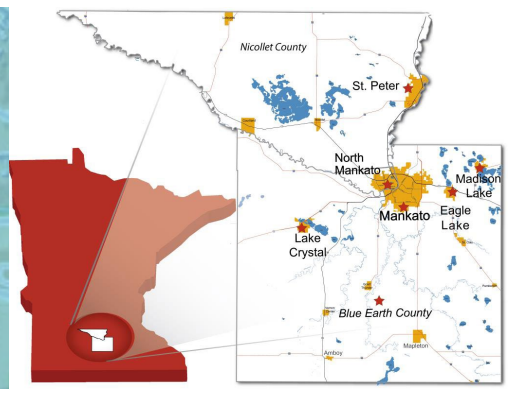
Appendix A: Open House Summaries

WARREN STREET
CORRIDOR STUDY
SUMMARY OF COMMENTS FROM PUBLIC ENGAGEMENT



GENERAL COMMENTS

- Consider a designated bike facility along the whole corridor.
- Riding bikes south to campus is difficult with no shoulder or bicycle facility. Bicyclists use sidewalk to feel safe.
- Some observe speeding traffic regularly. Speeding traffic makes crossing Warren Street on foot seem unsafe.
- Consider 3-lane conversion and medians along entire corridor.
- Consider wider sidewalk, benches and planters along the corridor.
- Sidewalks are in bad condition along the corridor.
- Vetter Stone design on Cherry Street constricts right-of-way; residents request omitting from Warren Street.

2019 ENGAGEMENT EVENTS TO DATE

August 27	Mankato Night to Unite - Highland Park
August 29	Alive After 5 Mankato
September 7	Mankato United Way Human Foosball Tournament
September 19	Cherry Ridge Apartments
October 2	Mankato State University Student Senate
October 2-4	Mankato Transit Outreach
October 8	Colonial Square Apartments
October 9	VINE Faith in Action
October 10	Durham Apartments (SMILES)
October 15	Highland Park Neighborhood Association
October 16	Gus Johnson Apartments (SMILES)
October 24	Warren Street Corridor Study Open House #1
November 18	Lincoln Park Neighborhood Association
Ongoing	Website comments

SITE-SPECIFIC COMMENTS

KEY
Study corridor
Comment reference area

Improve pedestrian crossings of Warren/ Riverfront and Liberty/ Riverfront

- Signal timing:
  - Red light seems unnecessarily long
  - Subsequent lights turn red immediately when advancing from green
  - Consider turning signals off at night
- Consider adding more street lighting for safety

Difficult to get here from Warren Street

- Steepness of 4th Street challenging in winter
- Difficult to enter Warren Street from 4th Street because of traffic
- Difficult pedestrian crossing

Historical Society:
- Remove the large sign pole by alley entrance
- Consider adding parking lot access to 5th Street

Southbound traffic backs up waiting to turn left onto Glenwood Avenue

- Poor sidewalk maintenance in winter
- Add pedestrian crossing like those on campus
- Consider grade separated pedestrian crossing

- Vehicles entering northbound Warren Street cut off traffic
- 2019 all-way stop preferred
- Difficult left turn onto Warren Street
- Sight line issues entering Warren Street from Glenwood Avenue
- Consider roundabout
- Consider an all-way stop
- Pedestrian crossings difficult
- Add pedestrian crossing at Warren Street

Consider bicycle facilities through Lincoln Park neighborhood instead of along Warren Street

- Sidewalk too close to curb, feels unsafe when walking
- Difficult to walk in winter; can't use

Trail really steep here

- Vehicles observed speeding into neighborhood
- Confusion about who has right-of-way: vehicles exiting park or exiting neighborhood
- Residents concerned about access during construction

- Sight lines are difficult when entering Warren Street
- High traffic speeds make Ramsey feel unsafe

- Add safe pedestrian crossing in this zone
- Lots of issues in winter

Blind entry from condos

- Very icy in winter, many vehicles off road
- Continue 4-lane
- Ample space on north side to accommodate improvements
- Consider widening trail

Risk for rear-end crashes to vehicles waiting to turn left into neighborhood

- Pedestrian infrastructure in poor condition
- Lane split confusing; forced into quick decision to change lanes
- Frequent skateboard traffic from Val Imm Drive to Warren poses safety issues
- Add pedestrian crossing like those on campus
- Close the bicycle lane gap from Val Imm to Broad

- Add sidewalk & bike lanes
- Consider signing difficulty/steepness of bike paths
- Pedestrians seen in street due to lack of sidewalk and safe crossings

- Consider adding pedestrian flasher
- Consider removing bump-out; causes issues in icy conditions
- Consider better street lighting for safety

Having small section of road named Cedar Street is confusing

Many people cross here, consider pedestrian crossing safety measures

WARREN STREET CORRIDOR STUDY

Open house #2, Facebook, and survey response report summary

As part of the City of Mankato's public outreach in the planning for the Warren Street Corridor Study, a 2nd open house survey was conducted from April 11, 2020 through May 10, 2020. The survey asked respondents to review the three concepts and provide feedback on each. After reviewing the options, respondents were asked to rank their preferred concept, 1 being first, 2 being second, and 3 being third. By this method, the lower the number in rank order indicates a higher preference. At the same time as the survey, the city was also collecting emailed and Facebook responses on the three concepts. These responses were included with the survey responses in drafting the summary below.

Three-lane with buffered bike lane

Preferred concept rank order 1.54

Comments in favor

- Keeps traffic moving with third lane
- Would be even safer if the 2ft buffer space was a physical barrier
- It allows pedestrian traffic, bike traffic, car traffic, and safe turning traffic

Comments against

- Even with center turn lane, option may lead to congestion
- Too tight of a fit with 3 lanes, two bike lanes, and two sidewalks
- A bike lane next to cars is not as safe as a separate trail

Side path with two-lane roadway

Preferred concept rank order 2.07

Comments in favor

- If bikes, skateboards, scooters, etc. are allowed on side path
- Would reduce speeds through corridor
- Would reduce distance for pedestrians crossing Warren Street

Comments against

- Traffic congestion, delays, and accidents while waiting for turning traffic
- Confusion about whether bicycles are supposed to use side path
- Safety concern combining pedestrians and cyclists on side path

Three-lane with alternate bike route

Preferred concept rank order 2.38

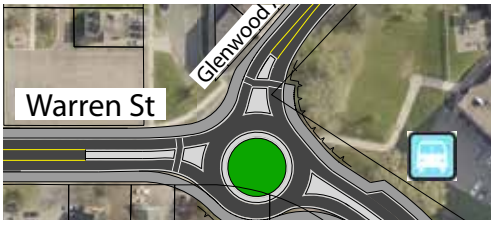
Comments in favor

- Provides ample room for vehicles and pedestrians
- Removes motorist/cyclist accidents
- Alternative route might be safest for less experienced cyclists

Comments against

- Inconvenient alternative route for bike traffic
- Not fair to cyclists to have to take alternate route
- Cyclists would use Warren Street vehicular lanes instead of alternate bike route

Roundabout at Glenwood Drive



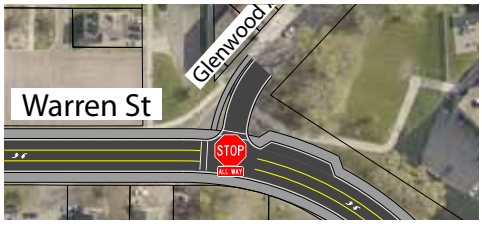
Comments in favor

- Would help slow traffic on Warren Street
- Controls intersection without requiring stopping

Comments against

- More expensive than 4-way stop
- Traffic may not be able to stop in slippery conditions

All-way stop at Glenwood Drive



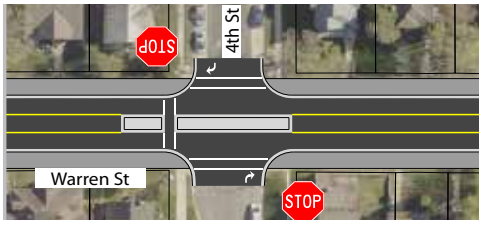
Comments in favor

- Would slow traffic and increase safety
- Less expensive than a roundabout

Comments against

- Vehicles may ignore 4-way stop
- Traffic may not be able to stop in slippery conditions

Right-in/right-out at 4th Street



Comments in favor

- Increases safety
- Decreases congestion by eliminating left turn conflict

Comments against

- Reduces access for emergency vehicles crossing Warren Street
- Creates a mid-street obstruction when plowing snow

Appendix B: Existing Conditions Analysis

Warren Street Corridor Study

MAPO and City of Mankato, MN

M E M O R A N D U M

Date: September 24, 2019

To: Paul Vogel, Executive Director, Mankato/North Mankato Area Planning Organization (MAPO)

From: Angie Bersaw, AICP, Principal Transportation Planner, Bolton & Menk, Inc.

Matt Lassonde, Transportation Planner, Bolton & Menk, Inc.

Subject: Existing and No-Build Conditions

Warren Street Corridor Study, Mankato, MN

Introduction

The Mankato/North Mankato Area Planning Organization (MAPO) and the City of Mankato are working together to identify multimodal transportation improvements on Warren Street between Riverfront Drive and Highland Park (**Appendix A**). Warren Street provides an important connection from City Center Mankato in the Minnesota River Valley to the Minnesota State University (MSU) Campus on the Mankato hilltop. The segment from Riverfront Drive to Highland Park plays a complex role as it passes through City Center core areas with high vehicle traffic volumes, pedestrian cross-traffic and road right-of-way confined by the topographical constraints of a wooded ravine. The corridor serves multiple transportation users including automobiles, transit, pedestrians and bicyclists. MAPO and the City of Mankato desire to define a comprehensive vision for Warren Street in preparation for the 2021 street reconstruction project to continue their momentum in City Center reinvestment. The study will include:

- Defining the issues and potential opportunities along the corridor.
- Establishing the corridor vision and goals.
- Developing and evaluating potential multimodal infrastructure improvement alternatives.
- Developing a short-term implementation plan in preparation for the 2020 street reconstruction.

The purpose of this memorandum is to document existing conditions on Warren Street as it relates to land use and previous studies, traffic operations, safety, access, pedestrian/bicycle accommodations and environmental resources. This information will serve as the framework to develop improvement goals for Warren Street.

Existing Literature Review

Several short- and long-range documents have been completed which provide planning direction for future transportation system needs within and near the Warren Street corridor. The key points in each study relevant to Warren Street are summarized below by plan title.

MAPO 2045 Long Range Transportation Plan (2015)

- Warren Street is identified as a primary transportation corridor providing access from lower to hilltop areas of Mankato.
- Warren Street is identified as an evacuation route from the City Center core area.
- Warren Street was identified as a significant corridor requiring future evaluation from Riverfront Drive to Balcerzak Drive to improve safety and travel.
- Warren Street from Riverfront Drive to Glenwood Avenue is proposed to convert from a major collector roadway to a minor arterial.
- This Plan shows transit intersecting with the corridor. Route 7 travels along the corridor from Riverfront Drive south where it diverges onto Val Imm Drive. Route 2 and Saturday service routes traverse Warren between Riverfront Drive and Second Street.
- Warren Street/Cedar Street/Highland Avenue from Val Imm Drive to Malin Street is anticipated to be over capacity by 2045.
- Glenwood Avenue is also anticipated to be over capacity from Highland Avenue/Warren Street to Monks Avenue.
- Warren Street from Riverfront Drive to Glenwood Avenue is identified for a four-lane urban reconstruct under the MAPO Long-Term Major Rehabilitation/Reconstruction Projects.
- Warren Street from Glenwood Avenue to Cedar Street and from Cedar to Haynes is identified for a two-lane urban reconstruct under the MAPO Long-Term Major Rehabilitation/Reconstruction Projects.
- Cedar Street/Warren Street from Highland Avenue to Malin Street is proposed to expand to three lanes as an illustrative project in the MAPO Major Rehabilitation/Reconstruction Projects.

Riverfront Drive Corridor Study (2017)

- Recommendations include
    1. Lane alignment modifications to the Riverfront Drive/Warren Street/Poplar Street intersection.
    2. Installation of protected lefts at the Riverfront Drive/Warren Street/Poplar Street intersection.
- Traffic backups were identified at the southbound approach to the Warren Street intersection during PM peak hour traffic.

- The Riverfront Drive intersection with Warren Street/Poplar Street exhibited 35 crashes including one pedestrian crash during the five-year period from 2010-2014.
- The westbound movement from Warren Street to Poplar Street is offset by six feet which may contribute to driver confusion.

MnDOT Intelligent Transportation Systems (ITS) Architecture Plan (2015)

This plan discusses statewide Intelligent Transportation Systems (ITS) initiatives and does not pertain specifically to the study area. However, the vision and goals of the plan apply to MAPO and the Mankato area in general. These are as follows:

1. Vision: Minnesota's ITS provides a safe and efficient transportation system for users by providing timely and effective communications utilizing innovation and cost-effective technologies.
2. Goals:
    a. Safety – Utilize Minnesota's Intelligent Transportation System (ITS) to reduce fatalities and serious injuries through the use of technology to enhance the overall safety of the transportation system.
    b. Mobility – Minimize overall travel delay by providing and operating systems that maximize highway capacity reduce delays and communicate information about road conditions to travelers.
    c. Operations & Maintenance – Provide an ITS to ensure the transportation system is reliable and effective for users and improves operational efficiency of systems and MnDOT.
    d. Consistency – Establish an ITS that provides consistency statewide for technology, processes and procedures, interoperability, operations and maintenance.

Minnesota Statewide Regional ITS Architecture Version 2018

The purpose of this is to:

1. Foster integration of the deployment of regional ITS systems.
2. Facilitate stakeholder coordination in ITS planning, deployment, and operations.
3. Reflect the current state of ITS planning and deployment.
4. Provide a high-level planning for enhancing the state transportation systems using current and future ITS technologies.
5. Conform with the National ITS Architecture and the Federal Highway Administration (FHWA) policy and standards.

This "system architecture" is focused on documenting ITS systems and statewide implementation of initiatives and does not provide recommendations that pertain

specifically to the study area. However, ITS initiatives should be considered in recommended improvements to the Warren Street corridor where possible.

City of Mankato Community Investment Plan (CIP) (2019 through 2023)

The following street projects are identified in the City of Mankato 2019-2023 Community Investment Plan (CIP) that intersect or are adjacent to the study area:

- Poplar street is identified for reconstruction in 2019 from Sibley Parkway to Riverfront Drive.
- 2nd Street is identified for reconstruction in 2020 from Warren Street to Main Street.
- Warren Street is identified for reconstruction in 2021 from Glenwood Avenue to Riverfront Drive.
- Broad Street is identified for reconstruction in 2022 from Warren Street to Main Street.

Mankato Transit Development Plan (2018)

- Route 7 currently traverses Warren Street/Highland Street/Cedar Street from Riverfront Drive to Maywood Monday through Friday and will continue that trend according to the plan. There are no weekend services proposed on Warren Street.

Front Street Connectivity Plan (2014)

- This plan's focus is on improving accessibility of Front Street from Main Street to Liberty Street.
- The plan recommends maximizing or maintaining parking levels in study area.
- The plan recommends improving pedestrian connectivity to entertainment, retail, lodging and recreational areas.

Wayfinding Signage Plan (2015)

- The plan recommends addition of wayfinding signage to announce arrival to and assist with navigation through the City Center. Signage may include informational kiosks, pedestrian signage on sidewalks, and vehicular signage directing to public parking and other points of interest.
- Signage staged in two phases. Phase 1 (2015) included the intersections of Riverfront Drive and Sibley Parkway, Warren Street, Main Street, and Rock Street. Phase 2 (2016) includes the intersection of Riverfront Drive and Cherry Street, Plum Street, Spring Street and Civic Center Plaza.

City of Mankato Complete Streets Plan and Policy (2015)

- Warren Street from Broad Street to Val Imm Drive was included in a 2017 Bike Facilities Project to complete the bicycle network from Pohl Road to the MSU campus and finally to the bicycle network on Broad Street.

Mankato Area Public Schools' Safe Routes to School Plan (2013)

- The plan identifies Warren Street within the study area as the split between the Jefferson and Washington Elementary School attendance areas on the west and east side of the corridor respectively.
- The Warren Street intersections with Riverfront Drive and Front Street are included in areas identified as hazardous areas for children walking/biking to Jefferson School (Hazardous Areas along Riverfront Drive and Front Street); Warren Street lines the northeastern edge of the walking zone for Jefferson Elementary School.
- There is one walking household identified on the south corner of Warren Street and 4th Street.
- No Safe Routes to School projects were identified along Warren Street in this plan.

MAPO Americans with Disabilities Act (ADA) Transition Plan and Inventory for Public Rights-of-Way (2019)

- Warren Street is programmed for 2021 reconstruction and exhibits significant deficiencies in ADA compliance considering sidewalks, pedestrian ramps and bus stops. The estimated planning-level cost to bring facilities into compliance with ADA is $138,207. These deficiencies will be rectified in the street reconstruction in 2021.

Demographics and Trends

Located in south central Minnesota, the Mankato/North Mankato metropolitan planning area is 75 miles south of Minneapolis-St. Paul at the junction of Highway 14 and Highway 169/60. The area has experienced widespread growth across the metropolitan area and serves southern Minnesota as a hub for health care, education, retail, agriculture and industry. The area is comprised of Mankato, North Mankato, Eagle Lake and Skyline; Blue Earth and Nicollet counties; and Belgrade, Lime, South Bend, LeRay and Mankato townships.

Population

The Mankato/North Mankato area has seen rapid growth. In 2010, the Metropolitan Statistical Area (MSA) population was 96,740 with an urbanized population of 58,265. The 2010 population estimate represents a 13 percent change from the year 2000 for the MSA. **Table 1** illustrates historic population figures referenced from the MAPO 2045 Long Range Transportation Plan along with 2018 estimates referenced from the State Demographer and the US Census Bureau.

A large portion of the rapid growth occurred in Mankato alone, exhibiting 21 percent change within the decade. Much of the growth probably occurred in the first half of the decade as the indicators, such as housing unit construction, show decline after 2007. More recent estimates indicate that growth has slowed to a more moderate rate. Trends implied the MAPO area added 450 to 535 people annually when the 2045 plan was developed.

	1980 CENSUS	1990 CENSUS	2000 CENSUS	2010 CENSUS	% CHANGE 2000-2010	2018 ESTIMATE	% CHANGE 2010-2018
Mankato	28,651	31,477	32,427	39,309	21%	43,567	10.8%
MSA	79,243	82,120	85,712	96,740	13%	101,647	5.1%

Table 1. 1980 – 2018 Population (Source: US Census Bureau); Minnesota State Demographer (Source: https://mn.gov/admin/demography/data-by-topic/population-data/our-estimates/); MAPO 2045 Long Range Transportation Plan.

The project team identified a critical population boundary (**Figure 1**) understand characteristics of the population most likely to use the corridor daily and with potential to be the most impacted by roadway improvements. Warren Street provides this population with the key connection between the downtown and the campus on the hilltop. The area also includes a large population of students and faculty from the university. This boundary also serves as the basis for our environmental justice review as seen in the **Environmental Justice Report** in **Appendix B**. Various demographic metrics were defined for this critical area using ESRI's Business Analyst application. This included an understanding of population, households, income, age, etc. for the area.

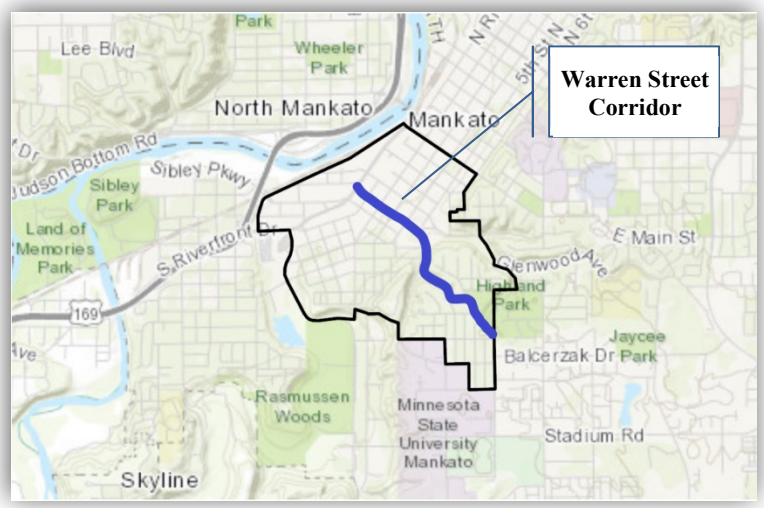


Figure 1. Warren Street Corridor Study - Critical Population Boundary.
***Source*: ESRI Business Analyst**

An estimated 5,087 people living in 2,204 households occupy this area. Eighty-five percent of the population is white, 6 percent is Hispanic, and 6 percent is Black/African American. Sixty-two percent of households are renter households and 28 percent of households fell below the poverty line (data from the American Community Survey (ACS). Twenty-five percent of households had one or more individuals with a disability. There were no minority populations identified in this area speaking limited or no English.

Age

The population's age distribution is important as it affects transportation usage. Within the period from 2000 to 2010 in the MSA, those ages 18-34 years and those ages 55-64 years saw the highest increases in populations indicating increased commuters and dial-a-ride transit users (**Table 2**). Those ages 18-20 years represented the largest demographic

group, while those ages 55-64 exhibited the greatest increase in population. With a large group of individuals ages 18-34 years, the area may see a higher demand for pedestrian and bicycle amenities.

The age of the population in the critical population boundary is illustrated in **Figure 2** for 2018. This shows the 20-24 age group is dominant in this area representing roughly 23 percent of the population. Those ages 25-29 make up nearly 15 percent of the population. Overall, those ages 20-34 make up nearly 50 percent of the population in this area.

	MSA		
AGE	2000	2010	CHANGE
0-9	9,869	11,466	1,597
10-17	9,447	8,298	(1,149)
18-20	17,249	19,606	2,357
25-34	10,460	13,342	2,882
35-44	11,879	10,009	(1,870)
45-54	10,640	12,129	1,489
55-64	6,161	10,411	4,250
65-74	4,785	5,627	842
75-84	3,649	3,867	218
85+	1,573	1,985	412
Total	85,712	96,740	11,028

Table 2. Population by Age (Source: US Census Bureau; MAPO 2045 Long Range Transportation Plan).

Employment

Most household trips include travel to and from places of employment. Mankato and North Mankato are the major employment centers for the region with a labor shed spanning 16 counties. There is a net inflow of primary jobs in the MAPO market area, meaning there are more jobs in the market than people living in the market area. Almost 72 percent of labor force living in the market area also work there.

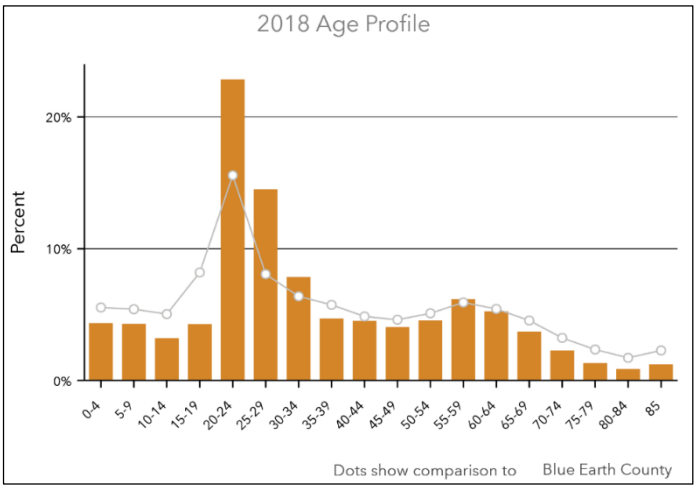


Figure 2. 2018 Age Profile of Critical Population Compared to Blue Earth County Population. *Source*: ESRI Business Analyst

Transportation System Characteristics

The transportation network characteristics identify major qualities of the physical roadway system of Warren Street and its connections. The following section provides details on existing roadway conditions including descriptions of functional classification, connections, speed limits, number of lanes and parking accommodations.

Functional Classification

The functional classification system is used to create a roadway network that efficiently collects and distributes traffic from neighborhoods to the state highway system. A successful system coordinates and manages mobility, roadway design, and route alignment and seeks to match current and future access and land use with the adjacent roadway's purpose, speeds, and spacing. The functional classification system is comprised of principal arterials, minor arterials, major and minor collectors and local roadways.

Warren Street serves as a minor arterial roadway providing a key connection from Riverfront Drive in Mankato's City Center core to Stadium Road on the MSU campus. It serves a diverse mix of vehicle, bicycle, and pedestrian traffic. It will be important to

understand how to balance access and mobility given the corridor's four-lane design and status as a minor arterial roadway as well as numerous access locations. MAPO's Functional Classification is illustrated in **Appendix C**.

Existing Number of Lanes and Parking Accommodations

Warren Street is a four-lane undivided roadway from Riverfront Drive to Val Imm Drive where it converts to a two-lane section which continues until Balcerzak Drive, south of the southern study area terminus. On-street parking is not permitted on Warren Street. On-street parking exists along most cross-streets and in Mankato City Lot 38 on the eastern corner of Warren Street and Front Street.

Study Area Characteristics

The following describes existing conditions related to land use, traffic operations, crash history, roadway access, and pedestrian and bicycle connections. This section also contains a review of known Social, Economic, and Environmental (SEE) resources within the study area. Several Figures are appended to this document relating to the existing characteristics of the study area as described in the text below. Refer to the **Appendix D** for the following graphics:

- **Figure D-1:** Existing Land Use
- **Figure D-2**: Existing Peak Hour Turning Movement Counts
- **Figure D-3**: Existing Traffic Operations
- **Figure D-4**: 2041 Peak Hour Turning Movement Counts
- **Figure D-5:** 2041 No-Build Traffic Operations
- **Figure D-6**: Crash History (2014-2018)
- **Figure D-7**: Access Inventory
- **Figure D-8**: Transit

Land Use and Major Traffic Generators

Land uses adjacent to this segment consist of commercial, institutional, residential and some open space. Commercial properties are concentrated around the corridor from 2nd Street to north of Riverfront Drive, the northern study extent. This section falls within the City's Central Business District and is a major traffic generator. Institutional uses are concentrated between 2nd Street and Broad Street and include the Malda Farnham Park, the Cray Mansion, the Hubbard House and the St. John's Episcopal Church. The Cray Mansion and Hubbard House are both listed on the National Register of Historic Places.

Several multi-family residential uses are located along the corridor, primarily between 2nd Street and Highland Avenue, which draws significant traffic from residents accessing Warren Street. Apartment complexes include the Durham Apartments and Chatham Square apartments just off the corridor near 2nd Street, Cherry Ridge Apartments and Colonial Square Apartments near the Warren Street/Glenwood Avenue intersection, and the Cedar

Bluff Condominiums across the corridor from the Highland Avenue/Warren Street/Cedar Street intersection. Single-family residential occupies most of the corridor south of Ramsey Street.

Other nearby locations that contribute to traffic on the corridor include the Lincoln Park neighborhood west of the corridor with a significant number of students and university faculty residing there; residential neighborhoods east of the corridor, close to the downtown; and the Old Main Village apartment complex among others.

The MSU campus surrounds the corridor south of the study extent providing a major draw for traffic accessing campus from Mankato in the river valley and points north. Wayfinding signage directs those traveling on Riverfront Drive to access MSU via Warren Street.

See **Figure D-1: Existing Land Use** in **Appendix D.**

Existing Traffic Operations

The existing traffic operations were analyzed for the corridor. **Figure D2** of **Appendix D** shows the existing peak hour turning movement counts. The AM and PM peak hours were found to be from 7:30-8:30 AM and 4:30-5:30 PM, respectively. **Figure D3 of Appendix D** illustrates existing traffic operations.

A level of service (LOS) analysis of the peak hours was completed using the existing turning movement counts. The LOS results are based on average delay per vehicle as calculated by the Highway Capacity Manual (HCM) 6th Edition, which defines the level of service, based on control delay. Control delay is the delay experienced by vehicles slowing down as they are approaching the intersection, the wait time at the intersection, and the time for the vehicle to speed up through the intersection and enter into the traffic stream. Intersections overall and each movement are given a ranking from LOS A through LOS F. LOS A indicates the best traffic operation, with vehicles experiencing minimal delays. LOS A through D is generally perceived to be acceptable to drivers. LOS E indicates that an intersection is operating at, or very near, its capacity and that drivers experience considerable delays. LOS F indicates an intersection where demand exceeds capacity and drivers experience substantial delays.

The existing AM and PM peak traffic volumes were analyzed in Synchro/SimTraffic. Operational results are shown in **Table 3**.

Table 3 shows that the intersections operate with LOS A or B during the peak hours. At the intersection of Riverfront Drive at Warren Street the eastbound left movement operates with LOS D during the AM peak hour. During the PM peak hour, the eastbound left, eastbound through, and westbound left turning movements operate with LOS D. All other movements operate with LOS C or better during both peak hours.

At the intersection of Riverfront Drive at Warren Street the maximum northbound through queue extends past the left turn lane during both peak hours and the southbound through queue extends past the left turn lane during the PM peak hour. All other intersection queues are acceptable. For more detailed information on the traffic operations please refer to the No Build Traffic Operations Memorandum.

Table 3. Existing (2017) Traffic Operational Analysis

Intersection	Peak Hour	Intersection Delay (1.)		Maximum Delay-LOS (2.)		Limiting Movement (3.)	Max Approach Queue		
							Direction	Average Queue (ft)	Max Queue (ft)
Riverfront Dr & Warren St	AM	9	A	36	D	EBL	NBT	75	175
Signalized Intersection	PM	13	B	44	D	EBL	SBT	100	225
Front St & Warren St	AM	10	B	20	C	EBL	WBL/T	50	125
Stop Controlled	PM	11	B	16	C	WBL	EBT/R	50	125
2nd St & Warren St	AM	8	A	13	B	SBL	SBL/T/R	50	125
Stop Controlled	PM	9	A	15	C	NBL	SBL/T/R	75	150
Broad St & Warren St	AM	11	B	16	C	EBL	SBL/T/R	75	150
Stop Controlled	PM	11	B	20	C	EBL	WBT/R	75	150
4th St & Warren St	AM	2	A	11	B	NBT	WBL/T	25	75
Stop Controlled	PM	2	A	18	C	NBL	EBL/T	25	125
Glenwood Ave &Warren St	AM	3	A	14	B	SBL	EBL/T	50	150
Stop Controlled	PM	3	A	17	C	SBL	EBL/T	50	150
Ramsey St & Highland Ave	AM	1	A	9	A	NBL	NBL/R	25	50
Stop Controlled	PM	1	A	9	A	NBL	WBL/T	25	50
Pleasant St & Highland Ave	AM	1	A	7	A	NBL	NBL/R	50	75
Stop Controlled	PM	1	A	8	A	NBL	NBL/R	50	100
Val Imm Dr & Highland Ave	AM	1	A	7	A	NBL	NBL/R	50	75
Stop Controlled	PM	2	A	8	A	NBL	NBL/R	50	100
Highland Ave & Cedar St	AM	1	A	6	A	NBL	NBL/R	25	50
Stop Controlled	PM	1	A	6	A	NBL	NBL/R	25	50
Cedar St & Warren St	AM	1	A	6	A	SBL	SBL/R	25	50
Stop Controlled	PM	1	A	7	A	SBL	EBL/T	25	75
Haynes St & Warren St	AM	1	A	6	A	NBL	WBL/T	25	50
Stop Controlled	PM	1	A	8	A	NBL	WBL/T	25	75

1. Delay in seconds per vehicle
2. Maximum delay and LOS on any approach and/or movement
3. Limiting Movement is the highest delay movement.

2041 No-Build Conditions

Traffic forecasts were developed using a combination of the 2045 MAPO Long Range Transportation Plan, historical data, and estimated population growth. See the No Build Traffic Analysis Memorandum for more information on the forecasting process. 2041 peak hour turning movement counts are shown in **Figure D4** of **Appendix D**. **Table 4** below shows the anticipated 2041 operations with the existing geometry. **Figure D-5** of **Appendix D** illustrates 2041 No-Build Traffic Operations.

Table 4 shows that the intersections are anticipated to operate with LOS A or B during the 2041 peak hours. At the intersection of Riverfront Dr at Warren St, the westbound left movement operates with LOS D during the AM peak hour. During the PM peak hour, the eastbound left, eastbound through, and westbound left turning movements operate with LOS

D. At the intersection of Glenwood Ave at Warren St, the southbound left movement operates with LOS E. All other movements operate with LOS C or better during both peak hours.

