WEST END MULTI-MODAL PLANNING STUDY

DRAFT REPORT
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SANDERSON STEWART

ACKNOWLEDGEMENTS

The West End Multi-Modal Planning Study was conducted under the direction of the Project Oversight Committee, which included the members listed below. Along with the input of numerous community members, the guidance of the Project Oversight Committee has been essential to the success of this process and is very much appreciated.

Project Oversight Committee

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EXECUTIVE SUMMARY

The West End Multi-Model Planning Study is the result of a collaborative effort between the Billings-Yellowstone County Metropolitan Planning Organization (MPO), the City of Billings, Yellowstone County and the consultant Project Team (Sanderson Stewart and Fehr & Peers). The purpose statement for the study is as follows:

To evaluate the cumulative effect of ongoing and projected future land development and population growth on the multi-modal transportation system for the area of Billings west of Shiloh Road

This document provides guidance in terms of cost and prioritization for multi-modal transportation system projects in the study area based on a pair of land development projection scenarios for the 20-year period leading up to the study Horizon Year of 2035.

Study Area

The study area for the West End Multi-Modal Planning Study is depicted at right in **Figure ES1**. The areas shown in light blue are in the City of Billings, while all other areas have not yet been annexed. The areas shaded in red have been identified for potential annexation by 2018, while the areas in yellow-orange have been identified for potential longer-term annexation. The orange dotted line represents the MPO planning jurisdictional boundary.

Methodology

The Project Team inventoried existing multi-modal transportation system features within the study area, collected traffic counts and crash history data and performed a comprehensive analysis of existing conditions to utilize as a baseline for the study. In addition to evaluating operations and safety for vehicular travel, the team evaluated conditions for the bicycle and pedestrian environment using latent demand and level of traffic stress (LTS) metrics.

Two (2) Horizon Year (2035) land development projection scenarios were calculated; one that approximated a continuation of recent historical development in the area, including a mixture of City and County subdivisions; and a second scenario that projected more aggressive annexation of study area property, thereby resulting in denser development and growth.

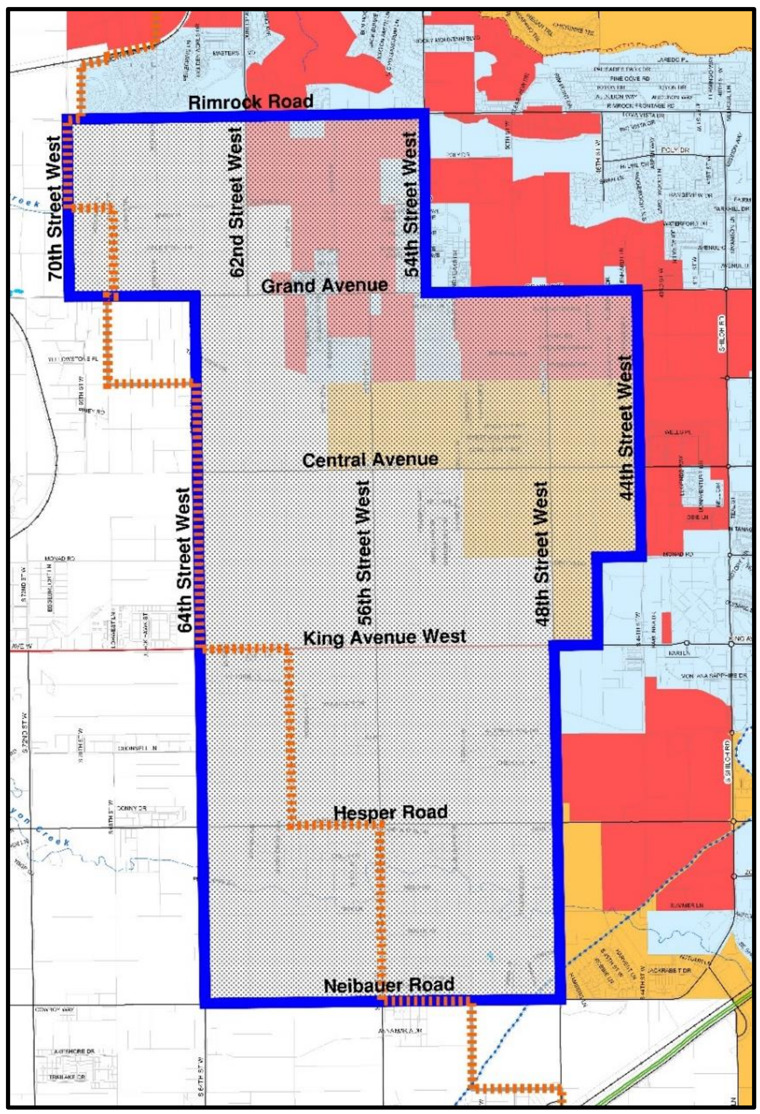

Figure ES1. Study Area

The parameters for the two growth scenarios were provided to the Montana Department of Transportation (MDT) for analysis in the Transcad transportation model for Yellowstone County. MDT returned link-specific average daily traffic (ADT) volume projections for both scenarios to be utilized for the Horizon Year (2035) analyses.

The Project Team analyzed future multi-modal operations for both of the growth scenarios. Based on the results of those efforts and the crash history analysis for the study area, the team developed a series of prioritized short-term and long-term project recommendations with high-level approximate construction cost ranges estimates.

Analysis Results

Existing Conditions

For the Existing Conditions (2015) scenario, all of the study area intersections and street corridor segments were found to operate at acceptable levels of service (LOS) during all periods of a typical day. However, an evaluation of crash history for study area intersections for the 5-year period from 2010-2014 revealed that there are seven (7) intersections with crash rates higher than 1.0 crashes/million vehicles entering (MVE), which is a threshold number that MDT uses to determine when an intersection may be of concern. The following three (3) of those intersections exhibited crash rates greater than 1.50 crashes/MVE:

- Rimrock Road & 62nd Street West
- Neibauer Road & 48th Street West
- Neibauer Road & 56th Street West

There were no fatalities reported as a result of any of the crashes during the 5-year analysis period. However, crash severity, which takes into account how many injuries and/or fatalities have occurred as a result of a sample of crashes, was found to be elevated for six (6) intersections. The two Neibauer Road intersections listed above had the highest crash severity rates.

From an active transportation (bicycle/pedestrian) standpoint, the availability of sidewalks, side paths, trails, or bike lanes in the study area is very limited with the exception of sidewalks internal to masterplanned communities. In general, the study area lacks connectivity to low stress bike/pedestrian facilities. A level of traffic stress (LTS) analysis showed that all of the major streets in the study area exhibit the highest LTS scores, thereby making them uninviting to typical bicyclists and pedestrians. This is generally due to the high speeds and narrow or non-existent shoulders in the study area.

Future Conditions (2035)

Under land use growth Scenario 1 (typical growth), most roadways in the study area continue to experience a LOS D or better. However, three of the primary east-west arterials (Rimrock Road, Grand Avenue, King Avenue West) are not projected to meet that standard. Of the north-south arterials, only 62nd Street West, north of Rimrock Road, is projected to operate below LOS D. **Figure ES2** on the following page provides a graphical illustration of the corridor LOS conditions for Scenario 1. Figure ES2 also shows the intersections that are projected to operate below an acceptable LOS C during one or both peak hour periods for Scenario 1.

Under the higher-growth Scenario 2 (aggressive growth), Central Avenue joins Rimrock Road, Grand Avenue and King Avenue West in having one or more segments exhibiting LOS E or worse conditions. For the north-south corridors, 62nd Street West, north of Rimrock Road degrades to LOS F, while 54th Street West is projected at LOS D north of Rimrock Road and LOS E south of Rimrock Road. **Figure ES3**, also on the following page, illustrates the corridor LOS analysis results for Scenario 2 and also shows graphically which intersections are projected to fail under that scenario.

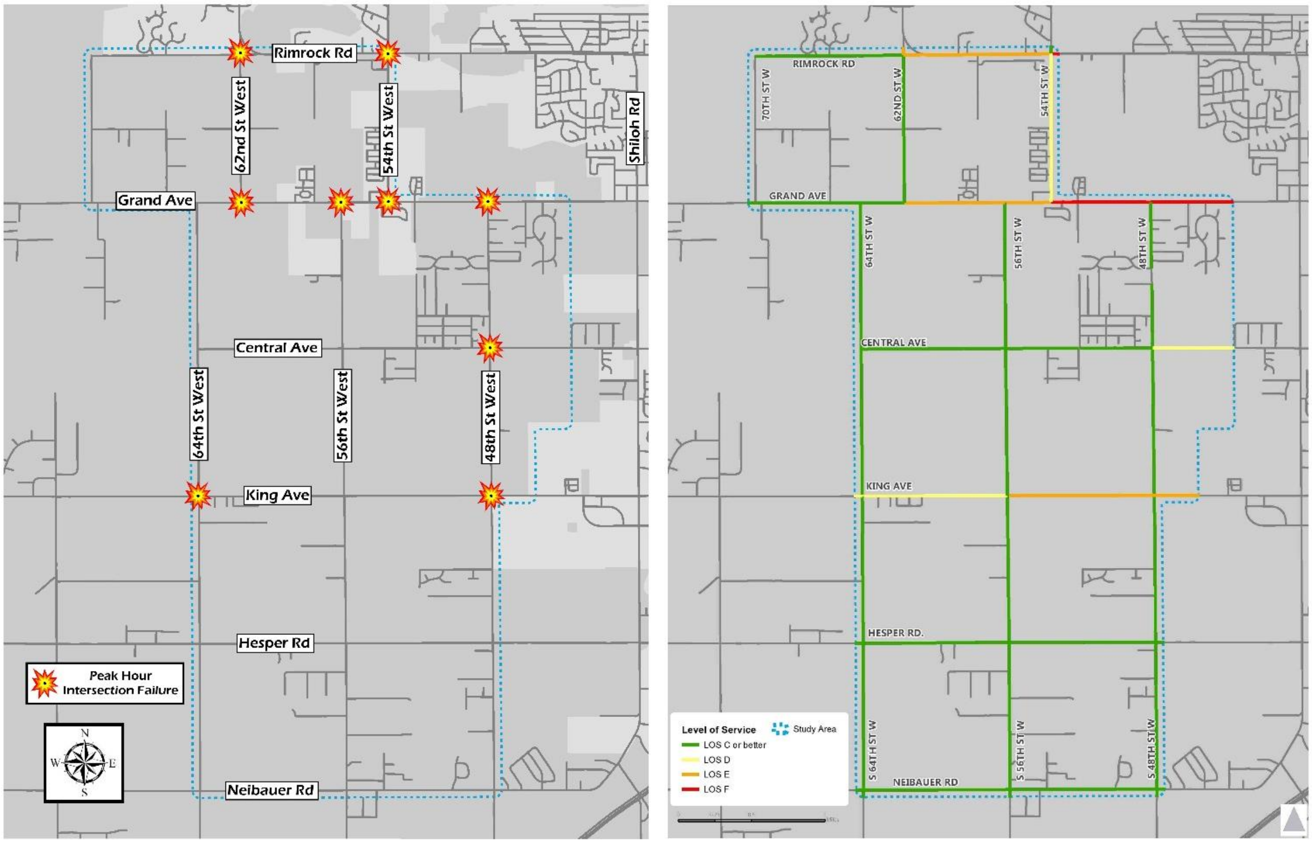

Figure ES2. Scenario 1 (2035) Intersection and Corridor LOS Analysis Results

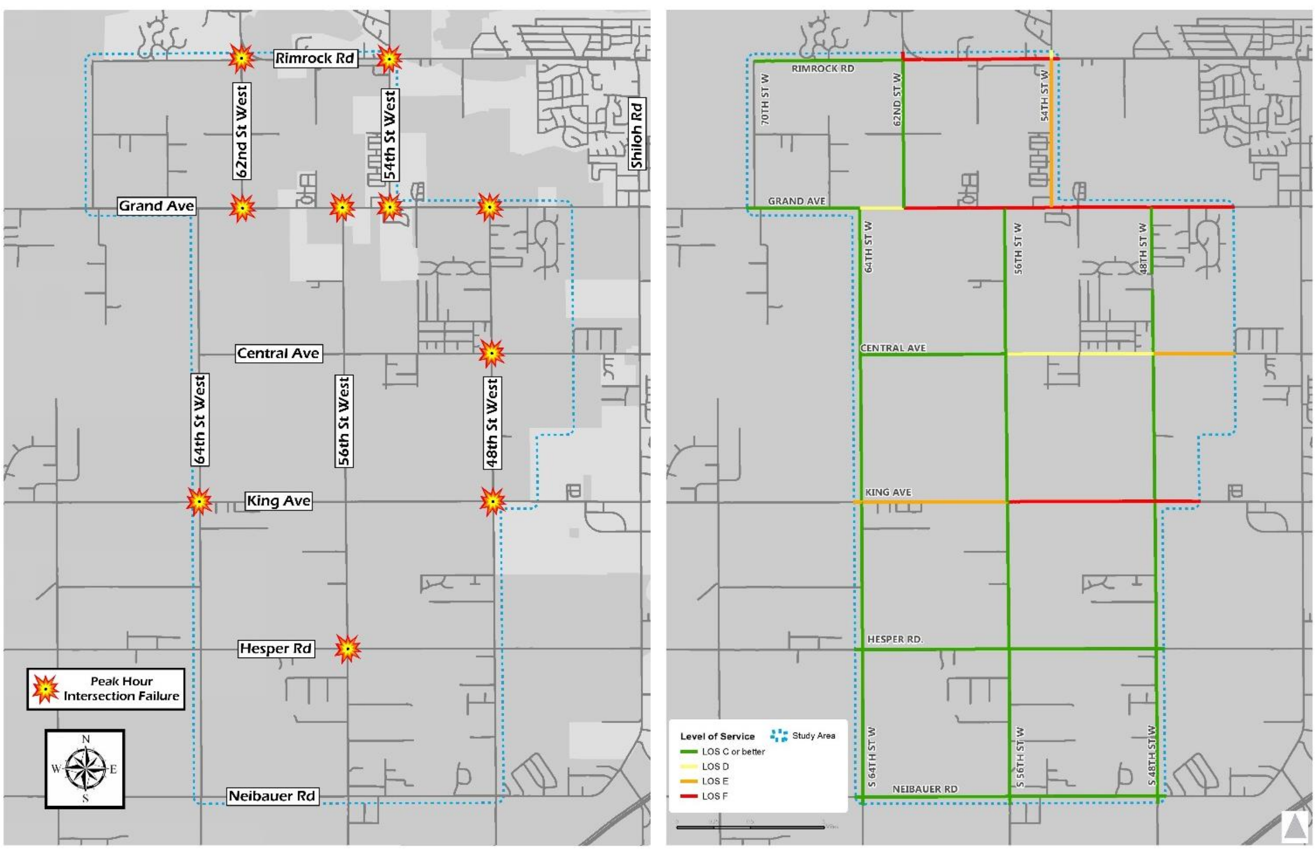

Figure ES3. Scenario 2 (2035) Intersection and Corridor LOS Analysis Results

A Latent Demand Model was used to provide a logical analysis framework to prioritize attention and investment for active transportation. Based on the growth projections, demand for active transportation is expected to increase significantly. Most of the study area north of King Avenue and east of 56th Street will generate demand, with the highest concentrations along 54th Street and Grand Avenue. **Figure ES4** below illustrates the projected change in active transportation demand from Existing Conditions (2015) to Scenario 2 (2035)

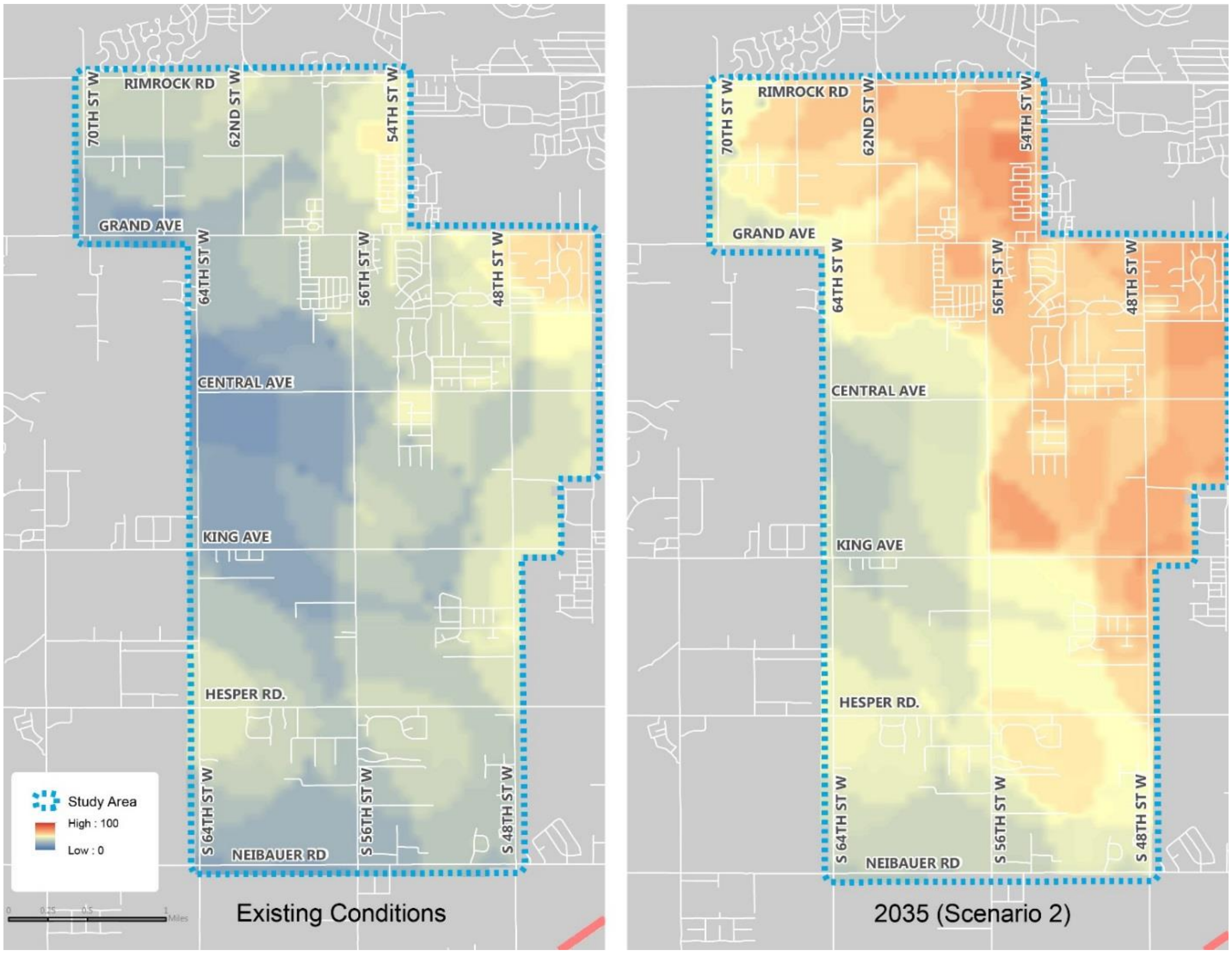

FIGURE ES4. LATENT DEMAND MODEL ANALYSIS RESULTS

Study Recommendations

Streets & Intersections

The priority project recommendations for this study were broken down into short-term and long-term categories. Short-term priority projects are those that could be necessary in order to maintain safe and efficient operations during the first half of the 20-year study period. Long-term priority projects are more likely to be needed during the second half of that period. However, it should be noted that there are many factors related to land development that could change the priority, location and cost considerations that are summarized in these recommendations. As such, the recommendations are to be utilized as a guideline for planning and not as a hard and fast committed projects list.

Tables ES1-ES4 and **Figure ES5-ES6** on the following pages list and illustrate the short term and long-term priority project recommendations for street and intersection improvements. In addition to details about each recommended project, the tables provide estimated construction cost ranges. The estimated costs do not consider right-of-way, irrigation systems modifications or street lighting other than as associated directly with traffic signals or roundabouts.

TABLE ES1. SHORT-TERM INTERSECTION PROJECT RECOMMENDATIONS

Priority Ranking	Project Location	Project Type	Estimated Cost
1	Neibauer Rd. & 56th St. West	All-Way Stop Control/OH Flashing Beacons/Transverse Rumble Strips	$120,000-$200,000
2	Neibauer Rd. & 48th St. West	OH Flashing Beacons/Transverse Rumble Strips	$120,000-$200,000
3	Rimrock Rd. & 54th St. West	Traffic Signal or Roundabout	$400,000-$1,500,000
4	King Ave. West & 64th St. West	Auxiliary Turn Lanes	$400,000-$600,000
5	Grand Ave. & 48th St. West	Traffic Signal or Roundabout	$400,000-$1,500,000
6	Molt Rd./Rimrock Rd./62nd St. West	Design Study	$20,000-$30,000
7	Grand Ave. & 56th St. West	Traffic Signal or Roundabout	$400,000-$1,500,000

TABLE ES2. SHORT-TERM CORRIDOR PROJECT RECOMMENDATIONS

Priority Ranking	Project Location	Project Type	Estimated Cost
1	Grand Ave. - Shiloh Rd. to 52nd St. West	Widening/Reconstruction (3-lane section)	$2,800,000-$4,500,000
2	Rimrock Rd. - 50th St. West to 54th St. West	Widening/Reconstruction (3-lane section)	$1,000,000-$1,600,000
3	King Ave. West - MT Sapphire Dr. to 48th St. West	Widening/Reconstruction (3-lane section)	$1,300,000-$2,000,000
4	Grand Ave. - Wilderness Dr. to 62nd St. West	Widening/Reconstruction (3-lane section)	$900,000-$1,400,000

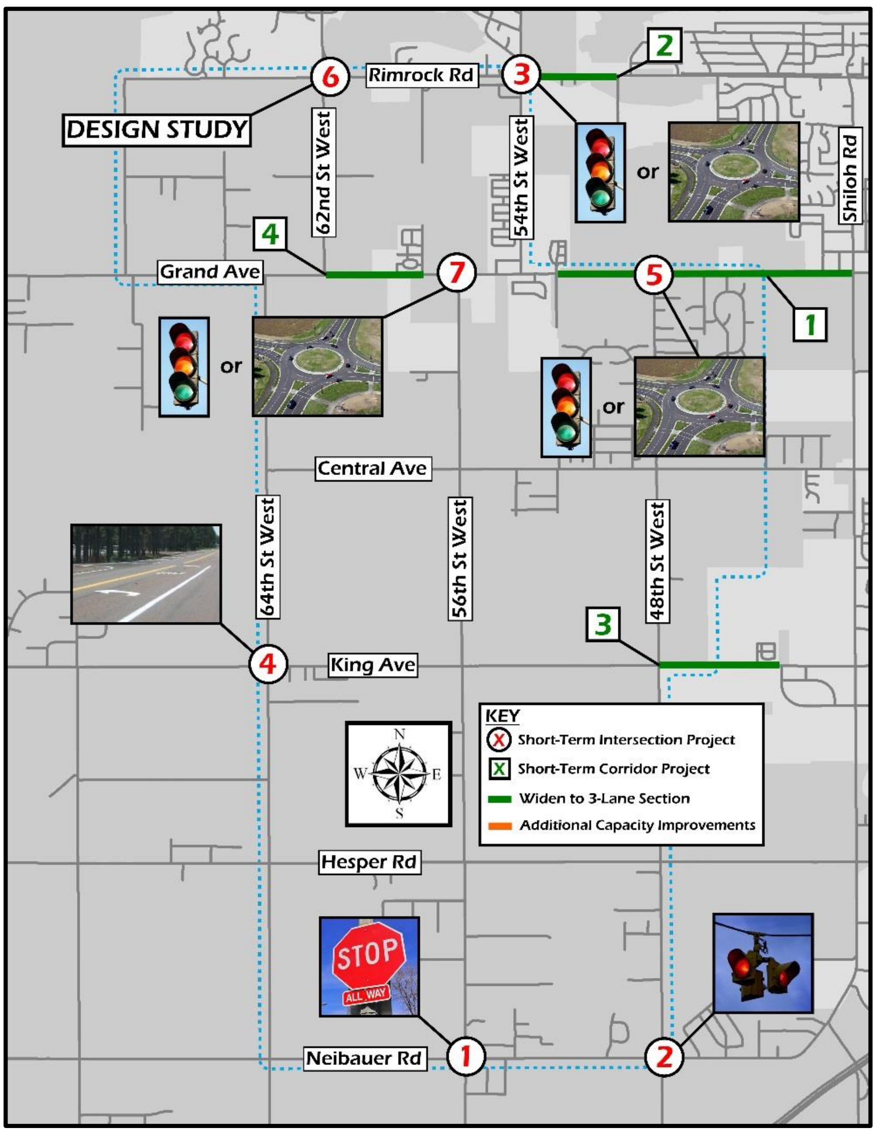

FIGURE ES5. SHORT-TERM INTERSECTION & CORRIDOR PROJECT RECOMMENDATIONS

TABLE ES3. LONG-TERM INTERSECTION PROJECT RECOMMENDATIONS

Priority Ranking	Project Location	Project Type	Estimated Cost
1	Molt Rd./Rimrock Rd./62nd St. West	Traffic Signal or Roundabout	$400,000-$1,500,000
2	King Ave. West & 48th St. West	Traffic Signal or Roundabout	$400,000-$1,500,000
3	Central Ave. & 48th St. West	Traffic Signal or Roundabout	$400,000-$1,500,000
4	King Ave. West & 64th St. West	Traffic Signal or Roundabout	$400,000-$1,500,000
5	Grand Ave. & 62nd St. West	Traffic Signal or Roundabout	$400,000-$1,500,000
6	Hesper Rd. & 56th St. West	All-Way Stop	$4,000-$200,000

TABLE ES4. LONG-TERM CORRIDOR PROJECT RECOMMENDATIONS

Priority Ranking	Project Location	Project Type	Estimated Cost
1	Grand Ave. - Shiloh Rd. to 62nd St. West	Widening/Reconstruction (5-lane section)	$7,500,000-$11,000,000
2	Rimrock Rd. - Shiloh Rd. to 62nd St. West	Widening/Reconstruction (5-lane section/3-lane section)	$6,900,000-$10,300,000
3	King Ave. West - MT Sapphire Dr. to 64th St. West	Widening/Reconstruction (5-lane section/3-lane section)	$6,100,000-$9,300,000
4	54th St. West - Grand Ave. to Rimrock Rd.	Widening/Reconstruction (3-lane section)	$2,100,000-$3,300,000
5	Central Ave. - Shiloh Rd. to 48th St. West	Widening/Reconstruction (3-lane section)	$2,000,000-$3,100,000
6	62nd St. West - Rimrock Rd. to Western Bluffs Dr.	Widening/Reconstruction (3-lane section)	$700,000-$1,100,000

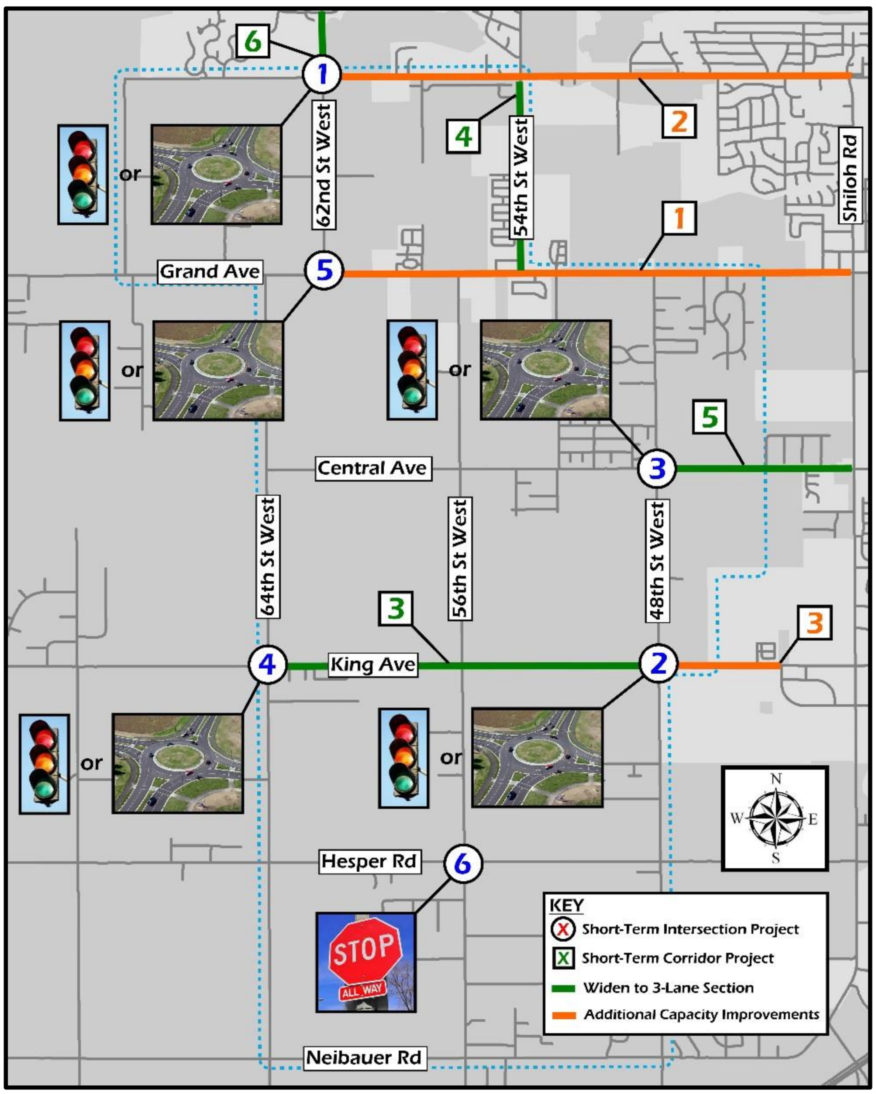

FIGURE ES6. LONG-TERM INTERSECTION & CORRIDOR PROJECT RECOMMENDATIONS

The City and County should also strongly consider the implementation of access control as a tool for extending the life (in terms of capacity) for roadway corridors in this area. Closely spaced driveways with no restrictions on turning movements can greatly degrade the throughput capacity for an arterial. A well-conceived access control plan can improve arterial capacity and also provide safety benefits by reducing conflict points in high-mobility corridors.

