)	45 (252)	48 (321)	46 (263)	124 (1099)
		Villard Ave to McHugh Ln	48 (385)	45 (344)	56 (470)	106 (1255)	93 (1320)	156 (1616)
		McHugh Ln to Cooney Dr	36 (205)	45 (189)	38 (163)	46 (393)	48 (255)	41 (261)
		Cooney Dr to Benton Ave	35 (199)	36 (176)	35 (150)	46 (355)	60 (497)	42 (266)
		Benton Ave to Green Meadow Dr	39 (135)	40 (169)	33 (146)	55 (336)	53 (374)	42 (299)
		Green Meadow Dr to Henderson St	40 (8)	41 (5)	37 (12)	45 (21)	46 (62)	46 (80)
		Westbound Total	**236**	**250**	**244**	**346**	**346**	**451**

Comparing Corridor 1 with Corridor 0, it can be seen that delay per vehicle decreased for all analysis periods, particularly during under projected conditions. Given the increased capacity that comes with the additional travel lanes, these results are expected. Stops per vehicle also decreased. The trend of fewer stops per vehicle under projected traffic conditions persists with Corridor 1. This likely points to a lack of capacity along the corridor as vehicles are forced to stop for longer durations. The average speed through the corridor decreased slightly under existing traffic conditions but increased slightly under projected conditions as compared to Corridor 0. The decreased speeds under existing volumes is likely attributable to the addition of a traffic signal at Villard Avenue.

Travel times on the west end of the corridor remained generally consistent between Corridor 0 and Corridor 1. However, travel times between McHugh Lane and Villard Avenue generally increased as a result of the change in traffic control at Villard Avenue. Improvements to the 95th percentile queue lengths varied across the corridor. Some locations realized a decreased queue length due to increased capacity along the corridor, while others suffered due to the increased upstream throughput. There was little consistency in improvement between the analysis periods, likely pointing to signal timing effects more so than network effects.

At a corridor-wide level, Corridor 1 provides some reductions in overall vehicle delay, particularly under projected conditions. However, further comparisons show only minimal improvements to corridor operations from the existing configuration. In general, traffic congestion is shifted further down the corridor to the west and is not fully alleviated with this scenario. This indicates the need to expand capacity along Custer Avenue further to the west.

6.3. Corridor 2 – Expanded to Benton Avenue

Corridor 2 represent the expansion of Custer Avenue to five lanes between Montana Avenue and Benton Avenue. To facilitate the expansion, Montana Avenue would be configured as shown in MT-2, Villard Avenue would be configured as shown in VA-1, McHugh Lane would be configured as shown in MCH-3, Cooney Drive would be configured as shown in CD-1, and Benton Avenue would be configured as shown in BEN-1. West of Benton Avenue, Green Meadow Drive would be reconfigured as shown in GM-1 and Henderson Street would be reconfigured to HEN-1. The results for this alternative are presented in **Table 6.3**.

Table 6.3: Corridor 2 Network Performance Results

Performance Measure			2017 AM	2017 School	2017 PM	2042 AM	2042 School	2042 PM
Network Average		Delay per Vehicle (s/veh)	613	717	714	912	1,323	1,711
		Stops per Vehicle	14	16	15	13	13	14
		Average Speed (mph)	19	18	18	14	10	8
		Fuel Used (gal)	118	126	144	205	234	308
Travel Time (s) (95th Percentile Queue [ft])	Eastbound	Henderson St to Green Meadow Dr	53 (171)	53 (180)	49 (167)	85 (676)	238 (2302)	196 (2227)
		Green Meadow Dr to Benton Ave	41 (235)	44 (250)	47 (287)	72 (980)	160 (1599)	164 (1526)
		Benton Ave to Cooney Dr	27 (93)	28 (91)	28 (93)	32 (202)	32 (182)	34 (259)
		Cooney Dr to McHugh Ln	50 (210)	47 (148)	43 (145)	55 (288)	55 (333)	80 (857)
		McHugh Ln to Villard Ave	35 (88)	38 (173)	38 (175)	36 (118)	61 (767)	113 (1334)
		Villard Ave to Montana Ave	66 (270)	77 (311)	79 (392)	74 (487)	155 (1469)	221 (1721)
		Eastbound Total	**272**	**287**	**284**	**354**	**701**	**808**
	Westbound	Montana Ave to Villard Ave	36 (117)	40 (173)	42 (209)	39 (155)	39 (96)	40 (117)
		Villard Ave to McHugh Ln	42 (194)	40 (174)	44 (186)	53 (377)	41 (169)	45 (185)
		McHugh Ln to Cooney Dr	33 (106)	45 (219)	37 (203)	43 (330)	48 (310)	37 (131)
		Cooney Dr to Benton Ave	31 (117)	37 (175)	35 (192)	46 (319)	62 (599)	45 (325)
		Benton Ave to Green Meadow Dr	39 (156)	37 (155)	31 (120)	63 (488)	55 (416)	44 (349)
		Green Meadow Dr to Henderson St	41 (0)	40 (7)	37 (12)	47 (19)	46 (64)	46 (64)
		Westbound Total	**222**	**239**	**226**	**291**	**291**	**257**