At the intersection of Riverfront Dr at Warren St the maximum northbound through and southbound through queues extend past the left turn lanes during both peak hours. During the PM peak hour, the maximum westbound through and southbound left queues extend past the left turn lanes. At the intersection of Glenwood Ave at Warren St the maximum

Table 4. 2041 No Build Traffic Operational Analysis

Intersection	Peak Hour	Intersection Delay (1.)		Maximum Delay-LOS (2.)		Limiting Movement (3.)	Max Approach Queue		
							Direction	Average Queue (ft)	Max Queue (ft)
Riverfront Dr & Warren St	AM	10	B	35	D	WBL	NBT	100	250
Signalized Intersection	PM	15	B	43	D	WBL	SBT	150	325
Front St & Warren St	AM	10	B	15	C	WBL	WBT/R	50	125
Stop Controlled	PM	11	B	18	C	WBL	WBT/R	75	150
2nd St & Warren St	AM	9	A	17	C	NBL	SBL/T/R	50	125
Stop Controlled	PM	10	B	17	C	WBL	SBL/T/R	100	200
Broad St & Warren St	AM	12	B	18	C	EBL	SBL/T/R	100	200
Stop Controlled	PM	12	B	21	C	EBL	WBT/R	100	175
4th St & Warren St	AM	2	A	15	C	SBT	SBL/T/R	50	100
Stop Controlled	PM	3	A	24	C	SBL	SBL/T/R	75	150
Glenwood Ave &Warren St	AM	6	A	38	E	SBL	SBL/R	75	250
Stop Controlled	PM	7	A	40	E	SBL	SBL/R	100	275
Ramsey St & Highland Ave	AM	1	A	9	A	NBL	WBL/T	25	75
Stop Controlled	PM	1	A	14	B	NBL	WBL/T	50	75
Pleasant St & Highland Ave	AM	1	A	9	A	NBL	NBL/R	50	75
Stop Controlled	PM	1	A	9	A	NBL	NBL/R	50	75
Val Imm Dr & Highland Ave	AM	2	A	9	A	NBL	NBL/R	50	100
Stop Controlled	PM	3	A	13	B	NBL	NBL/R	75	125
Highland Ave & Cedar St	AM	1	A	9	A	NBL	NBL/R	25	75
Stop Controlled	PM	1	A	9	A	NBL	NBL/R	25	50
Cedar St & Warren St	AM	1	A	8	A	SBL	SBL/R	25	50
Stop Controlled	PM	1	A	11	B	SBL	EBL/T	25	100
Haynes St & Warren St	AM	1	A	6	A	NBL	WBL/T	25	75
Stop Controlled	PM	1	A	7	A	NBL	WBL/T	25	75

1. Delay in seconds per vehicle
2. Maximum delay and LOS on any approach and/or movement
3. Limiting Movement is the highest delay movement.

southbound queue extends past the roadway split near Cherry St. All other intersection queues are acceptable.

Crash History (2014 – 2018)

A crash review was completed for the intersection in the project area for a five-year period from 2014 to 2018. Crash data was provided by MnDOT which uses a comparison of the crash rate and critical rate when determining if there is a safety issue at an intersection. The crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a

statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside of the expected, normal range. The critical index reports the magnitude of this difference and a critical index of less than one indicates that the intersection is operating within the normal range.

The following intersections have a critical index outside the normal range when compared to similar intersections statewide:

- 2nd Street at Warren Street
- 4th Street at Warren Street
- Glenwood Avenue at Warren Street
- Val Imm Drive at Highland Avenue

The crash worksheet for each intersection can be found in **Appendix E**. The latest available crash rates are from 2015 and were used for comparison purposes. **Table 5** below summarizes the crash data for each intersection.

Table 5. Crash Analysis Summary (2014-2018)

Intersection	Total Crashes	Critical Index	Critical Rate	Observed Crash Rate	Statewide Average
Riverfront Dr at Warren St	18	0.47	1.07	0.5	0.7
Front St at Warren St	8	0.73	1.18	0.86	0.52
2nd St at Warren St	28	**1.51**	0.96	1.45	0.52
Broad St at Warren St	14	0.76	0.46	0.74	0.52
4th St at Warren St	10	**1.15**	0.46	0.53	0.18
Glenwood Ave at Warren St	23	**2.19**	0.42	0.92	0.18
Ramsey St at Highland Ave	1	0.12	0.50	0.06	0.18
Pleasant St at Highland Ave	3	0.38	0.48	0.18	0.18
Val Imm Dr at Highland Ave	9	**1.14**	0.52	0.56	0.18
Cedar St at Highland Ave	5	0.73	0.52	0.38	0.18
Cedar St at Warren St	1	0.15	0.54	0.08	0.18

A more detailed analysis was completed for the intersection operating outside the normal range compared to similar intersection statewide.

2nd Street at Warren Street

Over the past five years, 28 crashes occurred at the intersection of 2nd St at Warren St. **Table 6** and **7** summarize the crash types and severity that occurred at the intersection.

Table 6. 2nd Street at Warren Street Crash Type

Crash Type	Frequency
Right Angle	15
Left Turn	6
Rear End	4
Ran off Road	1

Table 7. 2nd Street at Warren Street Crash Severity

Crash Severity	Frequency
Fatal	0
Incapacitating Injury	0
Non-Incapacitating Injury	5
Possible Injury	6

Table 6 shows that right angle crashes were the most common at the intersection accounting for 15 of the 28 crashes. Ten of the 15 right angle crashes involved a vehicle traveling northbound. The next most common were left turning crashes. Most of the crashes (17) resulted in property damage, but 11 crashes resulted in injury (**Table 7**). Fifteen of the crashes occurred between December and March when snow or ice could have been a factor.

The observed crash rate was 1.45. The statewide average for similar intersections is 0.52, indicating that the 2nd Street at Warren Street crash rate is over two times higher than the average. The critical index was 1.51, indicating that the segment is operating outside the normal range.

4th Street at Warren Street

Over the past five years, 10 crashes occurred at the intersection of 4th Street and Warren Street. **Table 8** and **9** summarize the crash types and severity that occurred at the intersection.

Table 8. 4th Street at Warren Street Crash Type

Crash Type	Frequency
Right Angle	5
Rear End	4
Right Turn	1

Table 9. 4th Street at Warren Street Crash Severity

Crash Severity	Frequency
Fatal	0
Incapacitating Injury	0
Non-Incapacitating Injury	1
Possible Injury	3

Table 8 shows that right angle crashes were the most common at the intersection accounting for half of the crashes. The next most common were rear end crashes. Six of the crashes resulted in property damage while four crashes resulted in injury (**Table 9**). Three of the crashes occurred between December and March when snow or ice could have been a factor.

The observed crash rate was 0.53. The statewide average for similar intersections is 0.18, indicating that the 4th Street at Warren Street crash rate is nearly three times higher than the average. The critical index was 1.15, indicating that the segment is operating outside the normal range.

Glenwood Avenue at Warren Street

Over the past five years, 23 crashes occurred at the intersection of Glenwood Avenue and Warren Street. **Table 10** and **11** summarize the crash types and severity that occurred at the intersection.

Table 10. Glenwood Avenue at Warren Street Crash Severity

Crash Type	Frequency
Rear End	6
Ran off Road	5
Right Turn	4
Other	3
Right Angle	2
Left Turn	2
Bicycle	1

Table 11. Glenwood Avenue at Warren Street Crash Severity

Crash Severity	Frequency
Fatal	0
Incapacitating Injury	0
Non-Incapacitating Injury	2
Possible Injury	8
Property Damage Only	13

Table 10 shows that rear end crashes were the most common at the intersection accounting for six of the crashes. The next most common were ran off road crashes accounting for five of the crashes and right turn crashes accounting for four of the crashes. Thirteen of the crashes resulted in property damage and 10 crashes resulted in injury (**Table 11**). Eleven of the crashes occurred between December and March when snow or ice could have been a factor.

The observed crash rate was 0.92. The statewide average for similar intersections is 0.18, indicating that the Glenwood Ave at Warren St crash rate is five times higher than the average. The critical index was 2.19, indicating that the segment is operating outside the normal range.

Val Imm Drive at Highland Avenue

Over the past five years, 10 crashes occurred at the intersection of Val Imm Drive and Highland Avenue. **Table 12** and **13** summarize the crash types and severity that occurred at the intersection.

Table 12. Val Imm Drive at Highland Avenue Crash Type

Crash Type	Frequency
Right Angle	5
Ran off Road	3
Sideswipe - Same Direction	1

Table 13. Val Imm Drive at Highland Avenue Crash Severity

Crash Severity	Frequency
Fatal	0
Incapacitating Injury	0
Non-Incapacitating Injury	1
Possible Injury	1
Property Damage Only	7

Table 12 shows that right angle crashes were the most common at the intersection accounting for half of the crashes. The next most common were ran off road crashes. Seven of the crashes resulted in property damage and two crashes resulted in injury (**Table 13**). Four of the crashes occurred in December through March when snow or ice could have been a factor.

The observed crash rate was 0.56. The statewide average for similar intersections is 0.18, indicating that the Val Imm Drive at Highland Avenue crash rate is three times higher than the average. The critical index was 1.14, indicating the segment is operating outside the normal range.

Pedestrian and bicycle crashes were also analyzed over the same five-year period. **Table 14** summarizes the location, frequency, and severity of the crashes.

Table 14. Pedestrian and Bicycle Crashes (2014-2018)

Location	Crashes
Riverfront Dr at Warren St	Two Bicycle Crashes (Possible Injury); One Pedestrian Crash (Minor Injury)
Front St at Warren St	One Bicycle Crash (Possible Injury); One Pedestrian Crash (Minor Injury)
Broad St at Warren St	One Pedestrian Crash (Property Damage)
Glenwood Ave at Warren St	One Bicycle Crash (Minor Injury)

Figure D6 of Appendix D illustrates crash history on the corridor in the 5-year period from 2014-2018.

Access

There are 38 access points along Warren Street in the study area including seven primary accesses (seven per mile), 10 secondary accesses (10 per mile), and 21 private accesses (21 per mile). Both primary and secondary access counts fall within or below MAPO's recommendations for 9 to 19 accesses per mile along minor arterial roadways. **Figure D-7** illustrates existing access on the corridor.

Pedestrian and Bicycle Connections

Sidewalks are present on both sides of Warren Street aside from a gap on the southwest side of the corridor from Val Imm Drive to Highland Avenue. Space to accommodate sidewalk in this location is limited as a large retaining wall holds back steep terrain behind the curb.

Designated crossings along the corridor are limited. No crosswalks exist for roughly three-fourths of a mile between Broad Street in City Center and Haynes Street on the hilltop. Pedestrian ramps do exist at the intersection of Warren Street and 4th Street, a location just south of Highland Avenue and Val Imm Drive, and at the intersection of Highland Street and Cedar Street near the Cedar Bluff Condominiums, but these locations are not marked with crosswalks.

Sidewalk space in this segment provides the only snow storage location in the winter. After being plowed onto the sidewalk, there is no space to displace the snow from there. When the

sidewalk is temporarily occupied by snow, pedestrians are forced to walk on the street right-of-way during times when snow and ice cause hazardous driving conditions.

Trash receptacles provide another temporary barrier to accessibility. Residents along Warren Street currently place trash receptacles on the sidewalk causing temporary barriers to accessibility.

Designated bicycle facilities do not exist on the corridor; however, on-street facilities intersect the corridor at its intersections with Front Street, Broad Street, and Val Imm Drive. Bicycle/pedestrian conflicts occur as bicyclists use the sidewalk to travel to the hilltop. On-street bicycle facilities on Val-Imm Drive provide one of the only facilities designated for bicyclists to reach the MSU campus and the hilltop in this part of town. This means that bicyclists are encouraged to use Warren Street to get to Val Imm Drive to use the facilities. Bicyclists have also been observed "taking the lane" as they travel downhill to Mankato City Center. This study will need to identify alternatives that accommodate pedestrian and bicycle needs along the corridor that consider this usage.

A Bicycle Network Analysis (BNA) was performed as part of this to assess the area's bicycle network. The BNA examines the following components of the bicycle network to identify recommended treatments:

- *Level of Traffic Stress.* The BNA first calculates the Level of Traffic Stress (LTS) for all streets to identify the low-stress street and bikeway network. Low-stress bike networks are important in encouraging and supporting bicyclists of all ages and abilities as routes must feel comfortable. An LTS score of one means the street is comfortable for all while a score of four indicates few adults would feel comfortable. Separation between vehicles and bicyclists will increase safety and comfort thus encouraging more people to bike on a corridor. This can be accomplished with off-street paths and trails and on-street protected bike facilities.

  The Warren Street corridor has an existing LTS score of 3 indicating it is comfortable for experienced adult riders but might not be for average adult riders and certainly not for children. This higher score is due to bicyclist sharing street lanes with vehicles on the corridor.

- *Bicycle Connectivity.* The connectivity score expands upon the LTS analysis evaluating census blocks in the area to determine network connections. Census blocks are considered connected if there is an unbroken, low-stress connection (LTS score 1 or 2) between them that does not require a trip more than 25% longer than the shortest car trip. The BNA also summarizes the number and types of destinations available in each census block including population, opportunities (jobs and education), core services, recreation, retail and transit. Using this, a connectivity score is generated. Higher scores indicate higher comfort and convenience.

  The Warren Street corridor scores moderate for connectivity. Surrounding residential neighborhoods score generally high due to close access to commercial

destinations and a relatively low-stress residential street grid. Connectivity to the MSU campus is moderate-to-low due to steep grades to the west limiting connectivity to the City.

The full BNA technical memorandum is located in **Appendix F.**

Transit

Existing Mankato Transit route 7 traverses Warren Street from Front Street to Val Imm Drive. Route 6 traverses southwest on Front Street from Warren Street. Route 10 and Route 11 intersect Warren Street at 2nd Street. Three bus stops are located on or near the corridor. This includes the following:

1. In front of Durham Apartments on 2nd Street at its approach to Warren Street.
2. Intersection of Ramsey Street with Warren Street, near the Colonial Square Apartments.
3. Intersection of Glenwood Avenue with Warren Street, near Cherry Ridge Apartments.

Existing transit facilities are illustrated in **Figure D-8** in **Appendix D.**

Social, Environmental, and Economic (SEE) Concerns

An environmental screening was completed for the entire study area. This screening included a high-level review of previously identified SEE resources. The following key findings are summarized from the environmental screening attached in **Appendix G:**

1. The study area falls within the Mankato Watershed of the Minnesota River Basin.
2. Low income and minority populations live close/adjacent to the corridor including several apartment complexes, some with many disabled residents.
3. The northern portion of the corridor between Riverfront Drive and Front Street is within the 500-year floodplain of the Minnesota River Basin.
4. Minnesota Department of Natural Resources Natural Heritage Information Systems data suggests threatened, endangered, and rare species do not exist within the study area.
5. The study area is dominated by developed residential and commercial uses with altered vegetation.
6. There were some locations with a known history of contamination based on the Minnesota Pollution Control Agency's "What's in My Neighborhood?" data. These are isolated to the northern project terminus. More detailed investigations may need to take place as roadway alternatives are implemented along the corridor.
7. There are three parks adjacent to the corridor that represent Section 4f and Section 6f properties. Impacts to these properties will need to be taken into consideration in a future environmental review.

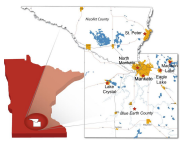
8. Various properties exist adjacent to the corridor that have been inventoried by the State Historic Preservation Office (SHPO). The Cray Mansion and the Hubbard House are listed on the National Register of Historic Places (NRHP).

Key Issues Summary

- *Consistency with State and Local Plans*. Previous planning efforts have identified corridor deficiencies and the need for the corridor to be reconstructed. Recommended improvements will need to accommodate multiple transportation modes, provide improved ADA facilities and alleviate safety concerns.
- *Capacity.* Despite projected traffic volume increases of 37%-40%, the corridor is anticipated to continue to function at acceptable levels of service except for some traffic backups.
- *Safety.* The corridor exhibits high crash counts at various intersections including several pedestrian and bicycle crashes. Safety improvements will need to be carefully considered in study recommendations.
- *Pedestrian and Bicycle*. Pedestrians and bicyclists are using the corridor daily. However, gaps exist and no bicycle facilities are present. Improvements to pedestrian facilities and implementation of bicycle facilities will need to be included in study recommendations. This may include closing sidewalk gaps, providing safer/more frequent crossings, and providing safer/designated bicycle facilities.
- *Environmental Considerations.* SEE resources including contaminated locations, parks and environmental justice populations will need to be considered in improvement recommendations.

APPENDIX A

Study Area Map



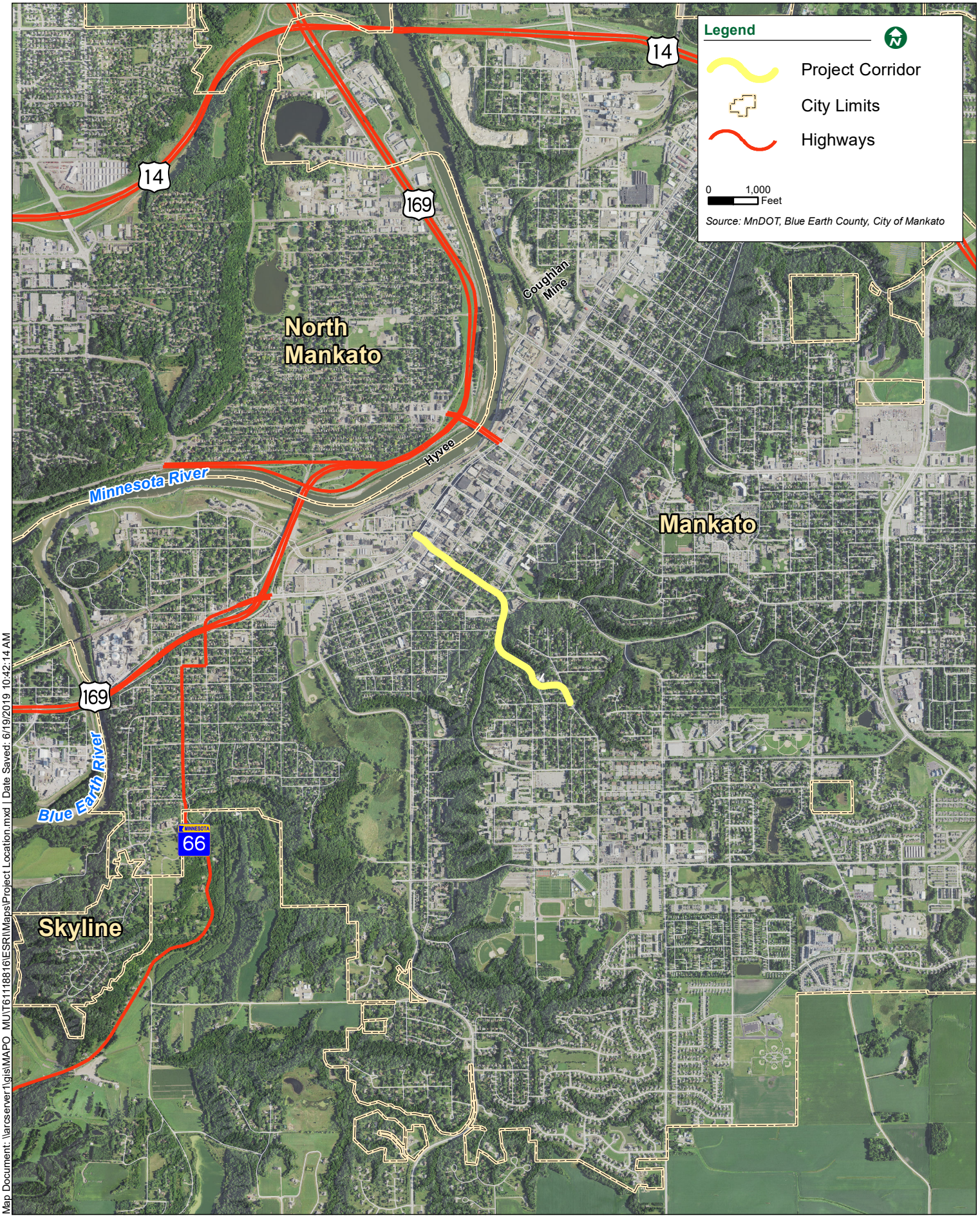
Warren Street Corridor Study

Mankato/North Mankato Area Planning Organization (MAPO)

Project Location

June 2019

BOLTON & MENK
Real People. Real Solutions.



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APPENDIX B

Environmental Justice Report

Warren Street Corridor Study

MAPO and City of Mankato, MN

M E M O R A N D U M

Date: September 27, 2019

To: Paul Vogel, Executive Director, Mankato/North Mankato Area Planning Organization

Charles Androsky, Transportation Planner, Mankato/North Mankato Area Planning Organization

From: Matt Lassonde, Transportation Planner, Bolton & Menk, Inc.

Liz Forbes, Senior Project Communications Specialist, Bolton and Menk, Inc.

Subject: Environmental Justice Report

Warren Street Corridor Study, Mankato, MN

Introduction

In 1994, President Clinton issued Executive Order 12898, which states that each federal agency "shall make environmental justice part of its mission by identifying and addressing disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations."

Data Source

In an effort to comply with Executive Order 12898, Environmental Systems Research Institute's (ESRI) Business Analyst was used to identify demographic and housing statistics for populations within the study area in an effort to limit disproportionate impacts to these communities.

A demographic target area was identified including properties surrounding the corridor with high potential to use Warren Street frequently to access the Mankato hilltop area and the Minnesota State University (MSU), Mankato Campus and, conversely, those with high potential to access the Mankato Downtown from the hilltop/MSU area. Business Analyst provides data from ESRI and the US Census American Community Survey (ACS) (2013-2017 estimates) on area demographics and housing estimates. An Environmental Justice Figure is provided as **Attachment A** illustrating the demographic target area analyzed with Business Analyst along with locations with potential to include environmental justice populations including minority, low income, disabled, and elderly populations within. Potential locations for environmental justice populations include apartment complexes in the area with large populations also known to house groups with disabilities, low income populations, and/or seniors. **Attachment B** includes the full report of target area profile statistics identified from Business Analyst.

Demographic and Housing Estimates

General Population

The target area contains a total of 5,087 people among 2,204 households. The median household income is $40,138 among this population. This is likely due to the high number of renter households (62%) in the target area among which many are students attending MSU. However, statistics do indicate that other factors contribute to this as well.

Minority Populations

2019 demographics identified through Business Analyst show 15% of the population in the target area is non-white. This includes 6% African American and 6% Hispanic making up most of the non-white population. There were no populations identified as unable to speak English indicating that language barriers are minimal in the study area.

Low-Income Populations

Low-income populations are measured by the percentage of population below the poverty line. 28% of households in the target area are below the poverty line with 17% receiving Food Stamps/SNAP Benefits. However, the area only has a 1.5% unemployment rate showing most are working that can. Colonial Square Apartments, Cherry Ridge Apartments, Old Main Village, and Durham Apartments are all locations known to house low income populations.

Disabled and Elderly Populations

25% of households in the area have one or more individuals with a disability. Colonial Square Apartments, Cherry Ridge Apartments, Old Main Village, and Durham Apartments are all locations known to house elderly and low-income populations.

Conclusion

Project partners will need to ensure environmental justice groups identified here are accommodated through public process and that improvement recommendations don't adversely affect them. This may include ensuring meetings are held at accessible locations with close access to public transit, ensuring notifications include language offering assistance and/or special accommodations for those with disabilities or language barriers upon request, working with groups such as SMILES Center for Independent Living who advocate for individuals with disabilities, and ensuring environmental justice populations have a full voice in the process.

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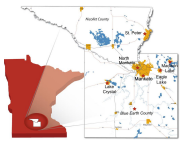
ATTACHMENT A

Environmental Justice Figure



Warren Street Corridor Study

Mankato/North Mankato Area Planning Organization (MAPO)

Environmental Justice

July 2019

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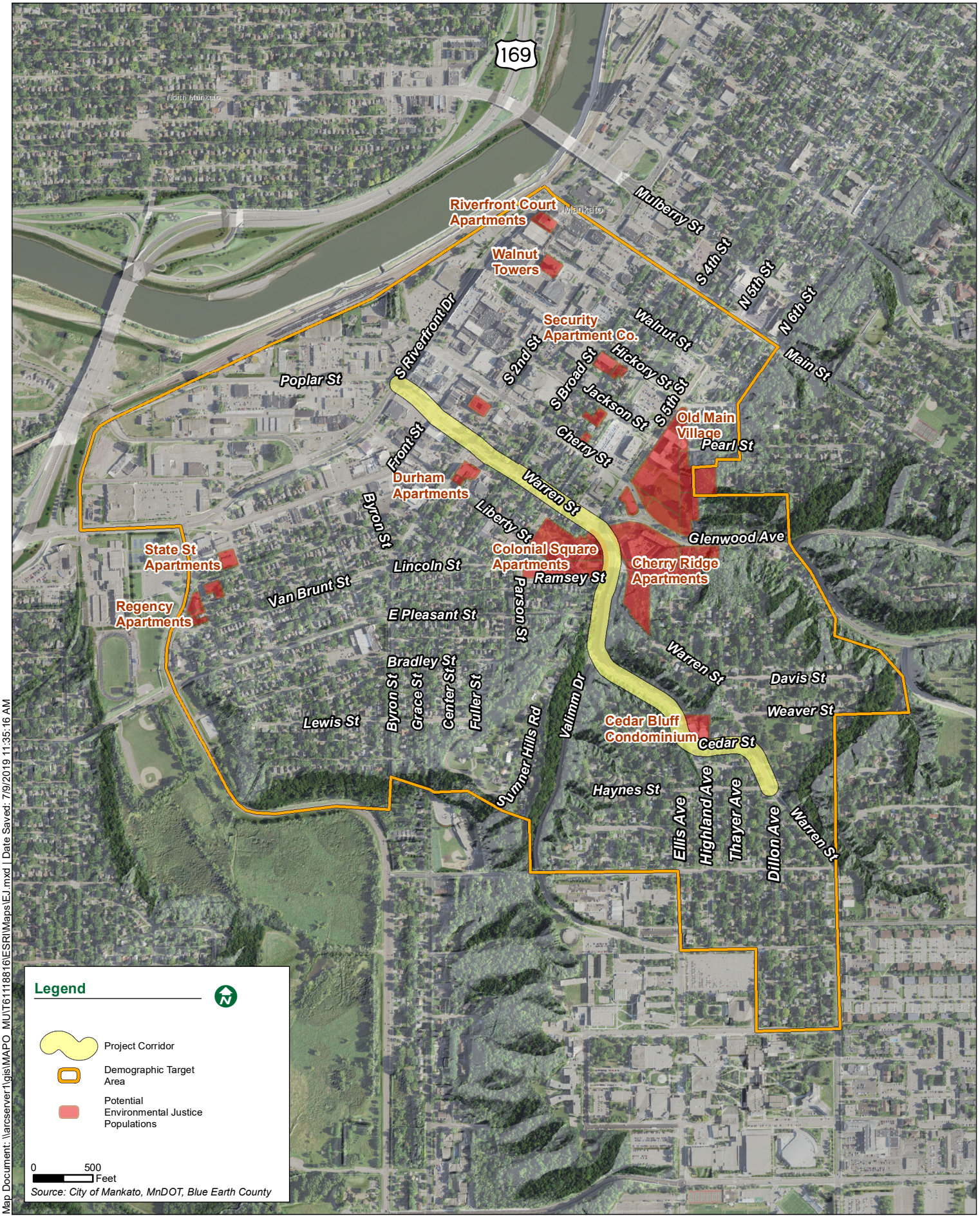

Legend

- Project Corridor
- Demographic Target Area
- Potential Environmental Justice Populations

0 500 Feet

Source: City of Mankato, MnDOT, Blue Earth County

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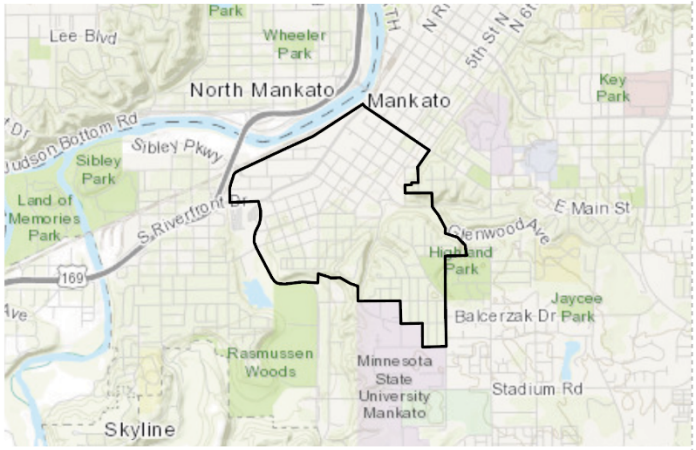
ATTACHMENT B

Target Area Demographics

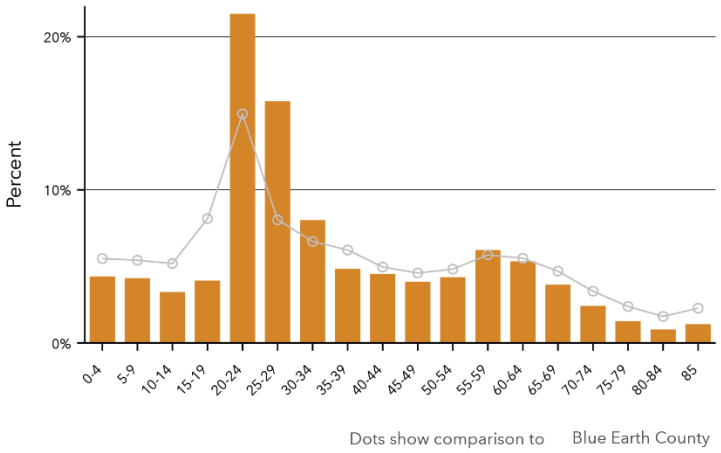
COMMUNITY PROFILE



Key Facts

5,087	2,204	$40,138
2019 Total Population (ESRI)	2019 Total Households (ESRI)	2019 Median Household Income (ESRI)

2019 Age Profile



Dots show comparison to Blue Earth County

Electronics and Internet

87%
Have a smartphone

92%
Used internet in last 30 days

73%
Used Facebook in last 30 days

Education

6%
No High School Diploma

25%
High School Graduate

37%
Some College

32%
Bachelor's / Grad/ Prof Degree

2010 Race and Ethnicity (U.S. Census)	
White	90%
Two or More Races	3%
Pacific Islander	0%
Other Race	1%
Hispanic	4%
Black/African American	3%
Asian	2%
American Indian/Alaska Native	1%

2019 Race and Ethnicity (ESRI)	
White	85%
Two or More Races	4%
Pacific Islander	0%
Other Race	2%
Hispanic	6%
Black/African American	6%
Asian	2%
American Indian/Alaska Native	1%

Housing Stats

$176,136
2019 Median Home Value (ESRI)

$5,292
2019 Average Spent on Mortgage & Basics

$618
2013-17 Median Contract Rent (ACS)

2013-17 Transportation to Work, Age 16+ (ACS)

74% Drive Alone

11% Carpool

3% Public Transportation

3% Bicycle

8% Walk

Renters

62%
2013-2017 Renter Households (ACS)

Employment

57% White Collar

21% Blue Collar

22% Services

1.5%
2019 Unemployment Rate (ESRI)

Poverty Status

28%
2013-2017 ACS Households Below the Poverty Level

Food Stamps

17%
2013-2017 ACS Households Receiving Food Stamps/SNAP Benefits

Persons with a Disability

25%
2013-2017 ACS Households with 1 or More Persons with a Disability

English Proficiency

2013-2017 Population by Language Spoken at Home (Source: American Community Survey, US Census Bureau)	
Ages 18-64 speak Spanish & English Not Well	0%
Ages 18-64 speak Spanish & No English	0%
Ages 18-64 speak Indo-Eur & English Not Well	0%
Ages 18-64 speak Indo-European & No English	0%
Ages 18-64 speak Asian-Pacific Isl & No English	0%
Ages 18-64 speak Asian-Pacific Islander & English Not Well	0%
Ages 18-64 speak Oth Language & English Not Well	0%
Ages 18-64 speak Other Language & No English	0%

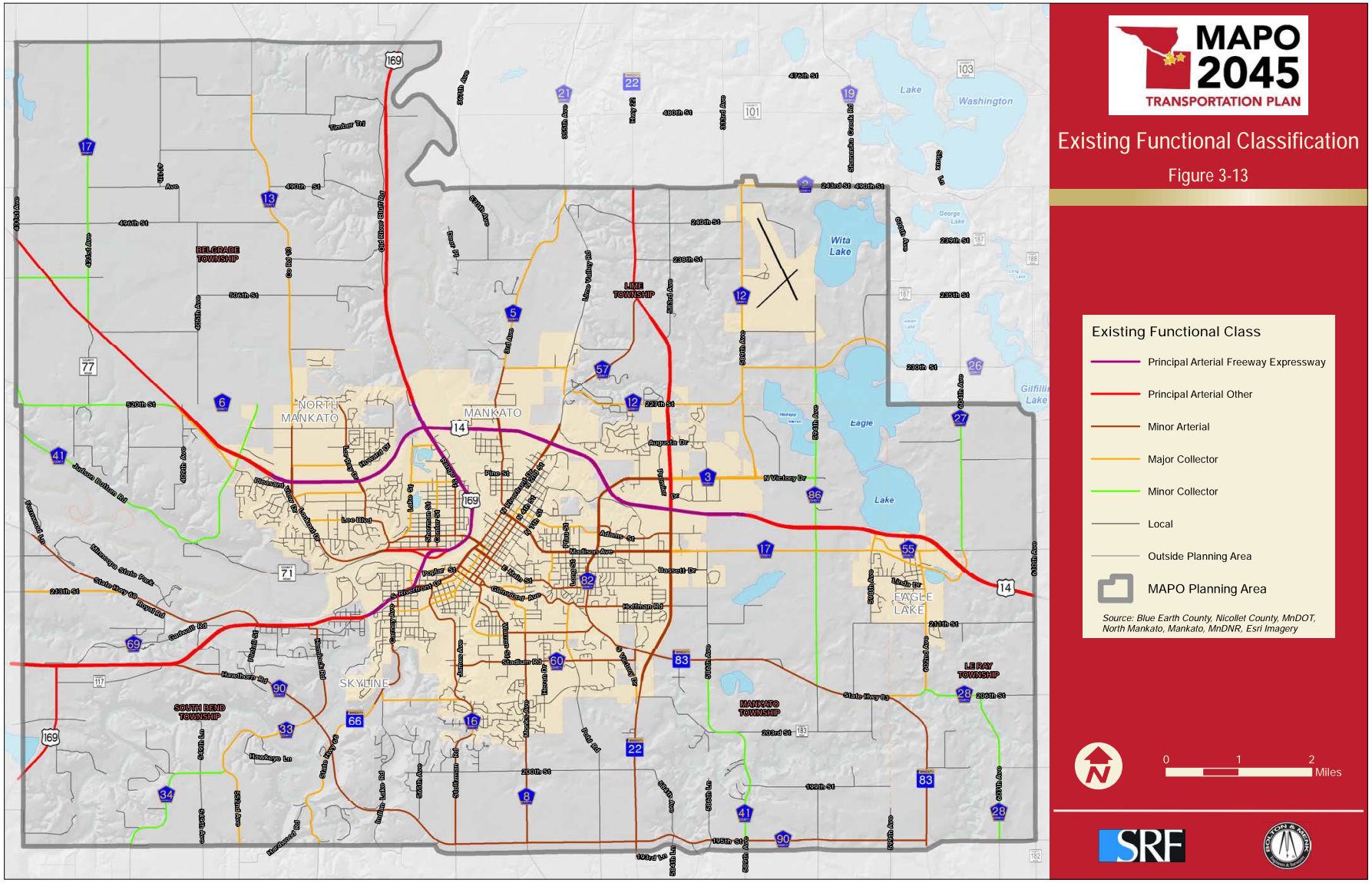
2013-2017 Population by Age by Language Spoken at Home (Source: American Community Survey, US Census Bureau)	
Ages 65+ speak Spanish & English Not Well	0%
Ages 65+ speak Spanish & No English	0%
Ages 65+ speak Indo-Eur & English Not Well	0%
Ages 65+ speak Indo-European & No English	0%
Ages 65+ speak Asian-Pacific Islander & English Not Well	0%
Ages 65+ speak Asian-Pacific Islander & No English	0%
Ages 65+ speak Other Language & English Not Well	0%
Ages 65+ speak Other Language & No English	0%

Source: This infographic contains data provided by American Community Survey (ACS), Esri, Esri and Bureau of Labor Statistics, Esri and GfK MRI, U.S. Census. The vintage of the data is 2010, 2013-2017, 2019, 2024.