Active Transportation Systems

The Project Team recommends the implantation of short-term bicycle facility improvements in the following locations:

- 54th Street from Rimrock Road to Grand Avenue
- 48th Street from Central Avenue to Grand Avenue
- Grand Avenue from 58th Street to Shiloh Road
- Central Avenue from 56th Street to Shiloh Road

Specific improvements could include shoulder widening to provide ridable space (5-8 ft of pavement outside of the shoulder stripe), protected bike lanes ("cycletrack"), and sidewalks or sidepaths. The provision of parallel multi-use pathways designed to serve both pedestrians and bicycles should also be a focus to better accommodate the needs of multiple user groups.

Near-term improvements for pedestrian facilities should focus on improving sidewalk connectivity with neighborhoods and providing crosswalks and related signage to make drivers aware of crossing locations. The following locations should be considered in the short-term for crossing improvements:

- Grand Ave/54th St: crosswalk enhancements, possibly a traffic signal, to improve pedestrian safety near school zone
- Grand Avenue midway between 56th Street West and 58th Street West: pedestrian actuated mid-block beacon, possibly a pedestrian hybrid beacon ("HAWK signal") or rectangular rapid flashing beacon (RRFB)
- 54th Street West at terminus of multi-use path (north end of Cottonwood Park): pedestrian actuated mid-block beacon, possibly a pedestrian hybrid beacon ("HAWK signal") or rectangular rapid flashing beacon (RRFB)
- Rimrock Road/54th St: crosswalk enhancements, possibly a traffic signal, to connect multi-use paths

The following corridors should be considered in the short-term for sidewalk or multi-use path improvements:

- Multi-use path on Grand Ave from 52nd Street West to west boundary of Trails West Subdivision
- Sidewalk on Grand Ave from west boundary of Foxtail Subdivision to HAWK signal
- Multi-use path from Grand Avenue to north boundary of Cottonwood Park along west side of 54th Street West
- Sidewalk along east side of 54th Street West from Grand Avenue to north boundary of Grand Peaks Subdivision

Figure ES7 on the following page illustrates the recommended locations for short-term active transportation system improvements.

Longer-term, it is recommended that a "layered network" principle be implemented as a way as to provide comfortable and efficient bike and pedestrian connectivity via lower-stress streets instead of force-fitting all modes onto the arterial corridors. Since many of these future collector corridors are platted but not built, it is an ideal time to establish the roadway standards that incorporate bike lanes, sidewalks and modest speed limits. A key consideration regarding this concept is cooperation between the City of Billings and Yellowstone County in terms of developing and implanting development requirements that will require construction of well-planned and consistent facilities as property develops in the study area. In the event that some of the major arterials become more urbanized over time, with speed limit reductions and bike facilities they could also become useful low-stress bikeways.

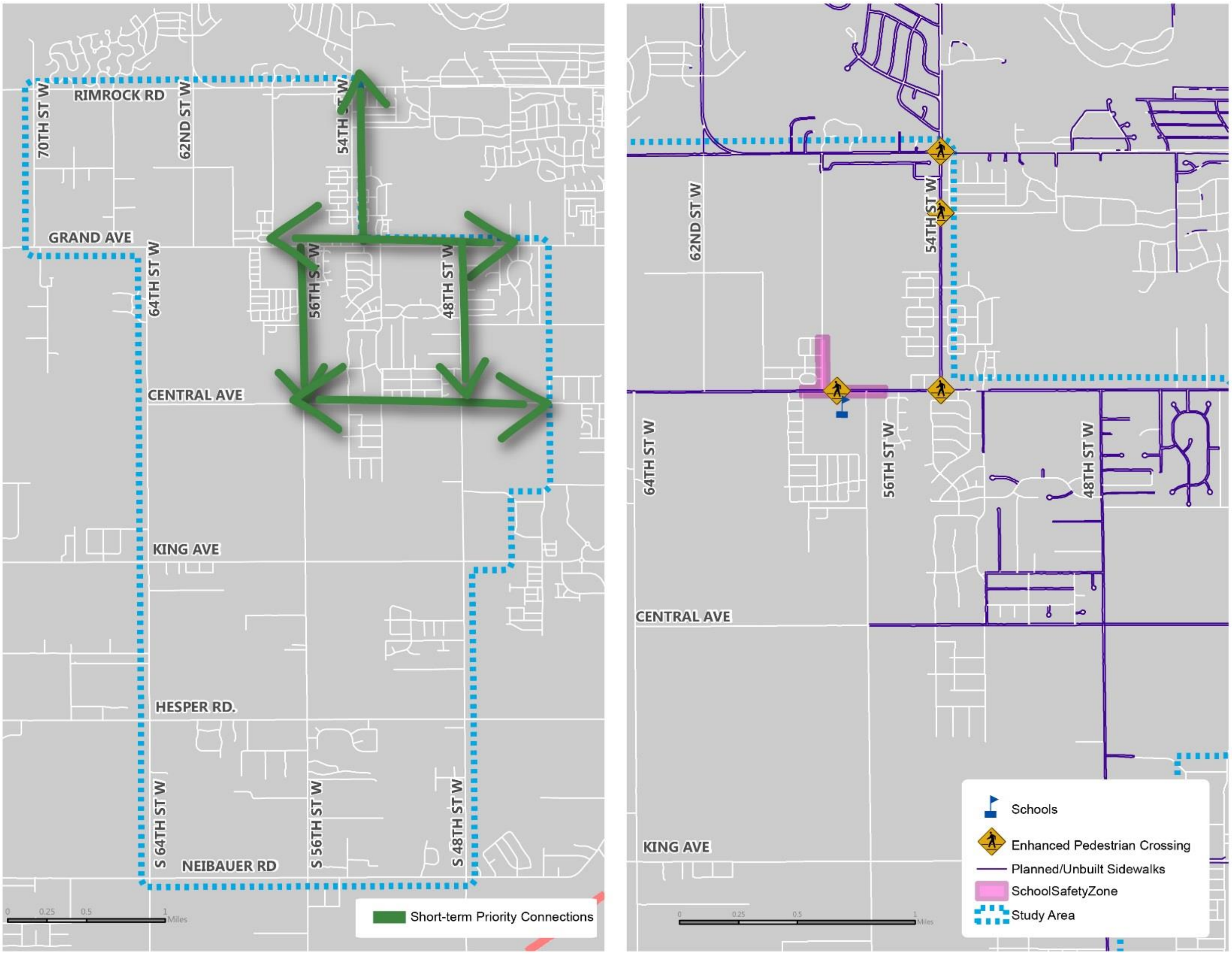

FIGURE ES7. SHORT-TERM IMPROVEMENTS FOR ON-STREET BICYCLE AND PEDESTRIAN FACILITIES

Recommended long-term low-stress corridors include:

- 58th Street West - Rimrock Road to Grand Avenue
- 66th Street West - Rimrock Road to Grand Avenue
- 60th Street West
- 52nd Street West
- Monad Road
- Broadwater Avenue
- Colton Boulevard

Future pathway segments should be prioritized based on the proximity to high demand areas and the ability of the segment to provide connectivity through barriers and gaps in the street system. **Figure ES8** on the following page illustrates the locations for recommended long-term active transportation projects. For more detail on all of the project conclusions and recommendations, please see the report body.

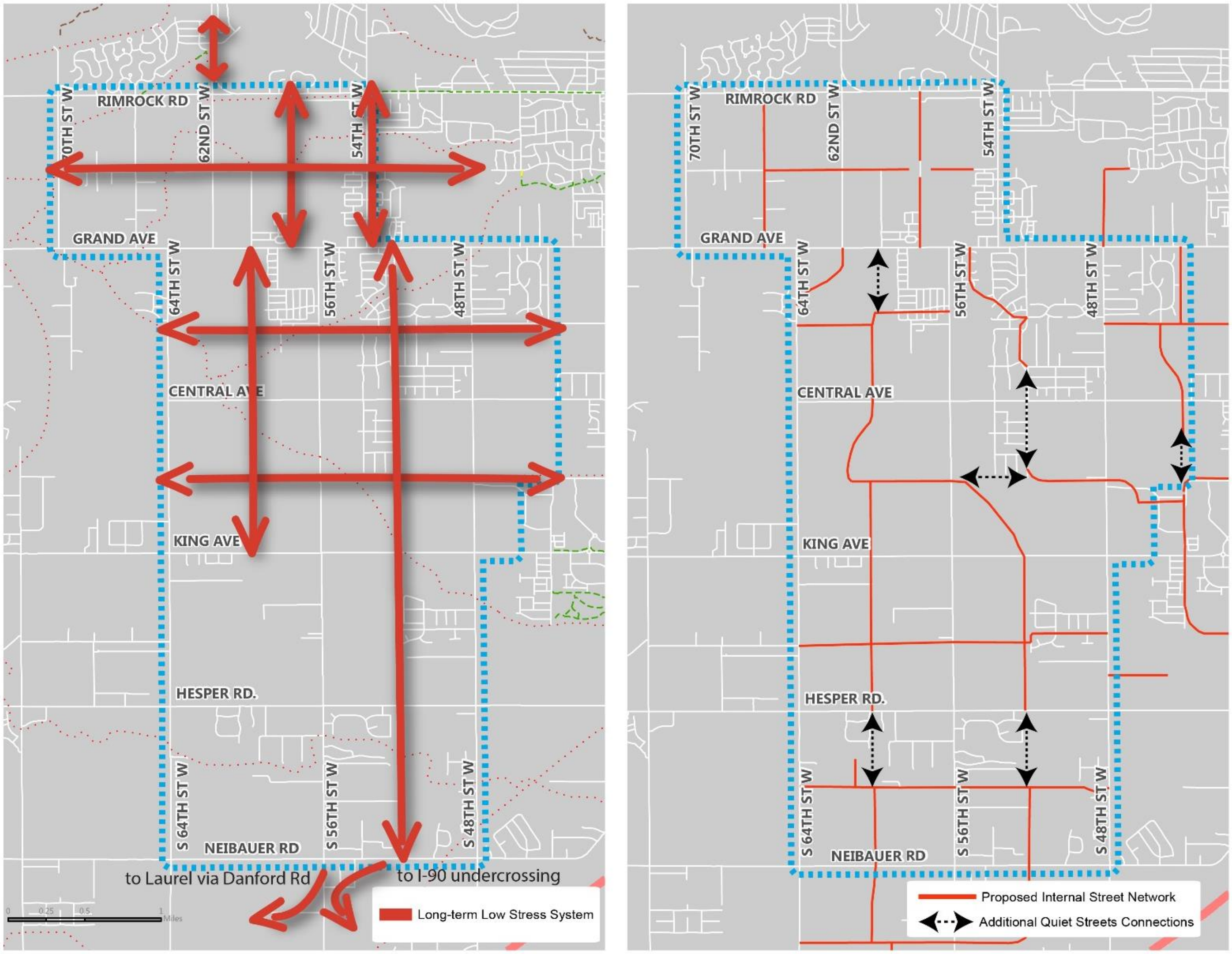

FIGURE ES8. LONG-TERM ACTIVE TRANSPORTATION STRATEGIES

INTRODUCTION

1

Billings is the largest municipality in the state of Montana with a population that was estimated at 108,869 by the US Census Bureau in 2014. Billings and Yellowstone County are governed by the City Council, County Commissioners and the Yellowstone County Board of Planning. The Metropolitan Planning Organization (MPO) administers the transportation planning program for the City and the County in the great Billings urban area.

In recent years, land development in the suburban/rural area west of Shiloh Road has brought about an increase in traffic volumes that directly impacts safety, operations and access. In addition to increased vehicular traffic, there is a growing demand for pedestrian and bicycle facilities in this area to provide connectivity amongst subdivisions and back to the more densely developed "West End" portion of Billings proper.

Study Objectives

The West End Multi-Modal Planning Study came about partially in response to complaints registered by residents west of Billings regarding increased traffic levels and the resulting impacts on traffic operations and safety. Through discussions between the MPO and the Technical Advisory Committee (TAC), it was determined that a study should be commissioned to look at the cumulative effect of subdivision development on the transportation system to help identify future gaps in infrastructure relative to all modes of transportation. To that end, the objectives of the West End Multi-Modal Planning Study are as follows:

1. Obtain Existing Conditions model data from the Montana Department of Transportation (MDT) and calibrate the study area based on recently collected traffic data and land usage information
2. Develop two (2) land development projection scenarios to be utilized as the basis for the future model runs; the "baseline" scenario represents a continuation of status quo growth and the "aggressive" scenario presumes more substantial annexation of the study area into the City
3. Develop preliminary improvement project recommendations based on model run results
4. Hold public meetings to present preliminary study results and solicit input from public
5. Revise model inputs as necessary based on public meeting and steering committee input; re-run models and revise improvement project recommendations accordingly

6. Summarize final results in a guiding document that provides recommendations on priority and approximate cost for improvement projects to mitigate projected impacts.

The Project Team also developed a purpose statement for the study that reads as follows:

To evaluate the cumulative effect of ongoing and projected future land development and population growth on the multi-modal transportation system for the area of Billings west of Shiloh Road.

Study Area Description

The study area for this project is depicted in **Figure 1** on the following page. The study area boundary was determined by the Planning Board and Planning Division. The intent was to include the areas generally outside of the City limits (though there are some annexed subdivisions that fall within the study area) that are most likely to develop with the 20-year horizon period for the study. It should be noted that there are some properties that were not included in the study area although they are currently still in the County. In general, those areas are already developed and/or are projected for annexation in the next few years.

Public Participation Process

A thorough public participation process was conducted for the West End Multi-Modal Planning Study in conformance with the 2009 Yellowstone County Board of Planning Participation Plan.

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

- **Project Steering Committee** meetings were held during most months to discuss the direction of the planning study.
- **Public Meeting No. 1** was held on February 2, 2016 to introduce the study to the public and request input on the type and prioritization of infrastructure improvement projects. Attendance was excellent (approximately 100 people). The primary themes of the question and comments received revolved around the anticipated Grand Avenue improvement project (City of Billings W.O. 16-09), roundabouts, and the high speeds within the study area. There was some discussion about active transportation (bike and pedestrian) modes and facilities.
- **Public Meeting No. 2** was held on April 14, 2016 in order to present preliminary recommendations and gather additional public input. Attendance was lower for this meeting, but we did receive some good input from the public.

The following dates were scheduled for review and approval of the West End Multi-Modal Planning Study:

- **Technical Advisory Committee** – Presentation and action on May 5, 2016
- **Yellowstone County Planning Board** – Presentation on May 10, 2016 and public hearing/action on May 24, 2016
- **Billings City Council** – Presentation on June 20, 2016 and action on June 27, 2016 (consent agenda, no public hearing)
- **Yellowstone County Commission** – Discussion on June 20, 2016 and presentation/action on June 28, 2016
- **Policy Coordinating Committee** – Final action on July 19, 2016

A project website was developed as a location to post draft documents for review and as a tool to request additional public input. The web address is www.sandersonstewart.com/projects/westend. The final document will be posted on the City of Billings website at http://ci.billings.mt.us/DocumentCenter/View/26772.

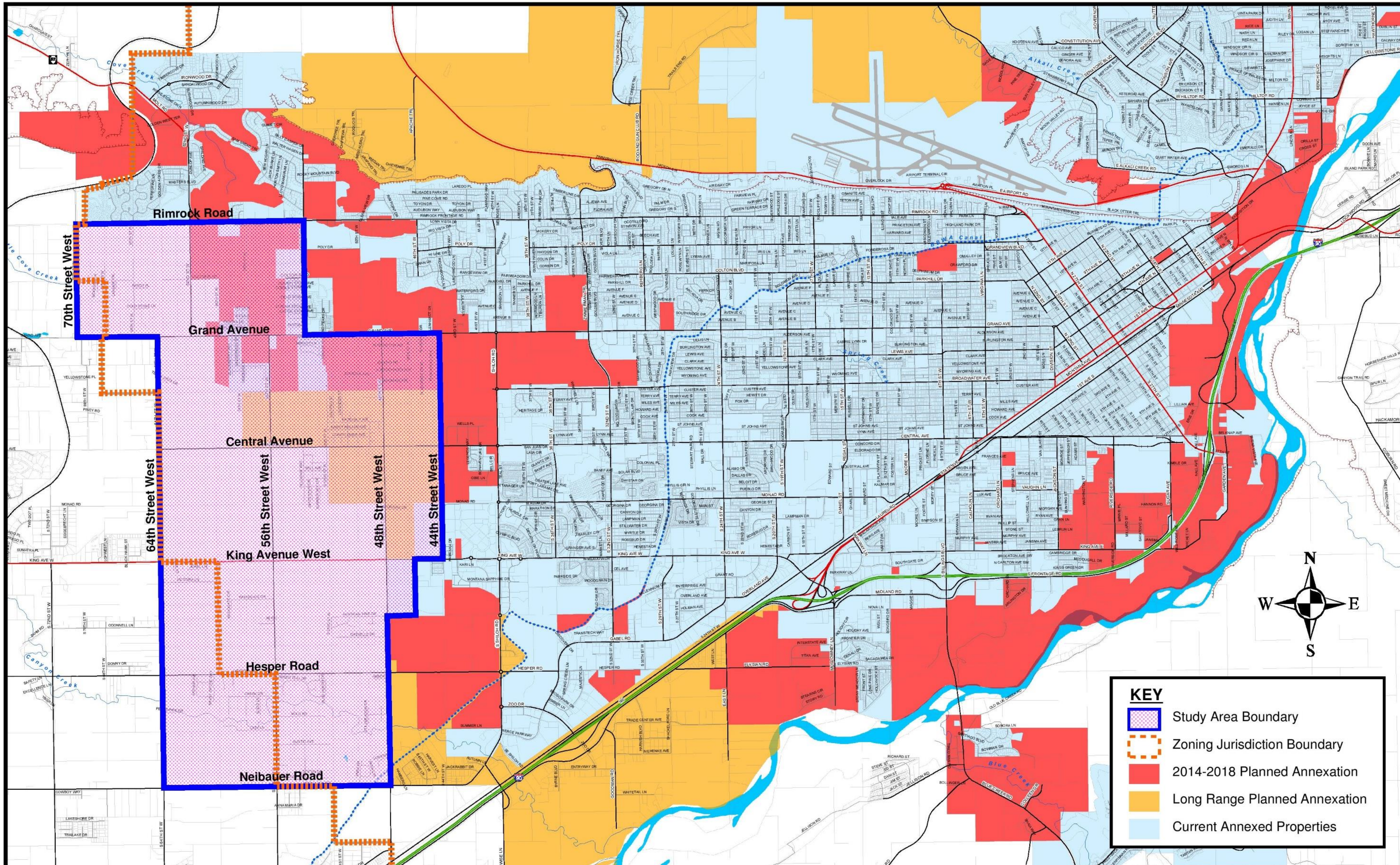

FIGURE 1 – STUDY AREA

EXISTING CONDITIONS

2

Although the primary intent of this study is to evaluate and prioritize potential project needs for a horizon year that is 20 years in the future, it was also important to evaluate existing conditions in order to provide a reasonable basis for comparison and expectations in terms of growth and demand. The following sections of this report summarize the Project Team's analysis of existing operational and safety conditions for all modes of travel.

Streets & Intersections

The following paragraphs provide background information about major streets and intersections that fall within the study area boundary for this project. The descriptions include physical measurements, speed limits, traffic control configurations and classification designations that help to determine the traffic demand and traffic stream makeup for the streets and intersections.

Streets

This region of Billings and Yellowstone County is transected by a series of streets that are generally laid out on a standard north-south-east-west grid. Those streets have a variety of roles, generally defined by Functional Classification, in the transportation of people and goods throughout the area. Functional Classification is the process by which streets and highways are grouped into classes according to the character of the traffic service that they are intended to provide. The basic system generally includes three categories: 1.) Arterials; 2.) Collectors; and 3.) Local Streets. Arterials are intended to provide a high level of mobility with limited local access. At the other end of the spectrum, Local Streets are designed to focus on providing access with limited function in terms of regional mobility. Collectors typically fall in between with an intended balance between mobility and access. Most jurisdictions further expand upon this system by adding Major (Principal) and Minor designations to the Arterial and sometimes Collector categories. Interstate is also often a separate classification category. The MPO utilizes the designations of Interstate, Principal Arterial, Minor Arterial, Collector and Local Street to define the streets and highways in Yellowstone County. MDT utilizes the categories of Interstate Principal Arterial, Other Principal Arterial, Minor Arterial, Major Collector, Minor Collector, Local and Alley to classify roadways. **Table 1** on the following page provides a listing of all non-Local streets within the study area, with functional classifications provided based on both systems where applicable.

TABLE 1. STUDY AREA STREET CHARACTERISTICS

Street	Functional Classification		Truck Traffic Restriction	Typical Street Widths (ft)		Speed Limit (mph)
	MPO	MDT		Travel Lanes	Shoulders	
Rimrock Road	Principal Arterial	Minor Arterial/Local Street[1]	No Restriction	11.0	0.5	55/(n/a)[5]
Grand Avenue	Principal Arterial	Major Collector/Minor Collector[2]	No Restriction	11.0	0.5-1.5	45/50/55[6]
Central Avenue	Principal Arterial	Major Collector/Minor Collector[3]	RESTRICTED	10.0	0.5-1.5	45/55/60[7]
King Avenue West	Principal Arterial	Major Collector	No Restriction	12.0	1.0	60
Hesper Road	Principal Arterial	Local Street	RESTRICTED	10.0-11.0	0.5-1.0	60
Neibauer Road	Principal Arterial	Minor Collector	RESTRICTED	11.5	1.0	60
64th Street West	Principal Arterial	Minor Collector/Local Street[4]	RESTRICTED	10.5-11.0	0.5-1.5	35/45/50/60[8]
62nd Street West	Principal Arterial	Minor Collector	RESTRICTED	11.0	1.0	(n/a)[9]
56th Street West	Principal Arterial	Minor Collector	No Restriction	11.0	0.5-1.0	45/50[10]
54th Street West	Minor Arterial	Local Street	No Restriction	12.0	0.5	45
48th Street West	Principal Arterial	Local Street	RESTRICTED	11.0	0.5-1.5	45/50[11]

[1] Minor Arterial - 54th Street West to Molt Road/Local Street - Molt Road to 70th Street West

[2] Major Collector - 48th Street West to 52nd Street West/Minor Collector - 52nd Street West to 64th Street West

[3] Major Collector - 48th Street West to 52nd Street West/Minor Collector - 52nd Street West to 64th Street West

[4] Minor Collector - Grand Avenue to King Avenue West/Local Street - King Avenue West to Neibauer Road

[5] 55 mph - 54th Street West to Molt Road/No speed limit posted - Molt Road to 70th Street West

[6] 45 mph - 44th Street West to 48th Street West/50 mph - 48th Street West to Molt Road/No speed limit posted - Molt Road to 70th Street West

[7] 45 mph - 44th Street West to 48th Street West/55 mph - 48th Street West to 56th Street West/60 mph - 56th Street West to 64th Street West

[8] 60 mph - Neibauer Road to School Zone area just south of Hesper Road/45 mph and 35 mph - School Zone area /55 mph - School Zone area to Grand Avenue

[9] No posted speed limit

[10] 50 mph - Neibauer Road to Central Avenue/45 mph - Central Avenue to Grand Avenue

[11] 50 mph - Neibauer Road to Central Avenue/45 mph - Central Avenue to Grand Avenue

Yellowstone County has an ordinance (07-107) in place that defines restrictions for the allowance of truck traffic on County roads. The ordinance states that "no truck traffic except for local deliveries" will be allowed on County roads designated as "restricted." For the purposes of the ordinance, a truck is defined as a vehicle with a combined gross vehicle weight of 16,000 pounds of more. Entities (businesses) located on roads that are designated as restricted are required to direct trucks via the shortest route possible to an unrestricted route. Within the study area for the West End Multi-Modal Planning Study, the majority of arterial streets are designated as restricted with the exception of Rimrock Road, Grand Avenue, King Avenue West and 56th Street West. **Table 1** includes a column that notes the restrictions accordingly.

In terms of the physical environment, the two biggest factors that impact multi-modal mobility in the study are roadway widths (lane and shoulder widths) and speeds. The Project Team performed an inventory of all of the above and the resulting data is included in **Table 1**. As indicated, all of the street segments within the study area boundaries have posted speed limits of 45 mph or higher. Combined with narrow travel lanes and shoulder widths, the travel speed conditions make for an uninviting setting for pedestrian and bicycle travel.

Intersections

Nineteen (19) existing intersections were identified as being prominent within the study area in terms of existing or future anticipated traffic demand. Those intersections are depicted in **Figure 2** on page 7. All 19 intersections are currently two-way stop-controlled. However, single-lane roundabouts are planned for the intersections of Central Avenue/56th Street West and King Avenue West/56th Street West and a traffic signal or roundabout is planned for construction at the Grand Avenue/54th Street West intersection as well. More detail is provided on these projects in a later section of the report. Several study area intersections also have overhead flashing beacons in place to warn high-speed drivers of approaching stop signs (red beacons) or stop-controlled side street approaches (amber beacons). It should also be noted that intersection sight distance is limited at various study area intersections during certain periods of the year as a result of agricultural crop production.

Traffic & Safety

A thorough evaluation of existing conditions relative to traffic and safety was conducted to establish a baseline future scenario operations analyses. That effort included a review of available historic traffic data from MDT, collection of new peak hour turning movement counts at major intersections, and review and analysis of historical crash data provided by MDT.

Traffic Volumes

The Project Team conducted AM and PM peak hour turning movement counts at eighteen (18) major intersections in May of 2105 and/or January of 2016 to utilize as the basis for existing conditions traffic analyses and model calibration. The AM and PM peak hours were generally found to occur from 7:15 to 8:15 AM and 4:45 to 5:45 PM. Raw count data was adjusted for seasonal variation utilizing MDT's published Seasonal Day of the Week For Axle Counts adjustment factors. **Figure 2** on the following page summarizes the Existing Conditions peak hour turning movement volume data. Detailed traffic count data is included in **Appendix A.**

Average Daily Traffic (ADT) volume count data for various key locations in the study area was provided by the MPO. The Project Team utilized that data and a K-factor approach (relating peak hour turning movement volumes to 24-hour ADT volumes) to estimate annual average daily traffic (AADT) volumes for study area corridor segments. **Figure 2** also illustrates the AADT estimates for the Existing Conditions scenario. The raw data counts from the MPO are included in Appendix A.

Crash History

Historical crash data was obtained from MDT for the 5-year period from January 1, 2010 through December 31, 2014 for the eighteen (18) study area intersections referenced previously. The data was analyzed for the purpose of calculating intersection crash and severity rates and evaluating collision type trends. **Table 2** on the page 8 illustrates the results of that analysis organized by intersection.

Intersection crash rates were calculated on the standard basis of crashes per million vehicle entering (MVE) each intersection. The MVE metric was estimated from the 2015 traffic counts. As a general rule, MDT considers that intersections with a crash rate greater than 1.0 crashes per million vehicles entering (MVE) should be examined further to determine if an inherent safety concern exists. The following seven (7) study area intersections exhibited intersection crash rates greater than 1.0 crashes/MVE per this analysis.

- Rimrock Road & 62nd Street West (crashes on Molt Road curve not included in this analysis)
- Central Avenue & 48th Street West
- Central Avenue & 56th Street West
- King Avenue & 56th Street West
- Hesper Road & 56th Street West
- Neibauer Road & 48th Street West
- Neibauer Road & 56th Street West

Of those seven (7) intersection, Rimrock Road & 62nd Street West, Neibauer Road & 48th Street West and Neibauer Road & 56th Street West exhibited crash rates higher than 1.50 with Neibauer Road having the highest rate at 2.87 crashes/MVE. The average intersection crash rate for the study area was 1.03 crashes/MVE.