Delay per vehicle for Corridor 2 improved considerably over the existing configuration. This decrease in delay is a result of the increased capacity of Custer Avenue. Average speed also improved over that of Corridors 0 and 1. In general fuel used also went down. Stops per vehicle under projected traffic conditions increased slightly over Corridor 1, however, this may be a result of a higher number of vehicles traveling through the network. Travel times were also greatly reduced under projected conditions. Corridor 2 generally shows improvement over Corridors 0 and 1 on all metrics. This indicates that the additional capacity on Custer Avenue is providing benefit to motorists throughout the project area.

Eastbound queue lengths increased at Montana Avenue over those seen in Corridor 1. This is likely the result of increased throughput west of Montana Avenue causing more vehicles to reach the intersection. Westbound queues show a large decrease in length at McHugh Lane. This shows that McHugh Lane is a bottle neck in Corridor 1 and that expanding Custer Avenue further to the west helps to relieve that bottle neck. Benton Avenue, however, shows increased queueing during the projected school and PM peak periods. This indicates that greater westbound capacity may be needed past Benton Avenue.

6.4. Corridor 3 – Expanded to Green Meadow Drive

Corridor 3 represents the expansion of Custer Avenue to five lanes between Montana Avenue and Green Meadow Drive. To facilitate the expansion, Montana Avenue would be configured as shown in MT-2, Villard Avenue would be configured as shown in VA-1, McHugh Lane would be configured as shown in MCH-3, Cooney Drive would be configured as shown in CD-1, Benton Avenue would be configured as shown in BEN-2, and Green Meadow would be configured as shown in GM-2. Henderson Street would be reconfigured to HEN-1. The results for this alternative are presented in **Table 6.4**.

Table 6.4: Corridor 3 Network Performance Results

Performance Measure			2017 AM	2017 School	2017 PM	2042 AM	2042 School	2042 PM
Network Average		Delay per Vehicle (s/veh)	589	716	681	801	1,162	1,572
		Stops per Vehicle	14	15	14	13	13	14
		Average Speed (mph)	19	18	19	16	12	9
		Fuel Used (gal)	117	125	144	200	224	284
Travel Time (s) (95^{th} Percentile Queue [ft])	Eastbound	Henderson St to Green Meadow Dr	48 (77)	48 (97)	46 (96)	63 (250)	67 (490)	79 (880)
		Green Meadow Dr to Benton Ave	43 (181)	40 (141)	46 (185)	53 (281)	62 (458)	72 (513)
		Benton Ave to Cooney Dr	28 (109)	28 (100)	29 (116)	29 (129)	40 (454)	53 (718)
		Cooney Dr to McHugh Ln	47 (170)	49 (186)	43 (146)	57 (309)	78 (817)	121 (1346)
		McHugh Ln to Villard Ave	35 (113)	36 (129)	38 (177)	36 (116)	93 (1150)	131 (1485)
		Villard Ave to Montana Ave	66 (261)	80 (331)	82 (383)	73 (500)	206 (1635)	247 (1583)
		Eastbound Total	**266**	**281**	**284**	**313**	**546**	**704**
	Westbound	Montana Ave to Villard Ave	36 (94)	41 (158)	41 (182)	40 (161)	38 (81)	45 (155)
		Villard Ave to McHugh Ln	42 (158)	41 (175)	44 (189)	55 (383)	41 (157)	49 (198)
		McHugh Ln to Cooney Dr	33 (109)	43 (126)	35 (148)	38 (209)	43 (114)	36 (109)
		Cooney Dr to Benton Ave	33 (142)	33 (149)	32 (127)	40 (271)	44 (348)	40 (286)
		Benton Ave to Green Meadow Dr	35 (99)	36 (141)	29 (90)	62 (693)	50 (406)	47 (397)
		Green Meadow Dr to Henderson St	41 (8)	40 (4)	36 (5)	47 (21)	44 (16)	47 (26)
		Westbound Total	**219**	**233**	**218**	**282**	**259**	**263**