APPENDIX C

MAPO Functional Classification (Referenced From the MAPO 2045 LRTP)

Figure 3-13: Existing Functional Classification



APPENDIX D

Existing Conditions Figures

Figure D-1

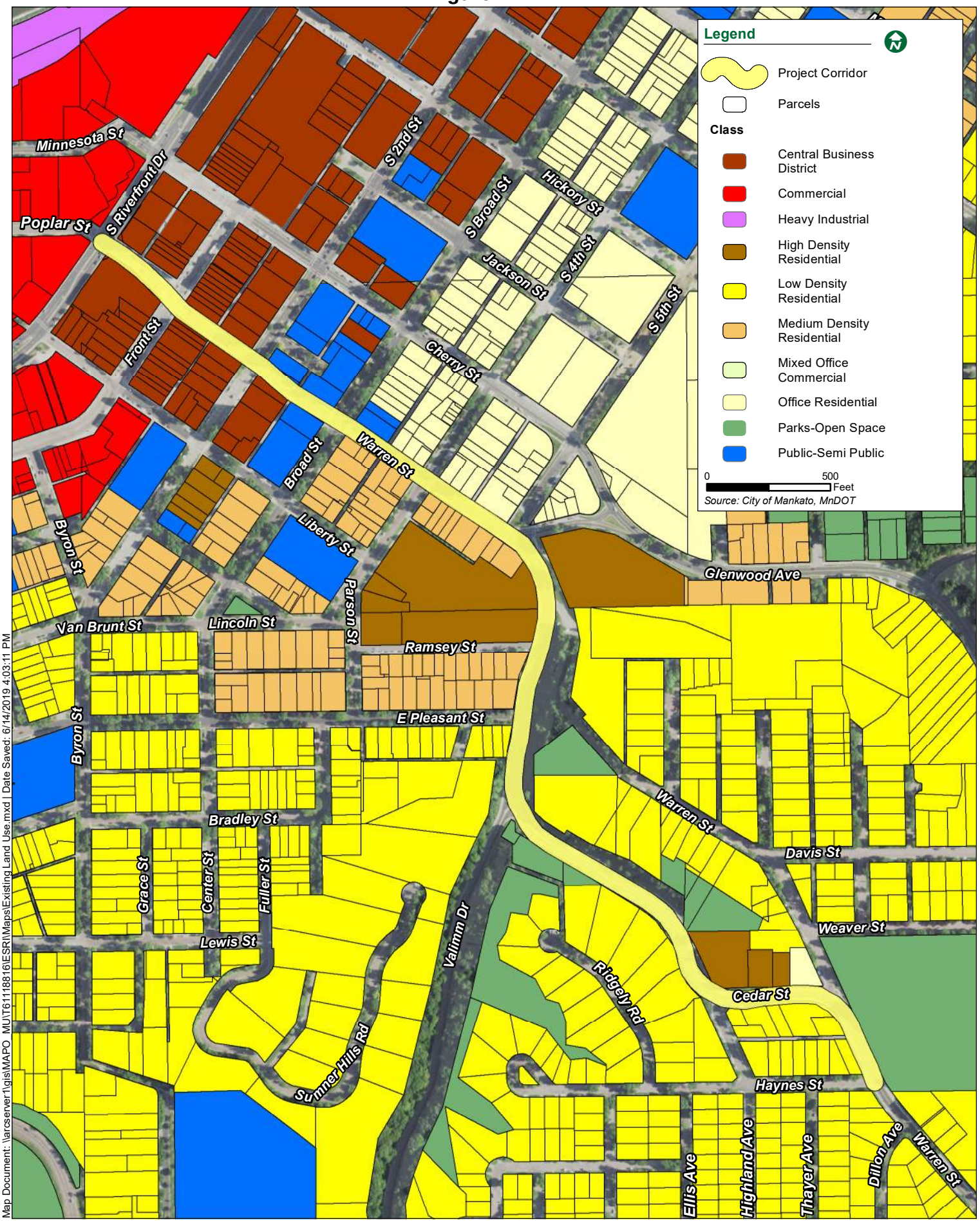


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Figure D-2

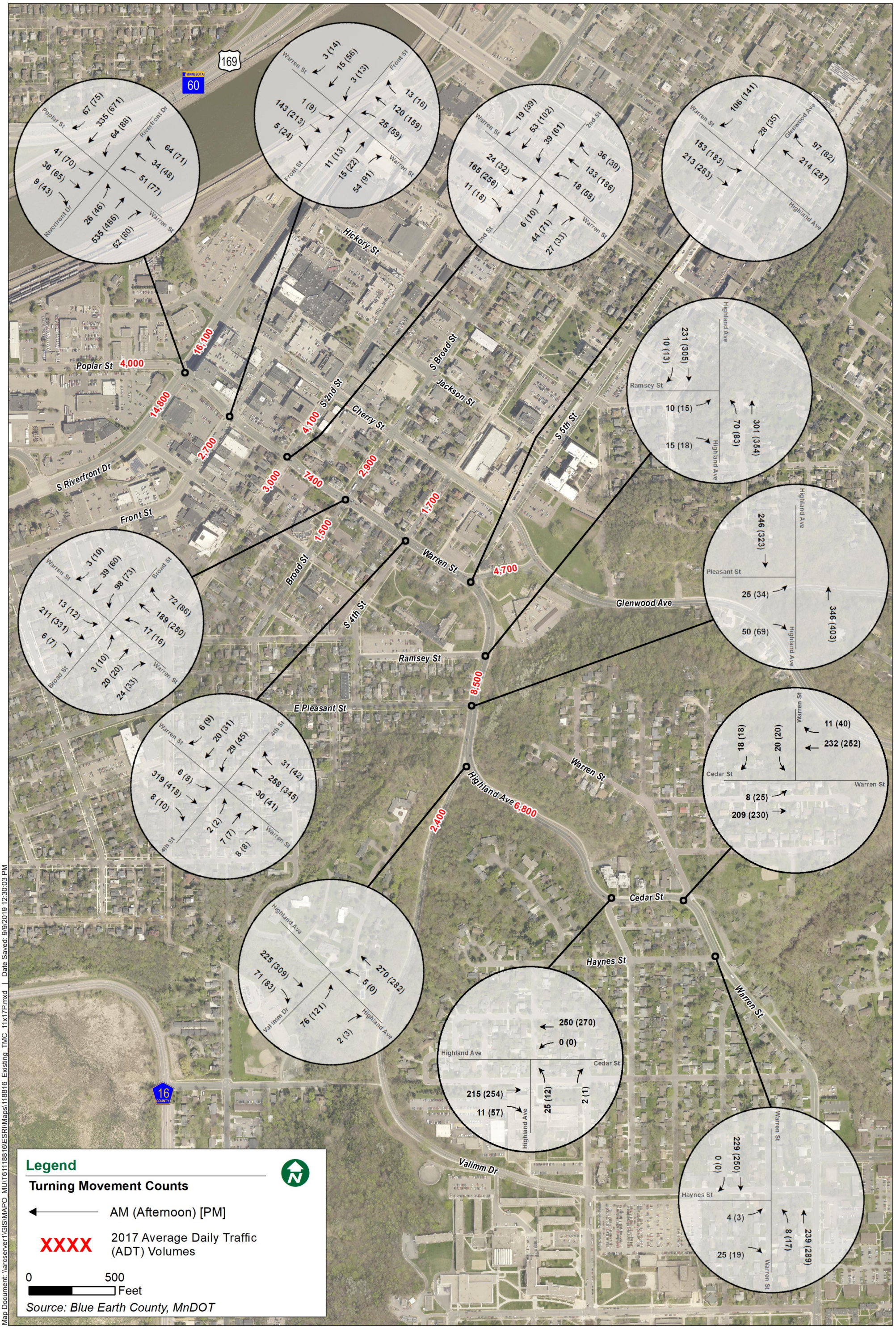
169
MINNESOTA 60
16 COUNTY
Poplar St
S Riverfront Dr
Front St
Broad St
S 2nd St
Cherry St
Hickory St
S Broad St
Jackson St
S 5th St
Warren St
S 4th St
Ramsey St
Glenwood Ave
E Pleasant St
Highland Ave
Cedar St
Haynes St
Valimm Dr
Pleasant St
16,100
14,800
4,000
2,700
4,100
2,900
3,000
7400
1,700
1,500
4,700
8,500
2,400
6,800
Legend
Turning Movement Counts
AM (Afternoon) [PM]
XXXX
2017 Average Daily Traffic (ADT) Volumes
0
500
Feet
Source: Blue Earth County, MnDOT
Map Document: \\arcserver1\GIS\MAPO_MU\T61118816\ESRI\Maps\118816_Existing_TMC_11x17P.mxd | Date Saved: 9/9/2019 12:30:03 PM

Figure D-3

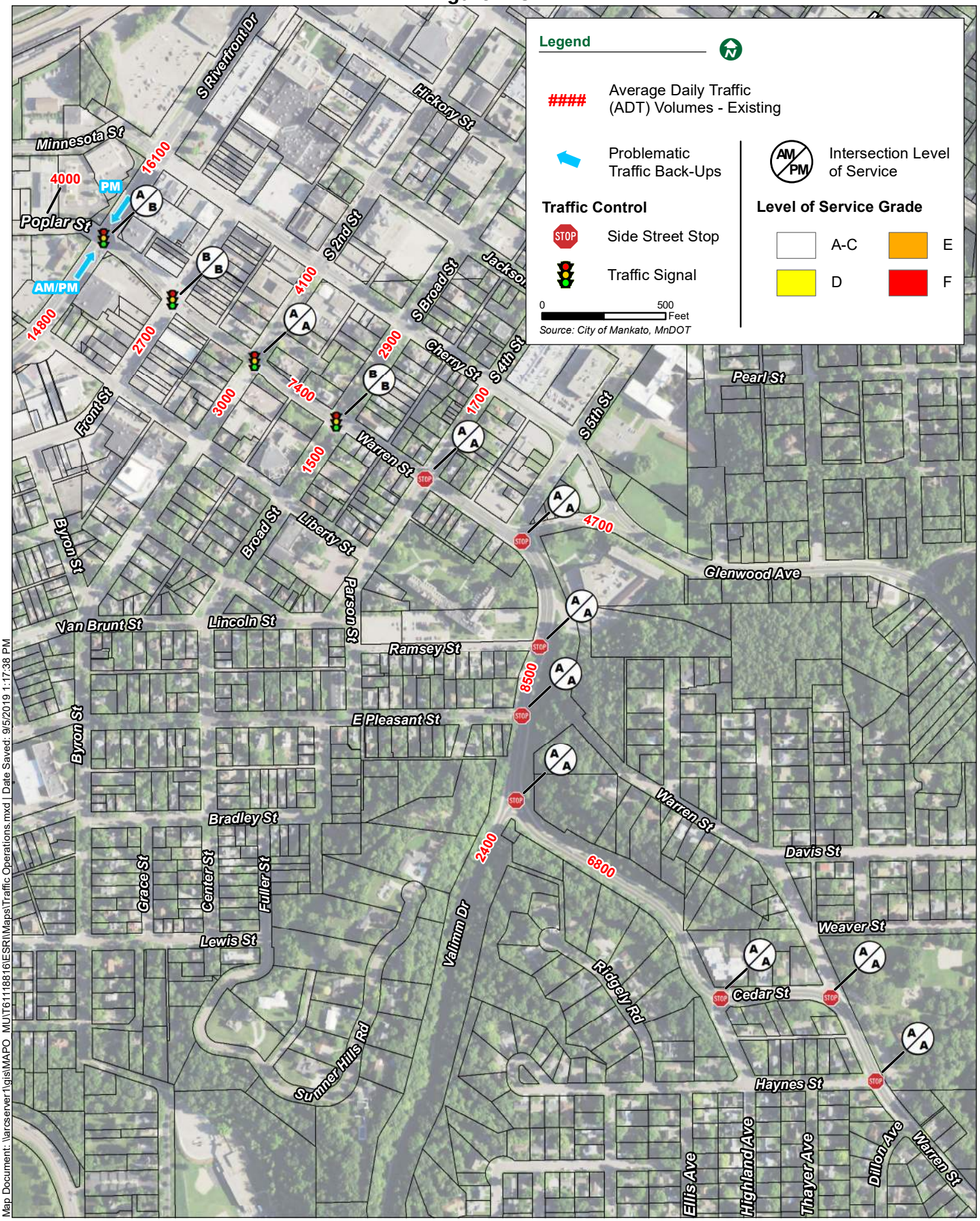

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Figure D-4

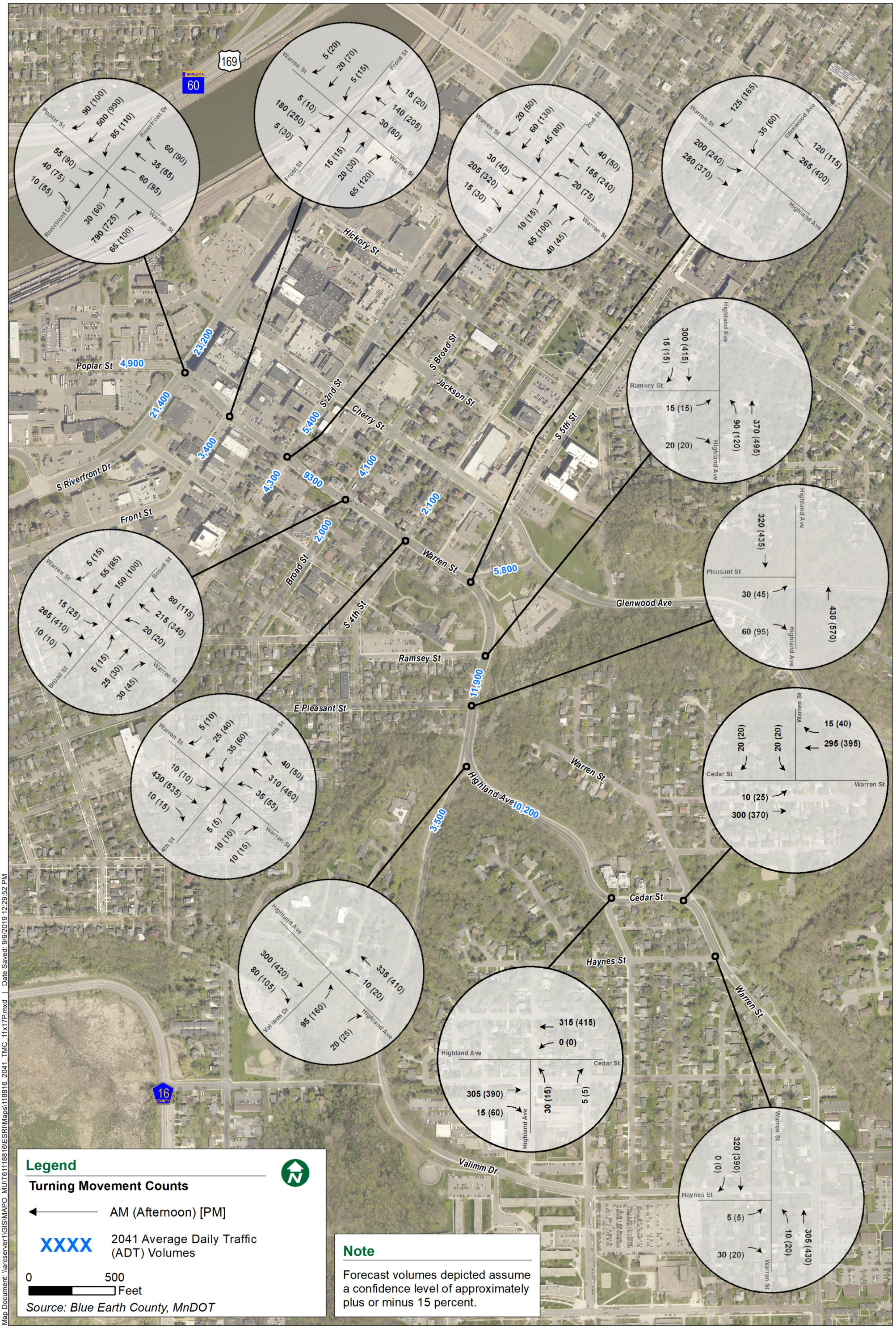

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Figure D-5

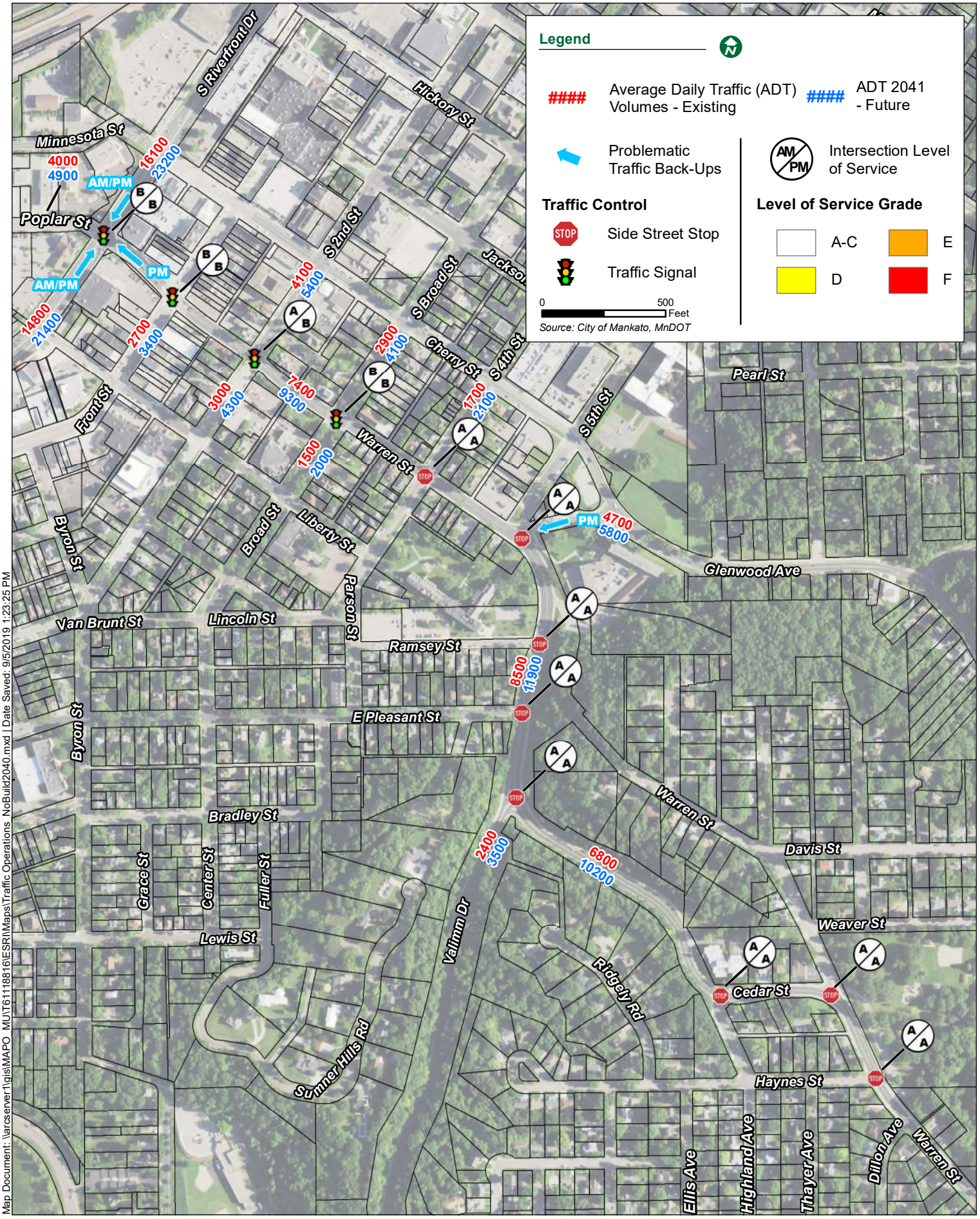

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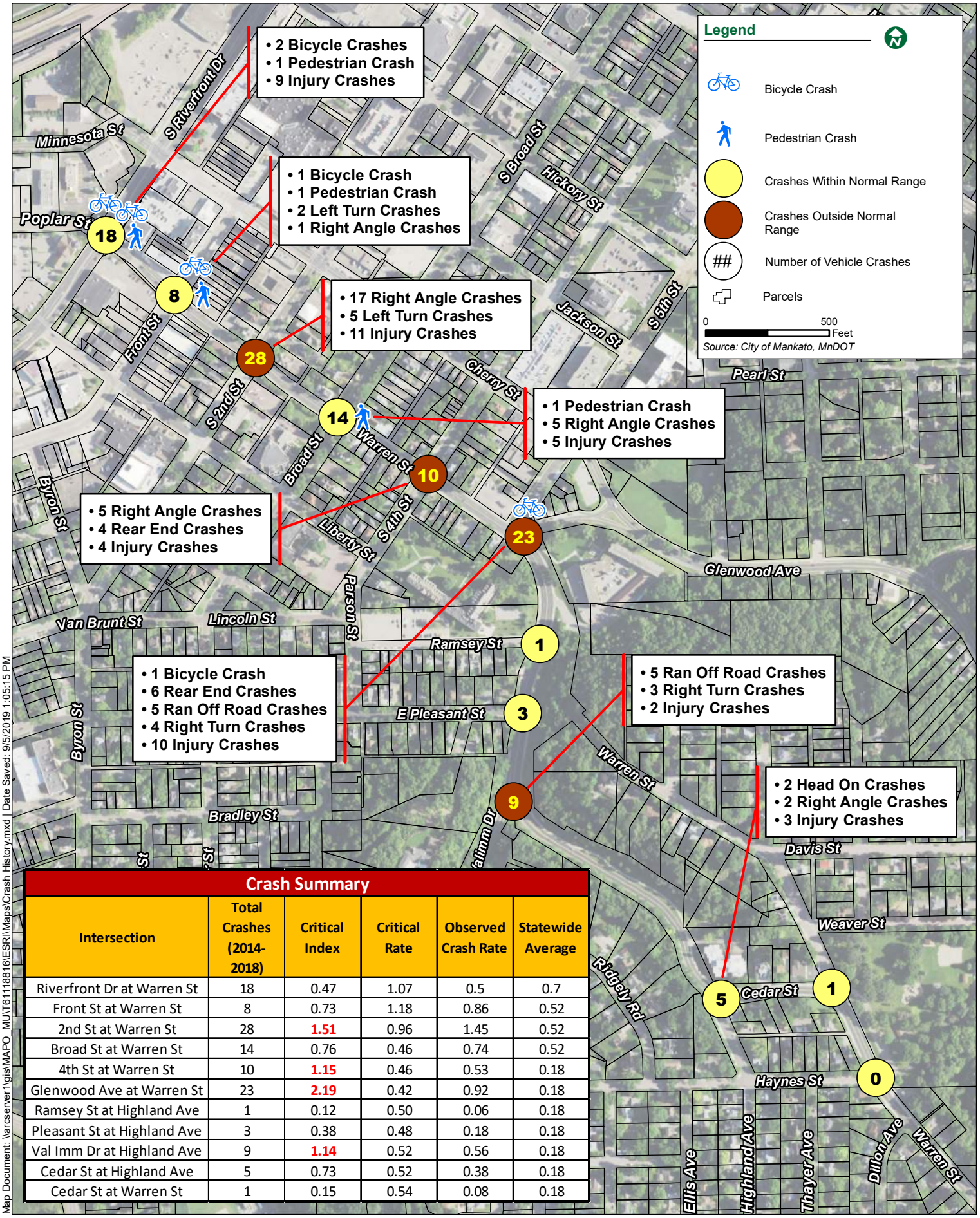
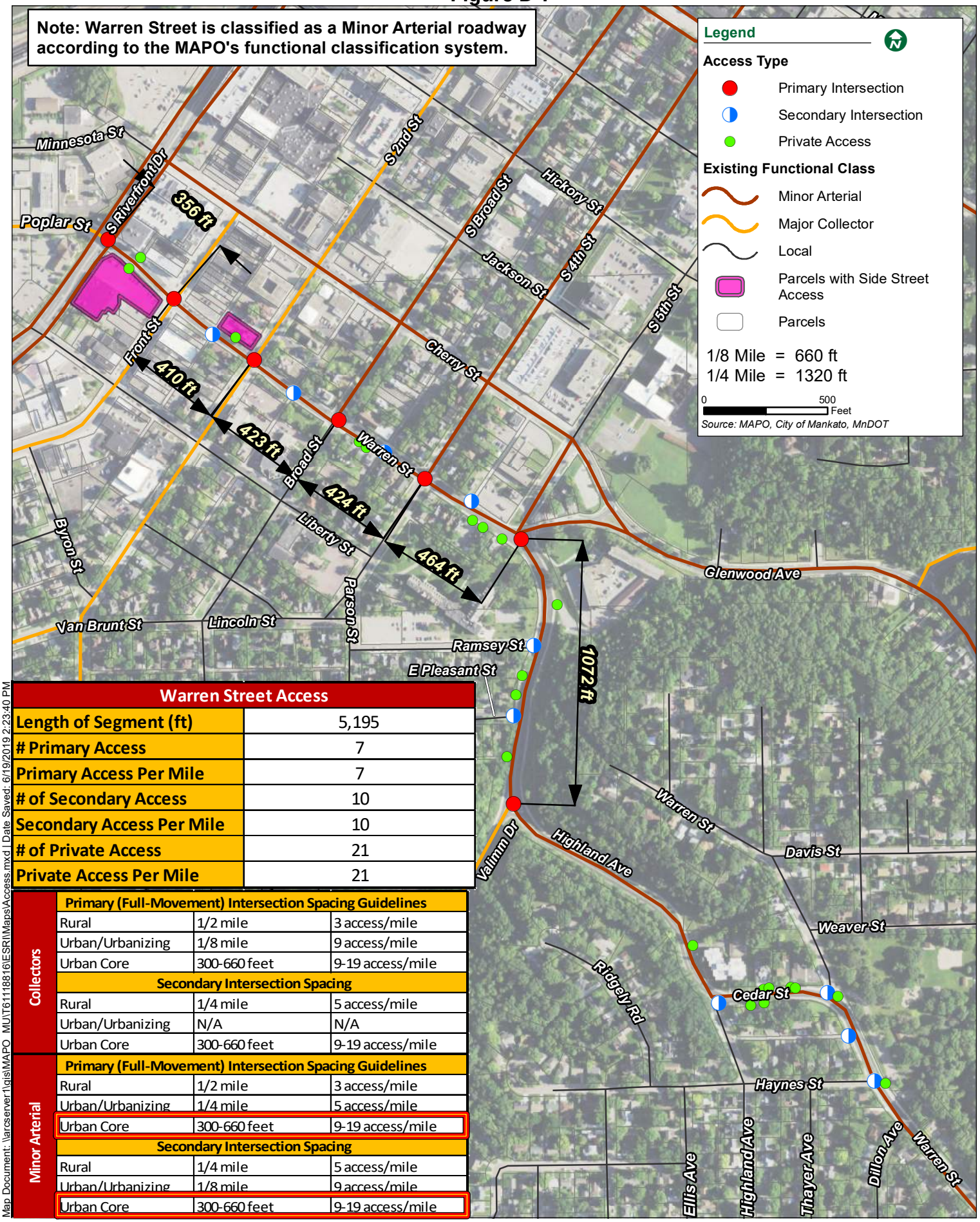
Figure D-6



Crash Summary

Intersection	Total Crashes (2014-2018)	Critical Index	Critical Rate	Observed Crash Rate	Statewide Average
Riverfront Dr at Warren St	18	0.47	1.07	0.5	0.7
Front St at Warren St	8	0.73	1.18	0.86	0.52
2nd St at Warren St	28	1.51	0.96	1.45	0.52
Broad St at Warren St	14	0.76	0.46	0.74	0.52
4th St at Warren St	10	1.15	0.46	0.53	0.18
Glenwood Ave at Warren St	23	2.19	0.42	0.92	0.18
Ramsey St at Highland Ave	1	0.12	0.50	0.06	0.18
Pleasant St at Highland Ave	3	0.38	0.48	0.18	0.18
Val Imm Dr at Highland Ave	9	1.14	0.52	0.56	0.18
Cedar St at Highland Ave	5	0.73	0.52	0.38	0.18
Cedar St at Warren St	1	0.15	0.54	0.08	0.18