Severity indexes and rates were also calculated for each of the study area intersections. The severity index is defined as the weighted average by crash severity, including fatal, injury, and property damage only crashes. Severity rate is defined as the crash rate multiplied by the severity index. There were no fatal crashes reported at any of the study area intersections, but

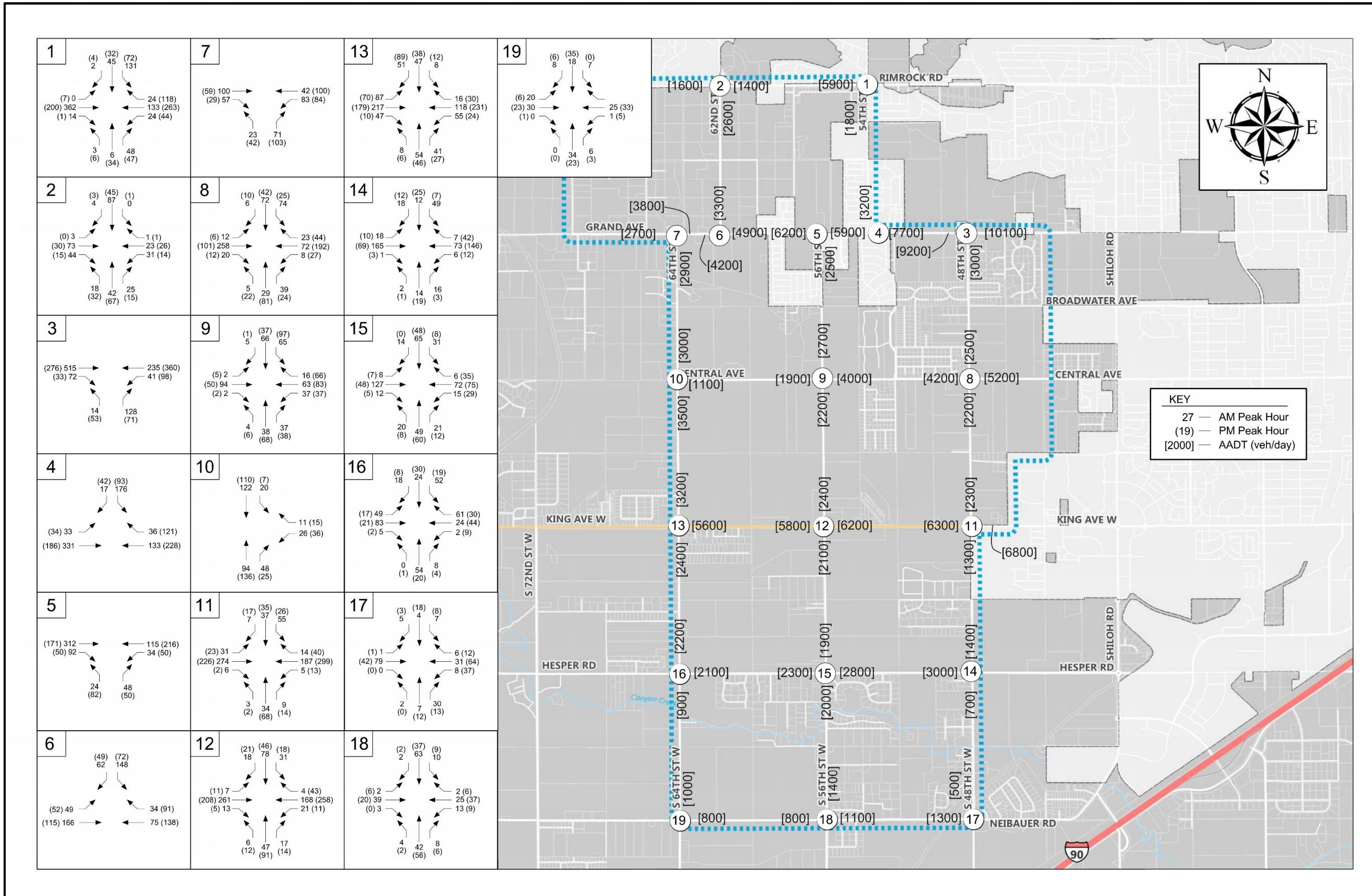

FIGURE 2 – EXISTING CONDITIONS (2015) TRAFFIC VOLUMES

TABLE 2. STUDY AREA INTERSECTION CRASH HISTORY

Intersection	2015 DEV[1]	Reported Crashes[2]	Crash Type			Rates (per MVE[3])		Collision Type						
			PDO	Injury	Fatality	Crash	Severity	Rear End	Right Angle	Fixed Object	Right Turn SD	Left Turn OD	Head On	Other[4]
Rimrock Road & 54th Street West	9526	13	9	4	0	0.75	1.21	3	8	2	0	0	0	0
Rimrock Road & 62nd Street West	3528	11	8	3	0	1.71	2.64	1	6	2	0	1	0	1
Grand Avenue & 48th Street West	11148	9	7	2	0	0.44	0.64	6	2	1	0	0	0	0
Grand Avenue & 54th Street West	8408	13	9	4	0	0.85	1.37	3	3	6	0	0	0	1
Grand Avenue & 56th Street West	7315	3	1	2	0	0.22	0.51	0	1	1	0	0	0	1
Grand Avenue & 62nd Street West	6180	7	5	2	0	0.62	0.97	2	2	1	0	1	0	1
Central Avenue & 48th Street West	3822	9	3	6	0	1.29	3.01	1	6	1	1	0	0	0
Central Avenue & 56th Street West	6292	13	5	8	0	1.13	2.52	2	8	2	0	0	0	1
Central Avenue & 64th Street West	7080	No Reported Crashes												
King Avenue & 48th Street West	8391	7	2	5	0	0.46	1.12	2	2	1	0	2	0	0
King Avenue & 56th Street West	8285	20	12	8	0	1.32	2.38	3	12	2	0	0	0	3
King Avenue & 64th Street West	8885	15	9	6	0	0.93	1.67	3	5	4	0	1	0	2
Hesper Road & 48th Street West	4292	7	4	3	0	0.89	1.65	1	3	1	0	0	0	2
Hesper Road & 56th Street West	4557	12	7	5	0	1.44	2.64	0	6	3	0	0	1	2
Hesper Road & 64th Street West	3440	1	1	0	0	0.16	0.16	0	0	0	0	0	0	1
Neibauer Road & 48th Street West	2293	12	5	7	0	2.87	6.22	2	9	1	0	0	0	0
Neibauer Road & 56th Street West	2370	8	4	4	0	1.85	3.70	0	4	4	0	0	0	0
Neibauer Road & 64th Street West	1723	No Reported Crashes												
TOTALS/AVERAGES	**6171**	**160**	**91**	**69**	**0**	**1.06**	**2.03**	**29**	**77**	**32**	**1**	**5**	**1**	**15**

[1] Daily Entering Volume (DEV) estimated from 2015 hourly counts
[2] Crashes reported from January 1, 2010 to December 31, 2014
[3] Crash and severity rates expressed as crashes per million vehicles entering (MVE) based on MDT severity factors
[4] "Other" crash types include sideswipes, backing vehicles, rollovers, animal-vehicle collisons and other

there were a substantial number of injury crashes reported (approximately 43.1 percent of crashes). There is not a rule-of-thumb threshold for severity rate that MDT utilizes to gauge concern for intersections. However, six (6) of the study area intersections exhibited severity rates above 2.50. Again it was the intersection of Neibauer Road & 56th Street West that had the highest severity rate at 6.22. The average severity rate for the study area was 2.03.

In terms of collision type, right-angle collisions were easily the most common, comprising almost 42 percent of the overall sample for the 5-year analysis period. This trend is not surprising given that the majority of the study area intersections are stop-controlled, right-angle intersections of high-speed rural facilities. Fixed-object (18.1 percent) and rear-end (15.6 percent) collisions were the next most prevalent. A couple of specific intersections contributed the majority of the fixed-object collision crashes. The fixed objects were most often utility poles or pedestals or in the case of the Grand Avenue & 54th Street West intersection, the masonry wall for Vintage Estates Subdivision. Again here, higher speeds are likely a contributing factor, as they are for the rear-end collisions which were generally clustered at higher-demand intersections that do not have auxiliary turn bays.

Intersection Traffic Operations

The Project Team performed Existing Conditions (2015) AM and PM peak hour intersection capacity calculations for all of the major study area intersections using Synchro, Version 8.0, the analysis methods for which are based on the HCM2010. The HCM2010 defines level of service (LOS) as "a quality measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience." LOS is a qualitative measure of the performance of an intersection with values ranging from LOS A, indicating good operation and low vehicle delays, to LOS F, which indicates congestion and longer vehicle delays. The purpose of this exercise was to establish a baseline for intersection operations and to identify any intersections that are currently at or approaching failure during peak traffic periods. **Table 3** on the following page illustrates the results of the Existing Conditions (2015) intersection capacity analysis.

The City of Billings and the Montana Department of Transportation generally consider Level of Service (LOS) C to be the minimum threshold for acceptable intersection operations. For the Existing Conditions (2015) scenario, all of the study area intersections were calculated to operate at LOS C or better (for the intersection as a whole) during both peaks. Overall, there were four individual intersection approaches that exhibited sub-standard LOS conditions (LOS D or E), all during the AM peak hour. Projected maximum queue lengths were generally manageable for all study area intersection approaches, even those with substandard LOS results. **Appendix B** contains Existing Conditions (2015) intersection capacity calculation worksheets.

Corridor Traffic Operations

In addition to peak hour intersections analysis, the Project Team performed an evaluation of daily corridor LOS to evaluate corridor capacity concerns and the potential need for road widening or other measures to improve capacity. The analysis was based on the Existing Conditions (2015) AADT volumes that are illustrated in **Figure 2**.

Planning-level corridor LOS values were estimated by comparing Existing Conditions (2015) AADT volumes to assumed capacity levels to calculate a volume-to-capacity (V/C) ratio. **Table 4** (page 11) displays the LOS categories and a description of the associated traffic conditions. It was determined collectively with the City that Level of Service D would be the desired minimum threshold for corridor traffic operations for this study. **Table 5** (page 11) contains typical LOS thresholds based on V/C ratio and categorized by the functional classifications of the streets. **Figure 3** (page 12) illustrates the results of this analysis for the Existing Conditions (2015) scenario. All corridors in the study area were projected to operate at LOS C or better. Note that the color-coding scheme in **Figure 3** matches those in **Tables 4 and 5**.

Table 3. Existing Conditions (2015) Intersection Capacity Calculation Results

Intersection	Approach	Existing (2015) AM Peak Avg Delay (s/veh)	AM Peak LOS	AM Peak 95th % Queue (veh)	Existing (2015) PM Peak Avg Delay (s/veh)	PM Peak LOS	PM Peak 95th % Queue (veh)
Intersection Control		*Stop Controlled (EB & WB)*					
62nd Street West & Rimrock Road	EB	11.5	B	1	10.2	B	1
	WB	12.9	B	1	10.9	B	1
	NB	1.6	A	1	2.1	A	1
	SB	0.0	A	0	0.2	A	0
	Intersection	6.3	A	--	4.9	A	--
Intersection Control		*Stop Controlled (NB & SB)*					
54th Street West & Rimrock Road	EB	0.0	A	0	0.3	A	0
	WB	1.2	A	1	0.8	A	1
	NB	14.4	B	1	14.0	B	1
	SB	*42.6*	*E*	*5*	23.7	C	2
	Intersection	9.1	A	--	5.1	A	--
Intersection Control		*Stop Controlled (SB)*					
62nd Street West & Grand Avenue	EB	1.7	A	1	2.5	A	1
	WB	0.0	A	0	0.0	A	0
	SB	14.5	B	2	12.8	B	1
	Intersection	6.5	A	--	4.1	A	--
Intersection Control		*Stop Controlled (NB)*					
64th Street West & Grand Avenue	EB	0.0	A	0	0.0	A	0
	WB	5.2	A	1	3.5	A	1
	NB	10.5	B	1	11.0	B	1
	Intersection	4.6	A	--	5.5	A	--
Intersection Control		*Stop Controlled (SB)*					
56th Street West & Grand Avenue	EB	0.0	A	0	0.0	A	0
	WB	1.9	A	1	1.5	A	1
	NB	13.8	B	1	15.7	C	2
	SB	15.1	C	1	0.0	A	0
	Intersection	2.4	A	--	4.4	A	--
Intersection Control		*Stop Controlled (SB)*					
54th Street West & Grand Avenue	EB	0.7	A	1	1.3	A	1
	WB	0.0	A	0	0.0	A	0
	SB	19.1	C	3	15.4	C	2
	Intersection	5.2	A	--	3.3	A	--
Intersection Control		*Stop Controlled (NB & SB)*					
48th Street West & Grand Avenue	EB	0.0	A	0	0.0	A	0
	WB	1.4	A	1	1.7	A	1
	NB	19.0	C	2	19.6	C	2
	SB	0.0	A	0	21.9	C	1
	Intersection	3.1	A	--	3.9	A	--
Intersection Control		*Stop Controlled (WB)*					
64th Street West & Central Avenue	WB	10.9	B	1	10.7	B	1
	NB	0.0	A	0	0.0	A	0
	SB	1.1	A	1	0.5	A	0
	Intersection	2.0	A	--	2.0	A	--
Intersection Control		*Stop Controlled (NB & SB)*					
56th Street West & Central Avenue	EB	0.2	A	0	0.7	A	0
	WB	2.4	A	1	1.5	A	1
	NB	11.7	B	1	11.8	B	1
	SB	15.2	C	2	14.6	B	2
	Intersection	7.3	A	--	7.4	A	--
Intersection Control		*Stop Controlled (NB & SB)*					
48th Street West & Central Avenue	EB	0.3	A	0	0.4	A	0
	WB	0.6	A	0	0.8	A	1
	NB	12.7	B	1	14.5	B	2
	SB	20.4	C	3	14.4	B	1
	Intersection	7.4	A	--	5.5	A	--

Intersection	Approach	Existing (2015) AM Peak Avg Delay (s/veh)	AM Peak LOS	AM Peak 96th % Queue (veh)	Existing (2015) PM Peak Avg Delay (s/veh)	PM Peak LOS	PM Peak 96th % Queue (veh)
Intersection Control		*Stop Controlled (NB & SB)*					
64th Street West & King Avenue West	EB	1.9	A	1	2.2	A	1
	WB	2.3	A	1	0.7	A	1
	NB	*32.3*	*D*	*4*	19.8	C	2
	SB	*25.7*	*D*	*3*	18.7	C	3
	Intersection	11.0	B	--	6.8	A	--
Intersection Control		*Stop Controlled (NB & SB)*					
56th Street West & King Avenue West	EB	0.2	A	0	0.4	A	0
	WB	0.9	A	1	0.3	A	0
	NB	16.4	C	1	21.8	C	3
	SB	21.2	C	3	19.2	C	2
	Intersection	6.5	A	--	6.8	A	--
Intersection Control		*Stop Controlled (NB & SB)*					
48th Street West & King Avenue West	EB	0.8	A	1	0.7	A	1
	WB	0.2	A	0	0.3	A	0
	NB	15.8	C	1	18.8	C	2
	SB	21.4	C	2	19.8	C	2
	Intersection	5.1	A	--	4.7	A	--
Intersection Control		*Stop Controlled (EB & WB)*					
64th Street West & Hesper Road	EB	17.8	C	3	10.4	B	1
	WB	11.0	B	1	10.1	B	1
	NB	0.0	A	0	0.3	A	0
	SB	4.2	A	1	2.4	A	1
	Intersection	9.6	A	--	6.5	A	--
Intersection Control		*Stop Controlled (EB & WB)*					
56th Street West & Hesper Road	EB	15.5	C	2	11.1	B	1
	WB	14.8	B	2	11.7	B	1
	NB	1.7	A	1	0.7	A	0
	SB	2.1	A	1	1.1	A	0
	Intersection	9.3	A	--	6.9	A	--
Intersection Control		*Stop Controlled (NB & SB)*					
48th Street West & Hesper Road	EB	0.7	A	0	0.9	A	0
	WB	0.5	A	0	0.4	A	0
	NB	10.7	B	1	11.7	B	1
	SB	12.5	B	1	11.4	B	1
	Intersection	4.8	A	--	2.8	A	--
Intersection Control		*Stop Controlled (EB & WB)*					
64th Street West & Neibauer Road	EB	10.5	B	1	9.7	A	1
	WB	9.9	A	1	9.7	A	1
	NB	0.0	A	0	0.0	A	0
	SB	1.6	A	0	0.0	A	0
	Intersection	6.4	A	--	4.6	A	--
Intersection Control		*Stop Controlled (EB & WB)*					
56th Street West & Neibauer Road	EB	10.6	B	1	10.3	B	1
	WB	10.8	B	1	10.3	B	1
	NB	0.5	A	0	0.2	A	0
	SB	1.0	A	0	1.4	A	0
	Intersection	4.5	A	--	4.7	A	--
Intersection Control		*Stop Controlled (NB & SB)*					
48th Street West & Neibauer Road	EB	0.1	A	0	0.2	A	0
	WB	1.3	A	0	2.4	A	1
	NB	9.3	A	1	10.1	B	1
	SB	9.8	A	1	11.1	B	1
	Intersection	3.4	A	--	4.3	A	--

TABLE 4. LEVEL OF SERVICE (LOS) CAPACITY ANALYSIS DESCRIPTIONS

	Level of Service	Traffic Flow	Description
Uncongested	A		• Light traffic • Free flow speeds
	B		• Slightly increased traffic levels • Still free flow speeds
	C		• Approaching moderate congestion levels • Speeds near free flow
Congesting	D		• Speeds reduced • Lane changes restricted due to traffic
Congested	E		• Congestion • Irregular traffic flow
	F		• Road at capacity • Gridlock with frequent stops

TABLE 5. LEVEL OF SERVICE (LOS) THRESHOLDS BY FUNCTIONAL CLASSIFICATION

LOS Threshold	A-C	D	E	F
Arterials/Collectors	*Upper Limit V/C Cutpoints*			
	0.58	0.75	0.92	>0.92
Principal Arterial	*(Daily Capacity Per Lane - 9000)*			
2 Lane	10,440	13,500	16,560	≥18,000
3 Lane	11,480	14,850	18,220	≥19,800
4 Lane	20,880	27,000	33,120	≥36,000
Minor Arterial	*(Daily Capacity Per Lane - 7000)*			
2 Lane	8120	10,500	12,880	≥14,000
3 Lane	8930	11,550	14,170	≥15,400
4 Lane	16,240	21,000	25,760	≥28,000
Collector	*(Daily Capacity Per Lane - 6000)*			
2 Lane	6960	9000	11,040	≥12,000
3 Lane	7660	9,900	12,140	≥13,200
4 Lane	13,920	18,000	22,080	≥24,000

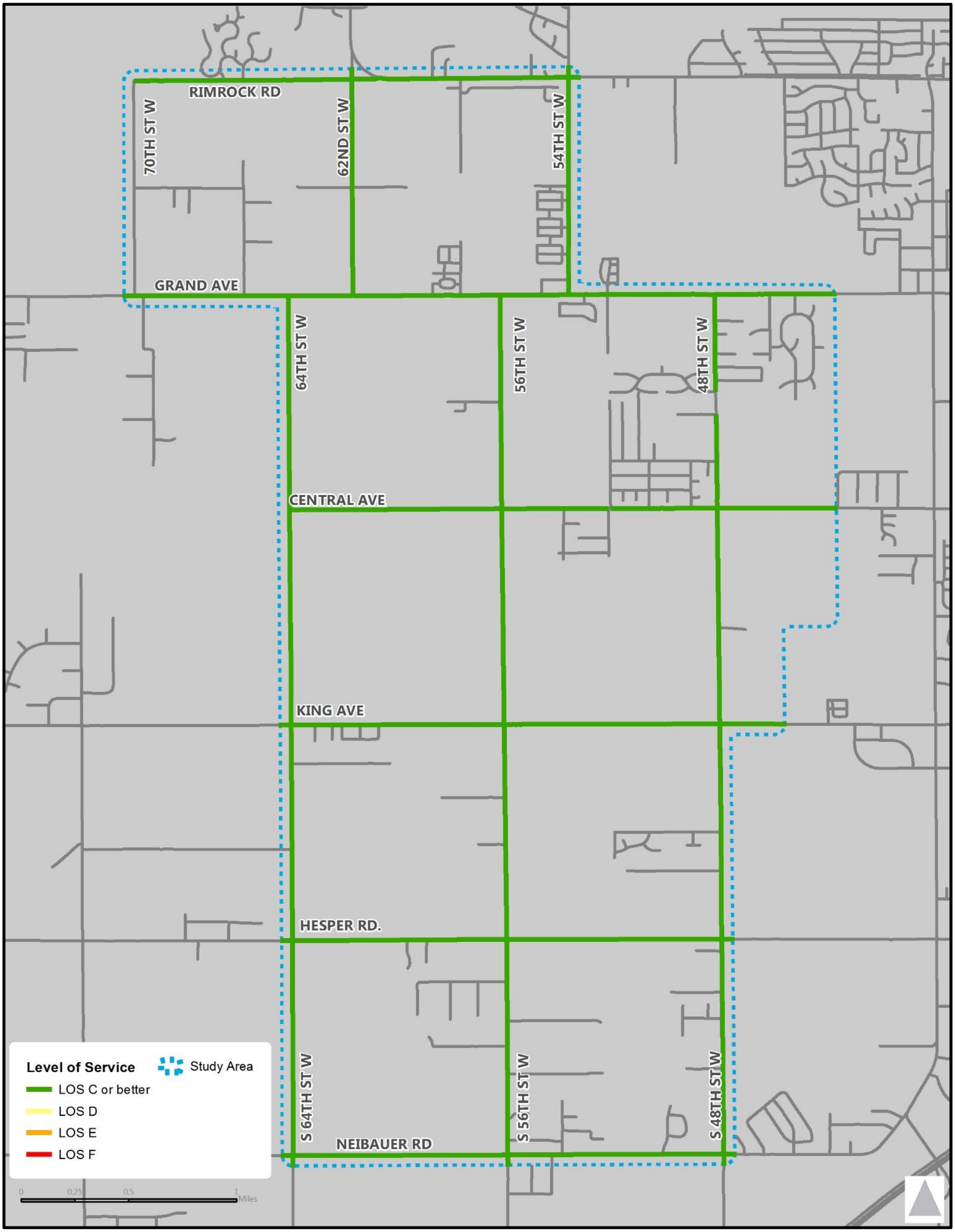

FIGURE 3. EXISTING CONDITIONS (2015) CORRIDOR LEVEL OF SERVICE (LOS)

Active Transportation Facilities

The term "active transportation" usually refers to walking and bicycle trips, but can include many forms of transportation powered by human energy, such as skateboards, kick scooters, or rollerblades. Active transportation trips offer an affordable and healthy way to access employment, schools, retail centers, or simply a way to recreate. Similar to the roadway networks that connect destinations for automobiles, active transportation networks get people from point A to point B on trails, quiet neighborhood streets, side paths, and bike lanes.

Figure 4 on the following page illustrates the existing network of active transportation facilities in the study area. Except for sidewalks internal to master-planned communities, the availability of sidewalks, side paths, trails, or bike lanes in the study area is very limited. This is primarily due to the undeveloped and agricultural nature of the study area, which is typical of rural areas. Towards the east side of the study area, development becomes denser approaching the urban core of the City of Billings. In these established urban areas (many of which are just outside the study area boundary), active transportation facilities are more prevalent. High quality paths on the eastern edge of the study area include the Rimrock Road Trail, Big Ditch Trail, Shiloh Road Trail, King Avenue West Trail, Zimmerman Trail, Gabel Road Trail, and the Olympic & Heritage Sub Trails. Additionally, there are striped bike lanes on Monad Road, and sidewalks are typical.

While there are nearby low-stress facilities, the study area generally lacks connectivity to these facilities. The existing roads that connect are arterials with very narrow shoulders and speeds limits between 45 to 60 MPH. The sidewalk and trail facilities that exist in and around subdivisions are isolated from connection to the Billings network.

What Type of Bike Rider Are You?

To be effective, Active Transportation systems should be designed to provide a network of facilities that accommodate a diversity of equipment and skill levels. For instance, it is not unusual to have side paths in a corridor with bike lanes; experienced adult riders may choose to ride at higher speeds adjacent to vehicle travel lanes, whereas a child riding to school may feel more comfortable on a path or sidewalk separated from traffic.

A commonly-cited study from the Portland Bureau of Transportation[1] developed four basic categories of cyclists: The Strong and the Fearless, The Enthused and Confident, The Interested but Concerned, and No Way No How. **Figure 5** on page 15 depicts the typical population split for these four categories and gives a description for reach. The categories are particularly useful when characterizing how different types of bikeways influence a rider's level of comfort. The percent of population breakdown for the four typologies indicates that the majority of cyclists (67 percent) fall into the Enthused and Confident and Interested but Concerned, suggesting that there is potential to increase cycling by investing in a low-stress bikeway system that is more comfortable to a wide range of people. While the percentage breakdown of four types of cyclists in Billings may not be exactly the same, the concept is a useful one for understanding aspects of a bike network that would increase cycling.

Level of Traffic Stress

Level of Traffic Stress (LTS) is a modern methodology developed by Mekuria, Furth and Nixon (2012) that examines the characteristics of city streets and how various aspects can cause stress on bicyclists and affect where they are likely to ride. LTS methodology classifies roadway segments into one of four levels of traffic stress, which are termed as LTS1 through LTS4. Groups of cyclists are categorized by how much stress they will tolerate in different environments:

[1] Geller, R. "Four Types of Cyclists," Portland Bureau of Transportation, Portland, OR, 2006. http://www.portlandoregon.gov/transportation/article/264746, Accessed March 2016.

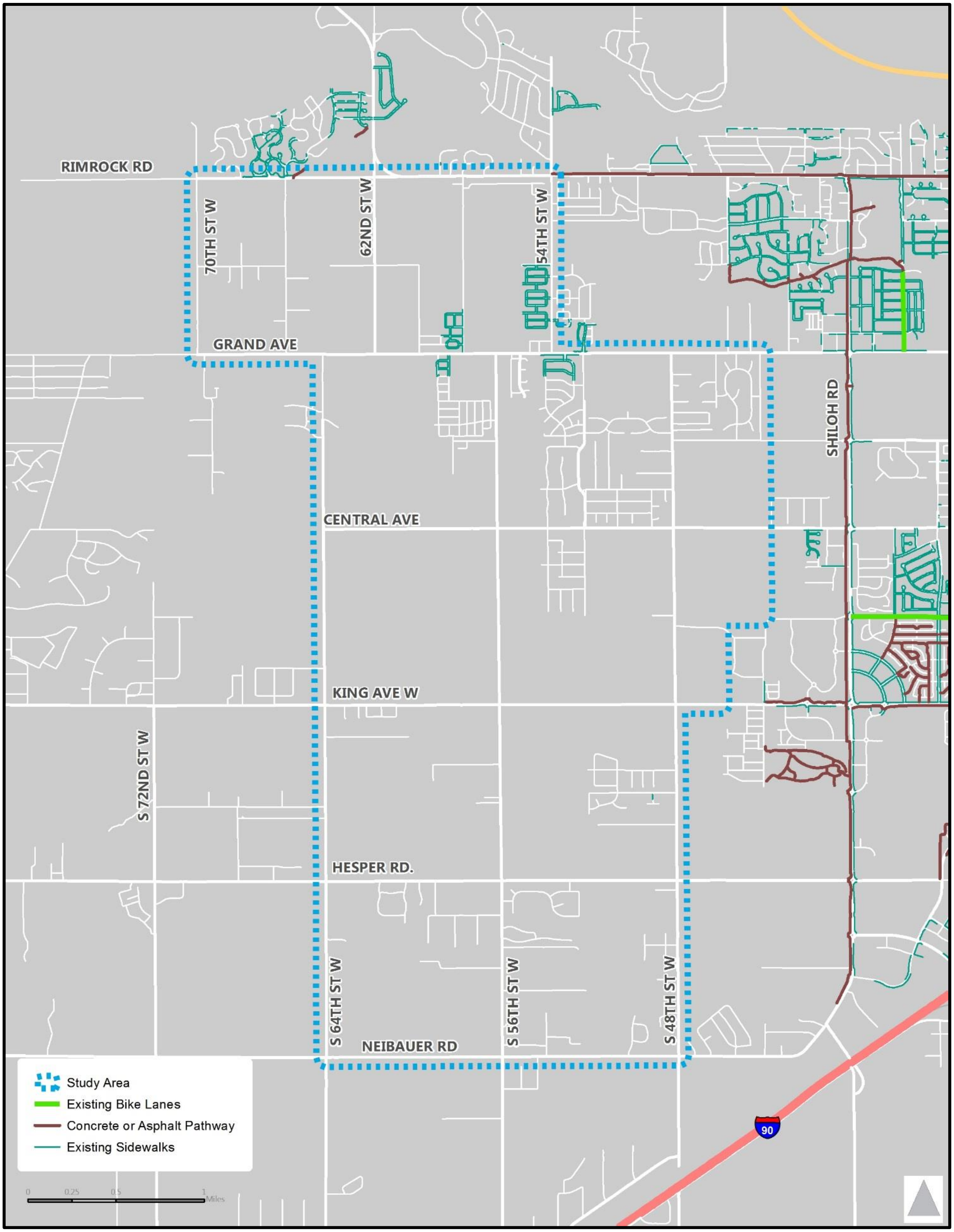

FIGURE 4. EXISTING STUDY AREA ACTIVE TRANSPORTATION FACILITIES

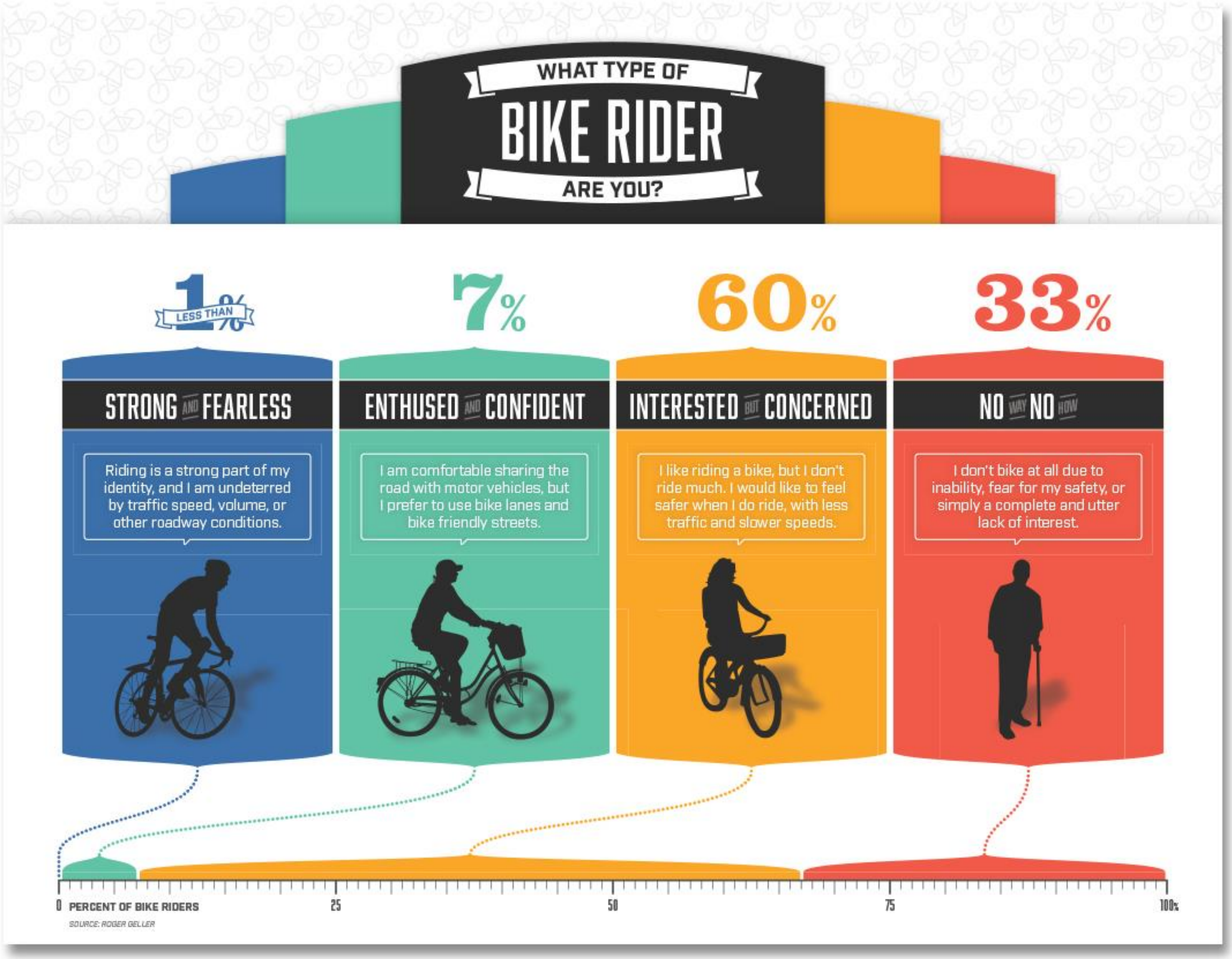

FIGURE 5 – TYPES OF BICYCLE RIDERS

- LTS1: most children can tolerate and feel safe while bicycling.
- LTS2: the mainstream adult population will tolerate and feel safe while bicycling
- LTS3: cyclists who are considered "enthused and confident," but still prefer having their own dedicated space for riding, will tolerate and feel safe while bicycling.
- LTS4: a level tolerated only by those characterized as "strong and fearless", which comprises just 0.5 percent of the population. The high-stress streets that LTS4 groups will ride are those with high speed limits, multiple travel lanes, limited or non-existent bike lanes and signage, and large distances to cross at intersections.