For all network metrics, Corridor 3 outperforms the previous corridor alternatives. Stops per vehicle decreased for all analysis periods. This points to consistent traffic flow through the corridor due to fewer bottlenecks. Fuel usage also improves due to less stopping and lower overall delay per vehicle. Travel times across the corridor improved as a result of the increased corridor capacity. Signal timing and coordination likely have a large effect on the travel times. The consistent corridor typical section helps to ensure that the green time that is made available is used more effectively. This can be seen in decrease of the 95^{th} percentile queues. Queues that do form are able to dissipate during each cycle as a result of the increased capacity. Having two travel lanes in each direction at intersections from Green Meadow Drive eastward helps to limit the effect of an intersection with high capacity flooding a downstream intersection with more traffic than available capacity. Long queues and extended travel times are still shown in the eastbound direction under projected conditions, however.

6.5. Corridor 4 – Expanded to Henderson Street

Corridor 4 represents the expansion of Custer Avenue to five lanes between Montana Avenue and Green Meadow Drive and continuing the duel lanes in the westbound direction from Green Meadow Drive to Henderson Street. To facilitate the expansion, Montana Avenue would be configured as shown in MT-2, Villard Avenue would be configured as shown in VA-1, McHugh Lane would be configured as shown in MCH-3, Cooney Drive would be configured as shown in CD-1, Benton Avenue would be configured as shown in BEN-2, and Green Meadow would be configured as shown in GM-4. Henderson Street would be reconfigured to HEN-2. The results for this alternative are presented in **Table 6.5**.

Table 6.5: Corridor 4 Network Performance Results

Performance Measure			2017 AM	2017 School	2017 PM	2042 AM	2042 School	2042 PM
Network Average		Delay per Vehicle (s/veh)	590	728	736	747	1,088	1,526
		Stops per Vehicle	14	16	16	12	14	14
		Average Speed (mph)	20	18	18	16	13	9
		Fuel Used (gal)	119	125	146	197	219	282
Travel Time (s) (95th Percentile Queue [ft])	Eastbound	Henderson St to Green Meadow Dr	49 (83)	50 (106)	47 (95)	59 (195)	62 (292)	65 (438)
		Green Meadow Dr to Benton Ave	43 (176)	40 (145)	46 (180)	52 (273)	60 (412)	85 (658)
		Benton Ave to Cooney Dr	28 (105)	28 (95)	29 (119)	29 (115)	32 (144)	62 (860)
		Cooney Dr to McHugh Ln	48 (185)	48 (171)	43 (140)	56 (305)	58 (328)	126 (1396)
		McHugh Ln to Villard Ave	35 (114)	36 (135)	37 (181)	37 (122)	55 (658)	132 (1493)
		Villard Ave to Montana Ave	65 (333)	77 (312)	81 (378)	75 (610)	172 (1578)	242 (1665)
		Eastbound Total	**269**	**279**	**283**	**308**	**439**	**711**
	Westbound	Montana Ave to Villard Ave	37 (93)	41 (176)	42 (206)	40 (156)	40 (116)	45 (163)
		Villard Ave to McHugh Ln	41 (163)	41 (171)	44 (213)	55 (365)	41 (149)	50 (223)
		McHugh Ln to Cooney Dr	33 (90)	42 (112)	35 (151)	35 (137)	45 (201)	36 (163)
		Cooney Dr to Benton Ave	32 (60)	33 (149)	32 (116)	37 (198)	39 (292)	34 (192)
		Benton Ave to Green Meadow Dr	34 (91)	36 (108)	30 (78)	43 (165)	47 (236)	39 (176)
		Green Meadow Dr to Henderson St	40 (0)	39 (4)	36 (3)	48 (9)	44 (8)	45 (14)
		Westbound Total	**217**	**233**	**219**	**258**	**257**	**249**