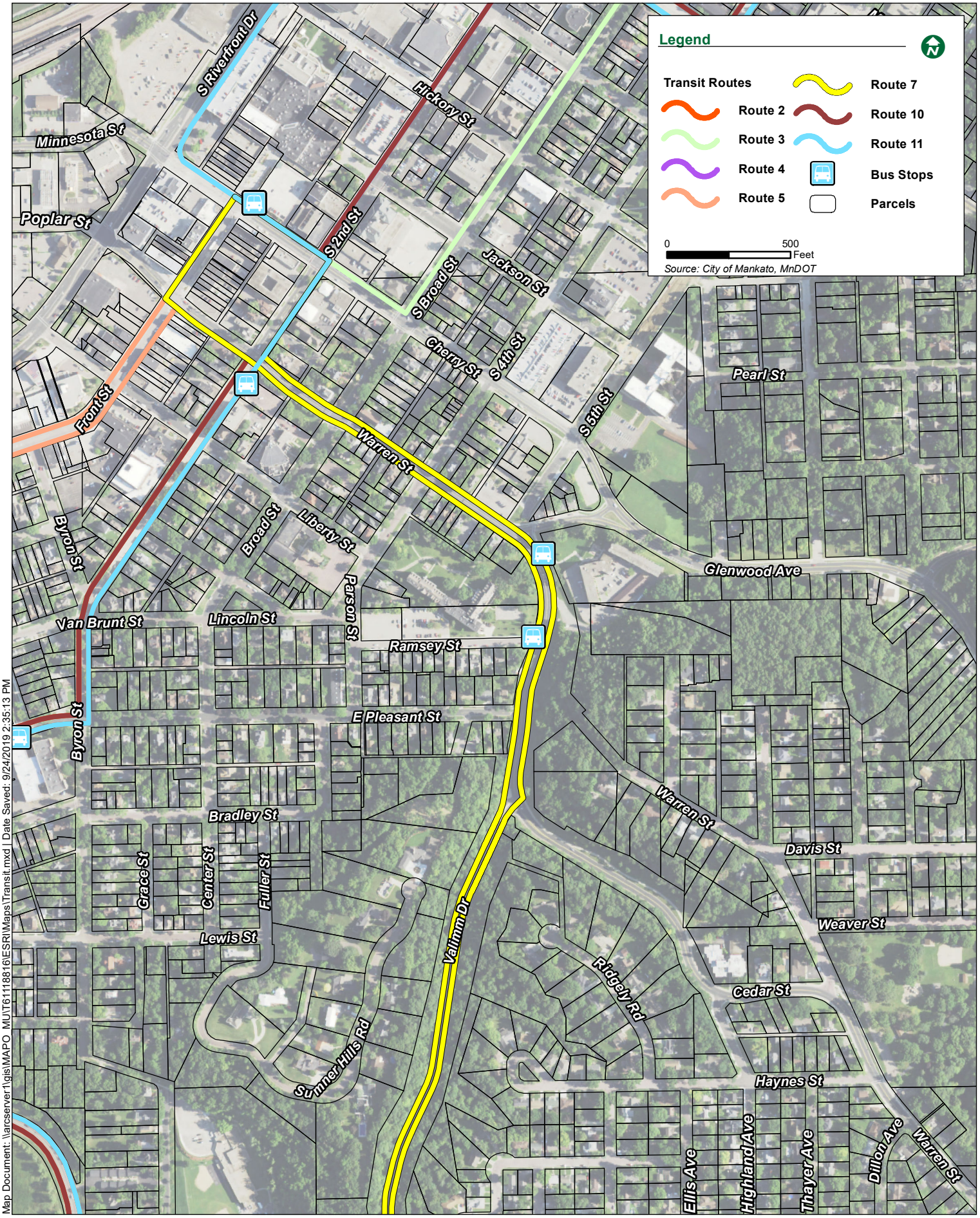
Figure D-7



Warren Street Access	
Length of Segment (ft)	5,195
# Primary Access	7
Primary Access Per Mile	7
# of Secondary Access	10
Secondary Access Per Mile	10
# of Private Access	21
Private Access Per Mile	21

Collectors	**Primary (Full-Movement) Intersection Spacing Guidelines**		
	Rural	1/2 mile	3 access/mile
	Urban/Urbanizing	1/8 mile	9 access/mile
	Urban Core	300-660 feet	9-19 access/mile
	Secondary Intersection Spacing		
	Rural	1/4 mile	5 access/mile
	Urban/Urbanizing	N/A	N/A
	Urban Core	300-660 feet	9-19 access/mile
Minor Arterial	**Primary (Full-Movement) Intersection Spacing Guidelines**		
	Rural	1/2 mile	3 access/mile
	Urban/Urbanizing	1/4 mile	5 access/mile
	Urban Core	300-660 feet	9-19 access/mile
	Secondary Intersection Spacing		
	Rural	1/4 mile	5 access/mile
	Urban/Urbanizing	1/8 mile	9 access/mile
	Urban Core	300-660 feet	9-19 access/mile

Figure D-8



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APPENDIX E

Crash Worksheets

Intersection Safety Screening

Intersection: Warren St at Riverfront Dr

Crash Data, 2014-2018.

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	3
Possible Injury	6
Property Damage	9
Total Crashes	18

Intersection Characteristics	
Entering Volume	19,600
Traffic Control	Signals
Environment	Suburban
Speed Limit	30 mph

Annual crash cost = $215,280

Statewide Comparison

Signals: high volume, low speed

Total Crash Rate	
Observed	0.50
Statewide Average	0.70
Critical Rate	1.07
Critical Index	**0.47**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.76
Critical Rate	4.03
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.50 per MEV; this is 53% below the critical rate. Based on similar statewide intersections, an additional 21 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.

Intersection Safety Screening

Intersection: Warren St at S Front St

Crash Data, 2014-2018.

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	2
Possible Injury	1
Property Damage	5
Total Crashes	8

Intersection Characteristics	
Entering Volume	5,100
Traffic Control	Signals
Environment	Suburban
Speed Limit	30 mph

Annual crash cost = $92,200

Statewide Comparison

Signals: low volume, low speed

Total Crash Rate	
Observed	0.86
Statewide Average	0.52
Critical Rate	1.18
Critical Index	**0.73**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.42
Critical Rate	8.53
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.86 per MEV; this is 27% below the critical rate. Based on similar statewide intersections, an additional 3 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.

Intersection Safety Screening

Intersection: Warren St at S 2nd St

Crash Data, 2014-2018.

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	5
Possible Injury	6
Property Damage	17
Total Crashes	28

Intersection Characteristics	
Entering Volume	10,600
Traffic Control	Signals
Environment	Suburban
Speed Limit	30 mph

Annual crash cost = $295,440

Statewide Comparison

Signals: low volume, low speed

Total Crash Rate	
Observed	1.45
Statewide Average	0.52
Critical Rate	0.96
Critical Index	**1.51**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.42
Critical Rate	4.90
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 1.45 per MEV; this is 1.5 times the critical rate. If crashes were reduced by 9 over five years, this intersection would perform within normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.

Intersection Safety Screening

Intersection: Warren St at S Broad St

Crash Data, 2014-2018.

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	1
Possible Injury	3
Property Damage	7
Total Crashes	11

Intersection Characteristics	
Entering Volume	10,325
Traffic Control	Thru / stop
Environment	Suburban
Speed Limit	30 mph

Annual crash cost = $94,440

Statewide Comparison *Urban Thru / Stop*

Total Crash Rate	
Observed	0.58
Statewide Average	0.18
Critical Rate	0.46
Critical Index	**1.26**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.33
Critical Rate	4.66
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.58 per MEV; this is 1.3 times the critical rate. If crashes were reduced by 2 over five years, this intersection would perform within normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.

Intersection Safety Screening

Intersection: Warren St at S 4th St

Crash Data, 2014-2018.

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	1
Possible Injury	3
Property Damage	6
Total Crashes	10

Intersection Characteristics	
Entering Volume	10,325
Traffic Control	Thru / stop
Environment	Suburban
Speed Limit	30 mph

Annual crash cost = $92,920

Statewide Comparison *Urban Thru / Stop*

Total Crash Rate	
Observed	0.53
Statewide Average	0.18
Critical Rate	0.46
Critical Index	**1.15**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.33
Critical Rate	4.66
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.53 per MEV; this is 1.2 times the critical rate. If crashes were reduced by 1 over five years, this intersection would perform within normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.

Intersection Safety Screening

Intersection: Warren St at Glenwood Ave

Crash Data, 2014-2018.

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	2
Possible Injury	8
Property Damage	13
Total Crashes	23

Intersection Characteristics	
Entering Volume	13,750
Traffic Control	Thru / stop
Environment	Suburban
Speed Limit	30 mph

Annual crash cost = $220,560

Statewide Comparison *Urban Thru / Stop*

Total Crash Rate	
Observed	0.92
Statewide Average	0.18
Critical Rate	0.42
Critical Index	**2.19**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.33
Critical Rate	3.78
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.92 per MEV; this is 2.2 times the critical rate. If crashes were reduced by 12 over five years, this intersection would perform within normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.

Intersection Safety Screening

Intersection: Warren St at Ramsey St

Crash Data, 2014-2018.

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	0
Possible Injury	0
Property Damage	1
Total Crashes	1

Intersection Characteristics	
Entering Volume	8,500
Traffic Control	Thru / stop
Environment	Suburban
Speed Limit	30 mph

Annual crash cost = $1,520

Statewide Comparison *Urban Thru / Stop*

Total Crash Rate	
Observed	0.06
Statewide Average	0.18
Critical Rate	0.50
Critical Index	**0.12**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.33
Critical Rate	5.40
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.06 per MEV; this is 88% below the critical rate. Based on similar statewide intersections, an additional 7 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.

Intersection Safety Screening

Intersection: Warren St at Pleasant St

Crash Data, 2014-2018.

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	0
Possible Injury	1
Property Damage	2
Total Crashes	3

Intersection Characteristics	
Entering Volume	9,100
Traffic Control	Thru / stop
Environment	Suburban
Speed Limit	30 mph

Annual crash cost = $19,640

Statewide Comparison *Urban Thru / Stop*

Total Crash Rate	
Observed	0.18
Statewide Average	0.18
Critical Rate	0.48
Critical Index	**0.38**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.33
Critical Rate	5.13
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.18 per MEV; this is 62% below the critical rate. Based on similar statewide intersections, an additional 5 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.

Intersection Safety Screening

Intersection: Warren St at Val Imm Dr

Crash Data, 2014-2018.

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	1
Possible Injury	1
Property Damage	7
Total Crashes	9

Intersection Characteristics	
Entering Volume	8,850
Traffic Control	Thru / stop
Environment	Suburban
Speed Limit	30 mph

Annual crash cost = $61,240

Statewide Comparison *Urban Thru / Stop*

Total Crash Rate	
Observed	0.56
Statewide Average	0.18
Critical Rate	0.49
Critical Index	**1.14**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.33
Critical Rate	5.24
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.56 per MEV; this is 1.1 times the critical rate. If crashes were reduced by 1 over five years, this intersection would perform within normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.

Intersection Safety Screening

Intersection: Cedar St at Highland Ave

Crash Data, 2014-2018.

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	1
Possible Injury	2
Property Damage	2
Total Crashes	5

Intersection Characteristics	
Entering Volume	7,250
Traffic Control	Thru / stop
Environment	Suburban
Speed Limit	30 mph

Annual crash cost = $70,240

Statewide Comparison *Urban Thru / Stop*

Total Crash Rate	
Observed	0.38
Statewide Average	0.18
Critical Rate	0.52
Critical Index	**0.73**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.33
Critical Rate	6.11
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.38 per MEV; this is 27% below the critical rate. Based on similar statewide intersections, an additional 2 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.

Intersection Safety Screening

Intersection: Cedar St at Warren St

Crash Data, 2014-2018.

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	0
Possible Injury	0
Property Damage	1
Total Crashes	1

Intersection Characteristics	
Entering Volume	6,800
Traffic Control	Thru / stop
Environment	Suburban
Speed Limit	30 mph

Annual crash cost = $1,520

Statewide Comparison *Urban Thru / Stop*

Total Crash Rate	
Observed	0.08
Statewide Average	0.18
Critical Rate	0.54
Critical Index	**0.15**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.33
Critical Rate	6.43
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.08 per MEV; this is 85% below the critical rate. Based on similar statewide intersections, an additional 6 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.

APPENDIX F

Bicycle Network Analysis Memorandum

TOOLE DESIGN

212 THIRD AVENUE NORTH
SUITE 476
MINNEAPOLIS, MN 55401

612.584.4094
TOOLEDESIGN.COM

MEMORANDUM

September 24, 2019

To: Paul Vogel
Organization: Mankato/North Mankato Area Planning Organization (MAPO)
From: Noah Halbach, PLA, AICP and Galen Omerso
Project: Warren Street Corridor Study

Re: Bicycle Network Analysis

Toole Design conducted a Bicycle Network Analysis (BNA) for the Warren Street corridor study area. This memo provides a summary of the process used and an explanation of the results. Toole Design's efforts on this study focused solely on assessing the area's bicycle network. Pedestrian facilities currently exist on the corridor making a pedestrian network analysis not sensitive to the types of potential changes, such as sidewalk widening, that might be proposed in the alternatives. However, improving comfort levels for those walking along and across the corridor is still important for Warren Street's ability to safety accommodate a greater range of people.

For the purposes of this analysis, "bicycle facilities" are defined as infrastructure intended to improve bicycle travel conditions including standard bicycle lanes, protected bicycle lanes, advisory bicycle lanes, shared lanes, paved shoulders, and shared use paths.

Bicycle analysis was conducted on the following scenarios:

- Existing corridor (**no bicycle** facilities)
- Scenario A: adding **standard** bicycle lanes to the corridor (e.g. 5' painted lanes)
- Scenario B: adding **protected** bicycle lanes to the corridor (e.g. 5' painted lanes with 3' buffer and vertical separation, such as a curb or delineator post)

Existing Bicycle Facilities

The Warren Street corridor serves as an important transportation connection between downtown Mankato, Minnesota State University (MSU), and the Highland Park neighborhood. Currently, there are no designated bicycle facilities along the Warren Street corridor. Standard bike lanes exist on Broad Street and the west side of Val Imm Drive, while shared roadway facilities exist on Front Street and the east side of Val Imm Drive. Adding bicycle facilities along Warren Street would fill a gap in the bicycle network that exists between downtown and the Highland area.

Existing Bicycle Facilities

Existing Front Street Shared Lanes

Existing Broad Street Bicycle Lanes

Existing Val Imm Drive Bicycle Lane

Low Stress Bicycle Networks

The BNA first calculates the Level of Traffic Stress (LTS) for all streets to identify the community's low-stress street and bikeway network.

An LTS **score of 1** means that the street is comfortable for cyclists of all ages and abilities. A **score of 2** means a street is comfortable for most adults. A **score of 3** means a street is comfortable for experienced adult riders. A **score of 4** indicate that few adults would feel comfortable bicycling on this street (see Appendix A for more information on level of traffic stress).

Low-stress connected bicycle networks have emerged as one of the most important parts of encouraging and supporting bicycling for people of all ages and abilities. For people to choose to ride a bicycle, they must feel comfortable at each step of their trip. One intimidating road segment or intersection can rule out an entire journey.

While stress for bicyclists is a subjective term, streets which are wider, have higher posted speed limits, contain more lanes, lack curbside parking (a factor which slows adjacent traffic), and serve more regional destinations tend to increase stress for bicyclists and expose them to greater levels of danger. Available facilities and the quality of these facilities, such as amount of separation between bicyclists and motor vehicles, are crucial. Higher-quality facilities such as off-street bike paths and trails, and on-street protected bike facilities, are safer and more comfortable than facilities with less separation. While a small subset of bicyclists will choose to bike along corridors with higher vehicular volumes and speeds, most will not. Therefore, networks should not be created with only this minority group in mind. Neighborhood streets, because of their lower speeds and lower traffic volumes, tend to be lower-stress segments.

Level of Traffic Stress for People Biking Examples

Level of Traffic Stress - Existing Conditions

The Warren Street corridor has an existing LTS score of 3, meaning it is likely comfortable for experienced adult riders, but might not be for average adult riders and is likely highly uncomfortable for children. The higher score is because people biking must ride in the same lane as motor vehicle traffic, which ranges from approximately 5,000-10,000 Average Annual Daily Traffic (AADT) along the 30-mph posted speed roadway.

The LTS score does not consider the steep grade change along the Warren Street corridor. Hills often act as a deterrent for people biking due to the extra effort required to climb them. They also factor into the traffic stress experienced by riders because people biking generally travel slower uphill with motor vehicles overtaking them at a greater rate. A rider going downhill is better able to move with the flow of traffic and will likely experience less traffic stress.

Existing Level of Traffic Stress for People Biking

Level of Traffic Stress - Scenario A: Standard Bicycle Lanes

Adding 5’ standard bicycle lanes to the Warren Street corridor decreases the LTS score to 2, which will help make it comfortable for most adult riders.

Level of Traffic Stress for People Biking with Planned Scenario A

Level of Traffic Stress - Scenario B: Protected Bicycle Lanes

Adding 5’ protected bicycle lanes to the Warren Street corridor decreases the LTS score to 1, which will help make it comfortable for riders of all ages and abilities.

Level of Traffic Stress for People Biking with Planned Scenario B

Bicycle Connectivity

The BNA connectivity score expands upon the Traffic Stress Analysis. It evaluates every census block in the area to determine how well that network connects places to one another. Two census blocks are considered connected if, and only if, there is an unbroken low-stress connection (LTS score of 1 or 2) between them that does not require a trip more than 25 percent longer than the shortest car trip. Even a short stretch of stressful biking negates a potential connection.

The BNA also summarizes the number and types of destinations available in each census block, including population, opportunities (jobs and education), core services, recreation, retail, and transit. Pairing this information with the knowledge of which census blocks are connected on the low-stress network, the BNA tool calculates a connectivity score for each census block. The tool compares the number and type of reachable destinations on the low-stress network to the destinations reachable by car within the same distance. Higher scores indicate areas where bicycling is comfortable and convenient (see Appendix B for more information about the BNA process).

Bicycle Connectivity - Existing Conditions

Some of the existing highest connectivity scores are found in the residential areas to the east and south of MSU. Lincoln Park and the City Center also score highly in connectivity. These areas have close access to commercial destinations and a relatively low-stress residential street grid.

Connectivity in MSU campus scores moderate-to-low since the steep grade-change to the west limits connection points to the rest of the city. One of its major connections, Warren Street, does not have bicycle facilities. There are bicycle facilities on Val Imm Drive, but they terminate at Warren Street, leaving a gap from campus to downtown. There are other portions of the city, primarily along the river, that can only be accessed by higher volume roadways. The residential neighborhoods of Highland Park score generally low for LTS (less-stressful). However, because of the area's suburban street grid, most trips require travel on Warren Street or Monk Avenue, which have a higher LTS (more stressful) and have a negative effect on their connectivity scores.

Existing Bicycle Connectivity

Bicycle Connectivity - Scenario A or B

Since the BNA considers LTS scores of 2 or less to be a low-stress connection, the connectivity map is the same for both Scenario A and B.

Adding standard or protected bicycle lanes to the Warren Street corridor greatly improves MSU and the Highland Park neighborhood's connectivity. The protected lanes give people in the Highland area a low-stress route to downtown destinations. Many of the downtown blocks adjacent to Warren Street would also see improvements to their connectivity score, shifting it from medium to moderate/well connected. These scenarios would provide people downtown with a low-stress route to get to campus, which is not currently available.

Bicycle Connectivity with Scenario A and B

Conclusion

Warren Street is an important corridor for the City of Mankato. It provides one of the few connections between downtown and the Highland Park area, which includes MSU and a high college student population. The existing configuration of no bicycle facilities on Warren Street has a negative impact on traffic stress experienced by bicycle riders using the corridor. The existing LTS score of 3 might be acceptable to experienced adult riders, but it fails to serve less experienced and younger riders. Adding standard bicycle lanes decreases the LTS score to 2, which will widen its appeal to most adult riders. However, if the goal is to make this a route for the broadest possible group of riders, adding protected bicycle lanes is required due to existing motor vehicle traffic volume and speeds.

The low bicycle connectivity near MSU campus is primarily due to a lack of low-stress routes connecting this area to the rest of Mankato. Adding either standard or protected bicycle lanes to the corridor could help improves this situation by providing a low-stress connection from campus to downtown. Other areas along Warren Street would also benefit from adding low-stress bicycle facilities as the “network effect” allows people biking in the area to expand their access to destinations. Warren Street provides a key perpendicular route to the city’s existing bikeway on Broad Street.

It is difficult to determine how much of a factor the hill along the corridor will affect ridership. However, if someone did want to ride uphill from downtown to Highland Park, they would not be able to do so using a low-stress facility as there are none existing. The Warren Street corridor is one of the few opportunities to make this connection and position the city for expanded ridership in the future.

Appendix A: Bicycle Level of Traffic Stress Background

The Bicycle Level of Traffic Stress (LTS) methodology was developed in 2012 and first published in a report by the Mineta Transportation Institute.[1] LTS uses readily available roadway data to help planners understand how comfortable a roadway may be for certain bicycling user types. LTS scores range from LTS 1 to LTS 4.

LTS	Target Bicycle User Type	Description[2]
1	All Ages and Abilities	Presenting little traffic stress and demanding little attention from cyclists, and attractive enough for a relaxing bike ride. Suitable for almost all cyclists, including children trained to safely cross intersections. On links, cyclists are either physically separated from traffic, or are in an exclusive bicycling zone next to a slow traffic stream with no more than one lane per direction, or are on a shared road where they interact with only occasional motor vehicles (as opposed to a stream of traffic) with a low speed differential. Where cyclists ride alongside a parking lane, they have ample operating space outside the zone into which car doors are opened. Intersections are easy to approach and cross.
2	Interested but Concerned (Mainstream Adults)	Presenting little traffic stress and therefore suitable to most adult cyclists but demanding more attention than might be expected from children. On links, cyclists are either physically separated from traffic, or are in an exclusive bicycling zone next to a well-confined traffic stream with adequate clearance from a parking lane, or are on a shared road where they interact with only occasional motor vehicles (as opposed to a stream of traffic) with a low speed differential. Where a bike lane lies between a through lane and a right turn lane, it is configured to give cyclists unambiguous priority where cars cross the bike lane and to keep car speed in the right-turn lane comparable to bicycling speeds. Crossings are not difficult for most adults.
3	Enthused and Confident (Adult Commuters)	More traffic stress than LTS 2, yet markedly less than the stress of integrating with multilane traffic, and therefore welcome to many people currently riding bikes in American cities. Offering cyclists either an exclusive riding zone (lane) next to moderate-speed traffic or shared lanes on streets that are not multilane and have moderately low speed. Crossings may be longer or across higher-speed roads than allowed by LTS 2 but are still considered acceptably safe to most adult pedestrians.

[1] Mekuria, Maaza C., Peter G. Furth, and Hilary Nixon. "Low-stress bicycling and network connectivity." (2012).
[2] Ibid.

4	Strong and Fearless (Long-Distance Recreational Bicyclists)	A level of stress beyond LTS3, featuring facilities that few adults would feel is acceptable to bicycle. Presenting a high level of traffic stress due to riding directly adjacent to high-speed and/or high-volume traffic with or without an exclusive riding lane.

The Mineta LTS is a "worst case scenario" analysis whereby the characteristic of the street segment (number of lanes, speed, bike lane presence/width, parking presence) that scores the highest stress level on a scale of 1 to 4 prevails over the rest. For instance, a low-volume two-lane street with a speed limit of 40 mph would rate poorly with an LTS 4 score because of the high-speed limit.

This methodology has been refined over the last few years in published and unpublished work[3]. Toole Design uses a combination of these methodologies to assess streets for LTS today. Tables provided below outline criteria that were used to execute the LTS analysis.

Level of Traffic Stress also assesses the impact of intersections on bicyclist stress. The original Mineta LTS paper presented a complex assessment of intersection and intersection approach stress involving the configuration of bike lanes, through lanes and right turn lanes, as well as right turn lane width, traffic control, and characteristics of the street being crossed. In more recent work, owing to the relative scarcity of good data on many of these characteristics, LTS crossing stress has been limited to the speed and number of lanes of the crossing street, as well as the presence of a traffic signal.[4] In the Project Team analysis, the intersection score is represented on the street segment approach leg. Intersection analysis is critical to understanding high-stress barriers between existing low-stress streets.

Segment Methodology

Tables 1 through 3 are adapted from the LTS authors academic webpage.[5] While not published in academic form, Toole Design believes that these are an important improvement over the original 2012 methodology. Of note, the updated tables include the impact of traffic in rating stress for shared lane conditions. The original LTS methodology did not include traffic volume and substituted number of travel lanes as a proxy. Toole Design has found that this method can frequently break down at the collector street classification. These "in-between" streets often have one lane in each direction, but can vary widely in traffic volume and width and thus comfort to bicyclists.

[3] Lowry, Michael B., Peter Furth, and Tracy Hadden-Loh. "Prioritizing new bicycle facilities to improve low-stress network connectivity." Transportation Research Part A: Policy and Practice 86 (2016): 124-140.

Furth, Peter. "Level of Traffic Stress Criteria for Road Segments, Version 2.0, June, 2017." http://www.northeastern.edu/peter.furth/wp-content/uploads/2014/05/LTS-Tables-v2-June-1.pdf

[4] Lowry, Michael B., Peter Furth, and Tracy Hadden-Loh. "Prioritizing new bicycle facilities to improve low-stress network connectivity." Transportation Research Part A: Policy and Practice 86 (2016): 124-140.

[5] http://www.northeastern.edu/peter.furth/criteria-for-level-of-traffic-stress/ (accessed May 30, 2018)

Mixed traffic criteria

Number of lanes	Effective ADT*	Prevailing Speed ≤ 20 mph	25 mph	30 mph	35 mph	40 mph	45 mph	50+mph
Unlaned 2-way street (no centerline)	0-750	LTS 1	LTS 1	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3
	751-1500	LTS 1	LTS 1	LTS 2	LTS 3	LTS 3	LTS 4	LTS 4
	1501-3000	LTS 2	LTS 2	LTS 2	LTS 3	LTS 4	LTS 4	LTS 4
	3000+	LTS 2	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4
1 thru lane per direction (1-way, 1-lane street or 2-way street with centerline)	0-750	LTS 1	LTS 1	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3
	751-1500	LTS 2	LTS 2	LTS 2	LTS 3	LTS 3	LTS 4	LTS 4
	1501+	LTS 2	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4	LTS 4
2 thru lanes per direction	0-8000	LTS 3	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4
	8001+	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4	LTS 4	LTS 4
3+ thru lanes per direction	any ADT	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4	LTS 4	LTS 4

* Effective ADT = ADT for two-way roads; Effective ADT = 1.67*ADT for one-way roads

Table 1 Assessment for shared lane conditions

Conventional bike lanes between the parking lane and general travel lanes are considered higher stress facilities when other variables (speed and number of lanes) are held constant. For instance, a bike lane on a 35 mph two-lane street is scored LTS 2 if it is not adjacent to parking, regardless of width. Where the lane is adjacent to parking, it is scored LTS 3. See the two circled cells in Tables 2 and 3 for this comparison. Increased traffic stress adjacent to parked cars can be caused by the potential for vehicle doors to be opened into the bicyclist's path of travel and force him or her into adjacent auto traffic. In addition, vehicles may cross the bike lane to park or enter into traffic.

Bike lanes and shoulders not adjacent to a parking lane

Number of lanes	Bike lane width	Prevailing Speed ≤ 25 mph	30 mph	35 mph	40 mph	45 mph	50+ mph
1 thru lane per direction, or unlaned	6+ ft	LTS 1	LTS 1	LTS 2	LTS 3	LTS 3	LTS 3
	4 or 5 ft	LTS 2	LTS 2	LTS 2	LTS 3	LTS 3	LTS 4
2 thru lanes per direction	6+ ft	LTS 2	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3
	4 or 5 ft	LTS 2	LTS 2	LTS 2	LTS 3	LTS 4	LTS 4
3+ lanes per direction	any width	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4

Table 2 Assessment for bike lanes not adjacent to a parking lane

Bike lanes alongside a parking lane

Number of lanes	Bike lane reach = Bike + Pkg lane width	Prevailing Speed ≤ 25 mph	30 mph	35 mph
1 lane per direction	15+ ft	LTS 1	LTS 2	LTS 3
	12-14 ft	LTS 2	LTS 2	LTS 3
2 lanes per direction (2-2-3 lanes per direction (1-way)	15+ ft	LTS 2	LTS 3	LTS 3
		LTS 2	LTS 3	LTS 3
other multilane		LTS 3	LTS 3	LTS 3

Table 3 Assessment for bike lanes adjacent to a parking lane

Appendix B: Connectivity Analysis Background[6]

Once the street segment stress ratings have been calculated, every census block is evaluated to determine which other census blocks are within biking distance and can be reached on the low-stress network. The BNA assumes a biking distance of 1.67 miles as measured along streets or paths, the distance an average rider would travel in ten minutes biking ten miles per hour. For convenience of travel, it is assumed that a low-stress route is only available if it doesn't force a person to go out of their way by more than 25% compared to a car trip. It is also assumed that a census block is connected to any road that either follows its perimeter or serves its interior. In practice, this means that a person biking can get to a destination whose front door is on a stressful street if they can get to a low-stress street around the corner. Finally, it is assumed that two census blocks are connected if and only if there is an unbroken low-stress connection between them. In other words, even a short stretch of stressful biking negates a potential connection. This is consistent with the Traffic Stress concept and also highlights the importance of a continuous network, rather than the patchwork of facilities that is common in many U.S. cities.

The transportation network is used to route from each census block to every other census block within biking distance, noting whether a low-stress connection between the two is possible. The number and types of destinations available in each census block are summarized. Using this information paired with the knowledge of which census blocks are connected on the low-stress network, the total number of destinations accessible on the low-stress network is calculated and compared to the total number of destinations that are within biking distance regardless of whether they are accessible via the low-stress network.

Points are assigned on a scale of 0 to 100 for each destination type based on the number of destinations available on the low-stress network as well as the ratio of low-stress destinations to all destinations within biking distance. The scoring places higher value on the first few low-stress destinations by assigning points on a stepped scale. Beyond the first few low-stress destinations, points are prorated up to 100 based on the ratio of low-stress to high-stress connections to those destinations. For example, a census block with low-stress access to only one park out of five nearby parks would receive 30 points. A census block with low-stress access to two parks out five would receive 50 points (30 for the first park, 20 for the second). A census block with low-stress access to four parks out of five would receive 85 points (30 for the first, 20 for the second, 20 for the third, and 15 out of the remaining 30 points for connecting one of the remaining two parks).