Table 6 on the following page presents the variables used to develop LTS scores for the roadway network in the study area. LTS works on the "weakest link" principle, where the traffic stress for a given corridor, intersection approach or crossing is dictated by the most stressful portion. This means a full segment receives the score of its lowest-scored portion. For example, a cross-town ride could have large portions of LTS1 and LTS2, but just one section of LTS3 would present a barrier. Only cyclists that could tolerate LTS3 would ride the entire route. So, LTS3 becomes the score for that route. LTS analysis was conducted only for minor arterials and arterials in the study area because there is limited connectivity for local/collector streets, requiring most trips to use the arterial system. **Figure 6** on page 17 illustrates the LTS rank for roads in the study area.

TABLE 6. LEVEL OF TRAFFIC STRESS (LTS) VARIABLES

Level of Traffic Stress (LTS) Variable	Data Source
Direction	Derived
Mode separation (mixed flow or bicycle lane)	Bike trails, field review
Is this a residential street?	Calculate based on land use
Adjacent parking	Field review
Lanes in analysis direction	Have from centerline file
Is there a median?	Field review
Is there a center line?	Field review
What is the prevailing speed? (Use speed limit if prevailing speed not available)	Speed limit from centerline file
Bike Lane + Parking Width (if bike lane present)	Field review
How often do bike lane blockages occur?	Estimate

This analysis suggests that virtually all the arterials in the study area are categorized as LTS4. The most significant elements of the physical roadway cross section contributing to the stressful cycling environment are vehicle speeds above 35 MPH and a lack of bike lanes or rideable shoulders.

Committed/Planned Projects

A variety of projects that are intended to improve multi-modal operations and/or safety are committed via the capital improvement plans for the City, County or MDT or are being tentatively planned for the near future. The following paragraphs provide descriptions of committed or planned projects as they are known at this time.

Street & Intersection Projects

Two projects are currently being designed under MDT administration that are specifically intended to improve safety conditions for the intersections of Central Avenue & 56th Street West and King Avenue West & 56th Street West. Both of those intersections will be reconstructed as single-lane roundabouts, and in both cases the projects were programmed in response to concerns about safety and the crash histories at those intersections. The current schedules for those projects would have the King Avenue-56th Street West roundabout starting construction in 2016 and the Central Avenue-56th Street West roundabout starting construction in 2017. Although both projects were initiated for safety reasons, the proposed improvements will also greatly increase traffic volume capacities for those intersections. The design years for the projects are 2035 (King) and 2036 (Central). It should be noted that crosswalks and sidewalk connections are not currently planned for construction at either the King Avenue West/56th Street West or Central Avenue/56th Street West roundabouts due to right-of-way constraints at the intersections. The roundabouts will be constructed with a removable sections of raised median so as to facilitate a retrofitting of crosswalks without complete reconstruction of the medians.

The City of Billings is in contract negotiations with Sanderson Stewart for design and construction services on the W.O. 16-09 Grand Avenue – 48th to 58th project, which is programmed for construction in 2017. That project will widen Grand Avenue to a 3-lane section from approximately 52nd Street West to 58th Street West. It will also construct eastbound and westbound auxiliary left-turn bays at the Grand Avenue-48th Street West intersection and a traffic signal or roundabout at the Grand Avenue-54th Street West intersection.

In addition to the committed street and intersection projects referenced above, it is tentatively planned that a traffic signal will be installed at the intersection of Rimrock Road and 54th Street West within the next couple years (per the City of Billings).

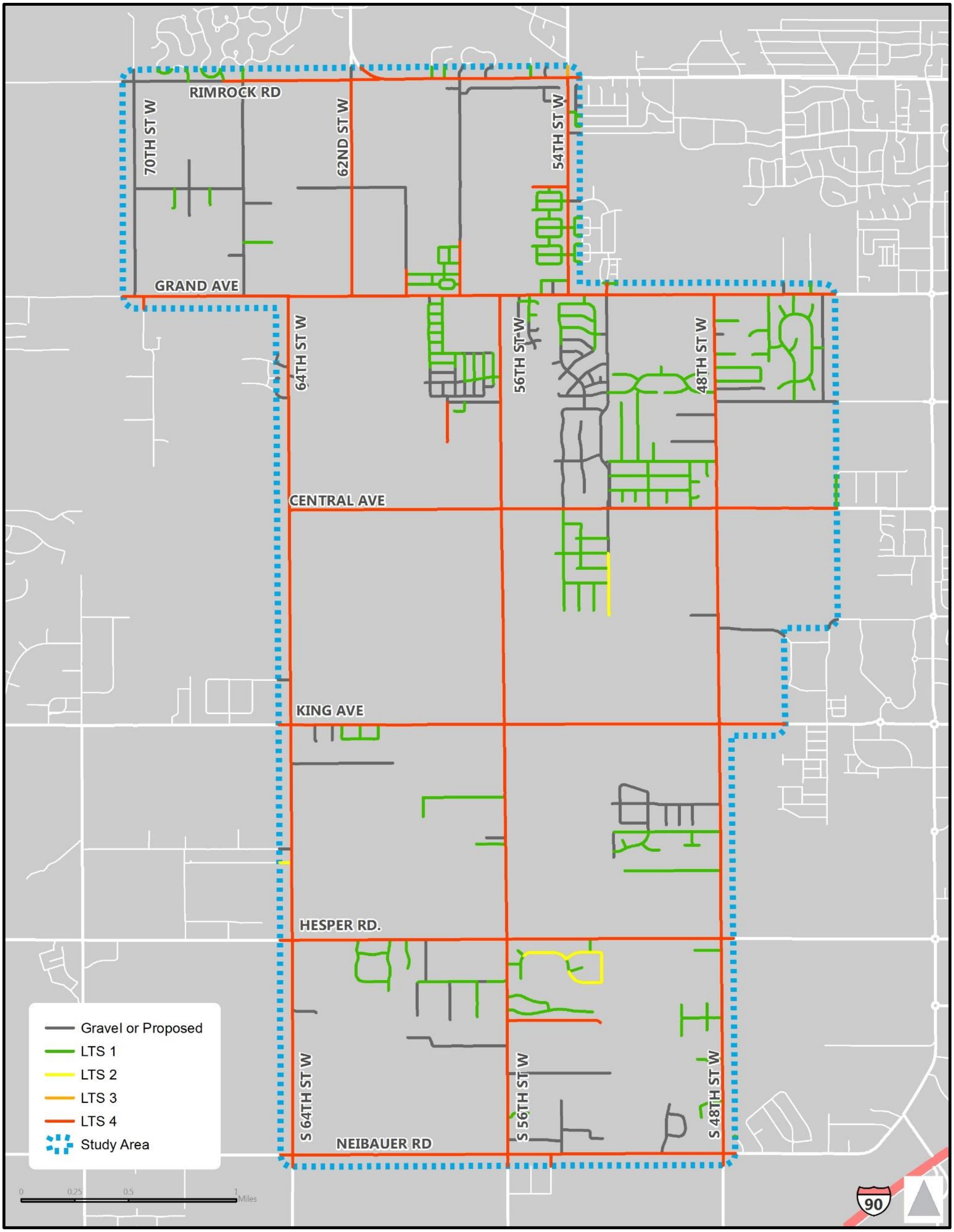

FIGURE 6. EXISTING CONDITIONS (2015) LEVEL OF TRAFFIC STRESS (LTS)

The Project Team is not aware of any other additional street or intersection improvement projects within or directly adjacent to the study area that are currently committed or even planned at this point in time.

Bicycle & Pedestrian Facility Projects

The above-referenced City of Billings W.O. 16-09 project is planned to construct a network of sidewalks and multi-use paths that will, at a minimum, provide pedestrian and bicycle connectivity along Grand Avenue from 52nd Street West to the west boundary of Trails West Subdivision and along 54th Street West from Grand Avenue to Rimrock Road. The ultimate configuration (and mixture of narrower sidewalk versus wider multi-use path) is yet to be finally determined and will depend somewhat on the availability of right-of-way or easement across a few key privately-held properties. The general intent of this network of bicycle and pedestrian facilities is to provide active transportation interconnectivity amongst area residential developments, Ben Steele Middle School and other neighborhood facilities.

Depending upon the final configuration of the system along 54th Street West, a mid-block pedestrian crossing with rectangular rapid flashing beacons (RRFBs) may be constructed at the boundary between Cottonwood Grove Subdivision and Cottonwood Park. Also, the City of Billings W.O. 16-09 project will install a High-Intensity Activated Crosswalk (HAWK) signal on Grand Avenue mid-block between 56th Street West and 58th Street West expressly for the purpose of getting pedestrians across Grand Avenue at the main entrance to Ben Steele Middle School. At this time, the Project Team is not aware of any other active transportation improvement projects that are committed or planned within the boundaries of the study area.

LAND DEVELOPMENT FORECASTING

3

The planned approach for analyzing the horizon year scenarios for this study was to work cooperatively with the MDT Statewide and Urban Planning Department to develop horizon year (2035) Transcad transportation model runs to projected future land development scenarios within the study area. MDT owns and maintains the transportation model for the Billings area, so its personnel were charged with creating the model runs for our study and it was the consultant team's responsibility to determine the input parameters that would most accurately represent the land development scenarios that were agreed upon by the Project Oversight Committee for analysis. The following paragraphs describe how those scenarios were planned and how the model input parameters were calculated.

Land Development Scenarios

Through discussions at the initial meetings of the project Steering Committee it was determined that two (2) land develop scenarios would be modeled and analyzed for the purposes of this study. Scenario 1 would represent an assumed progression of land development in the study area that was more conservatively consistent with recent historical trends in this area. Annexation (and thereby land development at densities consistent with City of Billings lot size requirements) would be presumed to occur only in the areas shown as "in the red" on the current version of the City's annexation planning map (see **Figure 1**). The areas not in the red (approximately 900 acres) would be presumed to develop with densities consistent with Montana Department of Environmental Quality (DEQ) requirements for lot size based on private water well and septic systems. Scenario 2 was more aggressively planned to represent an expansion of annexation that included the areas identified in yellow-orange on the City's annexation planning map (See **Figure 1**) in addition to the areas that are shown "in the red." That distinction increased the raw land area projected for City-based development densities by approximately 950 acres (total area of approximately 1850 acres).

In addition to the distinctions between the two scenarios that are based on presumed annexations, it was agreed that Scenario 1 would be based on a more conservative assumption of overall raw land development density, and that the assumptions for Scenario 2 would be more aggressive in terms of density of development. Since the undeveloped properties in the study area are owned by a multitude of different individuals, families and corporations, the Project Team relied heavily on the expertise of Mr. Bob Sanderson to project the raw land development densities for both scenarios. Mr. Sanderson is one of the founders of Sanderson Stewart and has more than 40 years of experience with land development in Billings area, but he has also resided at a rural residence located just outside the study area boundary for a similar timeframe. Mr. Sanderson knows this area very well and he also has relationships with several of the property owners. The Project Team worked with Mr. Sanderson to evaluate each and every parcel of land in the study area to project land development probabilities (percentages) for both scenarios. Those projections were then converted to residential dwelling units, retail employees and non-retail employees so that the projections could be utilized as inputs for the Transcad models for each scenario. The determination of where residential vs. commercial development would occur was based on the current adopted zoning scheme and discussions between the Project Team and the Steering Committee about where commercial nodes might be most likely to develop in the future.

The residential dwelling unit conversions were made using absorption rates for housing derived from data for recent (past 10 years) residential subdivisions developed in and around the study area. Separate rates were derived for subdivisions developed in the County vs. within City Limits, since lot sizes and subdivision covenants are generally very different for County and City subdivisions. The commercial employee projections were calculated using Institute of Transportation Engineers (ITE) *Trip Generation* rates for retail and industrial employees and actual employee projection numbers for Ben Steele Middle School and future potential elementary and high schools based on discussions with School District #2.

To differentiate between Scenarios 1 and 2 from a land development sprawl standpoint, the projected percentage of developable area for Scenario 1 (as calculated by Mr. Sanderson) was doubled for Scenario 2. If the Scenario 1 percentage was 50 percent or greater, the Scenario 2 percentage was capped at 100 percent. As an additional differentiation, it was presumed through discussions with School District #2 that the only likely school opening within the study area for Scenario 1 would be Ben Steele Middle School. For Scenario 2, it as additionally assumed that new elementary and high schools would also be in operation.

Growth Projections

Based on the detailed forecasting of land development densities, types and locations, the Project Team performed some simple exponential growth projections and presented that data to the Steering Committee for the purpose of building consensus on the anticipated levels of growth for the land development scenarios. **Table 7** (below) and **Table 8** (next page) present the results of the residential and commercial growth projections along with census-based projections for population growth.

Table 7. Summary of Residential Growth Projections

Scenario	2014		2035		Delta (Horizon Year)		Population Growth
	Homes[1]	Population[2]	Homes	Population	Homes	Population	
Existing Conditions	1,093	2,459	-	-	-	-	-
Scenario 1	-	-	9,269	20,855	8,176	18,396	10.7%
Scenario 2	-	-	19,334	43,502	18,241	41,043	14.7%
Delta (Scenario)	***-***	***-***	***10,065***	***22,647***	***10,065***	***22,647***	***3.9%***

[1] Calculated using 4.5% total growth from 2010 to 2014 (from US census data)

[2] Calculated using rate of 2.25 persons/household (from 2010 US census data)

Table 8. Summary of Commercial Growth Projections

Scenario	Employees						Annualized Growth	
	2010		2035		Delta (Horizon Year)			
	Retail[1]	Non-Retail[1]	Retail	Non-Retail	Retail	Non-Retail	Retail	Non-Retail
Existing Conditions	66	469	-	-	-	-	-	-
Scenario 1	-	-	187	757	121	288	4.09%	1.86%
Scenario 2	-	-	248	1,146	182	677	5.22%	3.50%
Delta (Scenario)	***-***	***-***	***61***	***389***	***61***	***389***	***1.14%***	***1.64%***

[1] From 2010 MDT Transcad model for Billings

The Project Team presented the preliminary growth projections to the Steering Committee at a meeting in November of 2015. The group reviewed the information, particularly as it related to ongoing efforts by the MPO to update the Billings/Yellowstone County Growth Policy (separate project). The MPO reported a Growth Policy target range for City-wide population growth of 40,000-70,000 people with a mid-range estimate of 55,000 new residents by 2035. The expectation is that the overall growth will be spread out into a handful of areas around Billings, but that the West End region that is largely included in our study area is likely to account for a significant percentage of the total growth. After reviewing the initial projections, the Steering Committee agreed that the targeted growth for the West End Multi-Modal Planning Study was consistent with the range of overall growth (in terms of population and employees) from the Growth Policy project. The Project Team was given the go-ahead to provide model inputs to MDT based on the growth projections and proceed with the travel demand modeling effort on that basis.

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Travel Demand Model Background

At the inception of this planning study, the original intent was to utilize the Yellowstone County travel demand model to develop future year traffic volume forecasts. The regional model is maintained by the Montana Department of Transportation (MDT), and includes traffic analysis zones (TAZs) and roadways in the study area. MDT does not allow consultants to run the model directly, and model documentation was not available; as such, the Project Team has limited knowledge of the assumptions, equations, and overall validation of the model. This chapter summarizes efforts made to use the travel model and describes assumptions ultimately used for the calculation of the traffic projections for this study.

Model Scenarios & Process

Initial Reasonability Checks - Base Year Validation

Model validation is the term used to describe model performance in terms of how closely the model's output matches existing travel data in the base year. Traditionally, most model validation guidelines have focused on the performance of the trip assignment step in accurately assigning trips to the street network. To determine the reasonableness of the Yellowstone County travel model in the project study area, daily volume results from the 2010 base year model runs were examined. Thirty daily traffic counts from 2014-2015 were compared to the base year model estimates; key validation measures are summarized below:

- At least 75 percent of the roadway links for which counts are available should be within the maximum desirable deviation, which ranges from approximately 15 to 60 percent depending on total volume (the larger the volume, the less deviation is permitted).

  Result: Model volumes were compared to existing traffic counts at thirty individual count sites for daily validation. Of those, 25 were within allowable deviation which meets the 75 percent requirement.

- The two-way sum of the volumes on all roadway links for which counts are available should be within 10 percent of the counts. Also called model-to-count ratio.

Result: The default model estimated 72 percent of volume indicated by counts, which is outside the allowable threshold.

Roadway Network Modifications - Calibration

Model calibration is the term used to describe the process by which the coefficients and inputs of the model may be adjusted to better replicate travel behavior and traffic volumes. Since the Project Team had limited access to the model to review key parameters such as trip generation rates, modifications to the roadway network were the primary calibration mechanism after verifying the base year land use was reasonable relative to Census population data. In an attempt to improve model validation, roadway characteristics were reviewed to ensure that the link attributes reflected local operating conditions. During this review, link characteristics such as speed, functional class, and capacity were modified to better reflect conditions on the ground. TAZ connectors were also modified to produce more realistic neighborhood access locations.

Future Land Use Scenarios

Land use data is one of the primary inputs to the Yellowstone County model, and this data is instrumental in estimating trip generation. The model's primary source of land use data is household and employment information. Households are categorized in terms of total dwelling units. The employment data is aggregated into two categories: retail employment, and non-retail employment. The future land use scenarios discussed in the previous chapter were summarized in terms of model-compatible inputs at the TAZ geography.

Model Run Results

Table 9 below summarizes the final model results in terms of annualized growth rates on key roadways in the study area. The annualized growth rates in excess of 6.0 percent were considered to be too high even for the more aggressive land development projection scenario. The application of the rates at that level or higher resulted in traffic volume projections that the Project Team and ultimately the Steering Committee found to be unrealistic for this market under any reasonable growth scenario. In general however, the geographic dispersion of growth as portrayed by the model was found to be relatively consistent with expected growth patterns. As such, the decision was made to manually override the model run results in terms of magnitude of traffic volume projections, but to utilize the model results as a basis for development of traffic growth projections (summarized in the following section).

Street	2035 Scenario 1 Annualized Growth Rate	2035 Scenario 2 Annualized Growth Rate
Rimrock Road	5.33%	7.31%
Grand Avenue	5.60%	6.94%
Central Avenue	8.14%	10.49%
King Avenue West	2.62%	3.59%
Hesper Road	2.58%	4.02%
Neibauer Road	3.51%	5.35%
48th Street West	2.83%	3.89%
54th Street West	6.29%	6.91%
56th Street West	7.47%	8.77%
62nd Street West	4.24%	4.35%
64th Street West	4.42%	6.80%

Table 9. Travel Demand Model Results – Average Annualized Corridor Growth

Horizon Year (2035) Traffic Projections

In order to temper the overall magnitude of the Horizon Year (2035) traffic projections relative to the output volumes from the travel demand model, the Project Team evaluated a series of annualized growth rates for each scenario that were blended across the study area so as to project a higher intensity of growth in the northeast portion of the study area and lesser growth as you move south and west. The blended approach was found to generally be consistent with how the travel demand model was distributing traffic for the Horizon Year (2035) model runs. An iterative process was utilized to test different growth rate schemes using design year projections from the MDT Central Avenue & 56th Street West and King Avenue & 56th Street West intersection reconstruction projects to calibrate the projections.

Ultimately, the Project Team settled on a pair of blended schemes whereby the annualized growth rate percentages for Scenario 1 ranged from 2.7 percent to 4.5 percent (average of 3.5 percent) and the growth percentages for Scenario 2 ranged from 3.5 percent to 5.9 percent (average of 4.6 percent). This approach and the resulting peak hour turning movement and annual average daily traffic (AADT) volume projections were presented to the Steering Committee for review and approval in March of 2016. After a thorough discussion of the pros and cons, the approach was approved and the Project Team moved forward with final adjustments to the projections. Since the simplified application of growth rates directly to existing turning movement volumes does not take into account individual movement capacity thresholds or other factors that could limit growth for specific movements, manual adjustments were made in certain cases based on the professional judgement of the Project Team. **Figure 7** and **Figure 8** on (pages 25 to 26) illustrate the projected AM and PM peak hour turning movement and AADT volumes for Scenarios 1 and 2, respectively.

The resulting increases in traffic volumes were substantial across the board. The average corridor AADTs for Scenario 1 (2035) increased when compared to Existing Conditions (2015) by approximately 122.9 percent. The average AADTs for Scenario two represented an increase over existing of approximately 177.2 percent. The projected magnitude of increase for peak hour turning movement volumes was similar.

Active Transportation Modeling

Although there is a growing interest in modeling active transportation, most travel demand models are sensitive only to automobile and transit trips. Forecasting tools have traditionally excluded pedestrian and bicycle activity. One key complication to modeling non-auto modes is the scale at which bicycle and pedestrian trip are made. Since most walk trips are less than three miles, most travel model networks and traffic analysis zone (TAZ) structures simply lack adequate resolution to develop reasonable trip distribution and assignment estimates.

Rather than try to forecast the magnitude of bicycle and pedestrian activity, the Project Team implemented a methodology that determines the relative level of demand for walking and biking in the study area. The Latent Demand Model uses economic, demographic, land use, and built environment factors to identify “hot spots” for active transportation, and provides a logical analysis framework to prioritize attention and investment.

Latent Demand Variables

Active transportation – bicycling and walking – are dependent on a variety of factors. This analysis uses a combination of existing and newly developed GIS data correlated with active transportation. The weighting of these variables is, in part, based on results of previous research, but is also tailored to this project based on planning and engineering judgment. The variables, as well as the corresponding scoring criteria are provided in **Table 10** and **Table 11** on page 27.

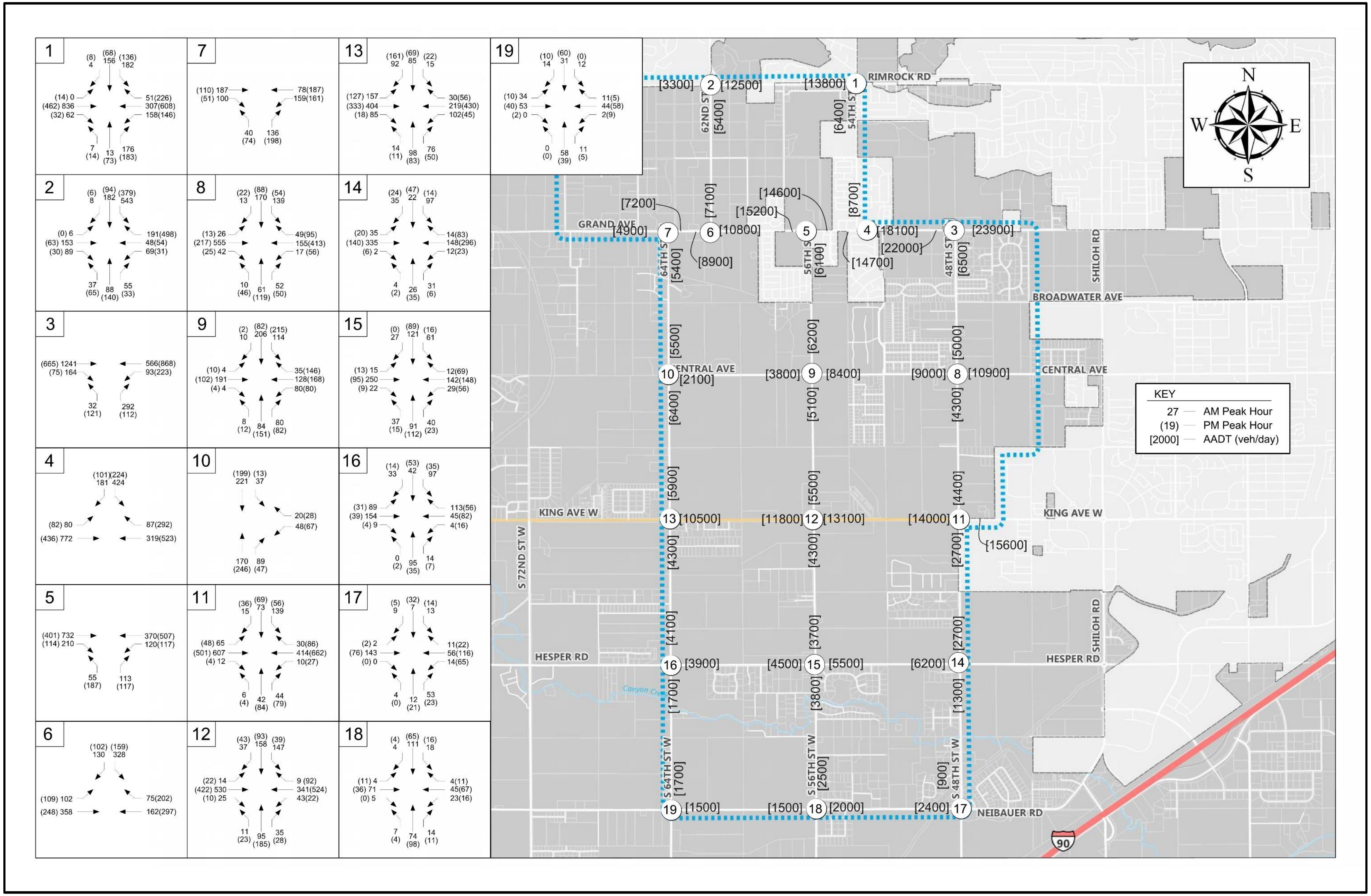

FIGURE 7 – SCENARIO 1 (2035) TRAFFIC VOLUME PROJECTIONS

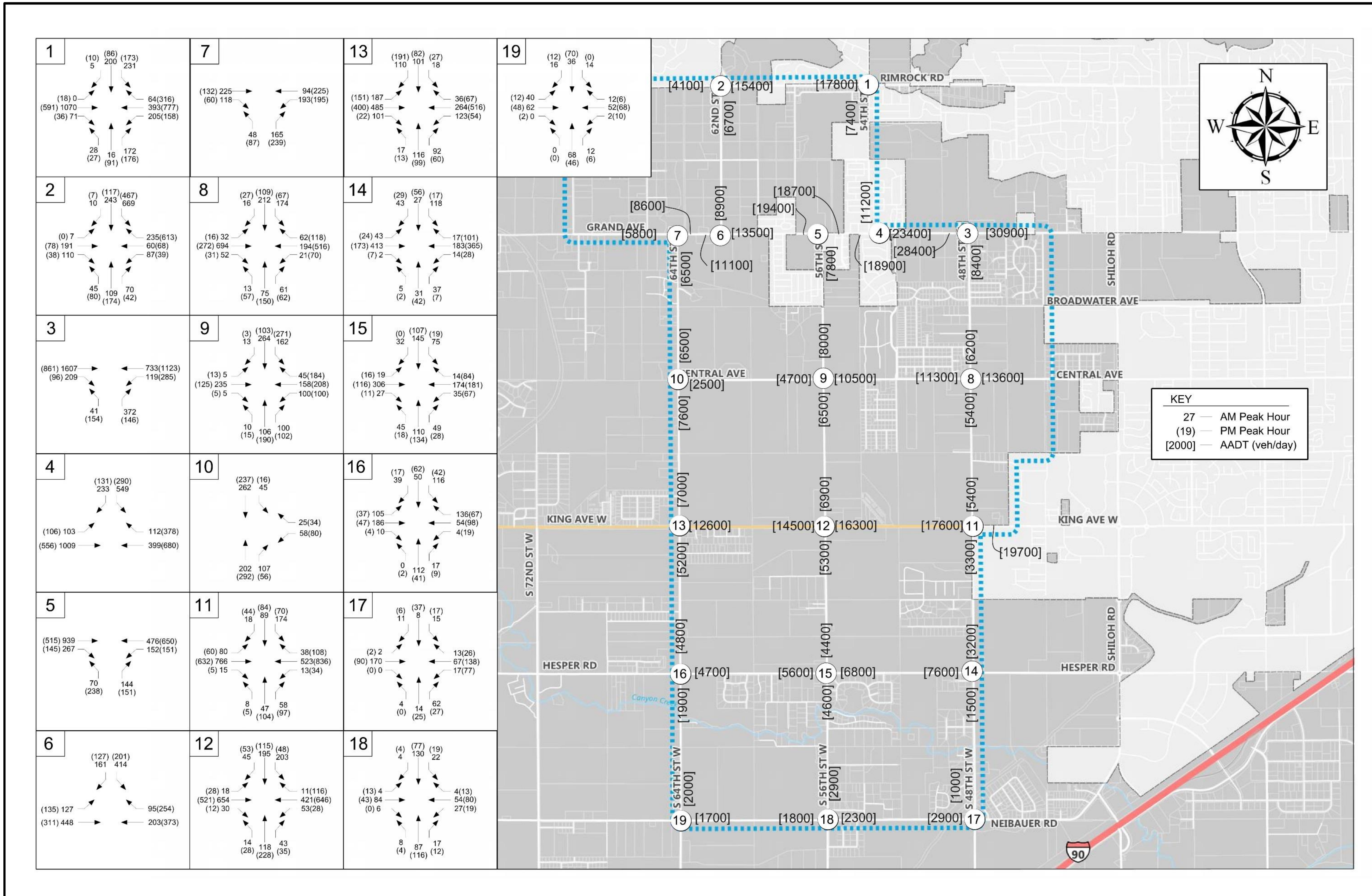

FIGURE 8 – SCENARIO 2 (2035) TRAFFIC VOLUME PROJECTIONS

TABLES 10 & 11. LATENT ACTIVE TRANSPORTATION DEMAND VARIABLES & SCORING

Built Environment Factors	
Dwelling Unity Density (Dwelling Units/Acre)	*Score (12 Maximum)*
0.0 - 0.4	0.0
0.5 - 1.3	2.4
1.4 - 2.3	4.8
2.4 - 4.1	7.2
4.2 - 6.7	9.6
> 6.7	12.0
Employment Density (Jobs/Acre)	*Score (12 Maximum)*
0.0 - 0.1	0.0
0.2 - 0.3	2.4
0.4 - 0.6	4.8
0.7 - 1.0	7.2
1.1 - 1.9	9.6
> 1.9	12.0
Land Use Mix (Jobs/Dwelling Units)	*Score (12 Maximum)*
0.0 - 0.2	0.0
0.3 - 0.6	1.5
0.7 - 1.5	3.0
1.6 - 2.5	4.5
> 2.5	6.0

Proximity Factors	
Schools (Proximity in Feet)	*Score (25 Maximum)*
0 - 660	25
661 - 1320	23.75
1231 - 2640	21.25
2641 - 3960	12.5
3961 - 5280	2.5
> 5280	0
Parks (Proximity in Feet)	*Score (20 Maximum)*
0 - 660	20
661 - 1320	15
1231 - 2640	10
2641 - 3960	5
> 3960	0
Retail (Proximity in Feet)	*Score (10 Maximum)*
0	10
1 - 2640	5
> 2640	0
Trails (Proximity in Feet)	*Score (15 Maximum)*
0 - 1320	15
1321 - 2640	7.5
> 2640	0

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HORIZON YEAR (2035) OPERATIONS ANALYSIS

Once the Horizon Year (2035) traffic projections were approved by the Steering Committee for both scenarios, the Project Team was able to proceed with analyses to determine where in the study area that deficiencies would be most likely to occur in terms of both operations and safety. The following paragraphs describe how those considerations were evaluated for the vehicular environment, as well as for the existing system of bicycle and pedestrian facilities.