The configuration of Corridor 4 is intended to help ease congestion related to events at Ryan Fields and the Fairgrounds. In general, Corridor 4 performs similar to Corridor 3. The simulation results may not fully illustrate the improvements to traffic flow that this corridor configuration may during special use times and events. Events at Ryan Park and the Fairgrounds can cause a large influx of traffic at one time. This traffic must slow when entering the parking lot because of high volume of pedestrians within the parking lot. This slow down can cause capacity limitations at the intersection of Henderson Street and Custer Avenue. By adding an additional westbound travel lane, motorists with a destination other than Ryan Field or the Fairgrounds can use one lane and those wishing to go to Ryan Fields or the Fairgrounds can use the other lane. While this additional capacity would not be needed at all times, the frequency in which events such as baseball practices occur may merit the additional capacity.

6.6. Corridor 5 – Multi-lane Roundabouts

Corridor 5 represents the expansion of Custer Avenue to five lanes from Montana Avenue to Green Meadow Drive. Each intersection from Villard Avenue to Henderson Street would be configured as a roundabout. The intersection with Henderson Street would be reconfigured to a partial multi-lane roundabout as described in HEN-2. The results for this alternative are presented in **Table 6.6**.

Table 6.6: Corridor 5 Network Performance Results

Performance Measure			2017			2042		
			AM	School	PM	AM	School	PM
Network Average		Delay per Vehicle (s/veh)	418	571	535	858	1,061	1,587
		Stops per Vehicle	9	11	10	9	11	11
		Average Speed (mph)	21	20	20	14	12	9
		Fuel Used (gal)	118	127	148	218	226	299
Travel Time (s) (95th Percentile Queue [ft])	Eastbound	Henderson St to Green Meadow Dr	41 (55)	46 (141)	42 (57)	43 (67)	46 (78)	46 (78)
		Green Meadow Dr to Benton Ave	39 (50)	38 (52)	38 (56)	40 (71)	41 (84)	42 (169)
		Benton Ave to Cooney Dr	32 (38)	32 (41)	32 (46)	34 (51)	38 (184)	53 (576)
		Cooney Dr to McHugh Ln	41 (66)	45 (71)	41 (85)	43 (118)	60 (552)	108 (1241)
		McHugh Ln to Villard Ave	38 (45)	38 (52)	39 (62)	41 (67)	85 (948)	143 (1429)
		Villard Ave to Montana Ave	69 (266)	83 (305)	84 (371)	75 (483)	207 (1636)	258 (1620)
		Eastbound Total	**260**	**282**	**276**	**276**	**477**	**650**
	Westbound	Montana Ave to Villard Ave	37 (36)	37 (36)	37 (34)	39 (55)	38 (43)	38 (41)
		Villard Ave to McHugh Ln	36 (71)	37 (74)	38 (75)	38 (119)	39 (100)	39 (102)
		McHugh Ln to Cooney Dr	37 (25)	45 (27)	38 (17)	40 (42)	46 (32)	40 (28)
		Cooney Dr to Benton Ave	33 (63)	36 (126)	34 (77)	35 (115)	36 (125)	35 (98)
		Benton Ave to Green Meadow Dr	37 (77)	40 (97)	35 (60)	41 (138)	41 (137)	41 (121)
		Green Meadow Dr to Henderson St	43 (0)	44 (0)	39 (3)	49 (100)	46 (4)	47 (5)
		Westbound Total	**223**	**239**	**221**	**242**	**246**	**240**

The results of this alternative are comparable to those of Corridors 3 and 4. Stops per vehicle were somewhat lower while travel speeds were higher in part to the nature of roundabouts allowing for continuous smooth flow of traffic. Delay per vehicle, travel times, and queue lengths are close to those in Corridors 3 and 4. Note that the queueing results presented for this corridor configuration may not be truly representative of the true congestion on the corridor due to the way *Simtraffic* determines queue lengths. To be included in a queue, *Simtraffic* requires that a vehicle be traveling at or below 10 feet per second or about 6.8 miles per hour. With a queue created by a roundabout, it is very common for the queue to be moving as a single unit, unlike with a signalized intersection for which vehicle must come to a full stop during a red light. A comparison of travel times may be a better indicator of the corridor operations which indicates similar performance to Corridors 3 and 4. Note that the modeling of the roundabout configurations does not include the effects of pedestrian crossings. In reality, if pedestrian signals were to be provided along the Custer Avenue approach legs, additional delay and reduced performance would result when pedestrian activity occurs. This may significantly decrease performance for short periods of time during the AM and school peak hours, particularly at Cooney Drive and McHugh Lane.