The BNA's six scoring categories are:

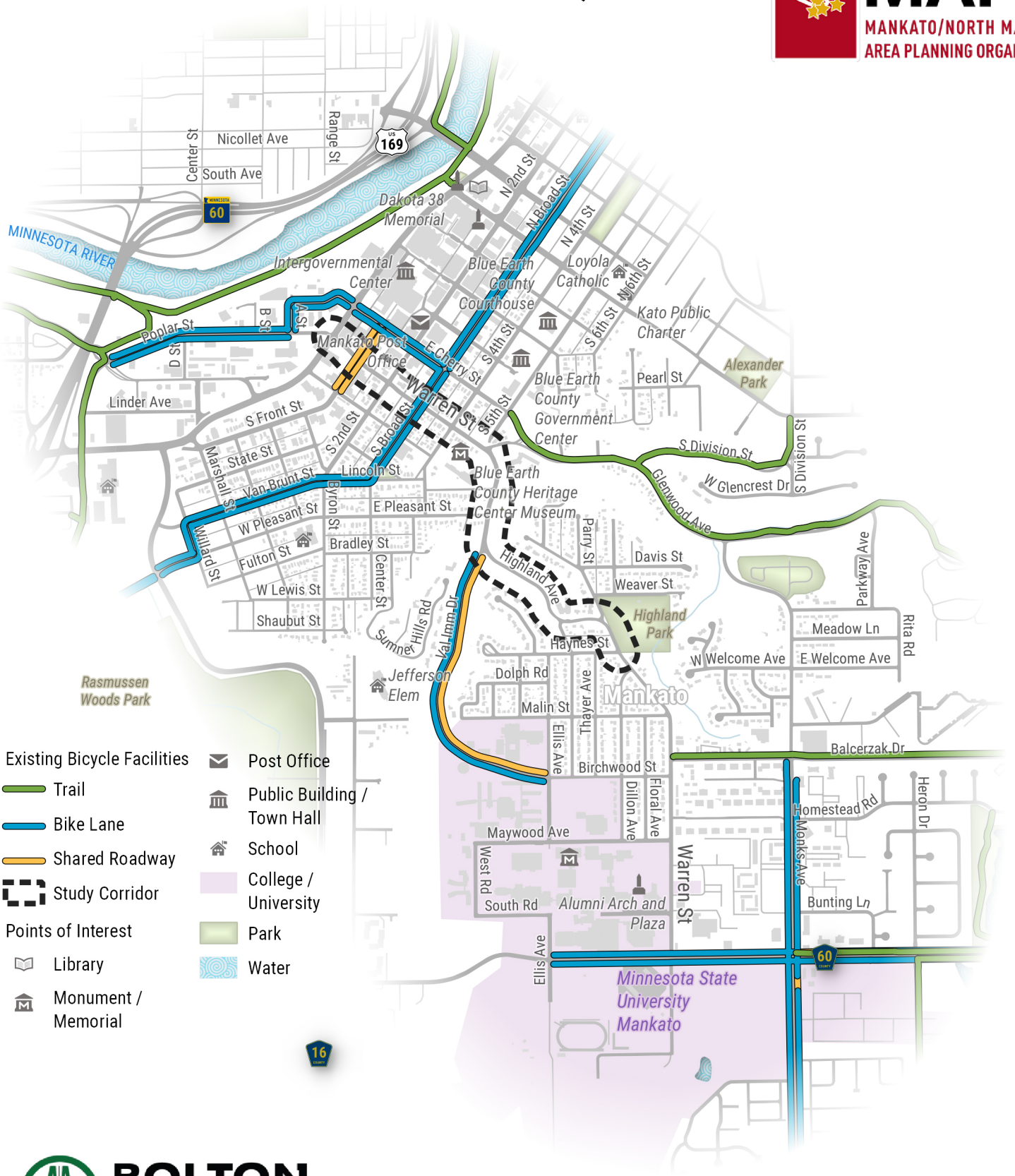
- People: Access to other people in the city based on the resident population distribution
- Opportunity: Access to jobs and educational institutions
- Core Services: Access to critical services such as health care
- Recreation: Access to public recreation outlets
- Retail: Access to shopping areas
- Transit: Access to major transit hubs

[6] https://bna.peopleforbikes.org/#/methodology (accessed August 16, 2019)

Appendix C: Warren Street Corridor BNA Maps

Warren Street Corridor - Mankato, MN

MAPO
MANKATO/NORTH MANKATO
AREA PLANNING ORGANIZATION



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TOOLE DESIGN

0 1000 2000 ft

N

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Warren Street Corridor - Mankato, MN

MAPO
MANKATO/NORTH MANKATO
AREA PLANNING ORGANIZATION

Level of Traffic Stress

Existing LTS Scores

- 1
- 2
- 3
- 4
- Study Corridor

Points of Interest

- Library
- Monument / Memorial
- Post Office
- Public Building / Town Hall
- School
- College / University
- Park
- Water

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TOOLE DESIGN

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Warren Street Corridor - Mankato, MN

MAPO
MANKATO/NORTH MANKATO
AREA PLANNING ORGANIZATION

Level of Traffic Stress

Planned Scenario A: LTS scores with a bike lane on Warren Street

- 1
- 2
- 3
- 4
- Study Corridor

Points of Interest

- Library
- Monument / Memorial
- Post Office
- Public Building / Town Hall
- School
- College / University
- Park
- Water

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TOOLE DESIGN

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Warren Street Corridor - Mankato, MN

MAPO
MANKATO/NORTH MANKATO
AREA PLANNING ORGANIZATION

Level of Traffic Stress

Planned Scenario B: LTS scores with a proteceted facility on Warren Street

- 1
- 2
- 3
- 4
- Study Corridor

Points of Interest

- Library
- Monument / Memorial
- Post Office
- Public Building / Town Hall
- School
- College / University
- Park
- Water

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Warren Street Corridor - Mankato, MN

MAPO
MANKATO/NORTH MANKATO
AREA PLANNING ORGANIZATION

Bicycle Connectivity

Existing BNA Scores

- Low
- Medium
- High

Existing LTS Scores

- 1
- 2
- 3
- 4
- Study Corridor

Points of Interest

- Library
- Monument / Memorial
- Post Office
- Public Building / Town Hall
- School
- College / University
- Park
- Water

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TOOLE DESIGN

0 1000 2000 ft

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Warren Street Corridor - Mankato, MN

MAPO
MANKATO/NORTH MANKATO AREA PLANNING ORGANIZATION

Bicycle Connectivity

Planned BNA Scores

- Low
- Medium
- High

LTS scores with a proteceted facility on Warren Street

- 1
- 2
- 3
- 4

Study Corridor

Points of Interest

- Library
- Monument / Memorial
- Post Office
- Public Building / Town Hall
- School
- College / University
- Park
- Water

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TOOLE DESIGN

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APPENDIX G

Social, Environmental, and Economic (SEE) Resources

Warren Street Corridor Study
Environmental Screening Table

Please note: This table does not include Land Use, which is summarized under the Study Area Characteristics heading of the Existing Conditions Memorandum.

Attachments for this Environmental Screening include:

- Study Location Map
- Social, Environmental, and Economic (SEE) Resources Figure
- Environmental Justice Report

Social, Economic, or Environmental Topic	Considerations	Existing/Planned Conditions
Social and Community	• Access and compatibility considerations • Hospitals, schools, libraries, churches, government buildings	Social and institutional resources are depicted in the attached Social, Environmental, and Economic (SEE) Resources figure. There are several Government facilities in the vicinity of the project corridor, but none adjacent. The Public Safety building is the closest located at the junction of Liberty Street and Front Street, one block west of Warren Street. St. John's Episcopal Church is adjacent to the corridor in the eastern quadrant of the Warren Street/Broad Street intersection. St. John the Baptist Catholic Church is located southwest of the corridor on Broad Street. Smiles Independent Living Center (ILC) is located at 709 Front Street which services local residents with mobility issues and other disabilities.
Environmental Justice	• Avoid/mitigate disproportionate impacts to low income and minority populations • Federal funding triggers review and potential mitigation requirements	Low income and/or minority populations are present in the study area, and Environmental Justice is anticipated to be a consideration regarding roadway planning and design. An Environmental Justice Report (see attached) has been prepared that identifies low income/minority populations to aid in alternative development and ensure those populations are effectively notified and accommodated through the public process.
Section 4f/6f Resources	• Require special evaluation, coordination, and documentation: o Parks and trails	**Section 4(f)** No trails exist along Warren Street however the Old Warren Street Trail extends from the Cherry Ridge Apartments driveway south to the old Warren

Social, Economic, or Environmental Topic	Considerations	Existing/Planned Conditions
	o Wildlife & waterfowl refuges o School playgrounds o Public golf courses	Street alignment (Warren Street extending north from Cedar Street). There is a nearby trail along Glenwood Avenue that is easily accessed from Warren Street sidewalks. There are three parks adjacent to the project area. The Malda Farnum Park and Hubbard House historical site are located across Warren Street from each other along the northwest side of Broad Street. Highland Park is located on the east side of Warren Street at the southern project terminus. **Section 6(f)** Section 6(f) resources have this designation because of the receipt of federal Land and Water Conservation Fund (LAWCON) monies. Section 6(f) has a set of review and mitigation requirements, beyond Section 4(f) requirements, which need to be approved by the US National Parks Service (NPS). Mitigation has to be in the form or resource replacement. Section 6(f) review, coordination, and mitigation requirements can be significant, as can the associated project schedule requirements. There are no Section 6(f) properties within the study area.
Traffic Noise	• Identify noise receptors • Comply with federal and state regulatory requirements • Potential mitigation (walls or other measures)	There are various potential noise receptors adjacent to the study corridors as defined in MnDOT requirements and guidelines (http://www.dot.state.mn.us/environment/noise/pdf/2017-noise-requirements.pdf). The largest residential concentrations adjacent to the project corridors occur at the intersections of Warren Street with Glenwood Avenue and Ramsey Street where the Cherry Ridge Apartments, Colonial Square Apartments, and various residences are located. Noise is also a consideration for historic structures or properties, parks, and outdoor spaces of churches along the corridor.
Farmland	• Farmland conservation policies	There is no land in conventional agricultural development adjacent to the project corridors. Farmland impacts will not be a constraint regarding roadway planning and design in the study area.
Historic/archaeological	• Require special evaluation, coordination, and documentation • Avoid impacts per state, federal, and local regulations and guidelines	**Historic** The Minnesota State Historic Preservation Office (SHPO) maintains a file of historic, or potentially historic, sites throughout the state. These are categorized as follows:

Social, Economic, or Environmental Topic	Considerations	Existing/Planned Conditions
		• SHPO-inventoried structure: a structure has been brought to SHPO's attention through some means that it may have significance under applicable law and guidelines; however, further review would be required. • Property Considered Eligible: consultation between SHPO and a lead agency (e.g. MnDOT's Cultural Resources Unit) has determined that for the purpose of identifying appropriate treatment, the structure would likely be included in the National Register of Historic Places if the applicable administrative procedures were initiated. • Listed on the National/State Register of Historic Places (NRHP): the structure has the protections identified under the National Historic Preservation Act and the Minnesota Historic Sites Act. SHPO's database for the study area was reviewed and summary information is presented in the attached SEE Resources figure. Several SHPO-inventoried properties are adjacent to the corridor primarily between Front Street and Glenwood Avenue. The Cray house and the Hubbard House occupy the entire block between 2nd Street and Broad Street and are listed on the NRHP. The St. John the Baptist Catholic Church located on Broad Street is NRHP Eligible. **Archaeology** There are no known archaeological sites within the study area.
Soils/Erosion	• Compatibility with construction/drainage design	A preliminary review of soils information using the Natural Resources Conservation Service (NRCS) Web Soil Survey indicates that most soils in the project area are Hydrologic Group B or C/D. Group B soils are 50 to 90-percent sand and have moderately low runoff potential with unimpeded water transmission through the soil. Group C/D soils meaning that the soils have high to very fines/clay content and infiltration rates are correspondingly low. Prior to the construction of any improvements in the project corridor, geotechnical analysis would be performed which would evaluate the suitability of the local soils for construction and identify any corrective measures needed.

Social, Economic, or Environmental Topic	Considerations	Existing/Planned Conditions
Utilities	• Conflicts with utilities may increase schedule/cost requirements	There are overhead power transmission lines along the corridor adjacent to Highland Park in the south and between Ramsey Street and Pleasant Street. These and others that cross the corridor in a few locations would need to be accounted for in planning and preliminary design activities. Locations include the Warren Street/Highland Avenue intersection and St. John's Episcopal Church. A review of US DOT's National Pipeline Mapping System indicates that there are no regional gas pipelines under Warren Street in the study area,
Water Resources	• Impacts need to be avoided/limited per regulatory requirements	**Watershed** The study area falls within the Mankato Watershed of the Minnesota River Basin. **Wetlands** National Wetland Inventory (NWI) wetland areas as defined by the US Fish and Wildlife are depicted in the attached SEE Resources figure. While any improvement project or projects in the study corridor would need to have field wetland delineations performed, NWI mapping is a desktop exercise that indicates the scale of wetland impacts which could be encountered. The NWI information shows no wetland resources in the study area. **Floodplain** FEMA 100- and 500-year floodplain information is provided in the attached SEE Resources figure. The Minnesota River 500-year flood-plain encompasses the corridor from Riverfront Drive to Front street.
Drainage	• Existing drainage systems • Sensitive waters	• The entire corridor is served by curb and gutter design in the study area. • The Minnesota River is an impaired waterway north of the study area.
Contaminated Properties	• Potential construction delays/costs • Potential cleanup liability	The Minnesota Pollution Control Agency's (MPCA's) "What's In My Neighborhood" (WIMN) database is a useful tool for preliminary screening and planning purposes. WIMN data was reviewed as part of this screening. Active sites are identified along the corridor including: • Hazardous waste generator and petroleum brownfield between Riverfront Drive and Front Street

Social, Economic, or Environmental Topic	Considerations	Existing/Planned Conditions
		• Hazardous waste on Broad Street While more detailed review will likely be required as part of preliminary and final design for future improvement projects, it is not anticipated that contaminated properties will be a substantial consideration relative to preliminary planning/conceptual design activities.
Fisheries	• Trout streams • Fish migrations • Spawning runs • Unique habitat conditions	There are no trout streams within a mile of the project corridors or known unique fisheries considerations.
Vegetation	• Native plant communities • Landscape vegetation • Functional vegetation • High value vegetation • Hazard trees	MnDNR Native Plant Community GIS data shows no instances in the vicinity of the corridor. Further review for functional/high value vegetation and hazard trees will need to be considered in future environmental review.
Protected Species	• Federal and state designations • Coordination and review requirements	Based on online US Fish and Wildlife Service (USFWS) information, there are only two federally protected species known to be in Blue Earth County: • Northern long-eared bat • Rusty-patched bumble bee Future improvement projects would involve review and potential mitigation using USFWS guidance. The MnDNR's Natural Heritage Information System (NHIS) database was reviewed as part of this environmental screening. There are no known occurrences of endangered or threatened species in the vicinity of the corridor.

Warren Street Corridor Study

Mankato/North Mankato Area Planning Organization (MAPO)

Social, Environmental, and Economic (SEE) Resources

June 2019

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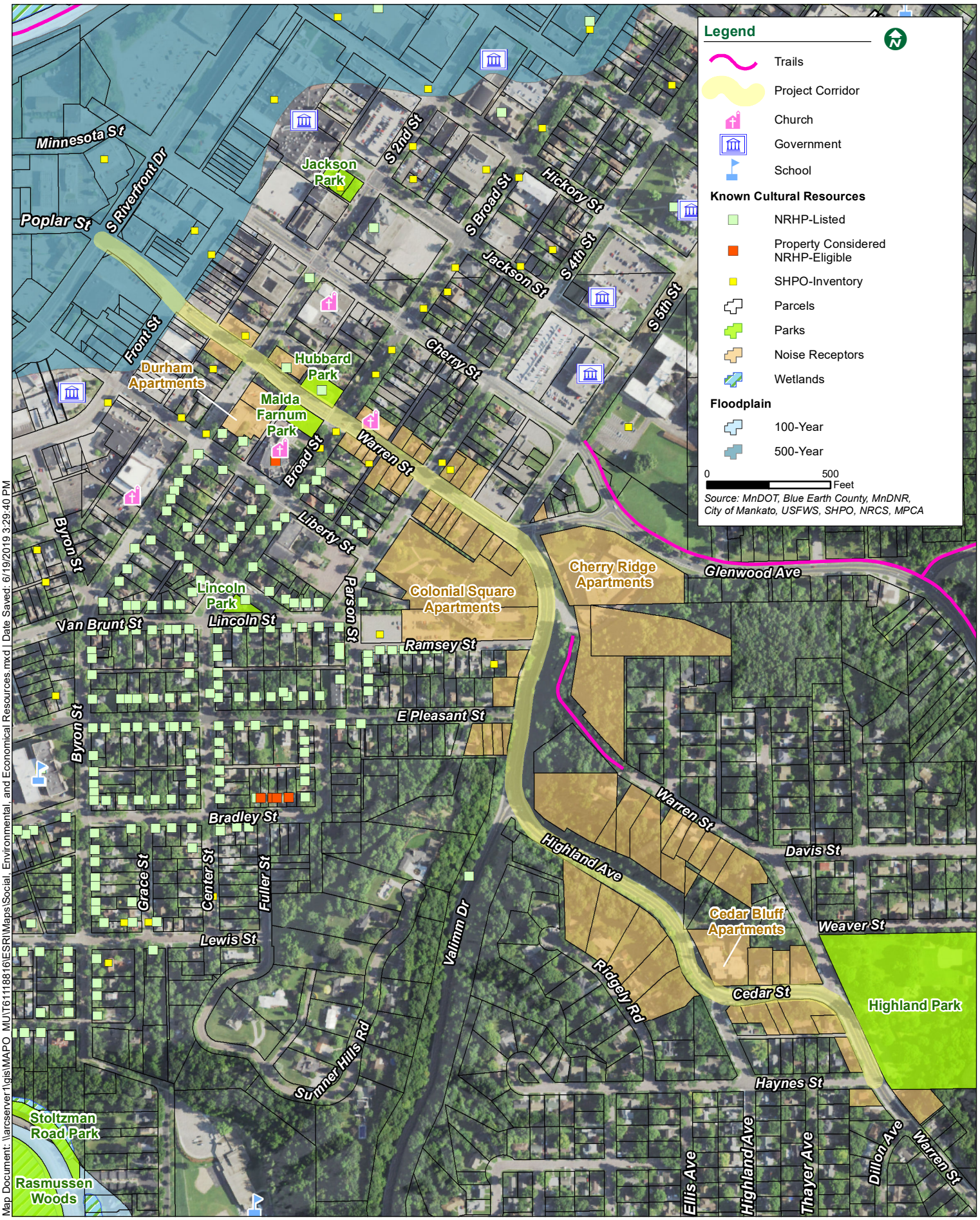

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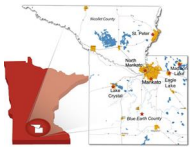
Appendix C: Purpose and Need Framework

Warren Street Corridor Study

MAPO and City of Mankato, MN



Purpose and Need Framework

October 22, 2019

PURPOSE

The Warren Street Corridor Study is designed to identify improvements on Warren Street (between Riverfront Drive and Highland Park). The study will evaluate existing issues and present alternatives to help improve all modes of transportation, including driving, walking, biking, rolling (wheelchairs) and using transit. An effort of the Mankato/North Mankato Area Planning Organization (MAPO) and the City of Mankato, the Warren Street Corridor Study will help define a comprehensive vision for Warren Street in preparation for the 2021 reconstruction project. Purposes of the study include:

- Defining the issues and potential opportunities along the corridor.
- Establishing the corridor vision and goals.
- Developing and evaluate potential multimodal infrastructure improvement alternatives.
- Developing a short-term implementation plan in preparation for the 2021 street reconstruction.

BACKGROUND

Route Importance

Warren Street provides an important connection from City Center Mankato in the Minnesota River Valley to the Minnesota State University (MSU), Mankato campus and many residential and community recreational uses on the Mankato hilltop. The segment from Riverfront Drive to Highland Park plays a complex role as it passes through City Center core areas with high vehicle traffic volumes, pedestrian cross-traffic and road right-of-way confined by the topographical constraints of a wooded ravine. The corridor serves multiple transportation users including automobiles, transit, pedestrians and bicyclists. To continue their momentum in City Center reinvestment, MAPO and the City of Mankato desire to define a comprehensive vision for Warren Street in preparation for the 2021 street reconstruction project.

NEED

Study partners seek to address the following needs for Warren Street and its supporting roadway network.

Consistency with State and Local Plans

Previous planning efforts for the study area emphasized the importance of Warren Street and surrounding streets for local transportation, and the need to make improvements to address existing deficiencies and prepare for reconstruction. These studies include:

- MAPO 2045 Long Range Transportation Plan (2015)

- Riverfront Drive Corridor Study (2017)
- MnDOT Intelligent Transportation Systems (ITS) Architecture Plan (2015)
- Minnesota Statewide Regional ITS Architecture Version 2018
- City of Mankato Community Investment Plan (CIP) (2019-2023)
- Mankato Transit Development Plan (2018)
- Front Street Connectivity Plan (2014)
- Wayfinding Signage Plan (2015)
- City of Mankato Complete Streets Plan and Policy (2015)
- Mankato Area Public Schools' Safe Routes to School Plan (2013)
- MAPO Americans with Disabilities Act (ADA) Transition Plan and Inventory for Public Rights-of-Way (2019)

Proposed improvements identified through these studies include roadway reconstruction, multimodal improvements and ADA infrastructure investment.

Previous planning efforts have also identified consistent population growth in the City of Mankato, which is anticipated to continue. Though the community continues to grow, the area surrounding the study corridor is fully built out and no plans exist for redevelopment. However, this does not mean redevelopment opportunities don't exist along the corridor, only that none are currently planned.

Key Finding: Previous planning efforts have identified corridor deficiencies and the need for corridor reconstruction. Recommended improvements need to accommodate multiple transportation modes, provide improved ADA facilities and address safety concerns.

Capacity

Existing Operations

Warren Street serves as a four-lane minor arterial roadway carrying 6,800 to 8,500 vehicles per day. A level of service (LOS) evaluation was completed for each intersection on the corridor. LOS results are based on average vehicle delay calculated by the Highway Capacity Manual (HCM) 6th Edition. This "control delay" is the delay experienced as drivers pass through an intersection. All intersections operate at acceptable LOS today. Vehicle backups periodically occur at the Warren Street/Riverfront Drive intersection (backups located along Riverfront Drive at this intersection).

2040 No-Build Operations

Traffic volumes along the corridor are anticipated to increase to a range of 9,300 to 11,900 by 2041. Without improvements, the corridor is anticipated to function at acceptable levels similar to today. The only exception would be additional traffic backups along Warren Street approaching Riverfront Drive and along Glenwood Avenue (on its approach to Warren Street).

Key Finding: Despite projected traffic volume increases of 37%-40%, the corridor is anticipated to continue to function at acceptable levels of service except for some traffic backups.

Safety

Warren Street is exhibiting crash issues. **Table 1** identifies intersections have a critical index exceeding 1.0 which provides an indication of statistical significance that conditions at those locations may be contributing to the higher crash rate:

Table 1. Crash locations exhibiting a critical index above the normal range. Crash data was provided by MnDOT for the time period of 2014 – 2018.

Location	Number of Crashes	Critical Index
2nd Street at Warren Street	28	1.51
4th Street at Warren Street	10	1.15
Glenwood Avenue at Warren Street	23	2.19
Val Imm Drive at Highland Avenue	9	1.14

Along with crash concerns at various intersections, there were several instances of pedestrian/bicycle crashes along Warren Street. **Table 2** identifies instances of pedestrian and bicycle crashes.

Table 2. Pedestrian and Bicycle Crashes along Warren Street. Crash data was provided by MnDOT for the time period of 2014 – 2018.

Location	Number of Pedestrian Crashes	Number of Bicycle Crashes
Riverfront Drive at Warren Street	2	1
Front Street at Warren Street	1	1
Broad Street at Warren Street	1	0
Glenwood Avenue at Warren Street/Highland Avenue	0	1

Key Finding: The corridor exhibits high crash counts at various intersections including several pedestrian and bicycle crashes. Safety improvements need to be carefully considered in study recommendations.

Pedestrian and Bicycle

Other than a gap between Val Imm drive and Highland Avenue, pedestrian facilities exist along both sides of the corridor. Space is limited with the current roadway configuration to accommodate sidewalks. Designated pedestrian crossings are limited along the corridor. However, participants have requested crosswalk facilities with flasher systems near Cherry Ridge Apartments, at Val Imm Drive, and at Highland Park near the Cedar Street/Warren Street Intersection.

Trash and recycling receptacles pose temporary barriers to accessibility; however, there is no other space to place receptacles for trash pick-up.

Bicycle facilities don't exist on the corridor today, however, on-street facilities intersect the roadway in several places. Bicyclists are observed daily using sidewalks and sharing lanes with vehicles. According to a Level of Traffic Stress (LTS) analysis performed, Warren Street provides a comfortable riding experience for some experienced adult riders who will share the lane with vehicle traffic. Lane sharing

with vehicles and steep grades combine to make biking on the corridor less comfortable for less experienced adults and children.

The corridor also scores a moderate LTS rating for connectivity. A connectivity score was generated that expands upon the LTS analysis which evaluates census blocks in the area to determine network connections. Census blocks are considered connected if there is an unbroken, low-stress connection (LTS score 1 or 2) between them that does not require a trip more than 25% longer than the shortest car trip. Higher scores indicate higher comfort and convenience. Warren Street receives a moderate score near the MSU campus primarily due to lack of low-stress routes connecting the area to the rest of Mankato. This and other areas along Warren Street would also benefit from adding low-stress bicycle facilities to create a better network connected to more destinations.

Key Finding: Improvements to pedestrian facilities and implementation of bicycle facilities need to be included in study recommendations. This may include closing sidewalk gaps, providing safer/more frequent crossings, and providing safer/designated bicycle facilities.

Environmental Considerations

There are Social, Economic, and Environmental (SEE) concerns in proximity to the study area that should be considered including contaminated locations (near Riverfront Drive), Section 4(f) and 6(f) properties (Malda Farnham Park, the Cray Mansion and the Hubbard House), and potential environmental justice populations (Durham Apartments, Cherry Ridge Apartments, and Colonial Square among others).

Key Finding: SEE resources including contaminated locations, parks and environmental justice populations need to be considered in improvement recommendations.

HOW THIS FRAMEWORK IS USED

Relevant portions of this text may be reported in the purpose and need section(s) of future NEPA and Minnesota Environmental Policy Act (MEPA) documentation potentially required for implementation of recommendations resulting from the Warren Street Corridor Study process. Based on MnDOT guidance which reflects FHWA requirements, need statements in NEPA documents are to focus on existing documented deficiencies.

Deficiencies clearly exist in the study area that need to be addressed. This planning study looks to the future to anticipate future network needs so that forward thinking and coordinated decisions may be made.

Appendix D: Issues Identification Document

Issues Identification

December 2, 2019

PURPOSE

Identification of issues assists decision makers develop and evaluate improvement opportunities. The Issues Identification section summarizes and refers to information provided in this Study's Existing Conditions Report and Purpose and Need Framework. Corridor issues were identified and evaluated based on several sources including:

1) Issues and needs identified through public, agency, and stakeholder engagement;

2) Study documents including the Existing Conditions Report and Purpose and Need Framework;

3) Data collection and data analysis

Combined analysis led to identification of primary and secondary issues. The primary issues identified are listed below:

Lack of Connectivity

Pedestrian

Input collected over the Study's various public engagement efforts indicated need for increased pedestrian connectivity throughout and across the corridor. Public comments relating to connectivity included sidewalk condition, sidewalk width, lack of curb cuts, Americans with Disabilities Act (ADA) compliance, and traffic noise/speed affecting the pedestrian environment.

Bicyclist

Public engagement indicated the corridor's lack of bicycle facilities is a source of discomfort to bicyclists and is a deterrent to bicycle use. This is particularly evident for southward (uphill) traveling bicyclists who, due to the uphill grade, are unable to maintain a comfortable speed with vehicle traffic. Further information regarding corridor bicycle connectivity can be found in this Study's Bicycle Network Analysis (BNA).

Key Finding: A primary issue is the lack of pedestrian and bicyclist connectivity throughout and across the corridor. This lack of connectivity suppresses active transportation throughout the corridor and presents an opportunity for increased multimodal use. Further information regarding pedestrian and bicycle connectivity can be found in this Study's Purpose and Need Framework.

Lack of safe/comfortable crossings

Public engagement indicated several corridor-wide issues related to safe/comfortable pedestrian crossings. This is of particular importance as there are several apartment buildings in the corridor which house wheelchair-dependent populations. Crossing issues include:

- Lack of designated pedestrian crossings in desirable locations.
- Vehicles stopping in crosswalks while waiting for signal lights. This issue was reported prevalent at several intersections including at Second Street. Study staff received input that potential causes of this issue include high vehicle speeds, insufficient pedestrian/wheelchair signage, and insufficient pavement markings.
- "Walk" signal lighting too quick at multiple corridor crossings. Public input indicated the amount of time allowing pedestrians to cross the street is insufficient.

Key Finding: A primary issue is the lack of safe and comfortable pedestrian and bicyclist crossings across and throughout the corridor. This lack of connectivity suppresses active transportation throughout the corridor and presents an opportunity for increased multimodal use.

Intersection safety at spot locations

Public engagement and data review/analysis indicated there are issues related to pedestrian and traffic safety and traffic flow at several intersections including Glenwood Avenue and Val Imm Drive. Further information regarding traffic capacity, safety issues, problem intersections, and crash rates can be found in this Study's Purpose and Need Framework.

Secondary Issues

Public engagement also identified a variety of secondary issues, including:

- Alignment of roadway/steep grades/ice in winter (particularly southern segment)
- Inconsistent road names
- Sidewalk maintenance issues (both sidewalk condition and winter maintenance)
- Lighting concerns in several areas throughout corridor's northern and southern segments
- Site comments outside of the public right-of-way (ROW) (see comments on map)
- Access point sight lines and safety related to vehicle speeds

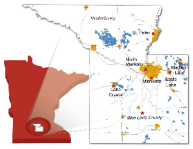
HOW THIS ISSUES IDENTIFICATION IS USED

This Issues Identification document will be considered in alternatives development and evaluation.

Appendix E: Goals and Objectives

Warren Street Corridor Study

MAPO and City of Mankato, MN



Goals, Objectives, and Performance Measures

October 22, 2019

Purpose

The purpose of this document is to outline the goals and objectives for the Warren Street corridor from Riverfront Drive to Highland Park which will guide the development and evaluation of improvement alternatives. The goals and objectives are intended to align with state and local transportation plans as much as possible. They build off the existing conditions, issues, needs and concerns outlined in the Existing Conditions Technical Memorandum and define desired results or outcomes. Multiple objectives are identified supporting each goal. These objectives provide additional details about how the goal can be achieved. Performance measures are also tied to the objectives and will be used during the concept evaluation process to assess and compare improvement options.

Corridor Goals, Objectives, and Performance Measures

GOAL A: Provide efficient vehicle mobility and access

Objectives	Performance Measures
Ensure mobility and reliability along the corridor.	Volume to capacity ratio.
Manage access consistent with access spacing guidelines.	Proposed access locations, spacing and treatments.

GOAL B: Safely accommodate all users (vehicles, transit, pedestrians, bicycles)

Objectives	Performance Measures
Reduce crash and severity rates below statewide averages for comparable facilities.	Forecasted crash and severity rates.
	Vehicle to vehicle conflict points.
Provide safe pedestrian and bicycle travel along and across the corridor.	Intersection and roadway design accommodations for pedestrians and bicyclists.
	Level of Traffic Stress.
Maintain community connections and local access for all modes of transportation.	Residential neighborhood access and circulation.
	Bicycle connectivity measure from Bicycle Network Analysis.
	Terrain/grading as a barrier to bicycles.
Ensure compatibility with Transit Development Plan.	Accommodates proposed transit stops and routes along corridor.
Address intersection visibility and sight line issues.	Intersection and roadway design.
Address roadway segment safety issues.	Addresses problematic, steep/curved sections of road.
	Addresses steep approaches to Warren Street.

GOAL C: Provide infrastructure improvements compatible with social, environmental, and economic resources

Objectives	Performance Measures
Avoid, minimize, and mitigate impacts to historic properties.	Impacts to historic resources.
Avoid, minimize, and mitigate impacts to cultural resources.	Impacts to cultural resources.
Avoid, minimize, and mitigate impacts to the built environment.	Acquisition of property.
Avoid, minimize, and mitigate impacts to the sensitive environmental justice populations.	Access to properties housing transit and/or walking/bicycling dependent populations.

GOAL D: Develop a financially responsible implementation plan.

Objectives	Performance Measures
Right-size improvements to address needs yet maximize use of existing infrastructure where possible.	Cost of improvements – capital costs and right-of-way.