Intersection Traffic Operations

The Project Team performed Horizon Year (2035) AM and PM peak hour intersection capacity calculations for all of the major study area intersection using Synchro, Version 8.0, for stop-controlled and signalized intersections and Rodel, Version 1.88, for roundabouts. Capacity calculations were performed for Scenarios 1 and 2. Each volume scenario was first analyzed for a "no-build" scenario using existing intersection traffic control and lane configurations, except in the cases of the Central Avenue and King Avenue intersections with 56th Street West, where single-lane roundabouts are being designed and planned for construction in the near future (committed projects). The purpose of this exercise was to establish future intersection operation conditions without improvements in order to identify deficiencies. **Table 12** and **Table 13** (pages 29 to 30) illustrate the results of the Scenario 1 and Scenario 2 Horizon Year (2035) intersection capacity analyses for the "no-build" condition. Detailed intersection capacity calculation worksheets for the Horizon Year (2035) scenarios can be found in **Appendix C**.

For the purposes of this study, a LOS C metric for an intersection (not individual approaches) was considered to be the minimum acceptable threshold for requiring improvements. For the Scenario 1 (2035) no build condition, nine (9) intersections were projected to fall below LOS C during the AM peak hour and eight (8) intersections were projected to fall below LOS C during the PM peak hour. Of the intersections that sustained acceptable metrics, there were two (64th Street West/Hesper Road and 56th Street West/Hesper Road) that exhibited LOS D conditions on one or more individual approaches during the AM peak only. However, projected maximum queue lengths for these approaches were projected to be relative minor. The following intersections were projected to fall below LOS C during one or both peak hours as noted:

- 62nd Street West & Rimrock Road (AM Peak and PM Peak)
- 54th Street West & Rimrock Road (AM Peak and PM Peak)
- 62nd Street West & Grand Avenue (AM Peak)

TABLE 12. SCENARIO 1 (2035) NO BUILD CAPACITY CALCULATION RESULTS

Intersection	Approach	Scenario 1 (2035) - No Build: AM Peak Avg Delay (s/veh)	AM Peak LOS	AM Peak 95th % Queue (veh)	PM Peak Avg Delay (s/veh)	PM Peak LOS	PM Peak 95th % Queue (veh)
Intersection Control		*Stop Controlled (EB & WB)*					
62nd Street West & Rimrock Road	EB	--	F	--	71.1	F	4
	WB	--	F	--	459.7	F	45
	NB	1.6	A	1	2.1	A	1
	SB	6.9	A	3	6.9	A	2
	Intersection	--	F	--	199.9	F	--
Intersection Control		*Stop Controlled (NB & SB)*					
54th Street West & Rimrock Road	EB	0.0	A	0	0.3	A	1
	WB	3.9	A	2	1.4	A	1
	NB	--	F	--	--	F	--
	SB	7661.1	F	48	--	F	--
	Intersection	--	F	--	--	F	--
Intersection Control		*Stop Controlled (SB)*					
62nd Street West & Grand Avenue	EB	1.8	A	1	2.8	A	1
	WB	0.0	A	0	0.0	A	0
	SB	228.9	F	26	66.8	F	9
	Intersection	91.5	F	--	16.5	C	--
Intersection Control		*Stop Controlled (NB)*					
64th Street West & Grand Avenue	EB	0.0	A	0	0.0	A	0
	WB	5.6	A	1	3.7	A	1
	NB	13.9	B	2	16.1	C	3
	Intersection	5.4	A	--	7.3	A	--
Intersection Control		*Stop Controlled (NB & SB)*					
56th Street West & Grand Avenue	EB	0.0	A	0	0.0	A	0
	WB	3.0	A	1	1.8	A	1
	NB	263.7	F	12	555.0	F	27
	Intersection	28.6	D	--	117.7	F	--
Intersection Control		*Stop Controlled (SB)*					
54th Street West & Grand Avenue	EB	0.9	A	1	1.7	A	1
	WB	0.0	A	0	0.0	A	0
	SB	1497.1	F	68	624.5	F	30
	Intersection	486.6	F	--	122.9	F	--
Intersection Control		*Stop Controlled (NB & SB)*					
48th Street West & Grand Avenue	EB	0.0	A	0	0.0	A	0
	WB	2.3	A	1	2.3	A	2
	NB	1467.5	F	38	4322.7	F	33
	Intersection	199.7	F	--	489.2	F	--
Intersection Control		*Stop Controlled (WB)*					
64th Street West & Central Avenue	WB	12.8	B	1	13.1	B	1
	NB	0.0	A	0	0.0	A	0
	SB	1.1	A	1	0.5	A	0
	Intersection	2.0	A	--	2.3	A	--
Intersection Control		*Roundabout*					
56th Street West & Central Avenue	EB	4.7	A	1	4.1	A	1
	WB	4.1	A	1	4.9	A	2
	NB	4.7	A	1	4.8	A	2
	SB	4.9	A	2	4.6	A	2
	Intersection	4.6	A	--	4.7	A	--
Intersection Control		*Stop Controlled (NB & SB)*					
48th Street West & Central Avenue	EB	0.3	A	1	0.4	A	0
	WB	0.7	A	1	0.8	A	1
	NB	37.9	E	4	102.3	F	10
	SB	440.4	F	26	127.2	F	9
	Intersection	113.9	F	--	36.2	E	--

Intersection	Approach	Scenario 1 (2035) - No Build: AM Peak Avg Delay (s/veh)	AM Peak LOS	AM Peak 95th % Queue (veh)	PM Peak Avg Delay (s/veh)	PM Peak LOS	PM Peak 95th % Queue (veh)
Intersection Control		*Stop Controlled (NB & SB)*					
64th Street West & King Avenue West	EB	2.0	A	1	2.4	A	1
	WB	2.6	A	1	0.7	A	1
	NB	678.9	F	19	182.3	F	10
	SB	--	F	--	266.4	F	18
	Intersection	--	F	--	73.5	F	--
Intersection Control		*Roundabout*					
56th Street West & King Avenue West	EB	8.9	A	5	7.4	A	3
	WB	5.1	A	2	20.1	C	15
	NB	5.5	A	1	5.5	A	2
	SB	5.9	A	2	6.5	A	1
	Intersection	6.8	A	--	13.5	B	--
Intersection Control		*Stop Controlled (NB & SB)*					
48th Street West & King Avenue West	EB	0.8	A	1	0.8	A	1
	WB	0.2	A	0	0.3	A	1
	NB	52.7	F	4	231.7	F	12
	SB	885.2	F	24	3381.6	F	23
	Intersection	141.7	F	--	352.5	F	--
Intersection Control		*Stop Controlled (EB & WB)*					
64th Street West & Hesper Road	EB	25.4	D	5	11.5	B	1
	WB	11.7	B	1	10.9	B	1
	NB	0.0	A	0	0.3	A	0
	SB	4.3	A	1	2.5	A	1
	Intersection	13.0	B	--	7.5	A	--
Intersection Control		*Stop Controlled (EB & WB)*					
56th Street West & Hesper Road	EB	33.6	D	6	13.2	B	1
	WB	29.7	D	4	16.0	C	3
	NB	1.7	A	1	0.7	A	0
	SB	2.2	A	1	1.1	A	0
	Intersection	18.7	C	--	9.5	A	--
Intersection Control		*Stop Controlled (NB & SB)*					
48th Street West & Hesper Road	EB	0.7	A	1	1.0	A	1
	WB	0.6	A	0	0.4	A	1
	NB	13.9	B	1	15.5	C	1
	SB	22.1	C	3	16.0	C	1
	Intersection	6.1	A	--	3.4	A	--
Intersection Control		*Stop Controlled (EB & WB)*					
64th Street West & Neibauer Road	EB	10.7	B	1	10.1	B	1
	WB	10.2	B	1	10.2	B	1
	NB	0.0	A	0	0.0	A	0
	SB	1.6	A	0	0.0	A	0
	Intersection	5.9	A	--	5.3	A	--
Intersection Control		*Stop Controlled (EB & WB)*					
56th Street West & Neibauer Road	EB	11.7	B	1	11.2	B	1
	WB	11.9	B	1	11.3	B	1
	NB	0.5	A	0	0.3	A	0
	SB	1.0	A	0	1.4	A	0
	Intersection	5.2	A	--	5.1	A	--
Intersection Control		*Stop Controlled (NB & SB)*					
48th Street West & Neibauer Road	EB	0.1	A	0	0.2	A	0
	WB	1.3	A	0	2.4	A	1
	NB	9.9	A	1	10.6	B	1
	SB	10.7	B	1	12.6	B	1
	Intersection	3.4	A	--	4.3	A	--

Table 13. Scenario 2 (2035) No Build Intersection Capacity Calculation Results

Intersection	Approach	Scenario 1 (2035) - No Build					
		AM Peak			PM Peak		
		Avg Delay (s/veh)	LOS	95th % Queue (veh)	Avg Delay (s/veh)	LOS	95th % Queue (veh)
Intersection Control		*Stop Controlled (EB & WB)*					
62nd Street West & Rimrock Road	EB	--	F	--	--	F	--
	WB	--	F	--	--	F	--
	NB	1.6	A	1	2.1	A	1
	SB	7.8	A	4	7.4	A	2
	Intersection	--	F	--	--	F	--
Intersection Control		*Stop Controlled (NB & SB)*					
54th Street West & Rimrock Road	EB	0.0	A	0	0.3	A	1
	WB	2.6	A	3	1.3	A	1
	NB	--	F	--	--	F	--
	SB	12806.0	F	62	--	F	--
	Intersection	--	F	--	--	F	--
Intersection Control		*Stop Controlled (SB)*					
62nd Street West & Grand Avenue	EB	1.9	A	1	3.0	A	1
	WB	0.0	A	0	0.0	A	0
	SB	684.3	F	52	353.5	F	24
	Intersection	272.5	F	--	83.7	F	--
Intersection Control		*Stop Controlled (NB)*					
64th Street West & Grand Avenue	EB	0.0	A	0	0.0	A	0
	WB	5.9	A	1	3.8	A	1
	NB	17.7	C	3	23.9	C	5
	Intersection	6.5	A	--	10.0	B	--
Intersection Control		*Stop Controlled (NB & SB)*					
56th Street West & Grand Avenue	EB	0.0	A	0	0.0	A	0
	WB	4.0	A	2	2.0	A	1
	NB	1506.4	F	26	2116.9	F	48
	Intersection	158.6	F	--	446.0	F	--
Intersection Control		*Stop Controlled (SB)*					
54th Street West & Grand Avenue	EB	0.9	A	1	2.0	A	1
	WB	0.0	A	0	0.0	A	0
	SB	5167.4	F	103	2284.2	F	52
	Intersection	1680.6	F	--	449.8	F	--
Intersection Control		*Stop Controlled (NB & SB)*					
48th Street West & Grand Avenue	EB	0.0	A	0	0.0	A	0
	WB	4.0	A	3	3.1	A	3
	NB	12129.7	F	59	7835.0	F	43
	Intersection	1627.1	F	--	883.6	F	--
Intersection Control		*Stop Controlled (WB)*					
64th Street West & Central Avenue	WB	14.6	B	1	15.1	C	1
	NB	0.0	A	0	0.0	A	0
	SB	1.2	A	1	0.5	A	0
	Intersection	2.3	A	--	2.6	A	--
Intersection Control		*Roundabout*					
56th Street West & Central Avenue	EB	8.3	A	2	4.5	A	1
	WB	4.5	A	2	5.9	A	3
	NB	6.5	A	2	5.6	A	2
	SB	18.3	C	17	5.4	A	2
	Intersection	12.6	B	--	5.5	B	--
Intersection Control		*Stop Controlled (NB & SB)*					
48th Street West & Central Avenue	EB	0.3	A	1	0.5	A	1
	WB	0.7	A	1	0.8	A	1
	NB	--	F	--	638.5	F	26
	SB	1492.1	F	46	--	F	--
	Intersection	--	F	--	--	F	--

Intersection	Approach	Scenario 1 (2035) - No Build					
		AM Peak			PM Peak		
		Avg Delay (s/veh)	LOS	95th % Queue (veh)	Avg Delay (s/veh)	LOS	95th % Queue (veh)
Intersection Control		*Stop Controlled (NB & SB)*					
64th Street West & King Avenue West	EB	2.1	A	1	2.5	A	1
	WB	2.7	A	1	0.7	A	1
	NB	--	F	--	--	F	--
	SB	--	F	--	--	F	--
	Intersection	--	F	--	--	F	--
Intersection Control		*Roundabout*					
56th Street West & King Avenue West	EB	17.1	C	14	7.2	A	4
	WB	6.0	A	3	16.8	C	15
	NB	7.0	A	2	6.5	A	2
	SB	7.9	A	4	6.3	A	2
	Intersection	10.9	B	--	11.1	B	--
Intersection Control		*Stop Controlled (NB & SB)*					
48th Street West & King Avenue West	EB	0.8	A	1	0.9	A	1
	WB	0.2	A	1	0.3	A	1
	NB	--	F	--	--	F	--
	SB	4487.2	F	39	--	F	--
	Intersection	--	F	--	--	F	--
Intersection Control		*Stop Controlled (EB & WB)*					
64th Street West & Hesper Road	EB	53.5	F	9	12.4	B	1
	WB	13.0	B	2	11.7	B	2
	NB	0.0	A	0	0.3	A	0
	SB	4.4	A	1	2.6	A	1
	Intersection	23.6	C	--	8.0	A	--
Intersection Control		*Stop Controlled (EB & WB)*					
56th Street West & Hesper Road	EB	109.2	F	15	15.3	C	2
	WB	313.8	F	17	22.3	C	5
	NB	1.7	A	1	0.7	A	0
	SB	2.3	A	1	1.1	A	0
	Intersection	106.1	F	--	12.6	B	--
Intersection Control		*Stop Controlled (NB & SB)*					
48th Street West & Hesper Road	EB	0.7	A	1	1.0	A	1
	WB	0.5	A	0	0.4	A	1
	NB	16.6	C	1	19.0	C	1
	SB	43.8	E	6	20.7	C	2
	Intersection	10.6	B	--	4.1	A	--
Intersection Control		*Stop Controlled (EB & WB)*					
64th Street West & Neibauer Road	EB	11.1	B	1	10.4	B	1
	WB	10.4	B	1	10.4	B	1
	NB	0.0	A	0	0.0	A	0
	SB	1.6	A	0	0.0	A	0
	Intersection	6.1	A	--	5.4	A	--
Intersection Control		*Stop Controlled (EB & WB)*					
56th Street West & Neibauer Road	EB	12.5	B	1	11.8	B	1
	WB	12.9	B	1	12.1	B	1
	NB	0.5	A	0	0.2	A	0
	SB	1.1	A	1	1.5	A	0
	Intersection	5.6	A	--	5.5	A	--
Intersection Control		*Stop Controlled (NB & SB)*					
48th Street West & Neibauer Road	EB	0.1	A	0	0.2	A	0
	WB	1.3	A	0	2.4	A	1
	NB	10.2	B	1	11.5	B	1
	SB	11.2	B	1	13.8	B	1
	Intersection	3.5	A	--	4.5	A	--

- 56th Street West & Grand Avenue (AM Peak and PM Peak)
- 54th Street West & Grand Avenue (AM Peak and PM Peak)
- 48th Street West & Grand Avenue (AM Peak and PM Peak)
- 48th Street West & Central Avenue (AM Peak and PM Peak)
- 64th Street West & King Avenue West (AM Peak and PM Peak)
- 48th Street West & King Avenue West (AM Peak and PM Peak)

For the Scenario 2 (2035) "no build" condition, ten (10) intersections were projected to fall below LOS C during the AM peak hour and nine (9) intersections were projected to fall below LOS C during the PM peak hour. The intersections of Hesper Road with 64th Street West and 48th Street West were projected to have individual approaches operate at LOS F and E during the AM peak hour. Projected maximum queue lengths for these approaches were still projected to be relatively manageable regardless of the poor LOS projections. Mitigation strategies for the substandard intersections are discussed in the next chapter of the report. The following intersections were projected to fall below LOS during one or both peak hours as noted:

- 62nd Street West & Rimrock Road (AM Peak and PM Peak)
- 54th Street West & Rimrock Road (AM Peak and PM Peak)
- 62nd Street West & Grand Avenue (AM Peak and PM Peak)
- 56th Street West & Grand Avenue (AM Peak and PM Peak)
- 54th Street West & Grand Avenue (AM Peak and PM Peak)
- 48th Street West & Grand Avenue (AM Peak and PM Peak)
- 48th Street West & Central Avenue (AM Peak and PM Peak)
- 64th Street West & King Avenue West (AM Peak and PM Peak)
- 48th Street West & King Avenue West (AM Peak and PM Peak)
- 56th Street West & Hesper Road (AM Peak)

Corridor Traffic Operations

The Project Team re-evaluated corridor LOS for all arterial streets within the study area boundary. As was previously discussed, the minimum required corridor LOS is D for the purposes of this planning study. The following paragraphs discuss the results of the analysis for the two Horizon Year (2035) land development scenarios.

Scenario 1 (2035)

As shown in **Figure 9** (next page), most roadways in the study area continue to experience a LOS D or better. However, three of the primary east-west arterials (Rimrock Road, Grand Avenue, King Avenue West) are not projected to meet that standard. In the worse instance, Grand Avenue and Rimrock Road are projected to operate at LOS F to the east of 54th Street West. Segments of Rimrock Road, Grand Avenue and King Avenue West are also projected to operate at LOS E. In general, the predominant traffic patterns show higher traffic volumes to the east, closer to existing urban development; these volumes decline substantially in the western portion of the study area, except in certain cases (King Avenue West, Grand Avenue). Of the north-south arterials, only 62nd Street West, north of Rimrock Road, is projected to operate below LOS D for Scenario 1, while 54th Street West is the only other north-south corridor that is projected to operate below LOS C.

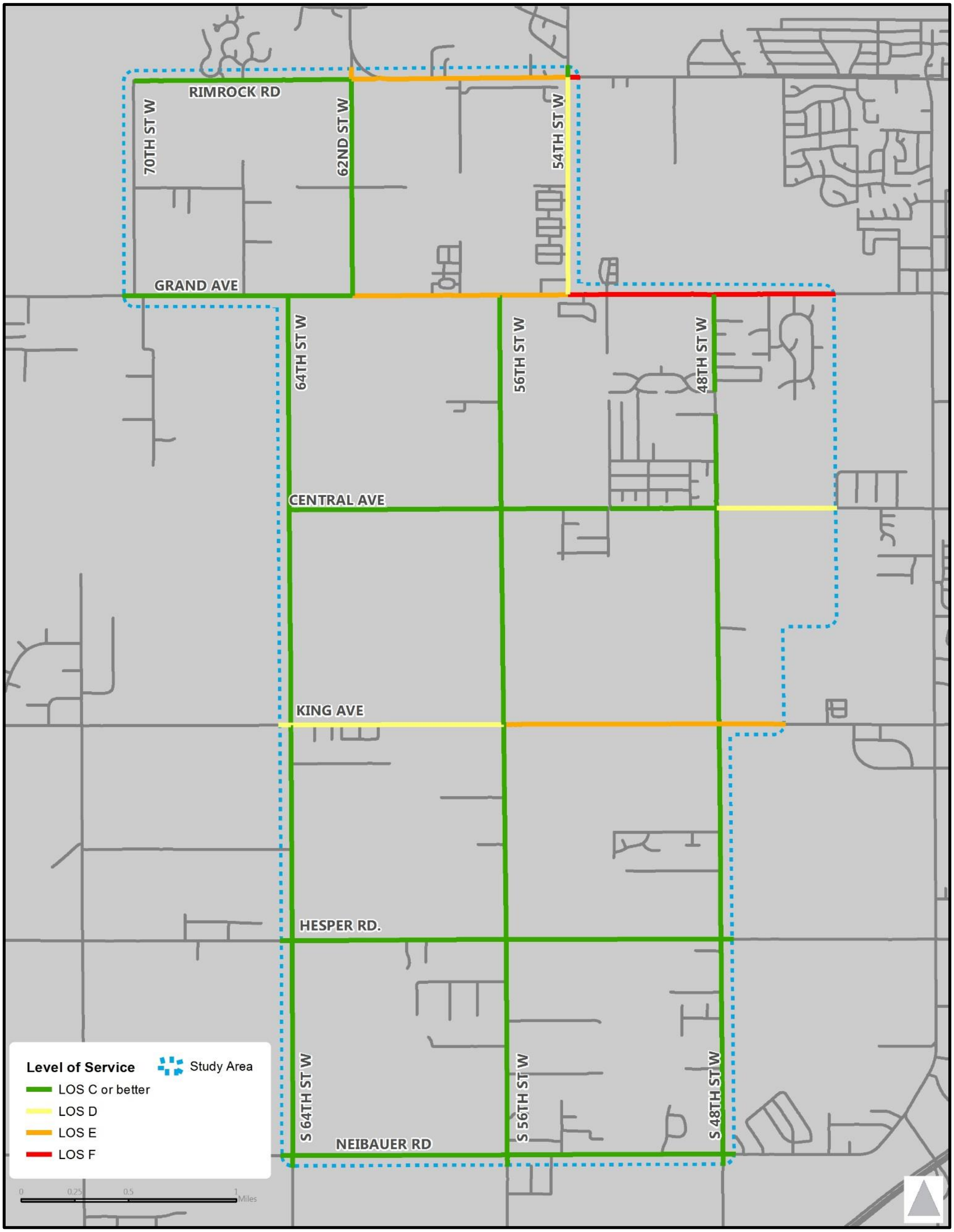


FIGURE 9. SCENARIO 1 (2035) CORRIDOR LEVEL OF SERVICE (LOS)

Scenario 2 (2035)

Under the higher-growth Scenario 2 (**Figure 10**, next page), conditions on these roadways become predictably more congested. Central Avenue joins Rimrock Road, Grand Avenue and King Avenue West in having one or more segments exhibit LOS E or worse conditions and the extent of the LOS F operation projection grows considerably, particularly along Grand Avenue. For the north-south corridors, 62nd Street West, north of Rimrock Road degrades to LOS F, while 54th Street West is projected at LOS D north of Rimrock Road and LOS E south of Rimrock Road. Chapter 6 of this report provides a discussion of mitigation alternatives for addressing the corridor LOS deficiencies identified for Scenarios 1 and 2.

Active Transportation Demand Analysis

The Latent Demand Model indicates areas where there is latent demand for active transportation (not necessarily usage); essentially places where walking or bicycling would be likely to occur if the conditions were favorable. Typically, favorable conditions mean the presence of bicycling facilities, sidewalks, and paths.

Two demand analyses were conducted; base year (2010) and future year (2035). The baseline analysis used current conditions based on GIS layers provided by the City of Billings and 2010 socio-economic data from the regional travel demand model provided by MDT. The second analysis was completed for the Horizon Year (2035). For this analysis, socio-economic data from the high-growth scenario - Scenario 2 - was used. Future retail and school locations were assumed based on local land use plans, zoning, and feedback from City staff.

Figure 11 (page 35) illustrates the analysis results, using blue color tones to indicate areas of lower demand and red/orange color tones to indicate the higher demand areas. For the 2010 baseline condition, higher active transportation demand is primarily limited to the northeast portion of the study area from 48th to 54th Street near Grand Avenue. This is rather intuitive since this district has established neighborhoods. Elsewhere there is very little demand, due to low density residential, few employment or commercial destinations, and predominantly agricultural land uses.

Based on the growth projections described in Chapter 3, demand for active transportation is expected to increase significantly in terms of relative magnitude and geographic area. Most of the study area north of King Avenue and east of 56th Street will generate demand, with the highest concentrations along 54th Street and Grand Avenue. This analysis suggests that investment in active transportation infrastructure should be prioritized in the northern and eastern portion of the study area.

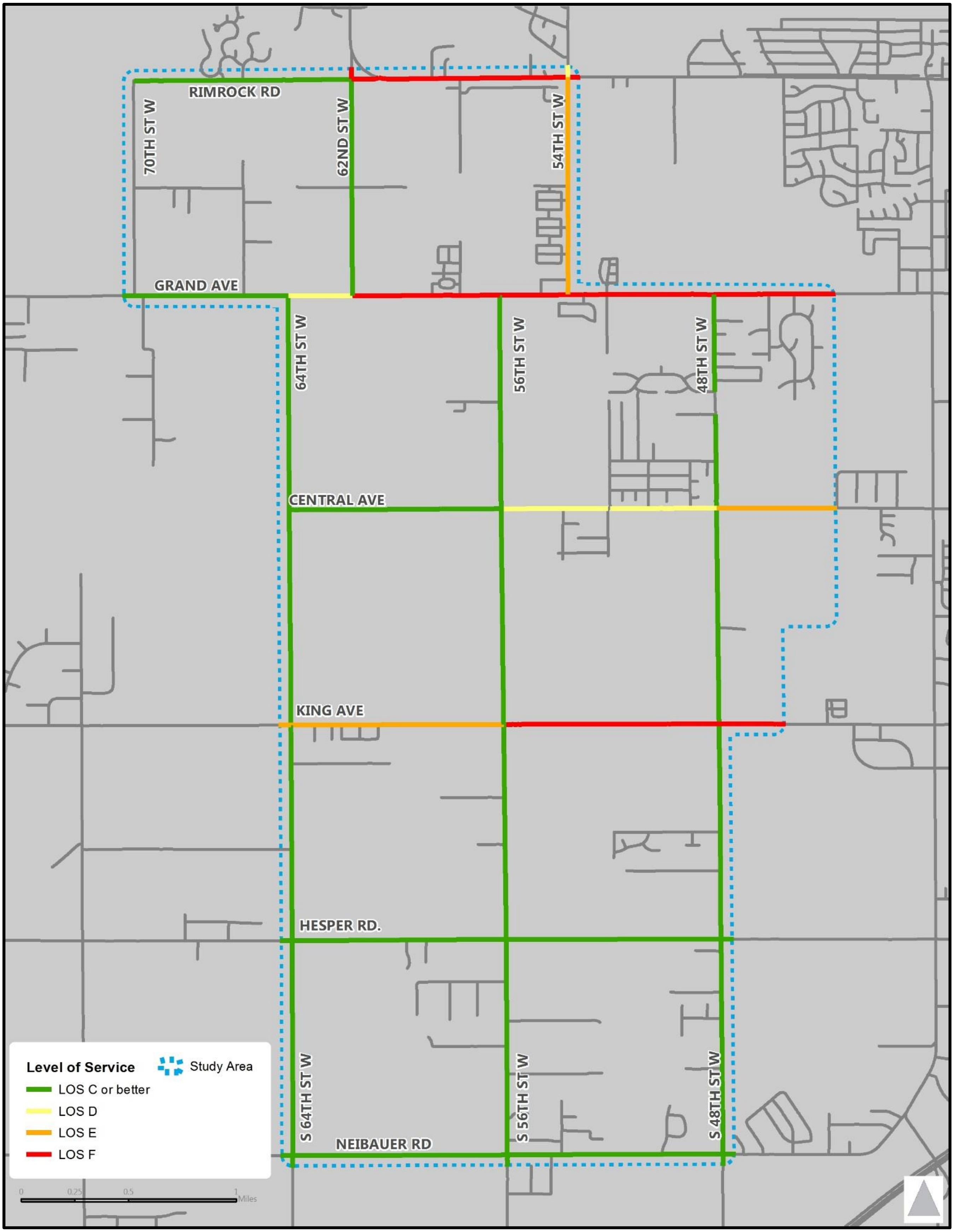


FIGURE 10. SCENARIO 2 (2035) CORRIDOR LEVEL OF SERVICE (LOS)