Note that in order to accommodate high traffic volumes, along with considerations for large vehicles associated with operations at Fort Harrison and the Fairgrounds, the size of multi-lane roundabouts would likely be much larger than signalized intersection options. Preliminary evaluation shows that substantial impacts to adjacent parcels would result from construction of the roundabouts at the intersections. Due to the constrained nature of the corridor, this may result in impacts to buildings and environmentally sensitive lands.

6.7. Corridor-wide Improvement Options Summary

The corridor alternatives presented in the previous sections represent an incremental approach to the expansion of Custer Avenue. Each corridor alternative builds on the previous alternative. Corridor 1 represents expanding Custer Avenue to a five-lane facility between Montana Avenue and McHugh Lane, Corridor 2 furthers this expansion to Benton Avenue, Corridor 3 extends the five-lane facility to Green Meadow Drive, Corridor 4 extends the five lane facility to Green Meadow Drive and further extends the dual westbound lanes to Henderson Street, and Corridor 5 expands the five lane facility to Green Meadow Drive and uses roundabouts at all major intersections from Henderson Street to Villard Avenue. Each corridor alternative also includes improvements to the intersections with Montana Avenue and with Henderson Street. **Table 6.7** presents a summary of the total delay per vehicle for the study corridor under each alternative. Note that the results of the microsimulation analysis for corridor alternatives includes some assumptions on signal timing/coordination for the corridor. As such, it should be noted that actual signal timings may alter the performance shown in this report. Other unforeseen changes to the area may also affect the analysis.

Table 6.7: Corridor Alternative Summary

	Corridor 0 (No Action)			Corridor 1 (Expanded to McHugh)			Corridor 2 (Expanded to Benton)			Corridor 3 (Expanded to Green Meadow)			Corridor 4 (Expanded to Henderson)			Corridor 5 (Roundabouts)		
Performance Measure	AM	School	PM	AM	School	PM	AM	School	PM	AM	School	PM	AM	School	PM	AM	School	PM
Existing Conditions (2017)																		
Average Delay per Vehicle (s)	789	863	1,240	649	780	761	613	717	714	589	716	681	590	728	736	418	571	535
Average Stops per Vehicle	15	16	19	14	16	14	14	16	15	14	15	14	14	16	16	9	11	10
Average Speed (mph)	17	17	15	19	18	17	19	18	18	19	18	19	20	18	18	21	20	20
Eastbound Travel Time (s)	310	302	319	277	297	299	272	287	284	266	281	284	269	279	283	260	282	276
Westbound Travel Time (s)	246	264	312	236	250	244	222	239	226	219	233	218	217	233	219	223	239	221
Projected Conditions (2042)																		
Average Delay per Vehicle (s)	1,899	2,141	2,604	1,273	1,527	1,979	912	1,323	1,711	801	1,162	1,572	747	1,088	1,526	858	1,061	1,587
Average Stops per Vehicle	11	9	9	13	14	15	13	13	14	13	13	14	12	14	14	9	11	11
Average Speed (mph)	5	4	3	11	9	7	14	10	8	16	12	9	16	13	9	14	12	9
Eastbound Travel Time (s)	1,450	2,116	2,689	376	732	854	354	701	808	313	546	704	308	439	711	276	477	650
Westbound Travel Time (s)	439	620	637	346	346	451	291	291	257	282	259	263	258	257	249	242	246	240

7.0. ADDITIONAL CONSIDERATIONS

The previous sections focused on the traffic operations of various improvement options for the study corridor. Additional considerations may also influence the selection of a preferred configuration. This section addresses additional considerations relevant to the development of improvements to the Custer Avenue corridor.

7.1. Future Growth and Transportation Network Changes

A number of factors can influence how traffic is distributed on the transportation system. Assumptions in traffic growth and distribution were defined for the study area based on historic and anticipated future growth characteristics. The location, type, and design of land use developments ultimately impacts the existing and future transportation system. If growth occurs at the rates identified in this report, it is anticipated that the project corridor will experience severe operational issues in the near future. However, if growth in the area differs from those assumptions made in this report, the results of the traffic operational analysis may no longer hold true.