Appendix F: Concept Alternatives


E CHERRY ST
GLENWOOD AVE
POPLAR ST
S RIVERFRONT DR
S FRONT ST
S 2ND ST
S BROAD ST
S 4TH ST
ALT 1
GLENWOOD AVE
SIDE STREET STOP
ENHANCED PEDESTRIAN CROSSING
FOR ALTERNATIVE INTERSECTION OPTIONS SEE INSETS B AND C
INSET B
GLENWOOD AVE ALT 2
ROUNDABOUT
GLENWOOD AVE
INSET C
GLENWOOD AVE ALT 3
ALL WAY STOP
STOP
RAMSEY ST
WARREN ST
E PLEASANT ST
ENHANCED PEDESTRIAN CROSSING
POTENTIAL CLOSURE OR REALIGNMENT
POTENTIAL REALIGNMENT TO MATCH HAINES ST
VAL IMMI DR
IN-STREET PEDESTRIAN SIGN, BANNING SIGNS, AND POSSIBLE ENHANCED TREATMENT
HIGHLAND AVE
HAINES ST
6 ft bike lane
12-ft sidepath
6-ft amenity zone
14-ft drive lane
14-ft drive lane
13-ft sidewalk
Warren St Corridor Study
Sidepath with 2-Lane Roadway
Mankato, MN
4/24/2020

Warren St Corridor Study

Buffered Bicycle Lanes With 3-Lane Roadway
Mankato, MN

4/27/2020


POPLAR ST
S RIVERFRONT DR
S FRONT ST
S 2ND ST
S 4TH ST
S BROAD ST
E CHERRY ST
GLENWOOD AVE
WARREN ST
RAMSEY ST
E PLEASANT ST
HIGHLAND AVE
HAYNES ST
ALT 1
4TH ST
TWO-WAY STOP
FOR ALTERNATIVE INTERSECTION OPTIONS SEE INSET A
ALT 1
GLENWOOD AVE
SIDE STREET STOP
FOR ALTERNATIVE INTERSECTION OPTIONS SEE INSETS B AND C
ENHANCED PEDESTRIAN CROSSING
INSET A
4TH ST ALT 2
RIGHT IN RIGHT OUT
INSET B
GLENWOOD AVE ALT 2
ROUNDABOUT
INSET C
GLENWOOD AVE ALT 3
ALL WAY STOP
POTENTIAL CLOSURE OR REALIGNMENT
POTENTIAL REALIGNMENT TO MATCH HAINES ST
IN-STREET PEDESTRIAN SIGN, BANNING SIGNS, AND POSSIBLE ENHANCED TREATMENT
11 ft sidewalk
11 ft drive lane
12 ft center turn lane
11 ft drive lane
11 ft sidewalk
LEGEND
ALTERNATIVE 1
ALTERNATIVE 2
ALTERNATIVE 3
Warren St Corridor Study
Alternate Bicycle Route With 3-Lane Roadway
Mankato, MN
4/27/2020

Appendix G: Build Traffic Analysis Summary

BOLTON & MENK
Real People. Real Solutions.

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MEMORANDUM

Date: July 10, 2020

To: Charles Androsky

From: Ross B. Tillman, P.E.
Kelsey E. Retherford, P.E.

Subject: Build Traffic Analysis Memorandum - Warren Street Corridor Study
Mankato/North Mankato Area Planning Organization
Project No.: T61.118816

Introduction

Warren St from Riverfront Dr to Highland Park is being analyzed to prepare for roadway reconstruction planned for 2021. This memorandum summarizes the build traffic operational analysis completed as a part of the Warren Street Corridor Study.

Corridor Alternatives

A level of service (LOS) analysis of the peak hours was completed using the existing turning movement counts. The LOS results are based on average delay per vehicle as calculated by the Highway Capacity Manual (HCM) 6th Edition, which defines the level of service, based on control delay. Control delay is the delay experienced by vehicles slowing down as they are approaching the intersection, the wait time at the intersection, and the time for the vehicle to speed up through the intersection and enter into the traffic stream. The average intersection control delay is a volume weighted average of delay experienced by all motorists entering the intersection on all intersection approaches. Intersections and each intersection approach are given a ranking from LOS A through LOS F. LOS A indicates the best traffic operation, with vehicles experiencing minimal delays. LOS A through D is generally perceived to be acceptable to drivers. LOS E indicates that an intersection is operating at, or very near, its capacity and that drivers experience considerable delays. LOS F indicates an intersection where demand exceeds capacity and drivers experience substantial delays.

Warren St is currently a four lane undivided roadway between Riverfront Dr and Val Imm Dr and a two lane undivided roadway between Val Imm Dr and Haynes St. An analysis was completed to determine how converting Warren St to a two lane or three lane from Riverfront Dr to Val Imm Dr would operate. Traffic control at each intersection was assumed to remain the same as the existing condition. The signals at Broad St, 2nd St and Front St were assumed to be coordinated under the build scenarios. The 2041 AM and PM peak traffic volumes were analyzed in Synchro/SimTraffic. Operational results for the three lane and two lane corridor options are shown in **Tables 1** and **2**.

Table 1. 2041 Build – Three Lane Traffic Operational Analysis

Intersection	Peak Hour	Intersection Delay (1.)		Maximum Delay-LOS (2.)		Limiting Movement (3.)	Max Approach Queue		
							Direction	Average Queue (ft)	Max Queue (ft)
Riverfront Dr & Warren St	AM	11	B	16	B	SBL	NBT/R	100	200
Signalized Intersection	PM	15	B	19	B	EBL	SBT/R	175	325
Front St & Warren St	AM	5	A	28	C	SBT	NBL/T/R	50	125
Signalized Intersection	PM	8	A	22	C	SBL	WBT/R	50	150
2nd St & Warren St	AM	9	A	25	C	SBL	WBT/R	50	175
Signalized Intersection	PM	12	B	23	C	SBL	WBT/R	100	250
Broad St & Warren St	AM	11	B	22	C	SBL	SBL/T/R	100	200
Signalized Intersection	PM	10	B	22	C	SBL	EBT/R	125	250
4th St & Warren St	AM	2	A	17	C	NBL	SBL/T/R	50	75
Stop Controlled	PM	3	A	36	E	NBL	SBL/T/R	75	125
Glenwood Ave & Warren St	AM	7	A	32	D	SBL	SBL/R	75	225
Stop Controlled	PM	15	C	93	F	SBL	SBL/R	175	425
Ramsey St & Highland Ave	AM	1	A	11	B	NBL	NBL/R	25	75
Stop Controlled	PM	1	A	12	B	NBL	WBL	50	75
Pleasant St & Highland Ave	AM	1	A	9	A	NBL	NBL/R	50	100
Stop Controlled	PM	2	A	12	B	NBL	NBL/R	50	100
Val Imm Dr & Highland Ave	AM	2	A	11	B	NBL	NBL/R	50	100
Stop Controlled	PM	4	A	18	C	NBL	NBL/R	75	175
Highland Ave & Cedar St	AM	1	A	7	A	NBL	NBL/R	25	75
Stop Controlled	PM	1	A	9	A	NBL	NBL/R	25	50
Cedar St & Warren St	AM	1	A	7	A	SBL	SBL/R	25	50
Stop Controlled	PM	1	A	9	A	SBL	EBL/T	25	75
Haynes St & Warren St	AM	1	A	9	A	NBL	WBL/T	25	75
Stop Controlled	PM	1	A	11	B	NBL	WBL/T	25	75

1. Delay in seconds per vehicle
2. Maximum delay and LOS on any approach and/or movement
3. Limiting Movement is the highest delay movement.

Table 1 shows that the intersections are anticipated to operate with LOS C or better during the 2041 peak hours with a three lane section along Warren St. At the intersection of 4th St at Warren St the northbound left operates with LOS E and the southbound left operates with LOS D during the PM peak hour. All other movements operate with LOS C or better during both peak hours.

At the intersection of Glenwood Ave at Warren St, the southbound left movement operates with LOS D during the AM peak hour and the LOS F during the PM peak hour. Additionally, the southbound right is anticipated to operate with LOS F during the PM peak hour. All other movements operate with LOS C or better during both peak hours.

At the intersection of Riverfront Dr at Warren St the maximum northbound through and southbound through queues extend past the left turn lanes during both peak hours. At the intersection of Glenwood Ave at Warren St the maximum southbound queue extends onto Cherry St/Glenwood Ave. All other intersection queues are acceptable.

Table A1 and **A2** in the **Appendix** show the detailed delay and queues for each movement at the intersections analyzed.

Table 2. 2041 Build – Two Lane Traffic Operational Analysis

Intersection	Peak Hour	Intersection Delay (1.)		Maximum Delay-LOS (2.)		Limiting Movement (3.)	Max Approach Queue		
							Direction	Average Queue (ft)	Max Queue (ft)
Riverfront Dr & Warren St	AM	12	B	16	B	SBL	NBT/R	125	275
Signalized Intersection	PM	17	B	18	B	NBL	SBT/R	175	350
Front St & Warren St	AM	6	A	29	C	NBL	NBL/T/R	50	125
Signalized Intersection	PM	8	A	23	C	NBL	EBL/T/R	75	175
2nd St & Warren St	AM	9	A	22	C	NBL	SBL/T/R	75	175
Signalized Intersection	PM	14	B	21	C	SBT	WBL/T/R	125	325
Broad St & Warren St	AM	11	B	23	C	SBT	WBL/T/R	100	225
Signalized Intersection	PM	11	B	22	C	SBT	EBL/T/R	125	300
4th St & Warren St	AM	2	A	20	C	NBL	WBL/T/R	25	125
Stop Controlled	PM	4	A	31	D	SBL	WBL/T/R	50	175
Glenwood Ave & Warren St	AM	6	A	30	D	SBL	EBL/T	75	200
Stop Controlled	PM	12	B	61	F	SBL	SBL/R	125	375
Ramsey St & Highland Ave	AM	2	A	12	B	NBL	WBL/T	25	100
Stop Controlled	PM	2	A	15	C	NBL	WBL/T	50	150
Pleasant St & Highland Ave	AM	1	A	11	B	NBL	NBL/R	50	75
Stop Controlled	PM	2	A	13	B	NBL	NBL/R	50	100
Val Imm Dr & Highland Ave	AM	2	A	12	B	NBL	NBL/R	50	125
Stop Controlled	PM	4	A	19	C	NBL	NBL/R	75	150
Highland Ave & Cedar St	AM	1	A	9	A	NBL	NBL/R	25	50
Stop Controlled	PM	1	A	10	B	NBL	NBL/R	25	50
Cedar St & Warren St	AM	1	A	7	A	SBL	SBL/R	25	50
Stop Controlled	PM	1	A	9	A	SBL	EBL/T	25	75
Haynes St & Warren St	AM	1	A	8	A	NBL	WBL/T	25	75
Stop Controlled	PM	1	A	9	A	NBL	WBL/T	25	75

1. Delay in seconds per vehicle
2. Maximum delay and LOS on any approach and/or movement
3. Limiting Movement is the highest delay movement.

Table 2 shows that the intersections are anticipated to operate with LOS B or better during the 2041 peak hours with a two lane section along Warren St. At the intersection of 4th St at Warren St the southbound left and through movements operate with LOS D during the PM peak hour. All other movements operate with LOS C or better during both peak hours.

At the intersection of Glenwood Ave at Warren St, the southbound left movement operates with LOS D during the AM peak hour and the LOS F during the PM peak hour. Additionally, the southbound right is anticipated to operate with LOS E during the PM peak hour. All other movements operate with LOS C or better during both peak hours.

At the intersection of Riverfront Dr at Warren St the maximum northbound through and southbound through queues extend past the left turn lanes during both peak hours. The maximum queue along the westbound approach at the intersection of 2nd St and Warren St extends into the intersection at Broad St during the PM peak hour. At the intersection of Glenwood Ave at Warren St the maximum southbound queue extends onto Cherry St/Glenwood Ave. All other intersection queues are acceptable.

Table A3 and **A4** in the **Appendix** show the detailed delay and queues for each movement at the intersections analyzed.

While both options do operate sufficiently in the 20-year forecast, the 2-lane scenario will provide limited ability to manage changes in travel patterns that could be caused by localized redevelopment.

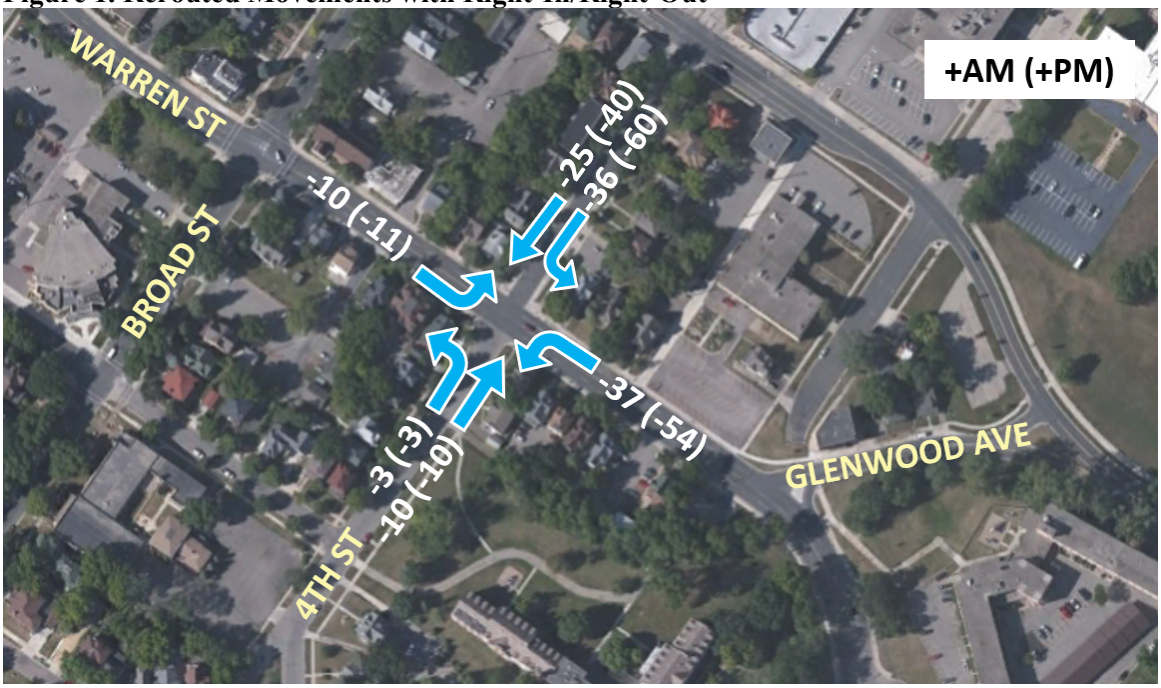
Intersection Alternatives

The intersections of Warren St at 4th St and Glenwood Ave were analyzed in further detail to determine how changes to the intersection geometry and/or traffic control would impact operations.

4th St at Warren St

This intersection was analyzed allowing full access (existing conditions) and as a right-in/right-out. **Figure 1** below shows the movements during the 2041 peak hours that would be rerouted with the right-in/right-out design.

Figure 1. Rerouted Movements with Right-In/Right-Out



The eastbound left, northbound left, northbound through, westbound left, and southbound through movements were re-routed via Broad St. Half of the southbound lefts were rerouted via Broad St and half were rerouted via Glenwood Ave.

Table 3. 2041 4th St at Warren St Traffic Operational Analysis

Option	Intersection	Peak Hour	Intersection Delay (1.)		Maximum Delay-LOS (2.)		Limiting Movement (3.)	Max Approach Queue		
								Direction	Average Queue (ft)	Max Queue (ft)
Full Access (With Three Lane)	4th St & Warren St	AM	2	A	17	C	NBL	SBL/T/R	50	75
	Stop Controlled	PM	3	A	36	E	NBL	SBL/T/R	75	125
	Broad St & Warren St	AM	11	B	22	C	SBL	SBL/T/R	100	200
	Signalized Intersection	PM	10	B	22	C	SBL	EBT/R	125	250
Right-In/Right-Out	4th St & Warren St	AM	1	A	5	A	SBR	NBR	25	50
	Stop Controlled	PM	1	A	6	A	NBR	SBR	25	50
	Broad St & Warren St	AM	11	B	21	C	SBT	SBL/T/R	125	250
	Signalized Intersection	PM	11	B	20	C	NBL	EBT/R	150	275

1. Delay in seconds per vehicle
2. Maximum delay and LOS on any approach and/or movement
3. Limiting Movement is the highest delay movement.

Table 3 shows how if the intersection of 4th St at Warren St has full access the northbound left operates with LOS E during the PM peak hour. The southbound left operates with LOS D during the PM peak hour and all other movements operate with LOS C or better. With a right-in/right-out, all movements at the 4th St and Warren St intersection operate with LOS A. Additionally, the delay for the intersection of Broad St at Warren St is shown in **Table 3**. This shows that the rerouted traffic does not cause any delay or queuing issues. The maximum delay is actually shown to decrease with move vehicles, which is due to the randomness of when vehicles enter the traffic model.

Table A5 and **A6** in the **Appendix** show the detailed delay and queues for each movement at the intersections analyzed.

Glenwood Ave at Warren St

This intersection was analyzed as a two way stop (existing condition), all way stop, and a single lane roundabout. The operations of each alternative are shown in **Table 4** below. The no build option was included for a comparison.

Table 4. 2041 Glenwood Ave at Warren St Traffic Operational Analysis

Option	Peak Hour	Intersection Delay (1.)		Maximum Delay-LOS (2.)		Limiting Movement (3.)	Max Approach Queue		
							Direction	Average Queue (ft)	Max Queue (ft)
No Build Two-Way Stop Contol	AM	6	A	38	E	SBL	SBL/R	75	250
	PM	7	A	40	E	SBL	SBL/R	100	275
Three Lane Two-Way Stop Contol	AM	7	A	32	D	SBL	SBL/R	75	225
	PM	15	C	93	F	SBL	SBL/R	175	425
Three Lane All-Way Stop Contol	AM	18	C	60	F	WBT	WBT/R	175	575
	PM	16	C	32	D	WBT	WBT/R	200	500
Roundabout	AM	7	A	7	A	WBTR	EB/WB	-	50
	PM	9	A	10	A	WBTR	EB/WB	-	75

1. Delay in seconds per vehicle
2. Maximum delay and LOS on any approach and/or movement
3. Limiting Movement is the highest delay movement.

Table 4 indicates that with a two way stop AM peak hour operations will remain acceptable with a three roadway, however during the PM peak hour operations show that the southbound left is anticipated to operate with LOS F and southbound queues would extend onto Cherry St/Glenwood Ave. The all way stop analysis indicates that delay for the overall intersection would worsen to LOS C, the westbound through is anticipated to operate with failing LOS during the AM peak hour and queues along the westbound approach are anticipated to extend beyond Ramsey St during both peak hours. The only option with no problematic queues in 2041 or excessive delay is the single lane roundabout which operates with LOS A for each movement and queues of 75 ft or less on each approach. While all analysis presented is in 2041, all options are expected to work well with existing volumes.

Table A7 and **A8** in the **Appendix** show the detailed delay and queues for each movement at the intersections analyzed.

Safety Analysis

The crash analysis completed analyzed five years (2014-2018) of crash data. This analysis indicated that the following intersections have a crash issue as they are operating outside the normal range when compared to similar intersections statewide.

- 2nd St at Warren St
- 4th St at Warren St
- Glenwood Ave at Warren St
- Val Imm Dr at Highland Ave

Each intersection was analyzed to determine the anticipated critical crash index with safety improvements. The existing and proposed critical indices are summarized below for each intersection

2nd St at Warren St

The existing critical index is 1.51 with a total of 28 crashes in the last five years. 11 of the 16 right angle crashes involved a northbound vehicle. The existing signal has a pedestal instead of a mast arm for the northbound approach which could be causing these northbound right-angle crashes. Clearinghouse crash modification factors were analyzed for installing a mast arm in addition to converting Warren St to a three-lane roadway as no other intersection changes were considered. CMF ID 1420 indicates that there is a 49% crash reduction for converting a pedestal mounted signal to a mast arm. CMF ID 199 indicates that there is a 29% crash reduction for converting a roadway from a four lane to a three lane. CMF ID 1420 was applied to crashes involving a northbound vehicle and CMF ID 199 was applied to all crashes. The anticipated critical index is 0.92 which shows that the intersection is expected to operate within the normal range compared to similar intersection statewide with these improvements.

4th St at Warren St

The existing critical index is 1.15 with a total of 10 crashes in the last five years. Half of the crashes were right angle crashes. CMF ID 199, which indicates that there is a 29% crash reduction for converting a roadway from a four lane to a three lane, was applied to the crashes at this intersection. The anticipated critical index with a three lane is 0.8 which shows that the intersection is expected to operate within the normal range compared to similar intersection statewide.

Additionally, the possibility of converting to a right-in/right-out intersection was considered as it relates to safety. CMF ID 9821 indicates that there is a 45% crash reduction for installing a right-in/right-out at a

stop controlled intersection. The anticipated critical index with a right-in/right-out is 0.7 which shows that the intersection is expected to operate within the normal range compared to similar intersection statewide.

Glenwood Ave at Warren St

The existing critical index is 2.19 with a total of 23 crashes in the last five years. The crashes were analyzed to determine any major trends. It was found that 11 of the crashes occurred when it was dark outside, 13 of the crashes occurred between the months of November and March, and there were 5 ran off road crashes involving vehicles driving down the hill along westbound Warren St that lost control of their vehicle.

Improvements considered at the intersection include converting Warren St to a three-lane roadway and reducing the intersection skew. A clearinghouse crash modification factors were analyzed both improvements. CMF ID 199 indicates that there is a 29% crash reduction for converting a roadway from a four lane to a three lane and CMF ID 5188 indicates that there is a 13% crash reduction with a ~34 degree reduction in intersection skew. Both CMF's were applied to all crashes at the intersection. The anticipated critical index with a three lane and reduction in intersection skew is 1.43 which shows that the intersection is still expected to operate outside the normal range compared to similar intersection statewide if these are the only improvements.

The anticipated critical index was also analyzed to see how changing the traffic control could reduce crashes. CMF ID 3130 indicates that converting a two way stop controlled intersection to an all way stop is anticipated to reduce crashes by 61%. Converting the intersection to an all way stop in addition to converting Warren St to a three lane roadway results in an anticipated critical index of 0.47 (within the normal range). Additionally, converting the intersection to a single lane roundabout was also analyzed. According to the MnDOT study "A Study of the Traffic Safety at Roundabouts in Minnesota" the average crash rate for a single lane roundabout is 0.32. A single lane roundabout at the intersection of Glenwood Ave and Warren St is anticipated to operate with a crash rate around the statewide average (0.32).

Val Imm Dr at Highland Ave

The existing critical index is 1.14 with a total of 9 crashes in the last five years. 5 of the 9 crashes were ran off the road crashes with two crossing over into oncoming traffic, one that spun off to the right and the other two crashes were not clear what happened. Improvements considered at the intersection include installing a raised median along the southeast approach, removing the pork chops that channelize the right turn movements and reducing the intersection skew. A clearinghouse crash modification factors were analyzed for installing a raised median along the roadway and reducing the intersection skew angle. CMF ID 3034 indicates that there is a 39% crash reduction when a raised median is installed. CMF ID 5188 indicates that there is a 12% crash reduction based on the ~32 degree reduction in intersection skew. CMF ID 5188 was applied to all crashes where CMF ID 3034 was applied to the ran off the road crashes. The anticipated critical index installing the raised median is 0.88 which shows that the intersection is expected to operate within the normal range compared to similar intersection statewide.

The clearinghouse crash modification factors are included in the **Appendix**.

Warrant Analysis

Traffic signal warrants have been developed as national guidelines to promote continuity of traffic control devices to ensure that traffic signals are installed at intersections that would benefit from their use. These warrants as outlined in the MnMUTCD are listed below:

- Warrant 1: Eight-Hour Vehicular Volume
- Warrant 2: Four-Hour Vehicular Volume
- Warrant 3: Peak Hour
- Warrant 4: Pedestrian Volume
- Warrant 5: School Crossing
- Warrant 6: Coordinated Signal System
- Warrant 7: Crash Experience
- Warrant 8: Roadway Network
- Warrant 9: Intersection Near a Grade Crossing

A traffic signal shall not be installed unless one or more of the warrants can be met. Furthermore, a signal shall not be installed unless an engineering study indicates that the signal will improve the overall safety and operation of the intersection.

A warrant analysis was completed for the intersections of Warren St at Riverfront Dr, Front St, 2nd St, Broad St, and Glenwood Ave with a focus on the volume warrants due to the type of data made available for analysis (no pedestrian counts). Currently the intersection of Warren St at Riverfront Dr, Front St, 2nd St, and Broad St are signalized.

Existing traffic signals are viewed slightly differently than presented directly in the MnMUTCD – lower volume thresholds than typical are used to justify retaining an existing traffic signal. The MnDOT Traffic Engineering Manual states that signals which meet 80% of the volume requirements for Warrant 1 (1A or 1B) are considered justified traffic signals and should not be removed, but signals which do not meet 60% of the volume requirements for Warrant 1 (1A or 1B) are no longer justified traffic signals and should be removed. Signalized intersection that do not meet the 80% volume requirements but meet the 60% volume requirements need engineering judgment and documentation to justify retaining the signal. **Table 5** below summarizes which volume threshold if any are met for the intersections analyzed.

Table 5. Warrant Analysis

Intersection	Signal Warrant Met	Volume Threshold
Riverfront Dr	✓	100%
Front St	✗	60%
2nd St	✓	60%
Broad St	✓	60%
Glenwood Ave	✗	100%

Riverfront Dr at Warren St

- 100% Volume Threshold
  - Warrant 1B met
  - 2 hours met for Warrants 1A and 2

Front St at Warren St

- 60% Volume Threshold
  - No hours met for Warrants 1A, 1B, 2, or 3

2nd St at Warren St

- 100% Volume Threshold
  - 1 hour met for Warrant 1A
  - No hours met for Warrants 1B, 2, or 3
- 80% Volume Threshold
  - 4 hours met for Warrant 1A
  - 1 hour met for Warrant 1B
- 60% Volume Threshold
  - Warrant 1A met
  - 5 hours met for Warrant1B

Broad St at Warren St

- 100% Volume Threshold
  - No hours met for Warrants 1A, 1B, 2, or 3
- 80% Volume Threshold
  - 4 hours met for Warrant 1A
  - 2 hours met for Warrant 1B
- 60% Volume Threshold:
  - Warrant 1A met
  - 7 hours met for Warrant1B

Glenwood Ave at Warren St

- 100% Volume Threshold:
  - 1 hour met for Warrants 1A and 2
  - 2 hours met for Warrant 1B
- AWS Warrant
  - No hours met

The results of the signal warrant analysis are documented in the **Appendix**.

Appendix

Table A1: 2041 Three Lane Traffic Operations Analysis - Warren St Corridor Study

Intersection	Peak Hour	Intersection Delay (1.)		Movement Delay (sec/veh)																					
				NBL		NBT		NBR		SBL		SBT		SBR		EBL		EBT		EBR		WBL		WBT		WBR	
Riverfront Dr & Warren St	AM	11	B	13	B	13	B	8	A	16	B	8	A	5	A	15	B	12	B	4	A	15	B	9	A	6	A
Signalized Intersection	PM	15	B	16	B	16	B	10	B	15	B	16	B	12	B	19	B	13	B	8	A	18	B	11	B	7	A
Front St & Warren St	AM	5	A	27	C	26	C	9	A	24	C	28	C	4	A	11	B	2	A	4	A	2	A	2	A	1	A
Signalized Intersection	PM	8	A	21	C	20	C	8	A	22	C	21	C	12	B	7	A	5	A	3	A	8	A	4	A	3	A
2nd St & Warren St	AM	9	A	24	C	21	C	8	A	25	C	23	C	13	B	7	A	4	A	3	A	7	A	4	A	4	A
Signalized Intersection	PM	12	B	20	C	17	B	10	B	23	C	21	C	12	B	13	B	7	A	5	A	17	B	8	A	8	A
Broad St & Warren St	AM	11	B	20	C	21	C	6	A	22	C	21	C	10	B	14	B	7	A	6	A	10	B	6	A	4	A
Signalized Intersection	PM	10	B	20	C	18	B	7	A	22	C	20	C	14	B	12	B	6	A	4	A	11	B	7	A	5	A
4th St & Warren St	AM	2	A	17	C	14	B	6	A	14	B	12	B	9	A	3	A	1	A	1	A	3	A	1	A	1	A
Stop Controlled	PM	3	A	36	E	24	C	8	A	27	D	23	C	14	B	3	A	1	A	1	A	4	A	1	A	1	A
Glenwood Ave & Warren St	AM	7	A	-		-		-		32	D	-		19	C	8	A	1	A	-		-		5	A	3	A
Stop Controlled	PM	15	C	-		-		-		93	F	-		62	F	9	A	1	A	-		-		5	A	3	A
Ramsey St & Highland Ave	AM	1	A	11	B	-		4	A	-		-		-		-		1	A	0	A	3	A	0	A	-	
Stop Controlled	PM	1	A	12	B	-		5	A	-		-		-		-		1	A	1	A	4	A	0	A	-	
Pleasant St & Highland Ave	AM	1	A	9	A	-		5	A	-		-		-		-		0	A	-		-		1	A	-	
Stop Controlled	PM	2	A	12	B	-		7	A	-		-		-		-		1	A	-		-		1	A	-	
Val Imm Dr & Highland Ave	AM	2	A	11	B	-		3	A	-		-		-		-		1	A	0	A	4	A	1	A	-	
Stop Controlled	PM	4	A	18	C	-		4	A	-		-		-		-		2	A	1	A	5	A	1	A	-	
Highland Ave & Cedar St	AM	1	A	7	A	-		4	A	-		-		-		-		1	A	0	A	-		1	A	-	
Stop Controlled	PM	1	A	9	A	-		3	A	-		-		-		-		1	A	1	A	-		1	A	-	
Cedar St & Warren St	AM	1	A	-		-		-		7	A	-		4	A	3	A	1	A	-		-		0	A	0	A
Stop Controlled	PM	1	A	-		-		-		9	A	-		4	A	3	A	1	A	-		-		1	A	0	A
Haynes St & Warren St	AM	1	A	9	A	-		3	A	-		-		-		-		1	A	-		3	A	1	A	-	
Stop Controlled	PM	1	A	11	B	-		4	A	-		-		-		-		1	A	-		4	A	1	A	-	

1. Delay in seconds per vehicle

Table A2: 2041 Three Lane Peak Hour Queues By Movement

Intersection	Peak Hour	Queue Lengths (ft)																							
		EBL		EBT		EBR		WBL		WBT		WBR		NBL		NBT		NBR		SBL		SBT		SBR	
		Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max
Riverfront Dr & Warren St	AM	50	100	50	100	50	100	50	100	50	100	50	100	25	75	125	200	100	200	50	125	75	175	75	175
Signalized Intersection	PM	50	100	50	100	50	100	50	125	75	150	75	150	50	75	125	225	125	225	75	225	175	325	175	325
Front St & Warren St	AM	25	25	25	100	25	100	25	50	25	75	25	75	50	125	50	125	50	125	25	75	25	75	25	75
Stop Controlled	PM	25	50	50	150	50	150	50	75	50	150	50	150	75	150	75	150	75	150	75	150	75	150	75	150
2nd St & Warren St	AM	25	75	50	150	50	150	25	50	50	175	50	175	75	150	75	150	75	150	75	150	75	150	75	150
Stop Controlled	PM	25	75	100	200	100	200	50	175	100	250	100	250	75	150	75	150	75	150	100	225	100	225	100	225
Broad St & Warren St	AM	25	75	75	175	75	175	25	75	75	175	75	175	50	100	50	100	50	100	100	200	100	200	100	200
Stop Controlled	PM	25	75	125	250	125	250	25	75	125	225	125	225	50	100	50	100	50	100	100	200	100	200	100	200
4th St & Warren St	AM	25	50	0	25	0	25	25	50	-	-	-	-	25	50	25	50	25	50	50	75	50	75	50	75
Stop Controlled	PM	25	50	0	25	0	25	25	75	0	25	0	25	25	75	25	75	25	75	75	125	75	125	75	125
Glenwood Ave & Warren St	AM	75	225	-	-	-	-	-	-	50	150	50	150	-	-	-	-	-	-	75	225	-	-	75	225
Stop Controlled	PM	75	150	-	-	-	-	-	-	50	125	50	125	-	-	-	-	-	-	175	425	-	-	175	425
Ramsey St & Highland Ave	AM	-	-	-	-	-	-	25	50	-	-	-	-	25	75	-	-	25	75	-	-	-	-	-	-
Stop Controlled	PM	-	-	-	-	-	-	50	75	-	-	-	-	25	50	-	-	25	50	-	-	-	-	-	-
Pleasant St & Highland Ave	AM	-	-	-	-	-	-	-	-	-	-	-	-	50	100	-	-	50	100	-	-	-	-	-	-
Stop Controlled	PM	-	-	-	-	-	-	-	-	-	-	-	-	50	100	-	-	50	100	-	-	-	-	-	-
Val Imm Dr & Highland Ave	AM	-	-	-	-	-	-	25	50	-	-	-	-	50	100	-	-	50	100	-	-	-	-	-	-
Stop Controlled	PM	-	-	0	25	0	25	25	50	-	-	-	-	75	175	-	-	75	175	-	-	-	-	-	-
Highland Ave & Cedar St	AM	-	-	-	-	-	-	-	-	-	-	-	-	25	75	-	-	25	75	-	-	-	-	-	-
Stop Controlled	PM	-	-	-	-	-	-	-	-	-	-	-	-	25	50	-	-	25	50	-	-	-	-	-	-
Cedar St & Warren St	AM	25	50	25	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	50	-	-	25	50
Stop Controlled	PM	25	75	25	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	75	-	-	25	75
Haynes St & Warren St	AM	-	-	-	-	-	-	25	75	25	75	-	-	25	50	-	-	25	50	-	-	-	-	-	-
Stop Controlled	PM	-	-	-	-	-	-	25	75	25	75	-	-	25	50	-	-	25	50	-	-	-	-	-	-