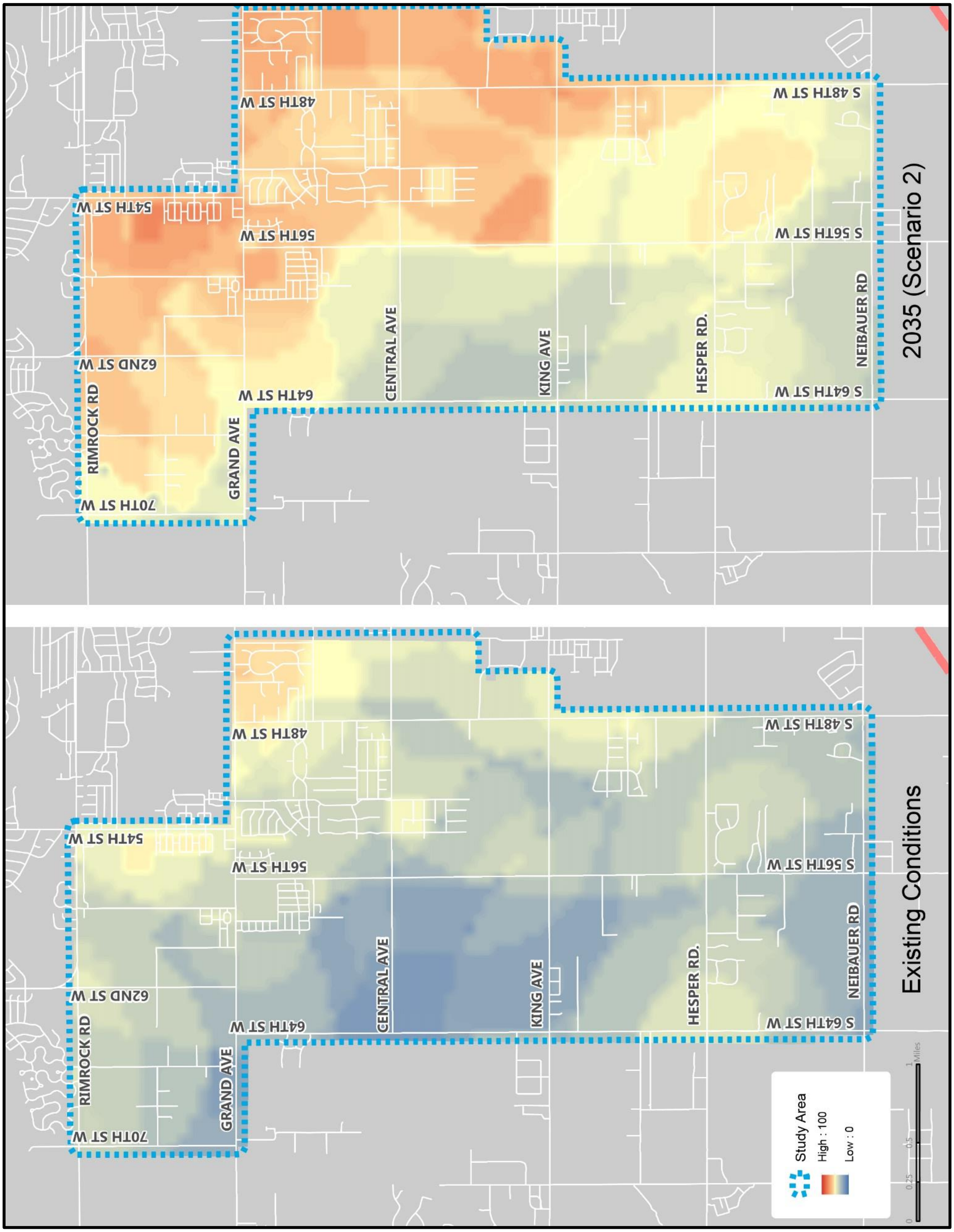
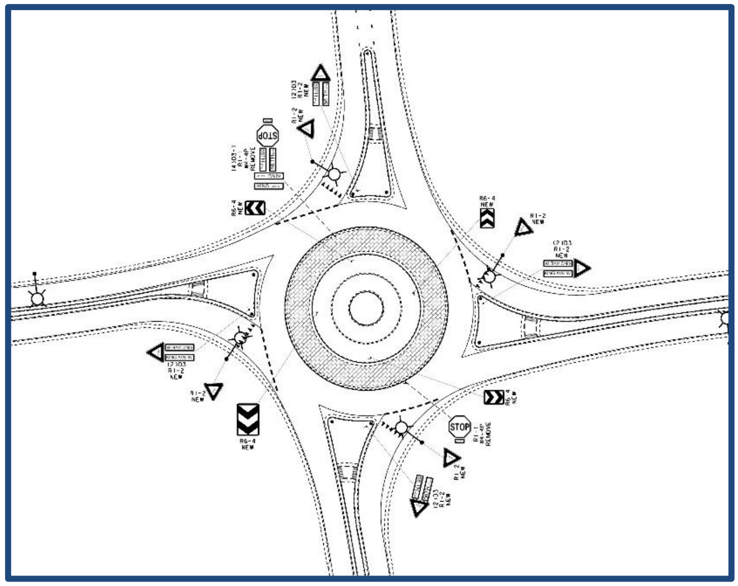


Figure 11. Existing Conditions (2015) and Scenario 2 (2035) Latent Demand Conditions Maps

MITIGATION ALTERNATIVES

6



The previous section of this report identified the major study area intersections, street corridors and active transportation facilities that are expected to require improvement or expansion in order to accommodate projected traffic demands for Horizon Year (2035) growth scenarios 1 and 2. This chapter will discuss mitigation alternatives for addressing the deficiencies that were identified in the previous chapter, as well as provide a summary of analysis results for those alternatives to illustrate the relative effectiveness of each measure.

Intersections

Based on the intersection LOS deficiencies that were identified for Scenarios 1 and 2 (2035) for the no-build condition, the Project Team evaluated potential mitigation alternatives to address those deficiencies. The purpose of this exercise was to establish a minimum level of improvements needed to bring each intersection up to an acceptable LOS C. The Project Team did not evaluate Manual on Uniform Traffic Control Devices (MUTCD) Traffic Signal Warrants for any of the intersections. The analysis was purely operation. Both volume scenarios were analyzed for an "improved" scenario implementing changes in intersection traffic control and lane configurations as necessary to achieve the minimum LOS C for each intersection. The sensitivity analyses were conducted using Synchro, Version 8.0, for stop-controlled and signalized intersections and Rodel, Version 1.88, for roundabouts. **Table 14** and **Table 15** on pages 37 and 38 illustrate the results of the Horizon Year (2035) peak hour intersection capacity analyses for the "improved" condition for Scenarios 1 and 2, respectively. In any case where signalization was required in order to achieve the desired intersection capacity results, a roundabout was also evaluated as an alternative to a traffic signal and those results are concurrently displayed in the tables. Detailed intersection capacity calculation worksheets for the improved alternatives for both Horizon Year (2035) scenarios are included in **Appendix D**.

Scenario 1 (2035)

This section of the report discusses mitigation alternatives for each of the study area intersections that were found to be deficient in terms of Scenario 1 (2035) peak hour traffic operations. The evaluations were originally made independent of any consideration of corridor widening (from two lanes to four lanes, for example) though references to the potential need for such widening are made in several cases. Specific discussion about the marriage of intersection and corridor improvements will occur in a later section of the report.

Table 14. Scenario 1 (2035) Improved Intersection Capacity Calculation Results

Intersection	Approach	Scenario 1 (2035) - Improved											
		AM Peak			PM Peak			AM Peak			PM Peak		
		Avg Delay (s/veh)	LOS	95th % Queue (veh)	Avg Delay (s/veh)	LOS	95th % Queue (veh)	Avg Delay (s/veh)	LOS	95th % Queue (veh)	Avg Delay (s/veh)	LOS	95th % Queue (veh)
Intersection Control		*Traffic Signal*						*Roundabout*					
62nd Street West & Rimrock Road	EB	15.0	B	6	10.7	B	3	8.2	A	2	4.5	A	1
	WB	9.0	A	3	9.4	A	2	4.5	A	2	6.9	A	4
	NB	18.4	B	4	18.8	B	5	5.9	A	1	4.9	A	1
	SB	11.0	B	12	12.3	B	7	10.1	B	8	5.6	A	3
	Intersection	12.2	B	--	12.1	B	--	8.1	A	--	5.9	A	--
Intersection Control		*Traffic Signal*						*Roundabout*					
54th Street West & Rimrock Road	EB	32.9	C	39	16.6	B	13	5.2	A	5	2.7	A	2
	WB	15.1	B	10	14.7	B	20	4.9	A	2	7.8	A	7
	NB	31.3	C	4	18.6	B	3	6.1	A	1	5.0	A	2
	SB	32.6	C	9	16.6	B	4	6.2	A	2	6.2	A	2
	Intersection	28.0	C	--	15.9	B	--	5.4	A	--	6.0	A	--
Intersection Control		*Traffic Signal*						*Roundabout*					
62nd Street West & Grand Avenue	EB	7.2	A	7	4.2	A	4	7.0	A	3	5.0	A	1
	WB	5.3	A	3	3.8	A	4	4.1	A	1	6.0	A	1
	SB	12.3	B	6	14.4	B	4	5.9	A	2	4.9	A	1
	Intersection	8.8	A	--	6.4	A	--	6.0	A	--	5.4	A	--
Intersection Control		*Stop Controlled (NB)*						*No Alternative Analysis Required*					
64th Street West & Grand Avenue	EB	0.0	A	0	0.0	A	0						
	WB	5.6	A	1	3.7	A	1						
	NB	13.9	B	2	16.1	C	3						
	Intersection	5.4	A	--	7.3	A	--						
Intersection Control		*Traffic Signal*						*Roundabout*					
56th Street West & Grand Avenue	EB	5.0	A	9	4.4	A	6	9.1	A	8	4.9	A	2
	WB	5.1	A	3	5.8	A	7	5.7	A	3	8.5	A	5
	NB	26.7	C	2	15.5	B	4	6.1	A	1	5.7	A	2
	Intersection	7.3	A	--	7.4	A	--	7.7	A	--	6.7	A	--
Intersection Control		*Traffic Signal*						*Roundabout*					
54th Street West & Grand Avenue	EB	17.4	B	24	6.2	A	8	4.9	A	4	3.1	A	2
	WB	7.8	A	6	6.0	A	10	2.5	A	1	4.1	A	3
	SB	27.4	C	15	15.2	B	5	8.4	A	5	5.6	A	2
	Intersection	18.6	B	--	7.9	A	--	5.5	A	--	4.1	A	--
Intersection Control		*Traffic Signal*						*Roundabout*					
48th Street West & Grand Avenue	EB	9.7	A	10	3.2	A	3	5.4	A	8	3.1	A	2
	WB	6.8	A	5	4.0	A	5	2.9	A	2	5.0	A	5
	NB	*44.7*	*D*	*10*	23.7	C	4	10.4	B	4	5.4	A	2
	Intersection	13.6	B	--	5.9	A	--	5.4	A	--	4.4	A	--
Intersection Control		*Stop Controlled (WB)*						*No Alternative Analysis Required*					
64th Street West & Central Avenue	WB	12.8	B	1	13.1	B	1						
	NB	0.0	A	0	0.0	A	0						
	SB	1.1	A	1	0.5	A	0						
	Intersection	2.0	A	--	2.3	A	--						
Intersection Control		*Roundabout (committed)*						*No Alternative Analysis Required*					
56th Street West & Central Avenue	EB	4.7	A	1	4.1	A	1						
	WB	4.1	A	1	4.9	A	2						
	NB	4.7	A	1	4.8	A	2						
	SB	4.9	A	2	4.6	A	2						
	Intersection	4.6	A	--	4.7	A	--						
Intersection Control		*Traffic Signal*						*Roundabout*					
48th Street West & Central Avenue	EB	8.8	B	12	5.3	A	3	12.2	A	3	4.5	A	1
	WB	5.5	A	3	8.2	A	7	4.0	A	1	6.5	A	3
	NB	14.4	B	3	11.0	B	3	5.7	A	1	4.2	A	1
	SB	16.2	B	5	10.8	B	2	4.7	A	1	4.7	A	1
	Intersection	10.6	B	--	8.5	A	--	8.3	A	--	5.4	A	--

Intersection	Approach	Scenario 1 (2035) - Improved											
		AM Peak			PM Peak			AM Peak			PM Peak		
		Avg Delay (s/veh)	LOS	95th % Queue (veh)	Avg Delay (s/veh)	LOS	95th % Queue (veh)	Avg Delay (s/veh)	LOS	95th % Queue (veh)	Avg Delay (s/veh)	LOS	95th % Queue (veh)
Intersection Control		*Traffic Signal*						*Roundabout*					
64th Street West & King Avenue West	EB	14.3	B	11	7.2	A	5	10.7	B	3	5.9	A	2
	WB	11.5	A	4	7.5	A	7	5.3	A	1	6.4	A	3
	NB	9.1	B	3	12.3	B	3	5.5	A	1	4.5	A	1
	SB	9.2	B	2	14.1	B	3	4.5	A	1	5.2	A	1
	Intersection	12.1	B	--	9.1	A	--	7.7	A	--	5.8	A	--
Intersection Control		*Roundabout (committed)*						*No Alternative Analysis Required*					
56th Street West & King Avenue West	EB	8.9	A	5	7.4	A	3						
	WB	5.1	A	2	20.1	C	15						
	NB	5.5	A	1	5.5	A	2						
	SB	5.9	A	2	6.5	A	1						
	Intersection	6.8	A	--	13.5	B	--						
Intersection Control		*Traffic Signal*						*Roundabout*					
48th Street West & King Avenue West	EB	8.1	A	16	6.3	A	8	12.5	B	4	6.8	A	3
	WB	5.8	A	8	9.0	A	14	5.4	A	1	9.9	A	7
	NB	18.6	B	3	21.2	C	4	5.9	A	1	5.0	A	1
	SB	21.4	C	8	21.0	C	3	5.0	A	1	5.4	A	1
	Intersection	10.1	B	--	10.5	B	--	8.7	A	--	7.9	A	--
Intersection Control		*Stop Controlled (EB & WB)*						*No Alternative Analysis Required*					
64th Street West & Hesper Road	EB	*25.4*	*D*	*5*	11.5	B	1						
	WB	11.7	B	1	10.9	B	1						
	NB	0.0	A	0	0.3	A	0						
	SB	4.3	A	1	2.5	A	1						
	Intersection	13.0	B	--	7.5	A	--						
Intersection Control		*Stop Controlled (EB & WB)*						*No Alternative Analysis Required*					
56th Street West & Hesper Road	EB	*33.6*	*D*	*6*	13.2	B	1						
	WB	*29.7*	*D*	*4*	16.0	C	3						
	NB	1.7	A	1	0.7	A	0						
	SB	2.2	A	1	1.1	A	0						
	Intersection	18.7	C	--	9.5	A	--						
Intersection Control		*Stop Controlled (NB & SB)*						*No Alternative Analysis Required*					
48th Street West & Hesper Road	EB	0.7	A	1	1.0	A	1						
	WB	0.6	A	0	0.4	A	1						
	NB	13.9	B	1	15.5	C	1						
	SB	22.1	C	3	16.0	C	1						
	Intersection	6.1	A	--	3.4	A	--						
Intersection Control		*Stop Controlled (EB & WB)*						*No Alternative Analysis Required*					
64th Street West & Neibauer Road	EB	10.7	B	1	10.1	B	1						
	WB	10.2	B	1	10.2	B	1						
	NB	0.0	A	0	0.0	A	0						
	SB	1.6	A	0	0.0	A	0						
	Intersection	5.9	A	--	5.3	A	--						
Intersection Control		*Stop Controlled (EB & WB)*						*No Alternative Analysis Required*					
56th Street West & Neibauer Road	EB	11.7	B	1	11.2	B	1						
	WB	11.9	B	1	11.3	B	1						
	NB	0.5	A	0	0.3	A	0						
	SB	1.0	A	0	1.4	A	0						
	Intersection	5.2	A	--	5.1	A	--						
Intersection Control		*Stop Controlled (NB & SB)*						*No Alternative Analysis Required*					
48th Street West & Neibauer Road	EB	0.1	A	0	0.2	A	0						
	WB	1.3	A	0	2.4	A	1						
	NB	9.9	A	1	10.6	B	1						
	SB	10.7	B	1	12.6	B	1						
	Intersection	3.4	A	--	4.3	A	--						

TABLE 15. SCENARIO 2 (2035) IMPROVED INTERSECTION CAPACITY CALCULATION RESULTS

Intersection	Approach	Scenario 2 (2035) - Improved											
		AM Peak			PM Peak			AM Peak			PM Peak		
		Avg Delay (s/veh)	LOS	95th % Queue (veh)	Avg Delay (s/veh)	LOS	95th % Queue (veh)	Avg Delay (s/veh)	LOS	95th % Queue (veh)	Avg Delay (s/veh)	LOS	95th % Queue (veh)
Intersection Control		*Traffic Signal*						*Roundabout*					
62nd Street West & Rimrock Road	EB	22.6	C	12	16.0	B	7	5.1	A	2	3.2	A	1
	WB	11.8	B	6	13.2	B	5	4.4	A	1	9.0	A	1
	NB	25.4	C	6	20.3	C	7	5.7	A	2	4.9	A	2
	SB	18.3	B	19	13.5	B	8	4.2	A	4	2.9	A	2
	Intersection	18.5	B	--	14.8	B	--	4.6	A	--	5.8	A	--
Intersection Control		*Traffic Signal*						*Roundabout*					
54th Street West & Rimrock Road	EB	33.7	C	23	17.8	B	9	8.8	A	11	3.1	A	2
	WB	13.0	B	9	29.7	C	18	3.2	A	2	3.3	A	3
	NB	33.0	C	4	24.7	C	6	7.9	A	2	5.7	A	2
	SB	*39.6*	*D*	*12*	17.1	B	6	7.0	A	3	6.1	A	2
	Intersection	29.1	C	--	24.6	C	--	6.8	A	--	3.9	A	--
Intersection Control		*Traffic Signal*						*Roundabout*					
62nd Street West & Grand Avenue	EB	9.9	A	9	6.1	A	5	10.6	B	6	6.0	A	3
	WB	6.6	A	4	5.4	A	6	4.5	A	2	8.0	A	5
	SB	14.9	B	9	12.1	B	4	7.8	A	5	5.8	A	2
	Intersection	11.2	B	--	7.2	A	--	8.2	A	--	6.9	A	--
Intersection Control		*Stop Controlled (NB)*						*No Alternative Analysis Required*					
64th Street West & Grand Avenue	EB	0.0	A	0	0.0	A	0						
	WB	5.9	A	1	3.8	A	1						
	NB	17.7	C	3	23.9	C	5						
	Intersection	6.5	A	--	10.0	B	--						
Intersection Control		*Traffic Signal*						*Roundabout*					
56th Street West & Grand Avenue	EB	13.3	B	21	5.9	A	7	4.9	A	6	3.1	A	2
	WB	5.3	A	3	8.8	A	10	3.0	A	2	3.6	A	3
	NB	*51.2*	*D*	*4*	16.9	B	6	6.1	A	2	6.3	A	3
	Intersection	14.8	B	--	9.5	A	--	4.4	A	--	4.0	A	--
Intersection Control		*Traffic Signal*						*Roundabout*					
54th Street West & Grand Avenue	EB	12.0	B	11	5.2	A	4	5.4	A	6	3.0	A	1
	WB	11.4	B	3	11.6	B	8	2.7	A	2	4.9	A	1
	SB	20.3	C	9	17.0	B	8	4.3	A	3	3.8	A	1
	Intersection	14.6	B	--	10.7	B	--	4.5	A	--	4.1	A	--
Intersection Control		*Traffic Signal*						*Roundabout*					
48th Street West & Grand Avenue	EB	14.4	B	19	3.2	A	4	15.7	A	16	4.0	A	4
	WB	13.0	B	5	6.7	A	12	3.4	A	1	8.5	A	12
	NB	*39.2*	*D*	*13*	*38.0*	*D*	*8*	*29.3*	*D*	*7*	6.7	A	2
	Intersection	17.4	B	--	9.0	A	--	14.2	B	--	6.7	A	--
Intersection Control		*Stop Controlled (WB)*						*No Alternative Analysis Required*					
64th Street West & Central Avenue	WB	14.6	B	1	15.1	C	1						
	NB	0.0	A	0	0.0	A	0						
	SB	1.2	A	1	0.5	A	0						
	Intersection	2.3	A	--	2.6	A	--						
Intersection Control		*Roundabout (committed)*						*No Alternative Analysis Required*					
56th Street West & Central Avenue	EB	8.3	A	2	4.5	A	1						
	WB	4.5	A	2	5.9	A	3						
	NB	6.5	A	2	5.6	A	2						
	SB	18.3	C	17	5.4	A	2						
	Intersection	12.6	B	--	5.5	A	--						
Intersection Control		*Traffic Signal*						*Roundabout*					
48th Street West & Central Avenue	EB	13.3	B	19	6.1	A	5	4.0	A	2	2.3	A	1
	WB	7.2	A	4	9.8	A	12	4.3	A	1	9.3	A	7
	NB	17.5	B	3	15.8	B	5	5.3	A	1	4.4	A	1
	SB	20.4	C	7	15.7	B	4	5.5	A	1	5.5	A	1
	Intersection	14.4	B	--	10.9	B	--	4.6	A	--	6.4	A	--

Intersection	Approach	Scenario 2 (2035) - Improved											
		AM Peak			PM Peak			AM Peak			PM Peak		
		Avg Delay (s/veh)	LOS	95th % Queue (veh)	Avg Delay (s/veh)	LOS	95th % Queue (veh)	Avg Delay (s/veh)	LOS	95th % Queue (veh)	Avg Delay (s/veh)	LOS	95th % Queue (veh)
Intersection Control		*Traffic Signal*						*Roundabout*					
64th Street West & King Avenue West	EB	11.5	B	11	8.6	A	7	4.2	A	2	3.1	A	2
	WB	10.7	B	6	8.4	A	11	6.3	A	1	8.4	A	5
	NB	15.1	B	4	17.5	B	4	5.3	A	1	4.3	A	1
	SB	15.2	B	4	22.1	C	4	4.9	A	1	6.1	A	2
	Intersection	12.3	B	--	11.9	B	--	5.0	A	--	5.8	A	--
Intersection Control		*Roundabout (committed)*						*No Alternative Analysis Required*					
56th Street West & King Avenue West	EB	17.1	C	14	7.2	A	4						
	WB	6.0	A	3	16.8	C	15						
	NB	7.0	A	2	6.5	A	2						
	SB	7.9	A	4	6.3	A	2						
	Intersection	10.9	B	--	11.1	B	--						
Intersection Control		*Traffic Signal*						*Roundabout*					
48th Street West & King Avenue West	EB	12.8	B	21	9.8	A	12	3.9	A	3	2.8	A	2
	WB	9.1	A	11	17.9	B	31	2.4	A	2	3.3	A	3
	NB	17.9	B	3	23.6	C	6	5.4	A	1	4.9	A	1
	SB	21.1	C	6	23.6	C	4	5.1	A	2	5.2	A	1
	Intersection	13.2	B	--	16.3	B	--	3.7	A	--	3.5	A	--
Intersection Control		*Stop Controlled (EB & WB)*						*No Alternative Analysis Required*					
64th Street West & Hesper Road	EB	*53.5*	*F*	*9*	12.4	B	1						
	WB	13.0	B	2	11.7	B	2						
	NB	0.0	A	0	0.3	A	0						
	SB	4.4	A	1	2.6	A	1						
	Intersection	23.6	C	--	8.0	A	--						
Intersection Control		*Stop Controlled (All-way)*						*Roundabout*					
56th Street West & Hesper Road	EB	20.8	C	5	10.1	B	1	5.5	A	2	3.9	A	1
	WB	16.2	C	3	13.2	B	3	4.2	A	1	4.5	A	1
	NB	14.3	B	2	10.9	B	2	4.9	A	1	3.7	A	1
	SB	16.2	C	3	10.3	B	1	4.0	A	1	3.8	A	1
	Intersection	17.4	C	--	11.6	B	--	4.8	A	--	4.1	A	--
Intersection Control		*Stop Controlled (NB & SB)*						*No Alternative Analysis Required*					
48th Street West & Hesper Road	EB	0.7	A	1	1.0	A	1						
	WB	0.5	A	0	0.4	A	1						
	NB	16.6	C	1	19.0	C	1						
	SB	*43.8*	*E*	*6*	20.7	C	2						
	Intersection	10.6	B	--	4.1	A	--						
Intersection Control		*Stop Controlled (EB & WB)*						*No Alternative Analysis Required*					
64th Street West & Neibauer Road	EB	11.1	B	1	10.4	B	1						
	WB	10.4	B	1	10.4	B	1						
	NB	0.0	A	0	0.0	A	0						
	SB	1.6	A	0	0.0	A	0						
	Intersection	6.1	A	--	5.4	A	--						
Intersection Control		*Stop Controlled (EB & WB)*						*No Alternative Analysis Required*					
56th Street West & Neibauer Road	EB	12.5	B	1	11.8	B	1						
	WB	12.9	B	1	12.1	B	1						
	NB	0.5	A	0	0.2	A	0						
	SB	1.1	A	1	1.5	A	0						
	Intersection	5.6	A	--	5.5	A	--						
Intersection Control		*Stop Controlled (NB & SB)*						*No Alternative Analysis Required*					
48th Street West & Neibauer Road	EB	0.1	A	0	0.2	A	0						
	WB	1.3	A	0	2.4	A	1						
	NB	10.2	B	1	11.5	B	1						
	SB	11.2	B	1	13.8	B	1						
	Intersection	3.5	A	--	4.5	A	--						

62nd Street West/Rimrock Road

For Scenario 1, a traffic signal with auxiliary left-turn bays on all four approaches and an auxiliary right-turn bay on the east (WB) approach would serve to provide excellent operational conditions. Thru movements could be served by single lanes (in the cases of the north, south and west approaches, shared with right turns). The east approach right-turn bay should be channelized given the high demand for that movement in both peak hours. Depending upon the relative demands of other movements and other approaches, the north approach may benefit from implementation of a southbound dual-left turn lane. However, two receiving lanes would then be required on the east approach.

A single-lane roundabout is also projected to operate fairly well for this intersection overall. That said, given the magnitude of the projected east approach (WB) right-turn volume, a westbound to northbound bypass (yielding to the north approach exit leg) would likely be implemented. Also, because the southbound left-turn demand is very high, the north approach would be susceptible to short periods of lengthy queuing, particularly during the peak hours. A flared approach to separate the southbound left-turn movement would help with to relieve some of the pressure.

54th Street West/Rimrock Road

A traffic signal at the intersection of 54th Street West and Rimrock Road would require auxiliary left-turn bays on all approaches, as well as auxiliary right-turn bays on all but the north (SB) approach, in combination with dedicated thru lanes on all but the north approach where a shared thru/right-turn lane would suffice. Although this configuration would provide LOS C or better conditions during both peak hours for all approaches, as well as the intersections as a whole, east and west approach queues would be very lengthy at times. In order to reduce those queues, widening to provide additional thru lanes would be necessary, at the very least to the east of the intersection.

A roundabout at this intersection would require dual entering and exit lanes for eastbound traffic and an east approach westbound to northbound right-turn bypass. This configuration would provide excellent operations with quite a bit of reserve capacity. Dual thru lanes for westbound traffic would extend that reserve capacity of the intersection considerably as well.

62nd Street West/Grand Avenue

For the intersection of 62nd Street West and Grand Avenue, a traffic signal with auxiliary left-turn bays on the north and west approaches and an auxiliary right-turn bay on the east approach projects to operate very well for Scenario 1 during both peaks. Max (95 percent) queues are projected to be limited to single digits for both the AM and PM peak hours.

A single-lane roundabout would also serve this intersection very well with no requirements for flared approaches or bypass lanes. Queuing projects to be minimal even during the busier surges of the AM and PM peak hours.

56th Street West/Grand Avenue

A traffic signal at the intersection of 56th Street West and Grand Avenue would require auxiliary left-turn bays on the east (WB) and south (NB) approaches, as well as auxiliary right-turn bays on the south (NB) and west (EB), in combination with dedicated thru lanes on the west (EB) and east (WB) approaches. This configuration would provide LOS C or better conditions during both peak hours for all approaches, as well as the intersections as a whole, and approach queues would be limited to the single digits for both the AM and PM peak hours.

A single-lane roundabout with an eastbound to southbound bypass would serve this intersection reasonably well during the standard peaks. However, the west approach (AM Peak) and east approach (PM Peak) would experience some extended queuing during surges within those peak periods.

54th Street West/Grand Avenue

A traffic signal at the intersection of 54th Street West and Grand Avenue would require auxiliary left-turn bays on the west (EB) and north (SB) approaches, as well as auxiliary right-turn bays on the north (SB) and east (WB), in combination with dedicated thru lanes on the west (EB) and east (WB) approaches. Although this configuration would provide LOS C or better conditions during both peak hours for all approaches, as well as the intersections as a whole, all approach queues would be very lengthy at times. In order to reduce those queues, widening to provide additional thru lanes would be necessary, at the very least to the west of the intersection. Depending upon the relative demands of other movements and other approaches, the north approach may benefit from implementation of a southbound dual-left turn lane. However, two receiving lanes would then be required on the east approach.

A roundabout for the intersection of 54th Street West and Grand Avenue would require dual entering, circulation and exit lanes for the east and west approaches. With that configuration in place, the intersection would operate very well with substantial reserve capacity on all but the north approach, where some queuing would be likely during the AM peak. A flared approach to split southbound left-turns and right-turns would help to address that issue.

48th Street West/Grand Avenue

A traffic signal at the intersection of 48th Street West and Grand Avenue would require auxiliary left-turn bays on the east (WB) and south (NB) approaches, as well as an auxiliary right-turn bay on the south (NB) approach. The east (WB) approach would require dual thru lanes in combination with a dedicated thru lane on and shared thru/right-turn lane on the west (EB) approach. Although this configuration would provide LOS C or better conditions during both peak hours for the intersections as a whole, the south (NB) approach would experience substandard delay in the AM peak hour as well as lengthy south and west approach queues at times. In order to reduce those queues and approach delay, widening to provide additional thru lanes would be necessary, at the very least to the east of the intersection.

A roundabout for the intersection of 48th Street West and Grand Avenue would also require dual entering, circulation and exit lanes for the east and west approaches. With that configuration in place, the intersection would operate very well with substantial reserve capacity on all approaches.

48th Street West/Central Avenue

A traffic signal at the intersection of 48th Street West and Central Avenue would require auxiliary left-turn bays on all approaches, in combination with shared thru/right-turn lanes on all approaches. This configuration would provide LOS C or better conditions during both peak hours for all approaches, as well as the intersections as a whole, and east and west approach queues would be lengthy but manageable. In order to reduce those queues, widening to provide additional thru lanes would be necessary.