7.2. Safety

A detailed discussion about existing safety and crash trends for the corridor is provided in **Section 4.0**. Additional consideration should be given to the future impacts on safety should improvements be made. The trend of rear end crashes suggests issues related to vehicle congestion. Additionally, a concentration of crashes was noted at the major intersections along the study corridor. There were also reported crashes at multiple locations with bicyclists and pedestrians. These trends may be addressed to varying degrees through the identified improvement options, but new trends may emerge due to increases in capacity, traffic volumes, and a wider roadway.

7.3. Non-Motorized Considerations

The Custer Avenue corridor has a variety of non-motorized activity and needs. The corridor provides access to multiple park and recreation lands including Ryan Fields, the Lewis and Clark County Fairgrounds, Capital High School, Four Georgians Elementary School, and Bill Roberts Golf Course. There is currently a shared use path along the south side of the project corridor, while the north side largely lacks accommodations. Striped crosswalks are provided at Montana Avenue, McHugh Lane, Cooney Drive, Benton Avenue, Green Meadows Drive, and Henderson Street. However, some of these crossings do not connect to facilities on the other side. Consideration should be made to appropriately accommodate pedestrians and bicyclists within the project area.

7.4. Funding

Custer Avenue is eligible for funding from Helena's Urban Highway Program. Urban funding allocations are based on a per capita distribution and are primarily used for resurfacing, rehabilitation, or reconstruction of existing facilities; operational improvements; bicycle facilities; pedestrian walkways, and carpool projects. The Helena urban area currently receives just over $1M annually in urban funding. Priorities for the use of the funds are established at the local level through local planning processes with final approval by the Transportation Commission. While the Helena Transportation Coordinating Committee has prioritized the Custer Avenue project, funding is limited and my not be enough to cover full reconstruction of the corridor. Additionally, priorities may change, and other needs may arise which may affect project development. Depending on project costs and available funding, it may be necessary to develop the project in phases.

7.5. Environmental Considerations

A detailed review of environmental conditions will need to be conducted during project development. The *Custer Avenue/Henderson Street Corridor Study* provided a high-level scan of environmental resources within the project area. The following highlights environmental resources identified in the study which may ultimately influence project development:

Historic Properties

There are multiple historic properties along the study corridor including; a rubblestone building on the 900 block of Custer, Waddell Construction site on the 600 block, Bill Roberts Golf Course, Lewis and Clark County Fairgrounds, Home of Peace Jewish Cemetery, and several residences. Each of these properties are 50 years or older, however, the historical significance of each is yet to be determined. Section 106 of the National Historic Preservation Act (NHPA) requires Federal agencies to take into account the effects of their undertakings on historic properties.

Section 4(f)

Section 4(f) of the *Department of Transportation Act of 1966* protects publicly-owned public parks, recreation areas, and wildlife/waterfowl refuges. Section 4(f) also protects historic sites of national, state, or local significance that are listed or are potentially eligible for listing on the NRHP. Numerous properties subject to protection under Section 4(f) exist in the project area. These properties include the Bill Roberts Golf Course, Capital High School, Ryan Fields, Lewis and Clark County Fairgrounds, the Home of Peace Jewish Cemetery, and the surrounding wetlands.

Section 6(f)

Section 6(f)(3) of the *Land and Water Conservation Fund Act* **(**LWCF) requires that no property acquired or developed with LWCF assistance be converted to non-recreation uses without approval of U.S. Department of the Interior's National Park Service. Section 6(f) directs the Department to ensure that replacement lands of comparable value, function, location, and usefulness are provided as conditions to such conversions. There are two 6(f) properties in the project area, the Lewis and Clark County Fairgrounds and the Bill Roberts Golf Course.

7.6. Right-of-Way

At this preliminary stage in project development, it is unknown the extent of impacts due to construction that may occur with each alternative. A planning-level evaluation was made with regards to potential right-of-way needs and project impacts. Existing right-of-way for the project corridor is generally 100 feet, measured 50 feet on either side of centerline. However, there are some locations along the corridor where right-of-way is less than 100 feet. Some improvements may result in impacts outside of existing right-of-way which may result in additional challenges to project development, particularly at locations which may affect protected or developed lands.