Table A3: 2041 Two Lane Traffic Operations Analysis - Warren St Corridor Study

Intersection	Peak Hour	Intersection Delay (1.)		Movement Delay (sec/veh)																					
				NBL		NBT		NBR		SBL		SBT		SBR		EBL		EBT		EBR		WBL		WBT		WBR	
Riverfront Dr & Warren St	AM	12	B	14	B	14	B	10	B	16	B	8	A	5	A	14	B	12	B	7	A	12	B	11	B	8	A
Signalized Intersection	PM	17	B	18	B	18	B	12	B	18	B	17	B	12	B	17	B	16	B	11	B	17	B	15	B	11	B
Front St & Warren St	AM	6	A	29	C	29	C	9	A	29	C	26	C	8	A	7	A	2	A	1	A	3	A	2	A	1	A
Signalized Intersection	PM	8	A	23	C	23	C	9	A	23	C	22	C	9	A	6	A	5	A	4	A	6	A	3	A	3	A
2nd St & Warren St	AM	9	A	22	C	22	C	9	A	21	C	21	C	11	B	7	A	5	A	2	A	6	A	3	A	2	A
Signalized Intersection	PM	14	B	18	B	17	B	9	A	20	C	21	C	13	B	14	B	11	B	10	B	20	C	12	B	15	B
Broad St & Warren St	AM	11	B	19	B	20	C	6	A	23	C	23	C	12	B	10	B	7	A	8	A	11	B	7	A	5	A
Signalized Intersection	PM	11	B	19	B	19	B	8	A	20	C	22	C	17	B	13	B	9	A	8	A	13	B	8	A	6	A
4th St & Warren St	AM	2	A	20	C	12	B	6	A	13	B	12	B	6	A	3	A	1	A	1	A	3	A	1	A	1	A
Stop Controlled	PM	4	A	20	C	18	C	10	B	31	D	29	D	17	C	4	A	1	A	1	A	5	A	2	A	1	A
Glenwood Ave & Warren St	AM	6	A	-		-		-		30	D	-		13	B	6	A	2	A	-		-		4	A	3	A
Stop Controlled	PM	12	B	-		-		-		61	F	-		40	E	7	A	4	A	-		-		4	A	3	A
Ramsey St & Highland Ave	AM	2	A	12	B	-		3	A	-		-		-		-		1	A	1	A	4	A	2	A	-	
Stop Controlled	PM	2	A	15	C	-		5	A	-		-		-		-		1	A	1	A	5	A	2	A	-	
Pleasant St & Highland Ave	AM	1	A	11	B	-		4	A	-		-		-		-		1	A	-		-		1	A	-	
Stop Controlled	PM	2	A	13	B	-		6	A	-		-		-		-		1	A	-		-		1	A	-	
Val Imm Dr & Highland Ave	AM	2	A	12	B	-		3	A	-		-		-		-		1	A	0	A	4	A	1	A	-	
Stop Controlled	PM	4	A	19	C	-		4	A	-		-		-		-		2	A	1	A	5	A	1	A	-	
Highland Ave & Cedar St	AM	1	A	9	A	-		3	A	-		-		-		-		1	A	0	A	-		1	A	-	
Stop Controlled	PM	1	A	10	B	-		4	A	-		-		-		-		1	A	1	A	-		1	A	-	
Cedar St & Warren St	AM	1	A	-		-		-		7	A	-		4	A	3	A	1	A	-		-		1	A	0	A
Stop Controlled	PM	1	A	-		-		-		9	A	-		4	A	4	A	1	A	-		-		1	A	0	A
Haynes St & Warren St	AM	1	A	8	A	-		3	A	-		-		-		-		1	A	-		3	A	1	A	-	
Stop Controlled	PM	1	A	9	A	-		3	A	-		-		-		-		1	A	-		4	A	1	A	-	

1. Delay in seconds per vehicle

Table A4: 2041 Two Lane Peak Hour Queues By Movement

Intersection	Peak Hour	Queue Lengths (ft)																							
		EBL		EBT		EBR		WBL		WBT		WBR		NBL		NBT		NBR		SBL		SBT		SBR	
		Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max
Riverfront Dr & Warren St	AM	50	125	50	125	50	125	75	175	75	175	75	175	25	50	125	275	125	275	50	125	75	175	75	175
Signalized Intersection	PM	75	150	75	150	75	150	100	225	100	225	100	225	50	75	150	250	125	250	75	175	175	350	175	350
Front St & Warren St	AM	25	125	25	125	25	125	25	100	25	100	25	100	50	125	50	125	50	125	25	100	25	100	25	100
Stop Controlled	PM	75	175	75	175	75	175	75	175	75	175	75	175	75	150	75	150	75	150	75	150	75	150	75	150
2nd St & Warren St	AM	75	125	75	125	75	125	50	150	50	150	50	150	50	125	50	125	50	125	75	175	75	175	75	175
Stop Controlled	PM	125	250	125	250	125	250	125	325	125	325	125	325	75	150	75	150	75	150	100	200	100	200	100	200
Broad St & Warren St	AM	75	225	75	225	75	225	100	225	100	225	100	225	50	75	50	75	50	75	100	225	100	225	100	225
Stop Controlled	PM	125	300	125	300	125	300	125	275	125	275	125	275	50	100	50	100	50	100	100	175	100	175	100	175
4th St & Warren St	AM	25	75	25	75	25	75	25	125	25	125	25	125	25	50	25	50	25	50	50	75	50	75	50	75
Stop Controlled	PM	25	125	25	125	25	125	50	175	50	175	50	175	25	75	25	75	25	75	75	175	75	175	75	175
Glenwood Ave & Warren St	AM	75	200	75	200	-	-	-	-	25	125	25	125	-	-	-	-	-	-	75	175	-	-	75	175
Stop Controlled	PM	125	300	125	300	-	-	-	-	25	125	25	125	-	-	-	-	-	-	125	375	-	-	125	375
Ramsey St & Highland Ave	AM	-	-	0	25	0	25	25	100	25	100	-	-	25	50	-	-	25	50	-	-	-	-	-	-
Stop Controlled	PM	-	-	-	-	-	-	50	150	50	150	-	-	25	75	-	-	25	75	-	-	-	-	-	-
Pleasant St & Highland Ave	AM	-	-	-	-	-	-	-	-	-	-	-	-	50	75	-	-	50	75	-	-	-	-	-	-
Stop Controlled	PM	-	-	-	-	-	-	-	-	-	-	-	-	50	100	-	-	50	100	-	-	-	-	-	-
Val Imm Dr & Highland Ave	AM	-	-	-	-	-	-	25	50	-	-	-	-	50	125	-	-	50	125	-	-	-	-	-	-
Stop Controlled	PM	-	-	0	25	0	25	25	50	-	-	-	-	75	150	-	-	75	150	-	-	-	-	-	-
Highland Ave & Cedar St	AM	-	-	-	-	-	-	-	-	-	-	-	-	25	50	-	-	25	50	-	-	-	-	-	-
Stop Controlled	PM	-	-	-	-	-	-	-	-	-	-	-	-	25	50	-	-	25	50	-	-	-	-	-	-
Cedar St & Warren St	AM	25	50	25	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	50	-	-	25	50
Stop Controlled	PM	25	75	25	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	50	-	-	25	50
Haynes St & Warren St	AM	-	-	-	-	-	-	25	75	25	75	-	-	25	50	-	-	25	50	-	-	-	-	-	-
Stop Controlled	PM	-	-	-	-	-	-	25	75	25	75	-	-	25	25	-	-	25	25	-	-	-	-	-	-

Table A5: 2041 Operations Analysis - 4th St at Warren St

Option	Intersection	Peak Hour	Intersection Delay (1.)		Movement Delay (sec/veh)																					
					NBL		NBT		NBR		SBL		SBT		SBR		EBL		EBT		EBR		WBL		WBT		WBR	
Full Access (With Three Lane)	4th St & Warren St	AM	2	A	17	C	14	B	6	A	14	B	12	B	9	A	3	A	1	A	1	A	3	A	1	A	1	A
	Stop Controlled	PM	3	A	36	E	24	C	8	A	27	D	23	C	14	B	3	A	1	A	1	A	4	A	1	A	1	A
	Broad St & Warren St	AM	11	B	20	C	21	C	6	A	22	C	21	C	10	B	14	B	7	A	6	A	10	B	6	A	4	A
	Signalized Intersection	PM	10	B	20	C	18	B	7	A	22	C	20	C	14	B	12	B	6	A	4	A	11	B	7	A	5	A
Right-In/Right-Out	4th St & Warren St	AM	1	A	-		-		4	A	-		-		5	A	-		1	A	1	A	-		1	A	1	A
	Stop Controlled	PM	1	A	-		-		6	A	-		-		5	A	-		1	A	1	A	-		1	A	1	A
	Broad St & Warren St	AM	11	B	13	B	18	B	8	A	21	C	21	C	20	C	14	B	7	A	6	A	12	B	7	A	4	A
	Signalized Intersection	PM	11	B	20	C	16	B	8	A	20	C	20	C	15	B	19	B	8	A	5	A	16	B	9	A	6	A

1. Delay in seconds per vehicle

Table A6: 2041 Three Lane Peak Hour Queues By Movement

Option	Intersection	Peak Hour	Queue Lengths (ft)																							
			EBL		EBT		EBR		WBL		WBT		WBR		NBL		NBT		NBR		SBL		SBT		SBR	
			Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max
Full Access (With Three Lane)	4th St & Warren St	AM	25	50	0	25	0	25	25	50	-	-	-	-	25	50	25	50	25	50	50	75	50	75	50	75
	Stop Controlled	PM	25	50	0	25	0	25	25	75	0	25	0	25	25	75	25	75	25	75	75	125	75	125	75	125
	Broad St & Warren St	AM	25	75	75	175	75	175	25	75	75	175	75	175	50	100	50	100	50	100	100	200	100	200	100	200
	Stop Controlled	PM	25	75	125	250	125	250	25	75	125	225	125	225	50	100	50	100	50	100	100	200	100	200	100	200
Right-In/Right-Out	4th St & Warren St	AM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	50	-	-	-	-	25	50
	Stop Controlled	PM	0	25	25	25	25	25	-	-	-	-	-	-	-	-	-	-	25	50	-	-	-	-	25	50
	Broad St & Warren St	AM	25	100	75	200	75	200	50	100	75	200	75	200	50	100	50	100	50	100	125	250	125	250	125	250
	Stop Controlled	PM	25	100	150	275	150	275	50	125	125	225	125	225	50	100	50	100	50	100	125	250	125	250	125	250

Table A7: 2041 Operations Analysis - Glenwood Ave at Warren St

Option	Peak Hour	Intersection Delay (1.)		Movement Delay (sec/veh)											
				SBL		SBR		EBL		EBT		WBT		WBR	
No Build Two-Way Stop Contol	AM	6	A	38	E	21	C	6	A	1	A	2	A	3	A
	PM	7	A	40	E	22	C	6	A	2	A	2	A	2	A
Three Lane Two-Way Stop Contol	AM	7	A	32	D	19	C	8	A	1	A	5	A	3	A
	PM	15	C	93	F	62	F	9	A	1	A	5	A	3	A
Three Lane All-Way Stop Contol	AM	18	C	7	A	5	A	7	A	4	A	60	F	29	D
	PM	16	C	11	B	8	A	7	A	6	A	32	D	18	C
Roundabout	AM	7	A	5	A	5	A	7	A	7	A	7	A	7	A
	PM	9	A	7	A	7	A	8	A	8	A	10	A	10	A

1. Delay in seconds per vehicle

Table A8: 2041 Glenwood Ave at Warren St Peak Hour Queues By Movement

Option	Peak Hour	Queue Lengths (ft)											
		EBL		EBT		WBT		WBR		SBL		SBR	
		Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max
No Build - Two-Way Stop Contol	AM	75	225	75	225	25	50	25	50	75	250	75	250
	PM	100	225	100	225	25	75	25	75	100	275	100	275
Three Lane - Two-Way Stop Contol	AM	75	225	-	-	50	150	50	150	75	225	75	225
	PM	75	150	-	-	50	125	50	125	175	425	175	425
Three Lane - All-Way Stop Contol	AM	75	175	75	150	175	400	175	400	50	75	50	75
	PM	75	125	75	150	200	400	200	400	75	175	75	175
Roundabout	AM	-	50	-	50	-	50	-	50	-	25	-	25
	PM	-	75	-	75	-	75	-	75	-	25	-	25

CMF / CRF Details

CMF ID: 1420

Convert signal from pedestal-mounted to mast arm

Description:

Prior Condition: Existing pedestals were removed and replaced with mast arm signals

Category: Intersection traffic control

Study: *Signalized Intersections: Informational Guide*, Rodegerdts et al., 2004

Star Quality Rating:	★★★☆☆ [View score details]

Crash Modification Factor (CMF)	
Value:	0.51
Adjusted Standard Error:	
Unadjusted Standard Error:	0.031

Crash Reduction Factor (CRF)	
Value:	49 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	

Unadjusted Standard Error:	3.1

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	Not specified
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	
Traffic Volume:	
Time of Day:	All

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	
Traffic Control:	Signalized
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	
Municipality:	
State:	KS

Country:	usa
Type of Methodology Used:	Simple before/after
Sample Size Used:	Crashes
Before Sample Size Used:	809 Crashes
After Sample Size Used:	412 Crashes

Other Details

Included in Highway Safety Manual?	No
Date Added to Clearinghouse:	Dec-01-2009
Comments:	

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CMF / CRF Details

CMF ID: 199

Road diet (Convert 4-lane undivided road to 2-lanes plus turning lane)

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Roadway

Study: ***Crash Reduction Factors for Traffic Engineering and ITS Improvements*****, Harkey et al., 2008**

Star Quality Rating:	★★★★★

Crash Modification Factor (CMF)	
Value:	0.71
Adjusted Standard Error:	0.02
Unadjusted Standard Error:	

Crash Reduction Factor (CRF)	
Value:	29 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	2

Unadjusted Standard Error:	

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	Minor Arterial
Number of Lanes:	4
Road Division Type:	
Speed Limit:	
Area Type:	Urban
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	
Intersection Geometry:	
Traffic Control:	
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	
Municipality:	
State:	

Country:	
Type of Methodology Used:	Before/after using empirical Bayes or full Bayes
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	Yes. HSM lists this CMF in **bold** font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.
Date Added to Clearinghouse:	Dec-01-2009
Comments:	

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CMF / CRF Details

CMF ID: 9821

Install right-in-right-out (RIRO) operations at stop-controlled intersections

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Access management

Study: ***Safety Effects of Turning Movement Restrictions at Stop-Controlled Intersections*****, Le et al., 2018**

Star Quality Rating:	★★★★☆ [View score details]

Crash Modification Factor (CMF)	
Value:	0.55
Adjusted Standard Error:	
Unadjusted Standard Error:	0.09

Crash Reduction Factor (CRF)	
Value:	45 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	

Unadjusted Standard Error:	9

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	Not specified
Number of Lanes:	4 and 6
Road Division Type:	Divided by Median
Speed Limit:	
Area Type:	Urban
Traffic Volume:	
Time of Day:	All

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	3-leg
Traffic Control:	Stop-controlled
Major Road Traffic Volume:	13433 to 75000 Annual Average Daily Traffic (AADT)
Minor Road Traffic Volume:	51 to 2600 Annual Average Daily Traffic (AADT)

Development Details

Date Range of Data Used:	
Municipality:	
State:	CA

Country:	USA
Type of Methodology Used:	Regression cross-section
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	No
Date Added to Clearinghouse:	Oct-27-2018
Comments:	This CMF compares urban, three-legged, stop-controlled intersections with RIRO operation to full movement. This CMF looks at Total crashes. Total crashes are defined as all crashes within 100 ft of intersection (all types and severities combined)

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CRASH MODIFICATION FACTORS CLEARINGHOUSE

CMF / CRF Details

CMF ID: 5188

Change intersection skew angle

Description: Skew angle is defined as the absolute value of the difference between 90 degrees and the actual intersection angle (see illustration).

Prior Condition: ***No Prior Condition(s)***

Category: Intersection geometry

Study: ***Prediction of the Expected Safety Performance of Rural Two-Lane Highways*****, Harwood et al., 2000**

Star Quality Rating:	

Crash Modification Factor (CMF)	
Value:	$CMF = e^{0.0040(proposedSkewAngle - existingSkewAngle)}$
Adjusted Standard Error:	
Unadjusted Standard Error:	

Crash Reduction Factor (CRF)	
Value:	*(This value indicates an **increase** in crashes)*

Adjusted Standard Error:	
Unadjusted Standard Error:	

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	Minor Arterial
Number of Lanes:	2
Road Division Type:	
Speed Limit:	
Area Type:	Rural
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	3-leg
Traffic Control:	Stop-controlled
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	
Municipality:	

State:	
Country:	
Type of Methodology Used:	Not specified
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	
Date Added to Clearinghouse:	Dec-01-2009
Comments:	A related form of this equation is found in the HSM 1st Ed, page 14-17. The HSM form is presented with an assumption that the existing skew angle (base condition) is 90 degrees. The formula has been rearranged for presentation on the CMF Clearinghouse to allow the user to input the existing and proposed skew angles in a single equation.

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CMF / CRF Details

CMF ID: 3130

Convert two-way (without flashing beacons) to all-way stop control (without flashing beacons)

Description: Conversion from two-way stop sign control without flashing beacons to all-way stop sign control without flashing beacons.

Prior Condition: Two-way stop sign control without flashing beacons.

Category: Intersection traffic control

Study: *Evaluation of the Conversion from Two-Way Stop Sign Control to All-Way Stop Sign Control at 53 Locations in North Carolina*, Simpson and Hummer, 2010

Star Quality Rating:	★★★★☆ [View score details]

Crash Modification Factor (CMF)	
Value:	0.393
Adjusted Standard Error:	
Unadjusted Standard Error:	0.033

Crash Reduction Factor (CRF)	
Value:	60.7 *(This value indicates a **decrease** in crashes)*

Adjusted Standard Error:	
Unadjusted Standard Error:	3.3

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	All
Number of Lanes:	1
Road Division Type:	Undivided
Speed Limit:	25-55
Area Type:	All
Traffic Volume:	
Time of Day:	Not specified

If countermeasure is intersection-based

Intersection Type:	
Intersection Geometry:	4-leg
Traffic Control:	Stop-controlled
Major Road Traffic Volume:	680 to 15100
Minor Road Traffic Volume:	680 to 15100

Development Details

Date Range of Data Used:	1990 to 2009
Municipality:	

State:	NC
Country:	
Type of Methodology Used:	Before/after using empirical Bayes or full Bayes
Sample Size Used:	Site-years

Other Details

Included in Highway Safety Manual?	No
Date Added to Clearinghouse:	Jul-15-2011
Comments:	

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CMF / CRF Details

CMF ID: 3034

Install raised median

Description:

Prior Condition: no raised median

Category: Access management

Study: *Analyzing Raised Median Safety Impacts Using Bayesian Methods*, Schultz et al., 2011

Star Quality Rating:	★★★★☆ [View score details]

Crash Modification Factor (CMF)	
Value:	0.61
Adjusted Standard Error:	
Unadjusted Standard Error:	

Crash Reduction Factor (CRF)	
Value:	39 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	

Unadjusted Standard Error:	

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	Not specified
Number of Lanes:	
Road Division Type:	Divided by Median
Speed Limit:	
Area Type:	
Traffic Volume:	10000 to 55000 *Average Daily Traffic (ADT)*
Time of Day:	All

If countermeasure is intersection-based

Intersection Type:	
Intersection Geometry:	
Traffic Control:	
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	1998 to 2008
Municipality:	
State:	UT

Country:	USA
Type of Methodology Used:	Before/after using empirical Bayes or full Bayes
Sample Size Used:	Site-years
Before Sample Size Used:	32 Site-years
After Sample Size Used:	28 Site-years

Other Details

Included in Highway Safety Manual?	No
Date Added to Clearinghouse:	Jul-15-2011
Comments:	

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SIGNAL WARRANTS ANALYSIS FOR

Riverfront Dr St & Warren St

LOCATION: Riverfront Dr St & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description		Lanes
30	Major App1:	NORTHBOUND - Riverfront Dr	3
30	Major App3:	SOUTHBOUND - Riverfront Dr	3
30	Minor App2:	EASTBOUND - Warren St	1
30	Minor App4:	WESTBOUND - Warren St	2

0.70 FACTOR USED? No
POPULATION < 10,000? No
N/A No

THRESHOLDS 1A/1B: 600/900 150/75 200/100

HOUR	MAJOR APP. 1	MAJOR APP. 3	TOTAL 1+3	MAJOR 1A/1B	MINOR APP. 2	MINOR 2 1A/1B	MINOR APP. 4	MINOR 4 (	**MET SAME 1A/1B**
0:00 - 1:00	48	75	123	/	9	/	10	/	**/**
1:00 - 2:00	41	29	70	/	5	/	7	/	**/**
2:00 - 3:00	18	29	47	/	3	/	9	/	**/**
3:00 - 4:00	25	25	50	/	5	/	5	/	**/**
4:00 - 5:00	34	30	64	/	6	/	3	/	**/**
5:00 - 6:00	95	72	167	/	8	/	17	/	**/**
6:00 - 7:00	229	152	381	/	34	/	31	/	**/**
7:00 - 8:00	483	322	805	X/	62	/	59	/	**/**
8:00 - 9:00	486	446	932	X/X	88	/X	66	/	**/X**
9:00 - 10:00	376	344	720	X/	83	/X	56	/	**/**
10:00 - 11:00	432	452	884	X/	90	/X	67	/	**/**
11:00 - 12:00	476	483	959	X/X	89	/X	77	/	**/X**
12:00 - 13:00	543	655	1198	X/X	158	X/X	102	/X	**X/X**
13:00 - 14:00	527	580	1107	X/X	139	/X	105	/X	**/X**
14:00 - 15:00	508	609	1117	X/X	126	/X	104	/X	**/X**
15:00 - 16:00	524	668	1192	X/X	123	/X	102	/X	**/X**
16:00 - 17:00	560	740	1300	X/X	156	X/X	118	/X	**X/X**
17:00 - 18:00	518	762	1280	X/X	118	/X	113	/X	**/X**
18:00 - 19:00	388	532	920	X/X	105	/X	88	/	**/X**
19:00 - 20:00	341	423	764	X/	53	/	85	/	**/**
20:00 - 21:00	227	326	553	/	41	/	78	/	**/**
21:00 - 22:00	184	260	444	/	36	/	45	/	**/**
22:00 - 23:00	117	192	309	/	30	/	33	/	**/**
23:00 - 24:00	58	98	156	/	21	/	21	/	**/**

	Met (Hr)	Required (Hr)	
Warrant 1A	2	8	Not satisfied
Warrant 1B	**9**	8	**Satisfied**
Warrant 2	2	4	Not satisfied
Warrant 3	0	1	Not satisfied
Warrant 7	**13**	8	**Satisfied, check accident record**

LOCATION: Riverfront Dr St & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description	Lanes
30	Major App1: NORTHBOUND - Riverfront Dr	3
30	Major App3: SOUTHBOUND - Riverfront Dr	3
30	Minor App2: EASTBOUND - Warren St	1
30	Minor App4: WESTBOUND - Warren St	2

0.70 FACTOR USED? No
POPULATION < 10,000? No

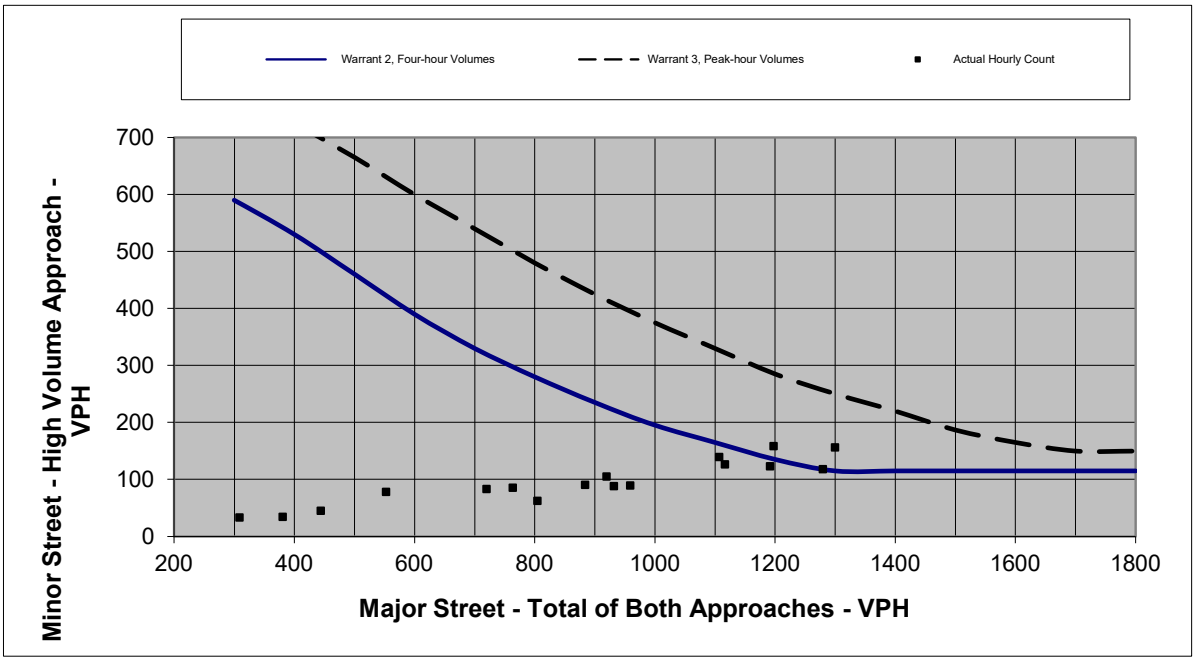

Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria		
Major	Warrant 2, F	Warrant 3, Pe
200		
300	590	
400	530	725
500	460	665
600	390	600
700	330	540
800	280	480
900	235	425
1000	195	375
1100	165	330
1200	135	285
1300	115	250
1400	115	220
1500	115	187
1600	115	165
1700	115	150
1800	115	150

Actual Hourly Count	
Major	Actual Hourly Count
123	10
70	7
47	9
50	5
64	6
167	17
381	34
805	62
932	88
720	83
884	90
959	89
1198	158
1107	139
1117	126
1192	123
1300	156
1280	118
920	105
764	85
553	78
444	45
309	33
156	21

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SIGNAL WARRANTS ANALYSIS FOR

Front St & Warren St

LOCATION: Front St & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description		Lanes
30	Major App1:	EASTBOUND - Warren St	2
30	Major App3:	WESTBOUND - Warren St	2
30	Minor App2:	NORTHBOUND - Front St	1
30	Minor App4:	SOUTHBOUND - Front St	1

0.70 FACTOR USED? No
POPULATION < 10,000? No
N/A Yes

60% THRESHOLDS 1A/1B: **360/540** **90/45** **90/45**

HOUR	MAJOR APP. 1	MAJOR APP. 3	TOTAL 1+3	MAJOR 1A/1B	MINOR APP. 2	MINOR 2 1A/1B	MINOR APP. 4	MINOR 4 (	**MET SAME 1A/1B**
0:00 - 1:00	27	16	43	/	5	/	9	/	/
1:00 - 2:00	16	9	25	/	1	/	11	/	/
2:00 - 3:00	12	16	28	/	5	/	6	/	/
3:00 - 4:00	11	7	18	/	3	/	1	/	/
4:00 - 5:00	6	9	15	/	1	/	1	/	/
5:00 - 6:00	15	38	53	/	3	/	1	/	/
6:00 - 7:00	50	65	115	/	8	/	13	/	/
7:00 - 8:00	121	112	233	/	12	/	15	/	/
8:00 - 9:00	148	119	267	/	28	/	22	/	/
9:00 - 10:00	141	124	265	/	22	/	38	/	/
10:00 - 11:00	124	120	244	/	28	/	45	/X	/
11:00 - 12:00	148	146	294	/	37	/	70	/X	/
12:00 - 13:00	200	222	422	X/	35	/	69	/X	/
13:00 - 14:00	190	204	394	X/	40	/	56	/X	/
14:00 - 15:00	173	220	393	X/	34	/	51	/X	/
15:00 - 16:00	179	222	401	X/	40	/	52	/X	/
16:00 - 17:00	228	216	444	X/	41	/	59	/X	/
17:00 - 18:00	223	222	445	X/	37	/	60	/X	/
18:00 - 19:00	152	135	287	/	32	/	47	/X	/
19:00 - 20:00	125	150	275	/	33	/	53	/X	/
20:00 - 21:00	108	104	212	/	20	/	28	/	/
21:00 - 22:00	64	97	161	/	17	/	23	/	/
22:00 - 23:00	68	58	126	/	13	/	27	/	/
23:00 - 24:00	37	35	72	/	6	/	13	/	/

	Met (Hr)	Required (Hr)	
Warrant 1A	0	8	Not satisfied
Warrant 1B	0	8	Not satisfied
Warrant 2	0	4	Not satisfied
Warrant 3	0	1	Not satisfied
Warrant 7	0	8	Not satisfied

LOCATION: Front St & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description	Lanes
30	Major App1: EASTBOUND - Warren St	2
30	Major App3: WESTBOUND - Warren St	2
30	Minor App2: NORTHBOUND - Front St	1
30	Minor App4: SOUTHBOUND - Front St	1

0.70 FACTOR USED? No
POPULATION < 10,000? No

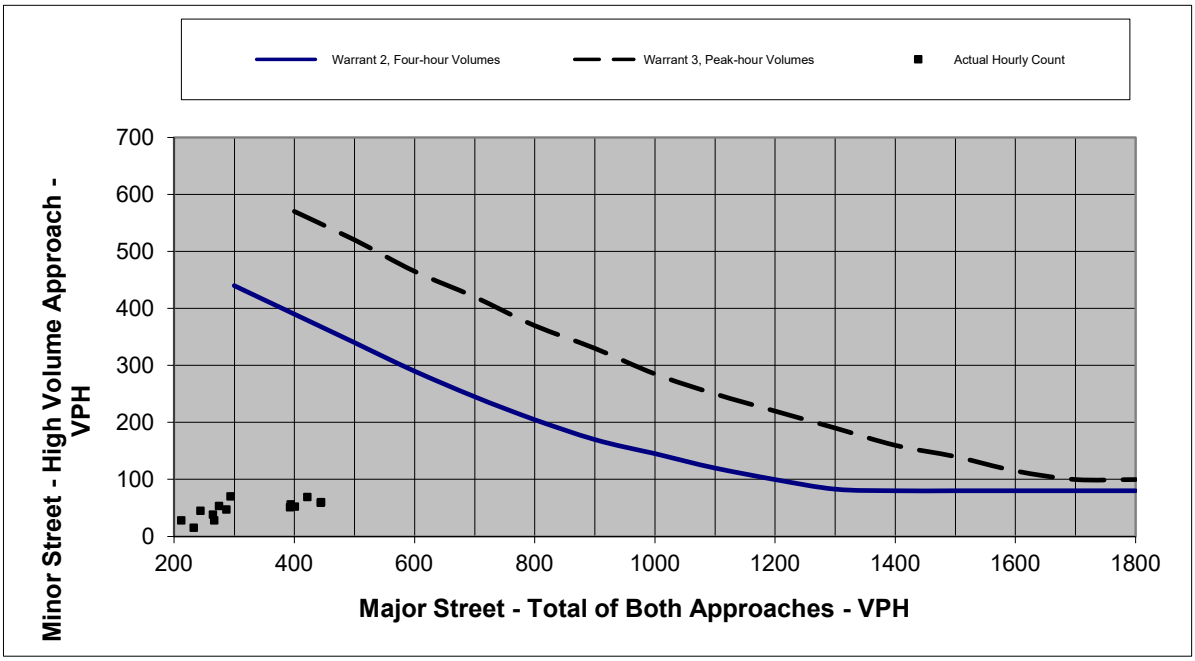

Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria			Actual Hourly Count	
Major	Warrant 2, F	Warrant 3, Pe	Major	Actual Hourly Count
200			43	9
300	440		25	11
400	390	570	28	6
500	340	520	18	3
600	290	465	15	1
700	245	420	53	3
800	205	370	115	13
900	170	330	233	15
1000	145	285	267	28
1100	120	250	265	38
1200	100	220	244	45
1300	83	190	294	70
1400	80	160	422	69
1500	80	140	394	56
1600	80	115	393	51
1700	80	100	401	52
1800	80	100	444	59
			445	60
			287	47
			275	53
			212	28
			161	23
			126	27
			72	13