For the intersection of 48th Street West and Central Avenue, a single-lane roundabout with no bypass lanes or flared approaches would provide excellent operations throughout the majority of the day. During the AM peak, however, there may be times when the relatively heavy eastbound thru volume would overwhelm that approach and cause substantial queues (greater than 20 vehicles) to occur for short periods. A flared approach would not provide much relief. An additional eastbound thru lane would be necessary to alleviate this condition.

64th Street West/King Avenue West

A traffic signal at the intersection of 64th Street West and King Avenue West would require auxiliary left-turn bays on all approaches, in combination with shared thru/right-turn lanes on all approaches. This configuration would provide LOS C or better conditions during both peak hours for all approaches, as well as the intersections as a whole, and east and west approach queues would be manageable.

For the intersection of 64th Street West and King Avenue West, a single-lane roundabout with no bypass lanes or flared approaches would provide excellent operations throughout the majority of the day. During the AM peak, however, there may be times when the eastbound thru demand would cause some lengthy queues to occur. In this case, a flared approach to separate eastbound left turns would help greatly with mitigating that risk.

48th Street West/King Avenue West

A traffic signal at the intersection of 48th Street West and King Avenue West would require auxiliary left-turn bays on all approaches, in combination with shared thru/right-turn lanes on all approaches. Although this configuration would provide LOS C or better conditions during both peak hours for all approaches, as well as the intersections as a whole, the east and west approach queues would be lengthy at times. In order to reduce those queues, widening to provide additional thru lanes would be necessary.

The intersection of 48th Street West and King Avenue West would operate much the same as the 48th Street West/Central Avenue intersection with a single-lane roundabout in place for Scenario 1. During the AM peak, there would be times when the heavy eastbound thru volume would overwhelm that approach and cause substantial queues (greater than 25 vehicles) to occur. A flared approach would not provide much relief. An additional eastbound thru lane would likely be necessary to alleviate this condition.

Scenario 2 (2035)

This section of the report discusses mitigation alternatives for each of the study area intersections that were found to be deficient in terms of Scenario 1 (2035) peak hour traffic operations. Once again, the evaluations were made independent of any consideration of corridor widening (from two lanes to four lanes, for example) though references to the potential need for such widening are made in several cases.

62nd Street West/Rimrock Road

For Scenario 2, a traffic signal with auxiliary left-turn bays on all four approaches and an auxiliary right-turn bay on the east (WB) approach would serve to provide excellent operational conditions. Thru movements could be served by single lanes (in the cases of the north, south and west approaches, shared with right turns). The east approach right-turn bay should be channelized given the high demand for that movement in both peak hours. Depending upon the relative demands of other movements and other approaches, the north approach may benefit from implementation of a southbound dual-left turn lane. However, two receiving lanes would then be required on the east approach.

For Scenario 2, a roundabout at this intersection would require the westbound to northbound bypass, as well as a southbound to eastbound dual left-turn configuration in order to function well. With this configuration in place, the intersection would operate very well with reserve capacity on all approaches.

54th Street West/Rimrock Road

A traffic signal at the intersection of 54th Street West and Rimrock Road would require auxiliary left-turn bays on all approaches, as well as a shared thru/right-turn lane on the north (SB) and south (NB) approach. The east (WB) and west (EB) approaches would require a combination with a dedicated thru lanes and shared thru/right-turn lanes. Although this configuration would provide LOS C conditions during both peak hours for the intersections as a whole, the north (SB) approach would experience substandard delay in the AM peak hour as well as lengthy north, east, and west approach queues at times. In order to reduce those queues and approach delay, the north approach may benefit from implementation of a southbound dual-left turn lane.

Scenario 2 peak hour traffic demands would require that a roundabout at the intersection of 54th Street West and Rimrock Road provide two lanes eastbound and westbound through the intersection. In addition, the west (EB) approach would need a drop/bypass lane for right-turns. Even then, the V/C ratio would be very high for the west approach during the AM peak, but it does appear that there would be some reserve capacity there before the approach would break down.

62nd Street West/Grand Avenue

For the intersection of 62nd Street West and Grand Avenue, a traffic signal with auxiliary left-turn bays on the north and west approaches and an auxiliary right-turn bay on the east approach projects to operate very well for Scenario 2 during both peaks. Max (95 percent) queues are projected to be limited to single digits for both the AM and PM peak hours.

At the intersection of 62nd Street West and Grand Avenue, a single-lane roundabout would continue to provide very good operations even during peak periods for Scenario 2. A flared approach on the west leg would help with surge period queuing for that approach, but would not be necessary to provide adequate LOS conditions.

56th Street West/Grand Avenue

A traffic signal at the intersection of 56th Street West and Grand Avenue would require auxiliary left-turn bays on the east (WB) and south (NB) approaches, as well as auxiliary right-turn bays on the south (NB) and west (EB), in combination with dedicated thru lanes on the west (EB) and east (WB) approaches. This configuration would provide LOS C or better conditions during both peak hours for all approaches, as well as the intersections as a whole, except the south (NB) approach in the AM peak hour. The west (EB) approach experiences high queues in the AM peak hour. In order to reduce those queues, the north approach may benefit from widening to provide additional thru lanes.

For Scenario 2, a roundabout at the intersection of 56th Street West and Grand Avenue would require dual entering and exit lanes on the east and west approaches and a single approach to the south. This configuration would operate very well with a lot of reserve capacity relative to the traffic projections.

54th Street West/Grand Avenue

A traffic signal at the intersection of 54th Street West and Grand Avenue would require auxiliary left-turn bays on the north (SB) and west (EB), as well as dedicated right-turn lanes on the north (SB) and east (WB) approach. The east (WB) and west (EB) approaches would require dual dedicated thru lanes. This configuration would provide LOS C conditions during both peak hours for the intersections as a whole, with manageable queues.

A roundabout for the intersection of 54th Street West and Grand Avenue would require dual entering, circulation and exit lanes for the east and west approaches, as well as a dual left-turn configuration for the north (SB) approach. With that roundabout configuration in place, the intersection would operate very well with substantial reserve capacity on all approaches for Scenario 2.

48th Street West/Grand Avenue

A traffic signal at the intersection of 48th Street West and Grand Avenue would require auxiliary left-turn bays on the east (WB) and south (NB) approaches, as well as auxiliary right-turn bays on the west (EB) and south (NB) approaches. The east (WB) and west (EB) approaches would require dual thru lanes. Although this configuration would provide LOS C or better conditions during both peak hours for the intersections as a whole, the south (NB) approach would experience substandard delay in both the AM and PM peak hours as well as lengthy queues at times. In order to reduce those queues and approach delay, the south approach may benefit from implementation of a northbound dual-right turn lane.

Scenario 2 peak hour traffic demands for the intersection of 48th Street West and Grand Avenue are projected to be high enough that dual approach and receiving lanes on Grand Avenue would still not provide enough capacity through a roundabout during peak period surges. If Scenario 2 traffic demands are realized at some point in the future a roundabout is selected for this intersection, a third eastbound approach and receiving lane would be required along with a northbound dual-left turn configuration in order to provide acceptable LOS conditions during the AM peak hour. However, dual lanes eastbound and westbound with a northbound dual-left turn would likely provide adequate capacity for a long period of time at this intersection regardless of growth.

48th Street West/Central Avenue

A traffic signal at the intersection of 48th Street West and Central Avenue would require auxiliary left-turn bays on all approaches, in combination with shared thru/right-turn lanes on all approaches. This configuration would provide LOS C or better conditions during both peak hours for all approaches, as well as the intersections as a whole, and east and west approach queues would be lengthy at times. In order to reduce those queues, widening to provide additional thru lanes would be necessary.

For the intersection of 48th Street West and Central Avenue, a roundabout configured with dual lanes for eastbound thru traffic and single lanes for all other movements would provide good operations with substantial reserve capacity. A westbound to northbound right-turn bypass would help alleviate potential for congestion on the east approach during the PM peak.

64th Street West/King Avenue West

A traffic signal at the intersection of 64th Street West and King Avenue West would require auxiliary left-turn bays on all approaches, in combination with shared thru/right-turn lanes on all approaches. This configuration would provide LOS C or better conditions during both peak hours for all approaches, as well as the intersections as a whole, and east and west approach queues would be manageable.

The intersection of 64th Street West and King Avenue West would function well as a roundabout configured with dual lanes for eastbound thru traffic and single lanes for all other movements, with substantial reserve capacity. Additional growth beyond what is projected for Scenario 2 would likely require dual entering and exit lanes for the westbound thru movement as well, though such growth is unlikely to occur during the 20-year horizon period for this study.

48th Street West/King Avenue West

A traffic signal at the intersection of 48th Street West and King Avenue West would require auxiliary left-turn bays on all approaches, in combination with shared thru/right-turn lanes on all approaches. Although this configuration would provide LOS C or better conditions during both peak hours for all approaches, as well as the intersections as a whole, and east and west approach queues would be lengthy at times. In order to reduce those queues, widening to provide additional thru lanes would be necessary.

For the intersection of 48th Street West and King Avenue West, a roundabout configured with dual lanes for eastbound and westbound thru traffic would function very well even for the peak period projections of Scenario 2. No flared approaches or bypass lanes would be required and the intersection would have a substantial amount of reserve capacity.

56th Street West/Hesper Road

The implementation of an all-way stop control at the intersection of 56th Street West and Hesper Road with a shared left-turn, thru, and right-turn lane on all approaches would provide LOS C or better conditions during both peak hours for all approaches, as well as the intersections as a whole, east and minimal queues.

The intersection of 56th Street West and Hesper Road would function very well as a single-lane roundabout. No flared approaches or bypass lines would be required. Reserve capacity would be substantial.

Corridors

Various major streets within the study area were projected to operate below an acceptable LOS D for the Horizon Year (2035) analysis scenarios. This section of the report will stratify those streets into specific segments and provide alternatives for mitigation of the corridor LOS deficiencies for both scenarios. To quantify the value of two-way left-turn lane (or a series of auxiliary left-turn lanes) in terms of added capacity, the project team assumed 3,600 vehicles per day increase, which is 20 percent of the daily capacity for a two lane facility. For a 5-lane cross section, the assumed capacity increase was also 3,600 vehicles per day, utilized a factor of 0.2 lanes for a turn lane that would create a 3-lane section from a 2-lane section or a 5-lane section from a 4-lane section. The thought here was that the added capacity for the lane itself would not change whether it was part of a 3-lane or 5-lane section.

Scenario 1 (2035)

Figure 9 on page 32 provided a graphical representation of the corridor LOS projections for Scenario 1 (2035). **Table 16** below illustrates how the addition of center turn lanes and/or additional thru lanes for impacted corridors would improve V/C ratio and in some cases, LOS. Note that since a center turn lane only provides a 5 percent increase in total volume capacity over and above a 4-lane section (4.2 lanes vs. 4.0 lanes), the 4-lane and 5-lane typical sections were grouped together for the purposes of this planning level analysis.

Table 16. Scenario 1 (2035) Corridor LOS Mitigation Analysis Results

	Scenario 1 - No Build		Scenario 1 - Mitigation			
	2 Lanes		3 Lanes		4/5 Lanes	
Segment	V/C Ratio	LOS	V/C Ratio	LOS	V/C Ratio	LOS
King Avenue West - East of 48th Street West	0.87	E	0.72	D	0.39	C or better
King Avenue West - 48th Street West to 56th Street West	0.77	E	0.65	D	0.35	C or better
Grand Avenue - East of 48th Street West	1.11	F	0.92	E	0.5	C or better
Grand Avenue - 48th Street West to 54th Street West	1.02	F	0.85	E	0.46	C or better
Grand Avenue - 54th Street West to 56th Street West	0.82	E	0.68	D	0.37	C or better
Grand Avenue - 56th Street West to 62nd Street West	0.84	E	0.70	D	0.38	C or better
Rimrock Road - East of 54th Street West	1.13	F	0.94	E	0.52	C or better
Rimrock Road - 54th Street West to 62nd Street West	0.77	E	0.64	D	0.35	C or better
62nd Street West - North of Rimrock Road	0.77	E	0.64	D	0.35	C or better

The analysis results show six of the impacted corridor segments could be improved to the required LOS D standard through the addition of a center turn lane or turn bays. However, Grand Avenue from east of 48th Street West to 54th Street West would need to be expanded to a 4-lane or 5-lane typical section in order to achieve LOS D or better corridor capacity results. The same is projected to be true for Rimrock Road east of 54th Street West.

Scenario 2 (2035)

Figure 10 on page 34 provided a graphical representation of the corridor LOS projections for Scenario 2 (2035). **Table 17** on the following page illustrates how the addition of lanes for impacted corridors would improve V/C ratio and in some cases, LOS.

As would be expected the number of corridors segments that would require additional thru lanes in order to meet the LOS D minimum planning standard would increase substantially. Nine (9) of the impacted Scenario 2 (2035) corridor segments would require 4 or 5-lane typical sections in order to achieve LOS D or better corridor metrics. Even with a 4-lane or 5-lane section in place, Grand Avenue would still only project to operate at LOS from east of 48th Street West to 54th Street West and the same is projected to be true for Rimrock Road east of 54th Street West.

TABLE 17. SCENARIO 2 (2035) CORRIDOR LOS MITIGATION ANALYSIS RESULTS

Segment	Scenario 2 - No Build		Scenario 2 - Mitigation			
	2 Lanes		3 Lanes		4/5 Lanes	
	V/C Ratio	LOS	V/C Ratio	LOS	V/C Ratio	LOS
King Avenue West - East of 48th Street West	1.09	F	0.91	E	0.50	C or better
King Avenue West - 48th Street West to 56th Street West	0.98	F	0.81	E	0.44	C or better
King Avenue West - West of 56th Street West	0.81	E	0.67	D	0.37	C or better
Central Avenue - East of 48th Street West	0.76	E	0.63	D	0.34	C or better
Grand Avenue - East of 48th Street West	1.43	F	1.19	F	0.65	D
Grand Avenue - 48th Street West to 54th Street West	1.31	F	1.1	F	0.6	D
Grand Avenue - 54th Street West to 56th Street West	1.05	F	0.88	E	0.48	C or better
Grand Avenue - 56th Street West to 62nd Street West	1.08	F	0.9	E	0.49	C or better
Rimrock Road - East of 54th Street West	1.41	F	1.18	F	0.64	D
Rimrock Road - 54th Street West to 62nd Street West	0.99	F	0.82	E	0.45	C or better
54th Street West - Grand Avenue to Rimrock Road	0.80	E	0.67	D	0.36	C or better
62nd Street West - North of Rimrock Road	0.98	F	0.82	E	0.45	C or better

Another important consideration for the preservation of overall corridor capacity is access management. Access management is a process of regulating public access to and from properties adjacent to a roadway corridor. Common access management tools include curbed medians, driveway consolidation and turn restrictions (e.g. right-in/right-out driveways). Where access is managed, driveways and sidestreets are designed to enable vehicles to enter and leave the roadway with minimal disruption to vehicle flow. Where there is no access management, turning vehicles can increase crash potential, reduce capacity, and erode the mobility of a corridor. The reduction in frequency and severity of crashes is important from a public safety perspective, but crash reduction also improves travel reliability since crash incidents can create substantial traffic congestion. In the context of West Billings, good access management practices may help forestall roadway widening by preserving vehicle capacity. It is noted that the benefits of access management depend on the context of the corridor, and some corridors will benefit from access management more than others.

From a transportation system perspective, the roadway network ideally offers a range of functional types to balance regional mobility and local access. In West Billings, there is relatively poor road network connectivity at the collector level, which forces drivers to rely primarily on the arterial road system. As the region develops, it will be important to create a connected network of collector and local streets to help distribute traffic and minimize the number of accesses on the arterial roads.

RECOMMENDATIONS

7

Intersections and Corridors

Short-Term Priority Projects

Based on the results of the Existing Conditions (2015) and Horizon Year (2035) analyses performed for this study, the following list of street and intersection projects (listed in order of anticipated priority) should be given strong consideration for construction within the next two to ten years. Note that some references to street corridor segments which fall outside of the study are made where it would make sense to include those segments in an actual improvement project. Approximate costs for the projects listed on the following pages are presented in **Tables 18 and 19** on Page 51. The estimated costs do not consider right-of-way, irrigation systems modifications or street lighting other than as associated directly with traffic signals or roundabouts.

Intersections

1. Neibauer Road/56th Street West – it will likely be a surprise to many that this intersection tops the list of recommended short-term priority projects, because traffic volume demands are pretty low in this area. However, the crash and severity rates for this intersection were the second highest of the 19 intersections within the study area. This is likely because intersection sight distance is very poor at this intersection while speeds on the major street (56th Street West) are very high. There are large, mature trees and utility poles that fall within the clear vision triangle on three corners of the intersection and a corn field occupied the fourth intersection corner as of Fall 2015. The intersection is equipped with an overhead flashing beacon for all four approaches, but the crash history implies that more improvements are needed.

   The sight obstructions could be removed, but that might be difficult and/or controversial given that the mature trees are in all three cases in landowner's yards. The other solution would be to implement all-way stop control at this intersection. The traffic volumes are reasonably balanced here. All-way stop control would function well. It would introduce additional delay for northbound/southbound traffic on 56th Street West, which is an unrestricted truck route, but given the crash history and the potential risk for a fatal crash, the Project Team recommends that all-way stop be implemented. The overhead flasher should be converted to red lights on the north and south faces.

Appropriate warning signage should be installed on those approaches as well. The County should also consider installing transverse rumble strips on the north and south intersection approaches to warn drivers of the conversion to all-way stop control. If the conversion is to be installed, a media campaign would also be helpful in notifying drivers of the change.

2. Neibauer Road/48th Street West – similarly, although this intersection had the 2nd lowest average daily entering traffic volume out of the 19 study area intersections, it experienced the 6th highest number of crashes and the third highest number of injury crashes. The crash and severity rates for the intersection were quite easily the highest in the study area. Over half of the total reported crashes resulted in injuries. Unlike the Neibauer Road/56th Street West intersection, it is not immediately apparent why this intersection is experiencing such a negative crash history. There are utility poles on the northwest and northeast (minor approach) corners and also some trees on the northeast corner, but those trees are set back a reasonable distance from both streets. There appears to be an irrigation ditch along north shoulder of the road, west of 48th Street West, the banks for which are higher than the street centerlines. It's certainly possible that when grass grows tall on those banks, vision could be obstructed to the west. Nine of the 12 crashes occurred between late April and late October (seven between early June and late August), but that may not necessarily be indicative of a correlation to vegetation growth. This is an area that experiences farm and ranch-related traffic, but only one of the crashes obviously involved a slow-moving piece of equipment. An examination of the crash reports showed that for eight of the 12 reported crashes, a violation was issued for failure to stop or failure to yield right-of-way.

   Regardless of the lack of a clear cause, the effect has been alarming. Potential mitigation options include installation of an overhead flashing beacon, installation of transverse rumble strips on the minor street approaches and conversion to all-way stop control. The traffic volumes are not very well balanced for this intersection, so a conversion to all-way stop control would introduce delay for what is clearly the more heavily used street (Neibauer Road). Given the history of citations for failure to stop/yield, the Project Team recommends that an overhead flashing beacon be installed at this intersection to provide additional warning of the required stop condition on 48th Street West. This treatment would be consistent with several other rural, high-speed intersections in the area. The County should also consider installing transverse rumble strips on the north and south intersection approaches to provide additional warning to drivers.

3. Rimrock Road/54th Street West Intersection – a traffic signal or roundabout should be installed at this intersection to reduce delay for the minor approaches and improve safety for vehicles and pedestrians. Based on the Horizon Year (2035) scenario traffic projections, a roundabout would be advantageous in that dual eastbound and westbound thru lanes could be provided with short lane drops to the east and west such that a full 4/5-lane section would not be required for a long distance upstream or downstream. Conversely though, a roundabout could require acquisition of right-of-way and would likely be substantially more expensive given that signal may be able to be retrofitted to the existing intersection. If a traffic signal is constructed, consideration should be given to locating signal poles and other infrastructure to accommodate additional future corridor widening for both intersecting streets.

4. King Avenue West/64th Street West Intersection – although this intersection operates at LOS B and LOS A during the AM and PM peaks for existing conditions, both minor approaches operate at LOS D during the AM peak. The crash rate for the intersection was found to be 0.93 crashes/MVE, which falls just below the 1.0 crashes/MVE threshold for concern. It is not likely that traffic signal warrants will be met for this intersection any time soon. However, the MDT auxiliary lane warrant criteria are met for eastbound left turn and right-turn lanes. The addition of these auxiliary turn lanes (as well as a westbound left-turn lane to mirror the eastbound lane) would improve intersection capacity and would likely improve safety conditions as well and therefore should be strongly considered in

the near-term. Prior to construction of these improvements, consideration should also be given to whether a traffic signal or roundabout is to be constructed for future traffic control at the intersection.

5. Grand Avenue/48th Street West Intersection – the traffic impact study for Ben Steele Middle School (*West End Middle School TIS, Sanderson Stewart, September 2015)* stated that all three traffic volume-based MUTCD traffic signal warrants are projected to be met for this intersection once the new school is open and generating traffic demand. Although the intersection may operate at LOS C or better without traffic control improvements, the south (minor) approach will continue to degrade in terms of peak hour delays and queuing. As such, a traffic signal or roundabout should be planned for implementation at this intersection within the next two to four years. By the time Scenario 1-level traffic demands are realized, both intersection types would require dual thru lanes in both directions on Grand Avenue, but it's highly likely that Grand Avenue would have a 5-lane typical section upstream and downstream of this intersection at that point anyway. In this case, the two intersection types seem to be very similar in terms of performance. It's also worth noting that the MPO Functional Classification map shows a future Collector connection from this intersection north and east to tie into 46th Street West, south of Rimrock Road. That connection could change traffic patterns substantially in this area. Therefore, the recommendation is that either a roundabout or traffic signal be constructed with careful consideration given to the future expansion of Grand Avenue and the timing of that future connection to the north.

6. Molt Road/Rimrock Road/62nd Street West Intersection – this "intersection" is currently made up of three intersections, two of which have approach alignment characteristics that do not meet current AASHTO standards relative to intersection skew. Also, the offsets between the actual Rimrock Road/62nd Street intersection and the intersections on Molt Road are such that there is not much space for queuing. The actual intersection of Rimrock Road and 62nd Street West also exhibited a high crash and severity rate during the 5-year crash analysis period for this study with the majority of the collisions being of a right-angle nature. The collisions most likely result from minor approach (EB/WB) cars misjudging the speed or intentions of southbound vehicles exiting Molt Road onto 62nd Street West.

   This intersection area has been studied in the past to try to determine how best to improve the configuration for both safety and operation's sake. For the purposes of the Horizon Year (2035) analysis for this study, it was assumed that all traffic on all three of the associated streets would be routed through one intersection. Since additional development may be forthcoming soon in this area, it is recommended that a new project is planned to finalize at least a design for improvements at this location. From an operational standpoint, construction could potentially be delayed for several years depending upon the pace of development in this area.

7. Grand Avenue/56th Street West – this intersection is could realize a degradation in AM peak hour operations within a relatively short time frame after Ben Steele Middle School opens if land development continues to occur in that area as expected. The TIS for this school projects a very palatable AM peak hour LOS even for the stop-controlled minor (south) approach. However, schools often have a unique impact on traffic operations by virtue of the surges in traffic that they generate. As such, operations will need to be monitored for this intersection to determine how well it is handling traffic demands after the school is operational. A single-lane roundabout (with bypasses) or a relatively simple lane configuration with a traffic signal would provide excellent operations for this intersections up to and beyond a traffic demand level consistent with the Scenario 1 projections. Pedestrian traffic control will be a key consideration for the intersection given its proximity to the school. In addition, this intersection will need to operate in cooperation with either a traffic signal or roundabout at the Grand Avenue/54th Street West intersection. The decision on whether a traffic signal or roundabout is to be implemented at the 56th Street West intersection should be based on those factors, as well as cost and right-of-way considerations.

There are two other intersections in the study area that should be monitored in the short-term relative to their respective crash histories. The intersection of Central Avenue and 48th Street West has a slightly elevated crash rate (1.29 crashes/MVE), but of more concern is the relative severity of the crashes. Six of the nine reported crashes during the analysis period resulted in injuries, which pushes the severity rate up to 3.01 (compared to a study area average of 2.03). Four of those crashes resulted in citations for failure to yield right-of-way. A physical observation of the intersection showed that there is a stand of trees on the northeast corner of the intersection that in combination with a trio of utility poles, could obstruct vision for north approach vehicles to the east. The intersection is already fitted with overhead flashers and oversized stop signs with supplementary signs that say "CROSS TRAFFIC DOES NOT STOP." Regardless, the intersection should be monitored to determine if the high frequency and severity of crashes continues, in which case additional measures may be necessary.

The intersection of Hesper Road and 56th Street West also exhibited crash (1.44 crashes/MVE) and severity (2.64) rates that were substantially above average for the study area. Half of the crashes were right-angle collisions, but only two citations were written for failure-to-yield. Sight distance at the intersection appears to be relatively good, though there could be periods of time where crops serve as a sight obstruction on the northwest corner of the intersection. Again, the recommendation is that the intersection be monitored going forward to determine if additional action is needed.

Corridors

1. Grand Avenue – Shiloh Road to 52nd Street West – this segment of Grand Avenue should be widened to three lanes at a minimum in the near future to improve capacity and safety. However, if funding allows, strong consideration should be given to additional capacity-building improvements, since the analysis from this study shows that a 3-lane section will most likely not be adequate for maintaining LOS D or better operations for the Horizon Year (2035) even if only Scenario 1 growth is realized.

2. Rimrock Road – 50th Street West to 54th Street West – Rimrock Road currently carries three lanes from 50th Street West to the east. That three-lane section may need to be extended to 54th Street West, although depending on the timing of the project, the analysis in this study projects that Rimrock Road will need a 4 or 5-lane section in order to provide acceptable LOS operations for the Horizon Year (2035), much like for Grand Avenue above. However, the segment of Rimrock Road to the east of 50th Street West was recently reconstructed, so it's not likely that it will be reconstructed again as a 4/5-lane facility in the short-term. Therefore, it may make sense to extend the 3-lane section on Rimrock Road in conjunction with a roundabout or traffic signal project at the intersection of Rimrock Road and 54th Street West.

3. King Avenue West – Montana Sapphire Drive to 48th Street West – this segment of King Avenue West may need to be widened to three lanes within the short-term project timeframe. This will depend largely upon the progression of development west of 44th Street West. For the purposes of planning for future funding needs, it is recommended that this improvement be considered.

4. Grand Avenue – Wilderness Drive to 62nd Street West – this segment of Grand Avenue may need to be widened to three lanes as depending upon the progression of land development along its frontage and in the area of the Rimrock Road/62nd Street West intersection. As such, it should be considered strongly in the short-term improvements plans in the coming years.

Figure 12 on the following page provides a graphical depiction of the locations, priority and features associated with the short-term priority project recommendations from this study.

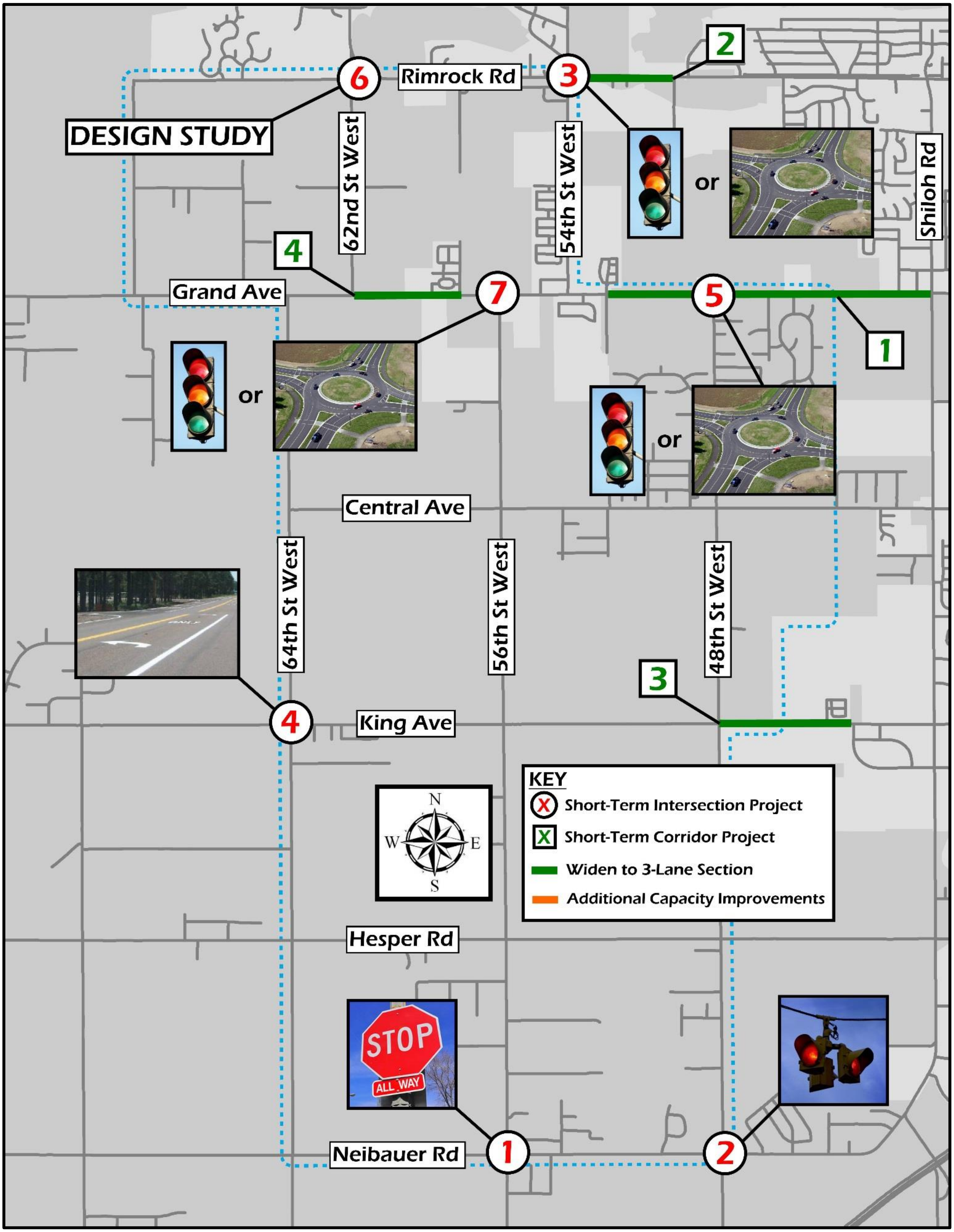


FIGURE 12 – SHORT-TERM PRIORITY STREET & INTERSECTION PROJECTS

TABLE 18. SHORT-TERM INTERSECTION PROJECT ESTIMATED CONSTRUCTION COSTS

Priority Ranking	Project Location	Project Type	Estimated Cost
1	Neibauer Rd. & 56th St. West	All-Way Stop Control/OH Flashing Beacons/Transverse Rumble Strips	$120,000-$200,000
2	Neibauer Rd. & 48th St. West	OH Flashing Beacons/Transverse Rumble Strips	$120,000-$200,000
3	Rimrock Rd. & 54th St. West	Traffic Signal or Roundabout	$400,000-$1,500,000
4	King Ave. West & 64th St. West	Auxiliary Turn Lanes	$400,000-$600,000
5	Grand Ave. & 48th St. West	Traffic Signal or Roundabout	$400,000-$1,500,000
6	Molt Rd./Rimrock Rd./62nd St. West	Design Study	$20,000-$30,000
7	Grand Ave. & 56th St. West	Traffic Signal or Roundabout	$400,000-$1,500,000

TABLE 19. SHORT-TERM CORRIDOR PROJECT ESTIMATED CONSTRUCTION COSTS

Priority Ranking	Project Location	Project Type	Estimated Cost
1	Grand Ave. - Shiloh Rd. to 52nd St. West	Widening/Reconstruction (3-lane section)	$2,800,000-$4,500,000
2	Rimrock Rd. - 50th St. West to 54th St. West	Widening/Reconstruction (3-lane section)	$1,000,000-$1,600,000
3	King Ave. West - MT Sapphire Dr. to 48th St. West	Widening/Reconstruction (3-lane section)	$1,300,000-$2,000,000
4	Grand Ave. - Wilderness Dr. to 62nd St. West	Widening/Reconstruction (3-lane section)	$900,000-$1,400,000

Long-Term Priority Projects

The following list of projects will be needed in order to maintain safe and efficient traffic operations conditions with the study area. These projections are anticipated to be needed in addition to those identified as Short-Term Priority projects. Approximate costs for the projects listed on the following pages are presented in **Tables 20 and 21** on Page 55. The estimated costs do not consider right-of-way, irrigation systems modifications or street lighting other than as associated directly with traffic signals or roundabouts.