7.7. Utilities

Additional considerations will also need to be made for impacts to utilities. The Custer Avenue corridor is a major utility corridor with utilities generally located near the right-of-way limits on both sides of the roadway. However, there are areas where the alignments of the utilities shift and may be impacted by roadway reconstruction. Identified utilities within the project area include underground telephone, fiber optics, natural gas, city water/sewer, major overhead power, overhead power distribution, and a high-pressure petroleum pipeline (Yellowstone Pipeline). Impacts to utilities have the potential to increase project costs and may influence project design.

8.0. CONCLUSION AND RECOMMENDATIONS

This *Preliminary Traffic Engineering Report* provides a thorough study of the Custer Avenue corridor between Henderson Street and Montana Avenue. The corridor has been identified in past studies and in the *Greater Helena Area Long Range Transportation Plan – 2014 Update* as needing improvements to address operational issues. The LRTP recommends the corridor be reconstructed to a five-lane urban arterial with accommodations for bicyclists and pedestrians. The Helena Transportation Coordinating Committee voted in 2016 to make Custer Avenue a top priority for allocation of urban funding within the Helena area. The project is being developed by MDT through the other (OT) project development phase.

The Custer Avenue corridor currently experiences traffic operational issues related to vehicle congestion and delay. Recent development, coupled with construction of the Custer Avenue Interchange, have resulted in increased traffic demands and deteriorating travel conditions. The corridor experiences influxes of traffic and varying conditions due to special events at Ryan Fields and the Fairgrounds on the west end of the corridor. A high school and elementary school are also accessed by Custer Avenue which creates operational issues and concerns with non-motorized activity.

The existing conditions of the corridor were defined through field review and data collection in 2017. Existing traffic volumes along the corridor range from approximately 9,000 vehicles per day (vpd) on the western end near Henderson Street, to almost 18,000 vpd on the eastern end near Montana Avenue. Future projections made out to the year 2042 show traffic volumes of between 15,000 vpd and 34,000 vpd. Without improvement to the corridor, traffic volumes are projected to exceed the capacity of the current facility resulting in increased vehicle delay, congestion, and safety issues.

A detailed evaluation of seven major intersections along the project corridor was conducted. For each intersection, improvement options were identified based on existing and projected traffic demands, corridor configuration, and known constraints. The intersection options were recommended to be advanced or not advanced for further consideration as part of a corridor-wide evaluation. For the corridor-wide evaluation, five options, in addition to a no action base option, were evaluated under existing and projected conditions. The following summarizes these options:

- **Corridor 0 – No Action:** Corridor 0 serves as a baseline to calibrate the simulation models to ensure that the results of all alternative modeling reasonably represents the driving behaviors seen in the real world. The results of the corridor modeling show that the delay per vehicle increases substantially when comparing the existing and projected traffic conditions. These results show that the corridor will experience severe congestion issues under projected conditions and that improvements to the corridor are necessary to accommodate projected traffic demands.
- **Corridor 1 – Expanded Capacity to McHugh Lane:** Corridor 1 includes the expansion of Custer Avenue between Montana Avenue and McHugh Lane. For intersections west of McHugh Lane, minor improvements are included at the intersections with Benton Avenue and Green Meadow Drive. Henderson Street is configured as a single-lane roundabout under this scenario. This configuration shows minor reductions in travel times under existing traffic volumes, with more substantial reductions under projected conditions. However, low travel speeds, long queue lengths, and high amounts of vehicle delay are still shown under projected conditions. Evaluation of this corridor option shows the need to increase capacity along Custer Avenue further west than McHugh Lane.
- **Corridor 2 – Expanded Capacity to Benton Avenue:** Corridor 2 furthers the expansion of Custer Avenue west to Benton Avenue. Evaluation of this configuration shows some improvement to traffic operations compared to Corridor 1. A minor reduction in overall travel times and vehicle delay is realized compared to Corridor 1. This indicates that expansion of Custer Avenue to Benton Avenue is providing

some improvements to corridor operations. Future conditions still show high amounts of vehicle delay and long queue lengths, however. This indicates that expansion of Custer Avenue is likely needed further west than Benton Avenue.