Intersections

1. Molt Road/Rimrock Road/62nd Street West Intersection – this intersection was referenced in the short-term priority project section, but the minimum recommendation was simply to commission a design study and program a project for planning purposes. Since this project may or may not be constructed as a short-term improvement, we are including it here with a formal recommendation for reconstruction of the intersection as a traffic signal or roundabout depending upon results of the design study.

2. King Avenue West/48th Street West Intersection – for this intersection, single thru lanes on King Avenue West would provide reasonably good operations for even Scenario 2 traffic demand projections, albeit with some pretty lengthy queues once you reach those demand levels. This is because there are a relatively small number of eastbound and westbound left-turn movements projected such that a protected left-turn phase would not necessarily be required even for Scenario 2. Conversely, a roundabout would be susceptible to extended queuing and potential short-term breakdowns on the east and west approaches during peak period surges even for Scenario 1. Those concerns could be addressed through the implementation of dual eastbound and westbound thru lanes. However, unless the major street left-turn demand grows to a point where protected left-turn phasing is required on the King Avenue West approaches, a traffic signal would seem to be a more cost-effective solution for this intersection.

3. Central Avenue/48th Street West Intersection – this intersection shares very similar operational characteristics to the King Avenue West/48th Street West intersection. A traffic signal with single eastbound and westbound thru lanes would handle projected traffic demands up to and beyond Scenario 2, whereas a roundabout would require dual entry

and receiving lanes east and west. As such, a traffic signal is recommended as the planned improvement for the intersection once traffic signal warrants are met and/or peak hour operations degrade substantially.

4. King Avenue West/64th Street West Intersection - it was previously recommended as a short-term project that auxiliary turn lanes be constructed on King Avenue West at 64th Street West to improve capacity (slightly) and safety for the intersection. However, it is also likely that improvements to traffic control will be required well before the advent of the Horizon Year of 2035. While either a traffic signal or roundabout would function well here for both Scenarios 1 and 2, a roundabout for Scenario 2 would need dual eastbound thru lanes. For that reason and given that the previously recommended auxiliary turn lanes would be sacrificial if a roundabout was constructed, a traffic signal would make more sense at this location in terms of a planning level recommendation now.

5. Grand Avenue/62nd Street West Intersection – this intersection would be served well for both Horizon Year (2035) traffic projection scenarios by either a traffic signal with auxiliary turn lanes or a single-lane roundabout. That being the case, right-of-way impacts and a comparison of cost should be considered prior to making a final decision on what type of intersection traffic control is to be programmed. It's also worth noting here that the MPO Functional Classification map shows a future Principal Arterial connection from this intersection to the north end of 64th Street West (which currently dead-ends north of Central Avenue). Such a connection would likely change traffic patterns for this intersection, possibly quite significantly.

6. Hesper Road/56th Street West Intersection – the intersection of Hesper Road and 56th Street West projects to fail during the AM peak hour for Scenario 2, though it would meet the minimum LOS criteria for Scenario 1. The Project Team's analysis showed that the deficiencies at this intersection could be addressed by implementing all-way stop control. That's not surprising given that the traffic demand is relatively balanced across the four approaches (at least during the peak hours). Traffic signal warrants would not be met for this intersection unless growth occurs much more rapidly than has been projected through Scenario 2 from this study, which is unlikely. A roundabout would also certainly address the AM peak LOS problems, but would be a very costly improvement for a problem that is projected to be isolated to the AM peak hour. All that taken into account, it shouldn't be necessary to plan or commit improvements for this project any time soon. If the intersection starts to break down at some point, all-way stop control.

The study area intersections not specifically referenced in the preceding sections are projected to operate acceptably from a peak hour LOS standpoint through both scenarios of the Horizon Year (2035) and they don't have recent crash history characteristics that raise specific concerns at this time. However, it is certainly possible that as traffic demand increase over time, safety concerns could arise for any of those intersections. As such, crash histories should be re-revaluated periodically to determine if improvements may be necessary to maintain safe operations. Likewise, as growth occurs, variations in traffic patterns could cause the projected impacts in the study area to very relative to the results of this study. As such, periodic re-evaluation of study area intersection and corridor operations is also recommended.

Corridors

1. Grand Avenue – Shiloh Road to 62nd Street West – if the segment of Grand Avenue from Shiloh Road to 54th Street West is not widened to a 4/5-lane section via an initial reconstruction project (as recommended in the Short-Term Priority Project section), that segment as a 3-lane street could very well remain as the highest priority project relative to V/C ratio. In addition, the segment of Grand Avenue from 54th Street West to 62nd Street West is projected to require 4 or 5 lanes based on Scenario 2 growth for the year 2035. At a minimum, it is recommended that plans be laid for Grand Avenue to be widened to 4/5 lanes from Shiloh Road to 54th Street West and three lanes from 54th Street West to 62nd Street West.

2. Rimrock Road – Shiloh Road to 62nd Street West – similarly, Rimrock Road projects to need 4/5 lanes from Shiloh Road to 62nd Street West for Scenario 2. At a minimum, it should be planned that Rimrock Road will be a 5-lane facility to 54th Street West and a 3-lane facility from 54th Street West to 62nd Street West.

3. King Avenue West – Montana Sapphire Drive to 64th Street West – the short-term priority project list included an expansion of King Avenue West to three lanes from Montana Sapphire Drive to 48th Street West. Longer-term, that 3-lane facility would likely need to extend to 56th Street West and possibly beyond. If the more aggressive growth progression is realized, four or five lanes may be necessary to 48th Street West or even to 56th Street West with the three-lane section needed as far west as 72nd Street West. The recommendation here is that the MPO plans long-term for 4/5 lanes from Montana Sapphire Drive to 48th Street West and three lanes from 48th Street West to 64th Street West.

4. 54th Street West – Grand Avenue to Rimrock Road – 54th Street West is projected to require a 3-lane section at some point in the future. That lane configuration is projected to be adequate for either growth scenario. This is one street segment that could benefit from the construction of future planned collectors or arterials as identified on the MPO functional classification map. The completion of 58th Street West between Grand Avenue and Rimrock Road would relieve some traffic demand on 54th Street West, as may the connection between 48th Street West (at Grand Avenue) to 46th Street West, south of Rimrock Road. Even so, it is recommended that the widening of 54th Street West to a 3-lane section be included in future CIP documents.

5. Central Avenue – Shiloh Road to 48th Street West – this segment of Central Avenue is projected to need three lanes if growth surpasses the Scenario 1 projection level and approaches the Scenario 2 level. The timing for that need will likely depend upon whether or not the rural agricultural properties along this segment are developed within the next 20 years. Our expectation is that development will progress in this corridor since water and sewer facilities are stubbed into Central Avenue part way into this stretch. As such, it is recommended that this widening improvement be programmed for long-term plans.

6. 62nd Street West – Rimrock Road to Western Bluffs Drive – the urgency of any improvement to this stretch of road depends largely upon what happens with the trio of intersections that were previously discussed in this chapter. If an intersection reconstruction occurs that results in Molt Road traffic being funneled through the Rimrock Road/62nd Street West intersection, widening to three lanes or even 4/5 lanes will be required. For the purposes of this study, it is recommended that 3-lane section is planned for this stretch of roadway.

Figure 13 in the following page provides a graphical representation of the location, priority and features associated with the long-term priority street and intersection project recommendations from this study.

As with the intersections, any study area street corridor segments not specifically referenced in the preceding pages is not projected to experience substandard corridor LOS conditions for either of the Horizon Year (2035) traffic projection scenarios. However, as development patterns change, those corridors may need to be monitored accordingly.

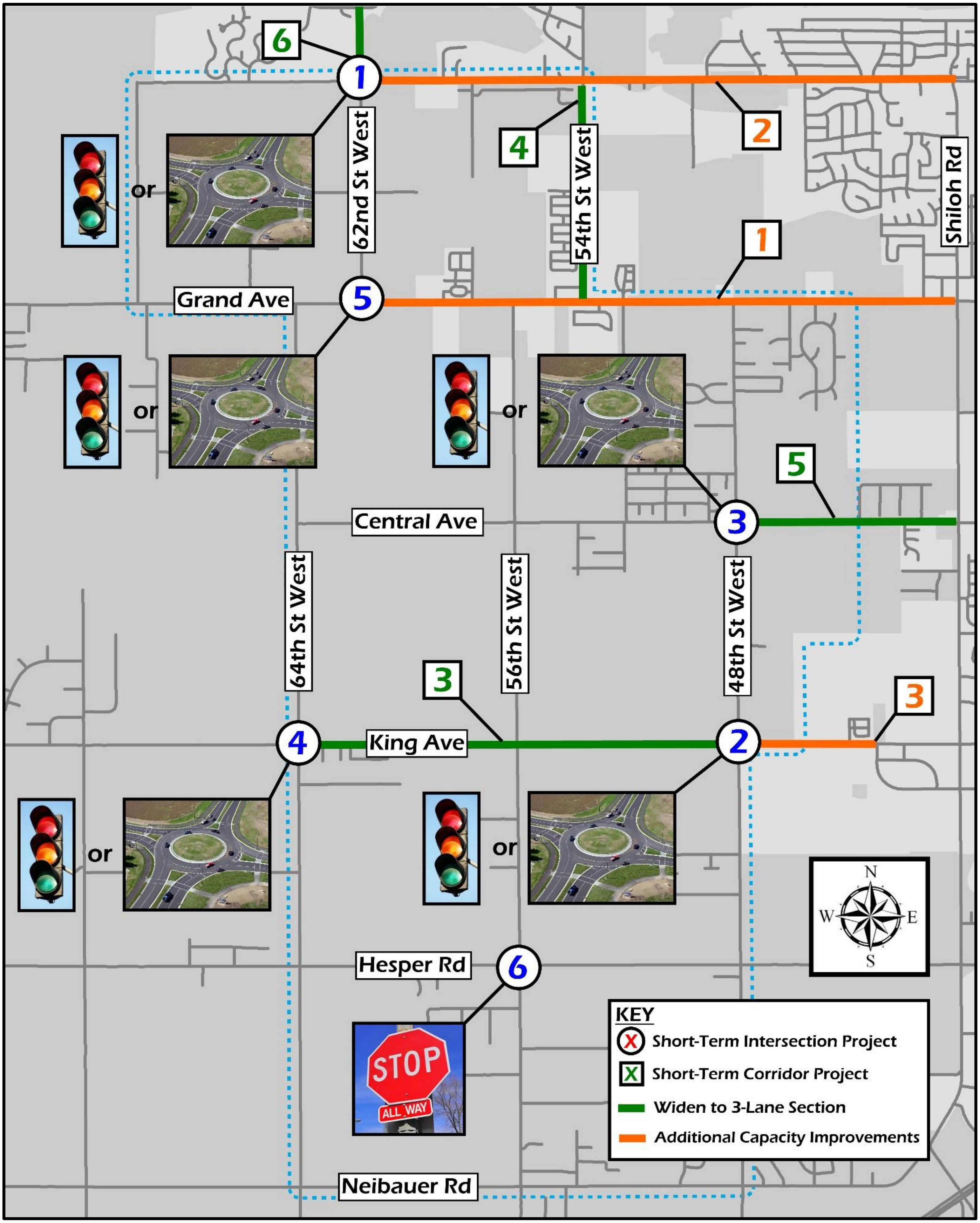


FIGURE 13 – LONG-TERM PRIORITY STREET & INTERSECTION PROJECTS

TABLE 20. LONG-TERM INTERSECTION PROJECT ESTIMATED CONSTRUCTION COSTS

Priority Ranking	Project Location	Project Type	Estimated Cost
1	Molt Rd./Rimrock Rd./62nd St. West	Traffic Signal or Roundabout	$400,000-$1,500,000
2	King Ave. West & 48th St. West	Traffic Signal or Roundabout	$400,000-$1,500,000
3	Central Ave. & 48th St. West	Traffic Signal or Roundabout	$400,000-$1,500,000
4	King Ave. West & 64th St. West	Traffic Signal or Roundabout	$400,000-$1,500,000
5	Grand Ave. & 62nd St. West	Traffic Signal or Roundabout	$400,000-$1,500,000
6	Hesper Rd. & 56th St. West	All-Way Stop	$4,000-$200,000

TABLE 21. LONG-TERM CORRIDOR PROJECT ESTIMATED CONSTRUCTION COSTS

Priority Ranking	Project Location	Project Type	Estimated Cost
1	Grand Ave. - Shiloh Rd. to 62nd St. West	Widening/Reconstruction (5-lane section)	$7,500,000-$11,000,000
2	Rimrock Rd. - Shiloh Rd. to 62nd St. West	Widening/Reconstruction (5-lane section/3-lane section)	$6,900,000-$10,300,000
3	King Ave. West - MT Sapphire Dr. to 64th St. West	Widening/Reconstruction (5-lane section/3-lane section)	$6,100,000-$9,300,000
4	54th St. West - Grand Ave. to Rimrock Rd.	Widening/Reconstruction (3-lane section)	$2,100,000-$3,300,000
5	Central Ave. - Shiloh Rd. to 48th St. West	Widening/Reconstruction (3-lane section)	$2,000,000-$3,100,000
6	62nd St. West - Rimrock Rd. to Western Bluffs Dr.	Widening/Reconstruction (3-lane section)	$700,000-$1,100,000

Active Transportation Recommendations

Combining the Latent Demand Model and Level of Traffic Stress, it is clear which geographic areas are most likely to generate walk/bike trips (based on land use) and that the existing arterial roadway network does not provide facilities the majority of people would feel comfortable using. Given the rural context of the area now, and understanding that over the next 20 years only a portion of the study area will begin to urbanize, this plan recommends a combination of short-term to meet immediate needs and long-term strategies that can leverage development-driven infrastructure.

Short-term Strategies

On-street Bicycle Facilities

There are few strategies for high-speed rural roads beyond shoulder widening; based on guidance for rural roadways from Minnesota Department of Transportation Bikeway Facility Design Manual and the AASHTO Guide for Development of Bicycle Facilities, a paved shoulder of six to eight feet is recommended to provide enough lateral separation to minimize wind blasts and other effects. However, the current arterial roadway system in the study area is likely to continue to exhibit high levels of traffic stress (LTS4) for bicyclists even if the roads are widened to provide better shoulders or on-street bike facilities, as long as speeds are higher than 35 mph and there is no physical separation from traffic. Speed limit modifications should be carefully considered, since arbitrarily lowering the speed limit below the design speed and/or the 85th-percentile speed can have negative unintended consequences for infractions and safety.

This means that widened arterials are not likely to attract or accommodate cyclists, except for the most confident user group. Furthermore, there is a significant amount of roadway centerline miles in the southern and western study area that are not likely to see even modest levels of demand in the near future. As such, the recommended strategies for short-term improvements focus on key corridors where there are gaps between existing land uses and existing trail/path systems (**Figure 14**, page 55):

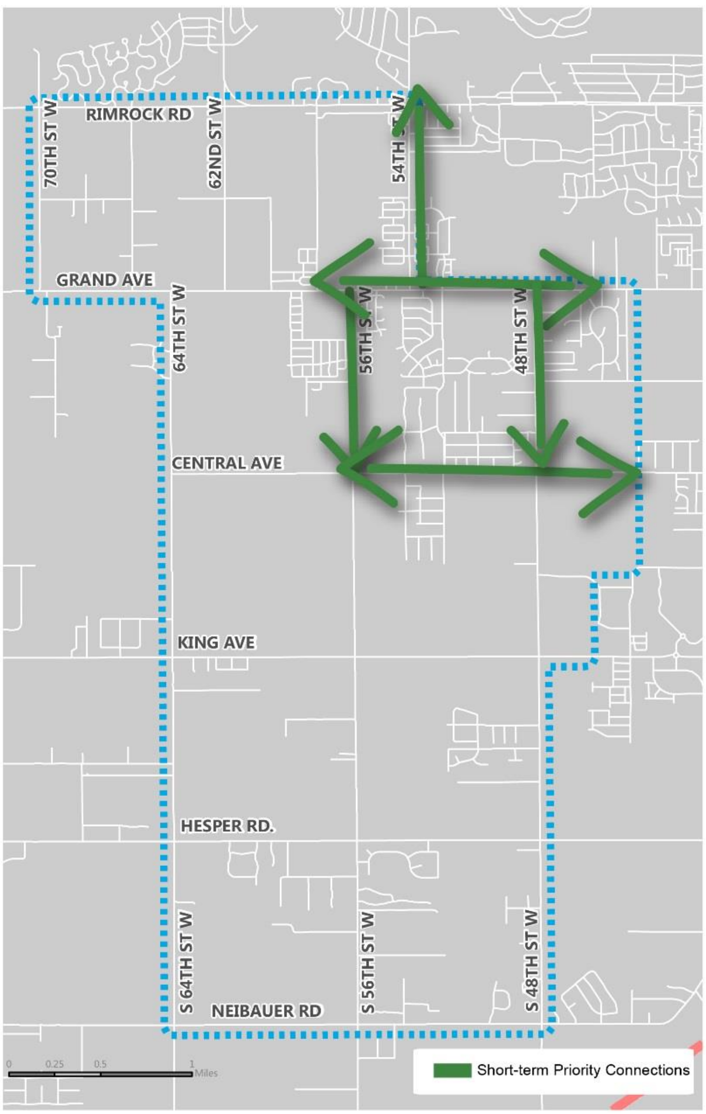
- 54th Street from Rimrock Road to Grand Avenue
- 48th Street from Central Avenue to Grand Avenue

- Grand Avenue from 58th Street to Shiloh Road
- Central Avenue from 56th Street to Shiloh Road

Improvements could include shoulder widening to provide ridable space (five to eight feet of pavement left of the white line), protected bike lane ("cycletrack"), and sidewalks or sidepaths. Providing parallel multi-use pathways designed to serve both pedestrians and bicycles should be a focus to better accommodate the needs of multiple user groups. In many instances this road expansion could have major impacts to utilities and private property.

Pedestrian Facilities

Near-term improvements for pedestrian facilities should focus on improving sidewalk connectivity with neighborhoods and providing crosswalks in the on the corridors shown in green in Figure 12. In many instances the pedestrian facilities can be complementary with the bikeways, by providing wider (eight to ten feet) sidewalks that function as sidepaths. In general, as intersection modifications are made to accommodate vehicle traffic, consideration should be given to accommodate safe pedestrian crossings.



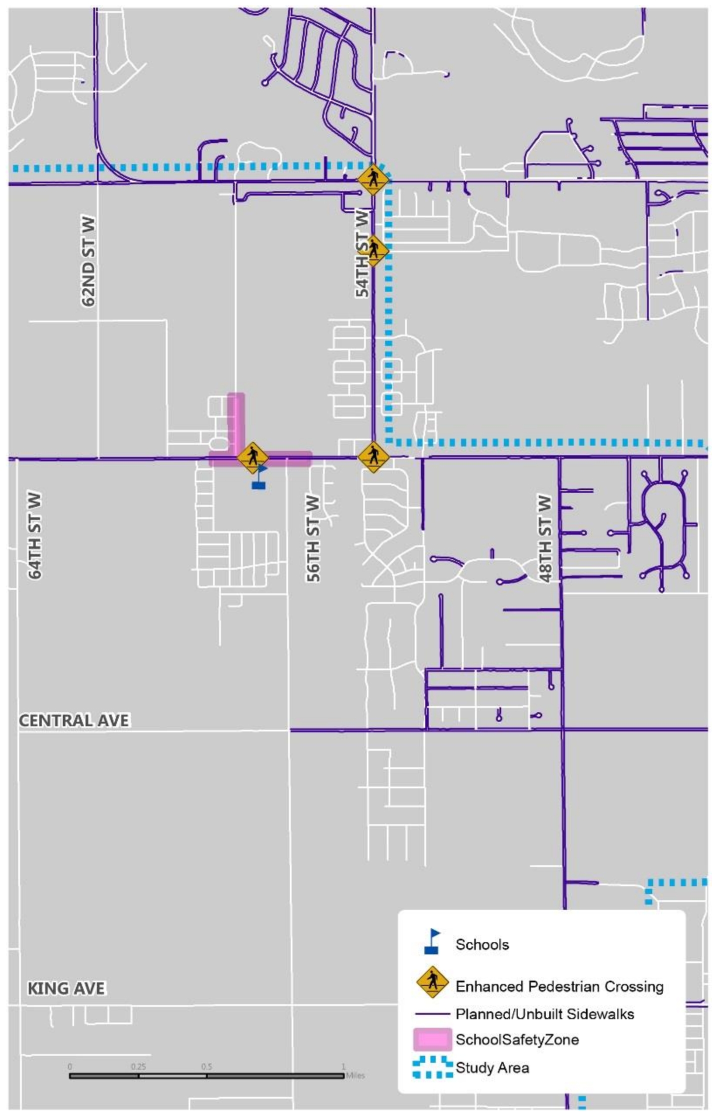


FIGURE 14 – SHORT-TERM IMPROVEMENTS FOR ON-STREET BICYCLE AND PEDESTRIAN FACILITIES

Crosswalks (note the following recommendations are planning-level, and the final determination of traffic control and safety measures should be based on an engineering study of prevailing vehicle patterns and pedestrian demand):

- Grand Ave/54th Street: crosswalk enhancements, possibly a traffic signal, to improve pedestrian safety near school zone
- Grand Avenue midway between 56th Street West and 58th Street West: pedestrian actuated mid-block beacon, possibly a pedestrian hybrid beacon ("HAWK signal") or rectangular rapid flashing beacon (RRFB)
- 54th Street West at terminus of multi-use path (north end of Cottonwood Park): pedestrian actuated mid-block beacon, possibly a pedestrian hybrid beacon ("HAWK signal") or rectangular rapid flashing beacon (RRFB)
- Rimrock Road/54th Street: crosswalk enhancements, possibly a traffic signal, to connect multi-use paths

Sidewalks:

- Multi-use path on Grand Ave from 52nd Street West to west boundary of Trails West Subdivision
- Sidewalk on Grand Ave from west boundary of Foxtail Subdivision to HAWK signal
- Multi-use path from Grand Avenue to north boundary of Cottonwood Park along west side of 54th Street West
- Sidewalk along east side of 54th Street West from Grand Avenue to north boundary of Grand Peaks Subdivision

Long-term Strategies

Except for local roads developed for master planned neighborhoods, there are few existing roadways internal to the arterial system. There is, however, a master plan (Functional Classification Map) for local and collector street system. The construction of those streets over time, if developed with multi-modal considerations directly in mind, could create a network of low-stress streets with organic active transportation facilities. This "layered network" principle is a way as to provide comfortable bike and pedestrian connectivity instead of force-fitting all modes onto the arterial corridors. Furthermore, a more developed collector street system can help disperse vehicle traffic and avoid over-reliance on arterial roadways. Since many of these future collector corridors are platted but not built, it is an ideal time to establish the roadway standards that incorporate bike lanes, sidewalks, and modest speed limits. In the event that some of the major arterials become more urbanized over time, with speed limit reductions and bike facilities they could also become useful low-stress bikeways. Recommended long-term low-stress corridors are (**Figure 15,** Page 58):

- 58th Street from Rimrock Road to Grand Avenue
- 66th Street from Rimrock Road to Grand Avenue
- 60th Street corridor
- 52nd Street corridor
- Monad Road
- Broadwater Avenue
- Colton Blvd

As shown by the black dashed lines in **Figure 15** (next page), this system of collector streets can also be linked by trail connectors similar to the way the Big Ditch Trail connects with local neighborhood streets. There are several planned multi-use pathways in the Long Range Transportation Plan that would complement a system of low-stress streets. Future pathway segments should be prioritized based on the proximity to high demand areas and the ability of the segment to provide connectivity through barriers and gaps in the street system.

Physical improvements and locations aside, the most important recommendation from a multi-modal transportation system perspective is that the City of Billings and Yellowstone County coordinate to implement a consistent and stringent set of

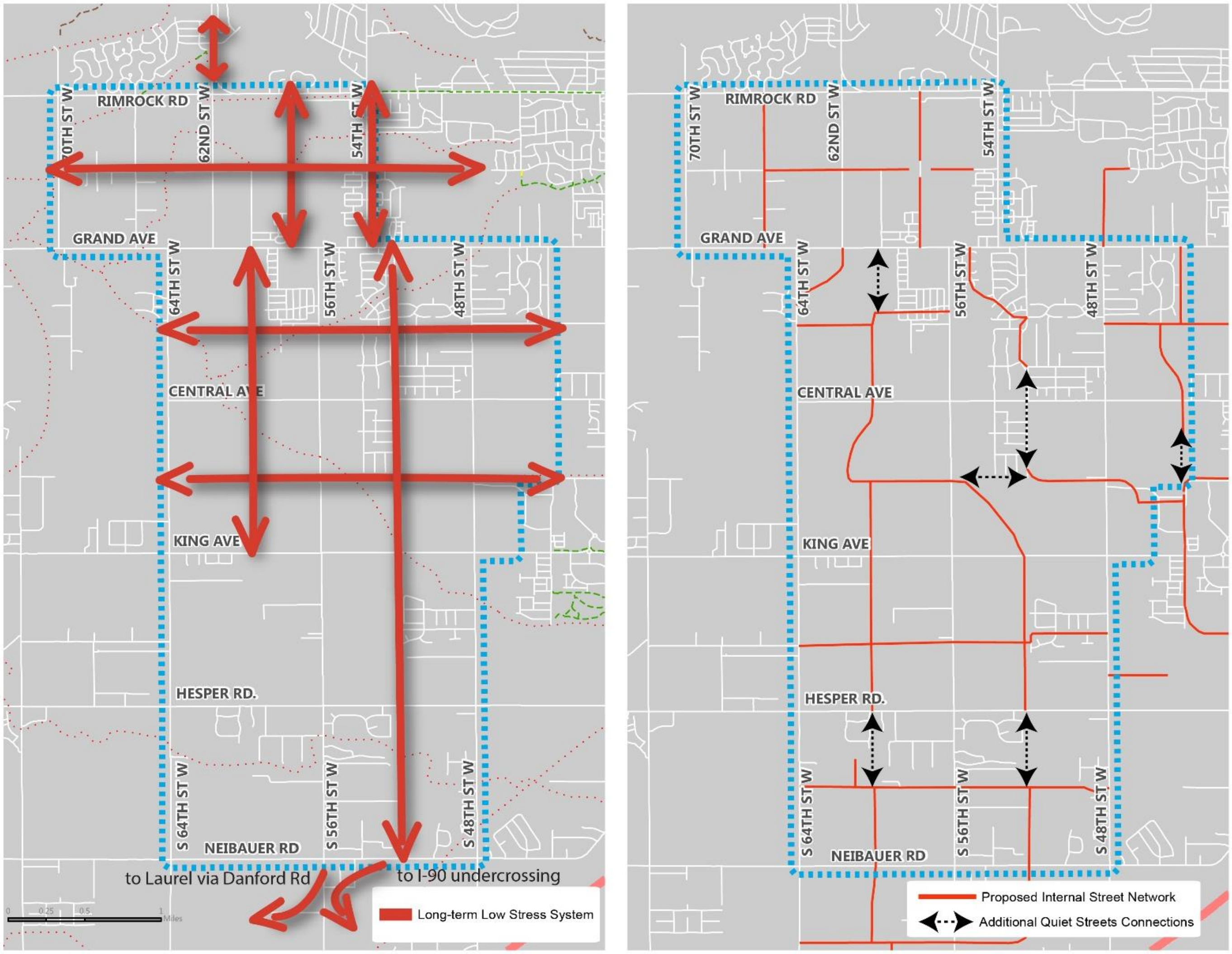


FIGURE 15 – LONG-TERM ACTIVE TRANSPORTATION STRATEGIES

requirements for the subdivision of land that requires dedication of right-of-way and construction of facilities to further the mission of expanding and improving safety for the multi-modal travel environment. If the development of multi-modal facilities becomes an integral part of the land development process, the system will inherently improve and expand in the general locations where demand for those facilities is also most likely to grow and the potential costs associated with independent multi-modal facility projects can be partially if not wholly defrayed.