- **Corridor 3 – Expanded Capacity to Green Meadow Drive:** Corridor 3 would extend the expansion of Custer Avenue west to Green Meadow Drive. Green Meadow Drive is approximately one quarter of a mile west of Benton Avenue. Corridor 3 provides similar results to Corridor 2 under existing traffic conditions. Corridor 3 results in a reduction in average vehicle delay of approximately ten percent under projected traffic volumes when compared to Corridor 2. Similar reductions in travel time are also realized. Eastbound queue lengths are shown to be much shorter at Green Meadow Drive and at Benton Avenue under Corridor 3 than Corridor 2.

- **Corridor 4 – Expanded Capacity to Henderson Street:** Corridor 4 would further extend the westbound dual travel lanes to Henderson Street. This expansion would help to address congestion issues created by events at Ryan Park and the Fairgrounds. Only minor improvements to traffic congestion during the existing and projected peak hours are shown. However, this configuration would provide additional storage and capacity during special events.

- **Corridor 5 – Multi-lane Roundabouts:** Corridor 5 includes the expansion of Custer Avenue to Henderson Street with construction of multi-lane roundabouts at major intersections. Delay per vehicle, travel times, and queue lengths are close to those in Corridors 3 and 4. While the modeling results show comparable performance between Corridor 5 and Corridors 4 and 3, the modeling does not include the effects of pedestrian crossings at the roundabouts. In reality, additional delay and reduced performance would result when pedestrian activity occurs. This may significantly decrease performance for short periods of time, particularly during the AM and school peak hours. This configuration is also the most impactful of the corridor options and would likely result in impacts to existing residences and developments.

8.1. Public Involvement

Public involvement has, and will continue to be, an integral part of project development for the Custer Avenue project. Multiple initial public involvement activities have already occurred. These include focus group outreach, a poll of Helena residents in August 2018, a landowner open house on October 3, 2018, and a public open house on November 14, 2018. During the public open house, concept options for a corridor with traffic signals and with roundabouts were displayed in comparison to the existing configuration (see **Appendix F**). In addition, traffic simulations of existing conditions, and projected "no action" conditions for the year 2027 were displayed on a video loop to discuss current and projected traffic concerns. Nearly 100 people signed in at the meeting, with additional people attending who did not sign in.

An *Initial Public Involvement Report and Findings* document was developed which provides an overview of the initial public involvement activities (see **Appendix F**). The document summarizes public comments received to date, the results of polling data completed in August 2018, and information obtained through focus group outreach. The following common themes were identified in the report:

- Villard intersection expressed as current and urgent concern for many
- Timing of signals is perceived as part of the current problem and part of the solution
- Some support for mix of roundabouts and signals
- Neighborhood residents have concerns about traffic flowing through during construction

- Bike/pedestrian facilities are highly desired; however, there is quite a bit of disagreement over landscaping (some people want trees, some feel they are a hazard)
- Timeline to arrive at the construction phase is a hurdle for many commenters; residents expressed distrust in the process and disappointment in the amount of time it has taken to develop a plan
    - City/County mentioned as key players

8.2. Recommendations and Next Steps

Evaluation of improvement options for Custer Avenue shows that expansion of the corridor to include two lanes in each direction is needed between Montana Avenue and Green Meadow Drive. Furthermore, it is recommended that an additional westbound lane be included between Green Meadow Drive and Henderson Street to accommodate activities and events at Ryan Park and the Fairgrounds. Consistent with these needs, it is shown that Corridor 4 and Corridor 5 best accommodate existing and projected demands.

Corridor 4 includes upgrading existing traffic signals and providing additional lanes at major intersections along with installation of a new signal at Villard Avenue and a roundabout at Henderson Street. Corridor 5 includes multi-lane roundabouts at the six major intersections. In order to accommodate high traffic volumes, along with considerations for large vehicles, the size of the multi-lane roundabouts is expected to be much larger than the signalized intersection options which is likely to result in greater impacts to adjacent parcels at the major intersections, some of which are environmentally sensitive.

From a traffic operations standpoint, both options are shown to perform similarly. The options are shown to reduce average vehicle delay by approximately 50 percent under projected conditions compared to the No Action alternative. Similarly, projected travel times are shown to be reduced by over 75 percent in the eastbound direction, and upwards of 60 percent in the westbound direction. Since both options are shown perform similarly, it is recommended that the concepts be evaluated in more detail during the design process to identify construction impacts, right-of-way needs, project costs, environmental constraints, and other challenges which may impact project development. The options should also continue to be vetted through the public involvement process.

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