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SIGNAL WARRANTS ANALYSIS FOR

2nd St St & Warren St

LOCATION: 2nd St St & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description		Lanes
30	Major App1:	EASTBOUND - Warren St	2
30	Major App3:	WESTBOUND - Warren St	2
30	Minor App2:	NORTHBOUND - 2nd St	1
30	Minor App4:	SOUTHBOUND - 2nd St	1

0.70 FACTOR USED? No
POPULATION < 10,000? No
N/A No

THRESHOLDS 1A/1B: 600/900 150/75 150/75

HOUR	MAJOR APP. 1	MAJOR APP. 3	TOTAL 1+3	MAJOR 1A/1B	MINOR APP. 2	MINOR 2 1A/1B	MINOR APP. 4	MINOR 4 (	**MET SAME 1A/1B**
0:00 - 1:00	17	14	31	/	5	/	16	/	**/**
1:00 - 2:00	20	15	35	/	1	/	8	/	**/**
2:00 - 3:00	12	9	21	/	3	/	6	/	**/**
3:00 - 4:00	7	9	16	/	1	/	1	/	**/**
4:00 - 5:00	15	38	53	/	5	/	6	/	**/**
5:00 - 6:00	54	63	117	/	7	/	17	/	**/**
6:00 - 7:00	136	131	267	/	53	/	57	/	**/**
7:00 - 8:00	204	181	385	/	67	/	131	/X	**/**
8:00 - 9:00	163	132	295	/	46	/	78	/X	**/**
9:00 - 10:00	188	139	327	/	61	/	81	/X	**/**
10:00 - 11:00	195	167	362	/	72	/	100	/X	**/**
11:00 - 12:00	261	198	459	/	63	/	102	/X	**/**
12:00 - 13:00	250	218	468	/	75	/X	116	/X	**/**
13:00 - 14:00	202	234	436	/	94	/X	124	/X	**/**
14:00 - 15:00	242	252	494	/	74	/	127	/X	**/**
15:00 - 16:00	272	247	519	/	74	/	149	/X	**/**
16:00 - 17:00	299	322	621	X/	83	/X	188	X/X	**X/**
17:00 - 18:00	205	191	396	/	53	/	123	/X	**/**
18:00 - 19:00	173	158	331	/	48	/	95	/X	**/**
19:00 - 20:00	138	156	294	/	35	/	102	/X	**/**
20:00 - 21:00	101	110	211	/	14	/	72	/	**/**
21:00 - 22:00	116	76	192	/	11	/	35	/	**/**
22:00 - 23:00	49	47	96	/	12	/	22	/	**/**
23:00 - 24:00	21	31	52	/	3	/	20	/	**/**

	Met (Hr)	Required (Hr)	
Warrant 1A	1	8	Not satisfied
Warrant 1B	0	8	Not satisfied
Warrant 2	0	4	Not satisfied
Warrant 3	0	1	Not satisfied
Warrant 7	3	8	Not satisfied

LOCATION: 2nd St St & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description	Lanes
30	Major App1: EASTBOUND - Warren St	2
30	Major App3: WESTBOUND - Warren St	2
30	Minor App2: NORTHBOUND - 2nd St	1
30	Minor App4: SOUTHBOUND - 2nd St	1

0.70 FACTOR USED? No
POPULATION < 10,000? No

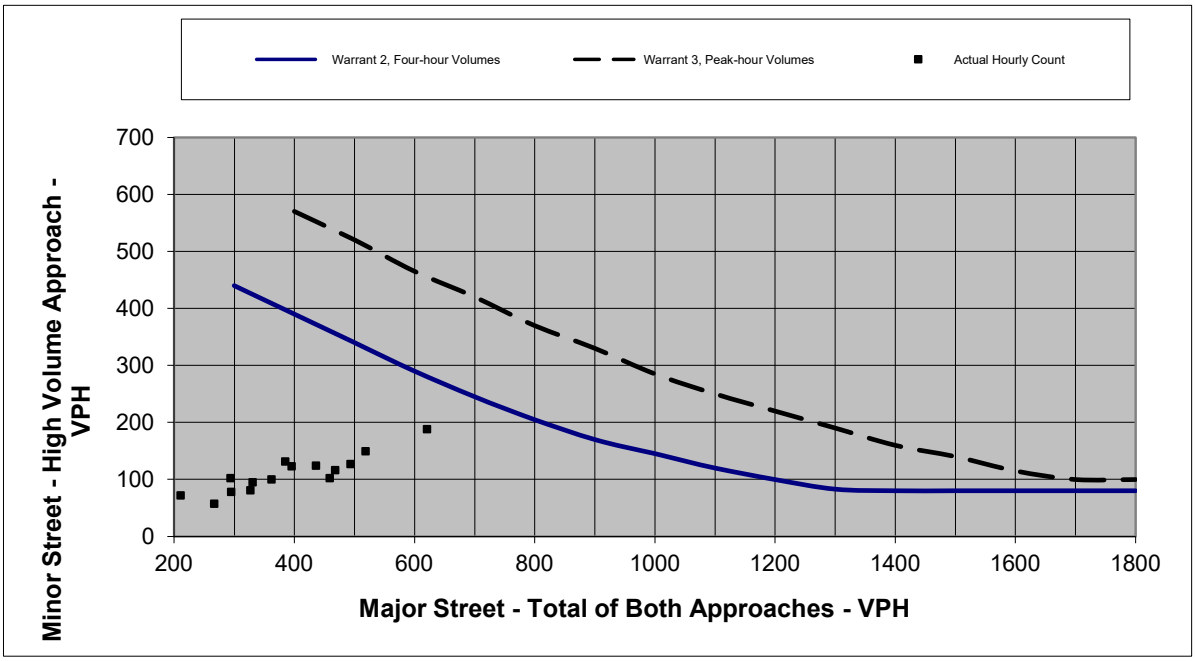

Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria		
Major	Warrant 2, F	Warrant 3, Pe
200		
300	440	
400	390	570
500	340	520
600	290	465
700	245	420
800	205	370
900	170	330
1000	145	285
1100	120	250
1200	100	220
1300	83	190
1400	80	160
1500	80	140
1600	80	115
1700	80	100
1800	80	100

Actual Hourly Count	
Major	Actual Hourly Count
31	16
35	8
21	6
16	1
53	6
117	17
267	57
385	131
295	78
327	81
362	100
459	102
468	116
436	124
494	127
519	149
621	188
396	123
331	95
294	102
211	72
192	35
96	22
52	20

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SIGNAL WARRANTS ANALYSIS FOR

2nd St St & Warren St

LOCATION: 2nd St St & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description		Lanes
30	Major App1:	EASTBOUND - Warren St	2
30	Major App3:	WESTBOUND - Warren St	2
30	Minor App2:	NORTHBOUND - 2nd St	1
30	Minor App4:	SOUTHBOUND - 2nd St	1

0.70 FACTOR USED? No
POPULATION < 10,000? No
N/A Yes

80% THRESHOLDS 1A/1B: **480/720** **120/60** **120/60**

HOUR	MAJOR APP. 1	MAJOR APP. 3	TOTAL 1+3	MAJOR 1A/1B	MINOR APP. 2	MINOR 2 1A/1B	MINOR APP. 4	MINOR 4 (	**MET SAME 1A/1B**
0:00 - 1:00	17	14	31	/	5	/	16	/	**/**
1:00 - 2:00	20	15	35	/	1	/	8	/	**/**
2:00 - 3:00	12	9	21	/	3	/	6	/	**/**
3:00 - 4:00	7	9	16	/	1	/	1	/	**/**
4:00 - 5:00	15	38	53	/	5	/	6	/	**/**
5:00 - 6:00	54	63	117	/	7	/	17	/	**/**
6:00 - 7:00	136	131	267	/	53	/	57	/	**/**
7:00 - 8:00	204	181	385	/	67	/X	131	X/X	**/**
8:00 - 9:00	163	132	295	/	46	/	78	/X	**/**
9:00 - 10:00	188	139	327	/	61	/X	81	/X	**/**
10:00 - 11:00	195	167	362	/	72	/X	100	/X	**/**
11:00 - 12:00	261	198	459	/	63	/X	102	/X	**/**
12:00 - 13:00	250	218	468	/	75	/X	116	/X	**/**
13:00 - 14:00	202	234	436	/	94	/X	124	X/X	**/**
14:00 - 15:00	242	252	494	X/	74	/X	127	X/X	**X/**
15:00 - 16:00	272	247	519	X/	74	/X	149	X/X	**X/**
16:00 - 17:00	299	322	621	X/	83	/X	188	X/X	**X/**
17:00 - 18:00	205	191	396	/	53	/	123	X/X	**/**
18:00 - 19:00	173	158	331	/	48	/	95	/X	**/**
19:00 - 20:00	138	156	294	/	35	/	102	/X	**/**
20:00 - 21:00	101	110	211	/	14	/	72	/X	**/**
21:00 - 22:00	116	76	192	/	11	/	35	/	**/**
22:00 - 23:00	49	47	96	/	12	/	22	/	**/**
23:00 - 24:00	21	31	52	/	3	/	20	/	**/**

	Met (Hr)	Required (Hr)	
Warrant 1A	3	8	Not satisfied
Warrant 1B	0	8	Not satisfied
Warrant 2	0	4	Not satisfied
Warrant 3	0	1	Not satisfied
Warrant 7	**8**	8	**Satisfied, check accident record**

LOCATION: 2nd St St & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020

OPERATOR: KR

Speed	Approach Description	Lanes
30	Major App1: EASTBOUND - Warren St	2
30	Major App3: WESTBOUND - Warren St	2
30	Minor App2: NORTHBOUND - 2nd St	1
30	Minor App4: SOUTHBOUND - 2nd St	1

0.70 FACTOR USED? No
POPULATION < 10,000? No

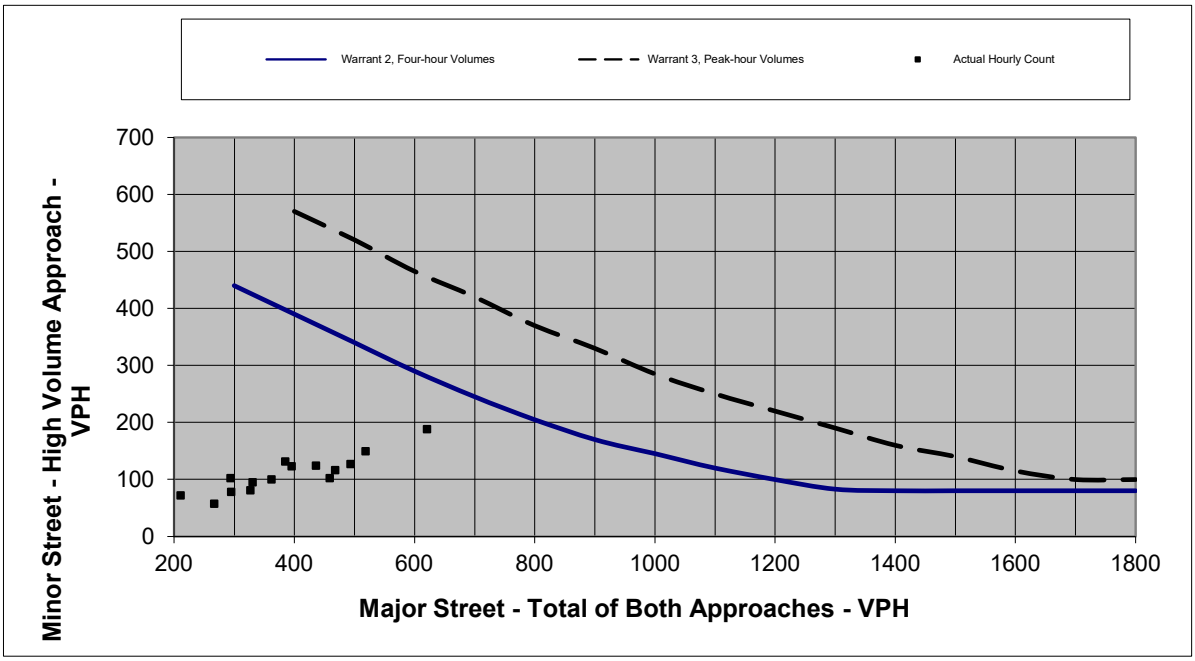

Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria		
Major	Warrant 2, F	Warrant 3, Pe
200		
300	440	
400	390	570
500	340	520
600	290	465
700	245	420
800	205	370
900	170	330
1000	145	285
1100	120	250
1200	100	220
1300	83	190
1400	80	160
1500	80	140
1600	80	115
1700	80	100
1800	80	100

Actual Hourly Count	
Major	Actual Hourly Count
31	16
35	8
21	6
16	1
53	6
117	17
267	57
385	131
295	78
327	81
362	100
459	102
468	116
436	124
494	127
519	149
621	188
396	123
331	95
294	102
211	72
192	35
96	22
52	20

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SIGNAL WARRANTS ANALYSIS FOR

2nd St St & Warren St

LOCATION: 2nd St St & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description		Lanes
30	Major App1:	EASTBOUND - Warren St	2
30	Major App3:	WESTBOUND - Warren St	2
30	Minor App2:	NORTHBOUND - 2nd St	1
30	Minor App4:	SOUTHBOUND - 2nd St	1

0.70 FACTOR USED? No
POPULATION < 10,000? No
N/A Yes

60% THRESHOLDS 1A/1B: 360/540 90/45 90/45

HOUR	MAJOR APP. 1	MAJOR APP. 3	TOTAL 1+3	MAJOR 1A/1B	MINOR APP. 2	MINOR 2 1A/1B	MINOR APP. 4	MINOR 4 (	**MET SAME 1A/1B**
0:00 - 1:00	17	14	31	/	5	/	16	/	**/**
1:00 - 2:00	20	15	35	/	1	/	8	/	**/**
2:00 - 3:00	12	9	21	/	3	/	6	/	**/**
3:00 - 4:00	7	9	16	/	1	/	1	/	**/**
4:00 - 5:00	15	38	53	/	5	/	6	/	**/**
5:00 - 6:00	54	63	117	/	7	/	17	/	**/**
6:00 - 7:00	136	131	267	/	53	/X	57	/X	**/**
7:00 - 8:00	204	181	385	X/	67	/X	131	X/X	**X/**
8:00 - 9:00	163	132	295	/	46	/X	78	/X	**/**
9:00 - 10:00	188	139	327	/	61	/X	81	/X	**/**
10:00 - 11:00	195	167	362	X/	72	/X	100	X/X	**X/**
11:00 - 12:00	261	198	459	X/	63	/X	102	X/X	**X/**
12:00 - 13:00	250	218	468	X/	75	/X	116	X/X	**X/**
13:00 - 14:00	202	234	436	X/	94	/X	124	X/X	**X/**
14:00 - 15:00	242	252	494	X/	74	/X	127	X/X	**X/**
15:00 - 16:00	272	247	519	X/	74	/X	149	X/X	**X/**
16:00 - 17:00	299	322	621	X/X	83	/X	188	X/X	**X/X**
17:00 - 18:00	205	191	396	X/	53	/X	123	X/X	**X/**
18:00 - 19:00	173	158	331	/	48	/X	95	X/X	**/**
19:00 - 20:00	138	156	294	/	35	/	102	X/X	**/**
20:00 - 21:00	101	110	211	/	14	/	72	/X	**/**
21:00 - 22:00	116	76	192	/	11	/	35	/	**/**
22:00 - 23:00	49	47	96	/	12	/	22	/	**/**
23:00 - 24:00	21	31	52	/	3	/	20	/	**/**

	Met (Hr)	Required (Hr)	
Warrant 1A	**9**	8	**Satisfied**
Warrant 1B	1	8	Not satisfied
Warrant 2	0	4	Not satisfied
Warrant 3	0	1	Not satisfied
Warrant 7	**8**	8	**Satisfied, check accident record**

LOCATION: 2nd St St & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description	Lanes
30	Major App1: EASTBOUND - Warren St	2
30	Major App3: WESTBOUND - Warren St	2
30	Minor App2: NORTHBOUND - 2nd St	1
30	Minor App4: SOUTHBOUND - 2nd St	1

0.70 FACTOR USED? No
POPULATION < 10,000? No

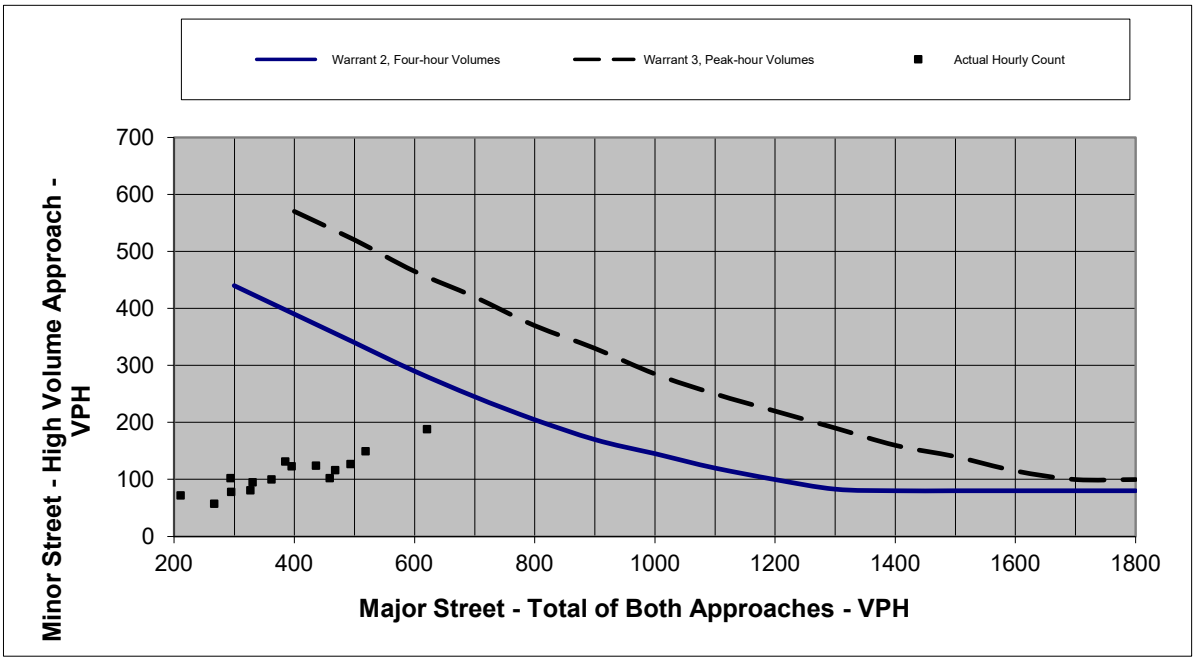

Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria		
Major	Warrant 2, F	Warrant 3, Pe
200		
300	440	
400	390	570
500	340	520
600	290	465
700	245	420
800	205	370
900	170	330
1000	145	285
1100	120	250
1200	100	220
1300	83	190
1400	80	160
1500	80	140
1600	80	115
1700	80	100
1800	80	100

Actual Hourly Count	
Major	Actual Hourly Count
31	16
35	8
21	6
16	1
53	6
117	17
267	57
385	131
295	78
327	81
362	100
459	102
468	116
436	124
494	127
519	149
621	188
396	123
331	95
294	102
211	72
192	35
96	22
52	20

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SIGNAL WARRANTS ANALYSIS FOR

Broad St St & Warren St

LOCATION: Broad St St & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description		Lanes
30	Major App1:	EASTBOUND - Warren St	2
30	Major App3:	WESTBOUND - Warren St	2
30	Minor App2:	NORTHBOUND - Broad St	1
30	Minor App4:	SOUTHBOUND - Broad St	1

0.70 FACTOR USED? No
POPULATION < 10,000? No
N/A No

THRESHOLDS 1A/1B: 600/900 150/75 150/75

HOUR	MAJOR APP. 1	MAJOR APP. 3	TOTAL 1+3	MAJOR 1A/1B	MINOR APP. 2	MINOR 2 1A/1B	MINOR APP. 4	MINOR 4 (	**MET SAME 1A/1B**
0:00 - 1:00	52	37	89	/	2	/	11	/	/
1:00 - 2:00	23	18	41	/	1	/	8	/	/
2:00 - 3:00	21	13	34	/	2	/	8	/	/
3:00 - 4:00	10	10	20	/	1	/	2	/	/
4:00 - 5:00	9	15	24	/	0	/	3	/	/
5:00 - 6:00	26	33	59	/	4	/	5	/	/
6:00 - 7:00	57	77	134	/	8	/	17	/	/
7:00 - 8:00	162	224	386	/	16	/	75	/X	/
8:00 - 9:00	231	207	438	/	21	/	133	/X	/
9:00 - 10:00	191	144	335	/	14	/	68	/	/
10:00 - 11:00	168	168	336	/	11	/	71	/	/
11:00 - 12:00	221	193	414	/	18	/	90	/X	/
12:00 - 13:00	264	270	534	/	19	/	98	/X	/
13:00 - 14:00	231	248	479	/	25	/	83	/X	/
14:00 - 15:00	250	290	540	/	33	/	110	/X	/
15:00 - 16:00	237	277	514	/	24	/	121	/X	/
16:00 - 17:00	338	364	702	X/	19	/	121	/X	/
17:00 - 18:00	355	318	673	X/	24	/	133	/X	/
18:00 - 19:00	263	236	499	/	19	/	105	/X	/
19:00 - 20:00	223	198	421	/	15	/	71	/	/
20:00 - 21:00	188	203	391	/	17	/	58	/	/
21:00 - 22:00	156	136	292	/	9	/	33	/	/
22:00 - 23:00	129	68	197	/	5	/	36	/	/
23:00 - 24:00	58	50	108	/	2	/	14	/	/

	Met (Hr)	Required (Hr)	
Warrant 1A	0	8	Not satisfied
Warrant 1B	0	8	Not satisfied
Warrant 2	0	4	Not satisfied
Warrant 3	0	1	Not satisfied
Warrant 7	3	8	Not satisfied

LOCATION: Broad St St & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description	Lanes
30	Major App1: EASTBOUND - Warren St	2
30	Major App3: WESTBOUND - Warren St	2
30	Minor App2: NORTHBOUND - Broad St	1
30	Minor App4: SOUTHBOUND - Broad St	1

0.70 FACTOR USED? No
POPULATION < 10,000? No

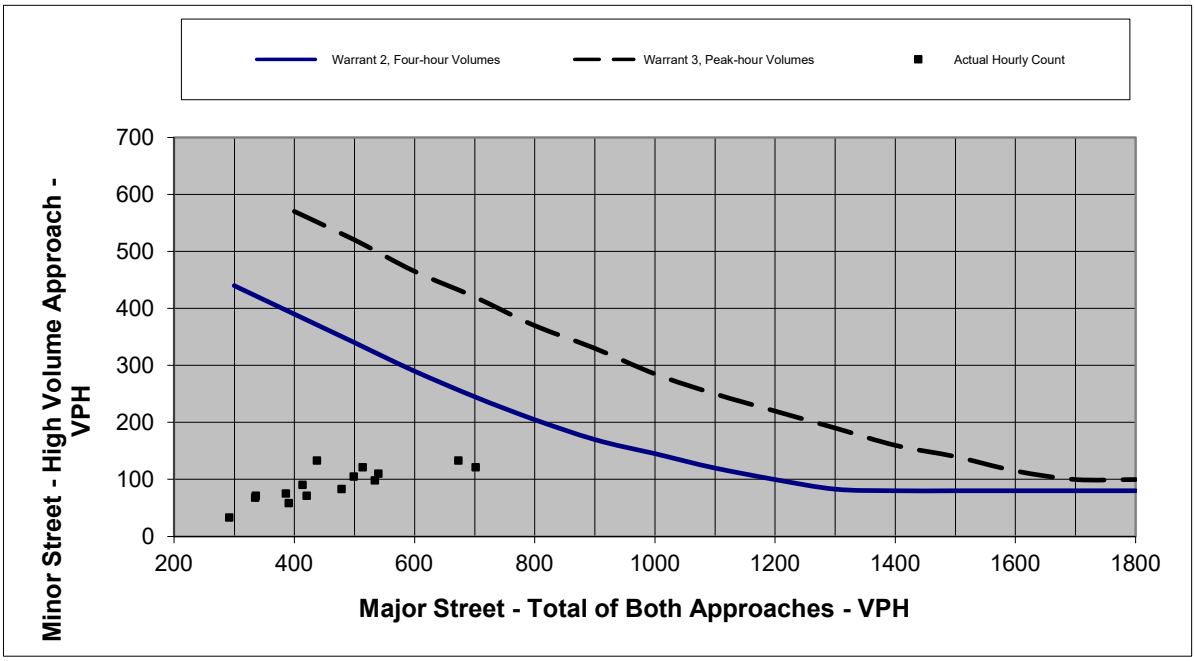

Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria		
Major	Warrant 2, F	Warrant 3, Pe
200		
300	440	
400	390	570
500	340	520
600	290	465
700	245	420
800	205	370
900	170	330
1000	145	285
1100	120	250
1200	100	220
1300	83	190
1400	80	160
1500	80	140
1600	80	115
1700	80	100
1800	80	100

Actual Hourly Count	
Major	Actual Hourly Count
89	11
41	8
34	8
20	2
24	3
59	5
134	17
386	75
438	133
335	68
336	71
414	90
534	98
479	83
540	110
514	121
702	121
673	133
499	105
421	71
391	58
292	33
197	36
108	14

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SIGNAL WARRANTS ANALYSIS FOR

Broad St St & Warren St

LOCATION: Broad St St & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description		Lanes
30	Major App1:	EASTBOUND - Warren St	2
30	Major App3:	WESTBOUND - Warren St	2
30	Minor App2:	NORTHBOUND - Broad St	1
30	Minor App4:	SOUTHBOUND - Broad St	1

0.70 FACTOR USED? No
POPULATION < 10,000? No
N/A Yes

80% THRESHOLDS 1A/1B: **480/720** **120/60** **120/60**

HOUR	MAJOR APP. 1	MAJOR APP. 3	TOTAL 1+3	MAJOR 1A/1B	MINOR APP. 2	MINOR 2 1A/1B	MINOR APP. 4	MINOR 4 (	**MET SAME 1A/1B**
0:00 - 1:00	52	37	89	/	2	/	11	/	/
1:00 - 2:00	23	18	41	/	1	/	8	/	/
2:00 - 3:00	21	13	34	/	2	/	8	/	/
3:00 - 4:00	10	10	20	/	1	/	2	/	/
4:00 - 5:00	9	15	24	/	0	/	3	/	/
5:00 - 6:00	26	33	59	/	4	/	5	/	/
6:00 - 7:00	57	77	134	/	8	/	17	/	/
7:00 - 8:00	162	224	386	/	16	/	75	/X	/
8:00 - 9:00	231	207	438	/	21	/	133	X/X	/
9:00 - 10:00	191	144	335	/	14	/	68	/X	/
10:00 - 11:00	168	168	336	/	11	/	71	/X	/
11:00 - 12:00	221	193	414	/	18	/	90	/X	/
12:00 - 13:00	264	270	534	X/	19	/	98	/X	/
13:00 - 14:00	231	248	479	/	25	/	83	/X	/
14:00 - 15:00	250	290	540	X/	33	/	110	/X	/
15:00 - 16:00	237	277	514	X/	24	/	121	X/X	**X/**
16:00 - 17:00	338	364	702	X/	19	/	121	X/X	**X/**
17:00 - 18:00	355	318	673	X/	24	/	133	X/X	**X/**
18:00 - 19:00	263	236	499	X/	19	/	105	/X	/
19:00 - 20:00	223	198	421	/	15	/	71	/X	/
20:00 - 21:00	188	203	391	/	17	/	58	/	/
21:00 - 22:00	156	136	292	/	9	/	33	/	/
22:00 - 23:00	129	68	197	/	5	/	36	/	/
23:00 - 24:00	58	50	108	/	2	/	14	/	/

	Met (Hr)	Required (Hr)	
Warrant 1A	3	8	Not satisfied
Warrant 1B	0	8	Not satisfied
Warrant 2	0	4	Not satisfied
Warrant 3	0	1	Not satisfied
Warrant 7	7	8	Not satisfied

LOCATION: Broad St St & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description	Lanes
30	Major App1: EASTBOUND - Warren St	2
30	Major App3: WESTBOUND - Warren St	2
30	Minor App2: NORTHBOUND - Broad St	1
30	Minor App4: SOUTHBOUND - Broad St	1

0.70 FACTOR USED? No
POPULATION < 10,000? No

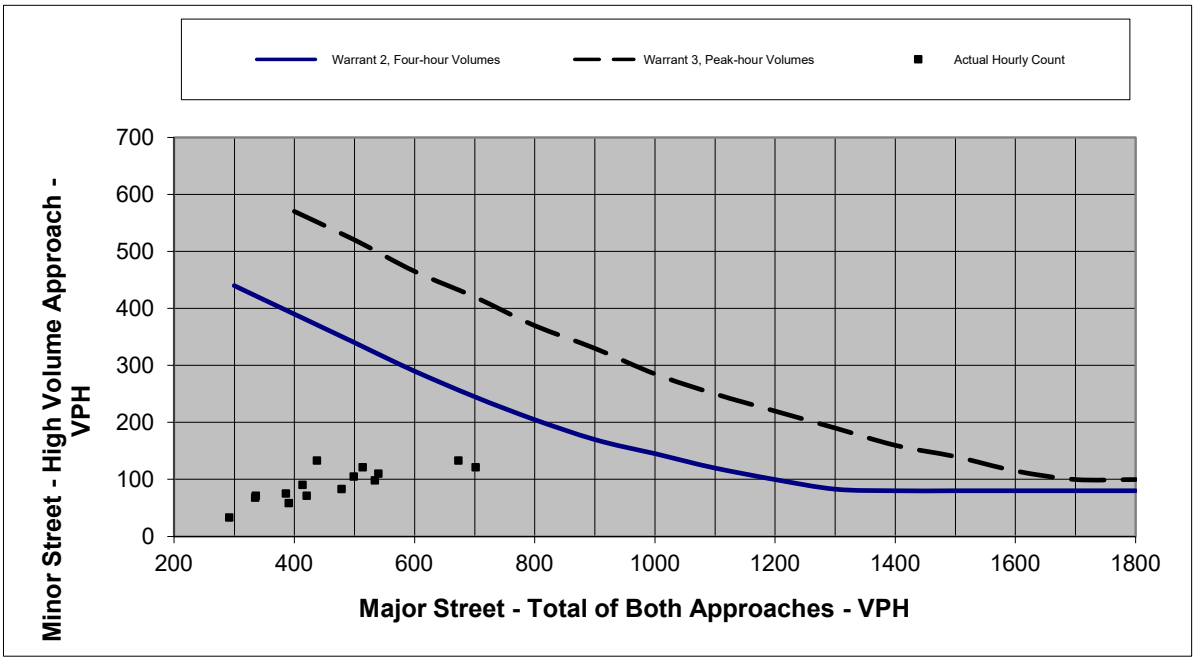

Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria			Actual Hourly Count	
Major	Warrant 2, F	Warrant 3, Pe	Major	Actual Hourly Count
200			89	11
300	440		41	8
400	390	570	34	8
500	340	520	20	2
600	290	465	24	3
700	245	420	59	5
800	205	370	134	17
900	170	330	386	75
1000	145	285	438	133
1100	120	250	335	68
1200	100	220	336	71
1300	83	190	414	90
1400	80	160	534	98
1500	80	140	479	83
1600	80	115	540	110
1700	80	100	514	121
1800	80	100	702	121
			673	133
			499	105
			421	71
			391	58
			292	33
			197	36
			108	14

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SIGNAL WARRANTS ANALYSIS FOR

Broad St St & Warren St

LOCATION: Broad St St & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description		Lanes
30	Major App1:	EASTBOUND - Warren St	2
30	Major App3:	WESTBOUND - Warren St	2
30	Minor App2:	NORTHBOUND - Broad St	1
30	Minor App4:	SOUTHBOUND - Broad St	1

0.70 FACTOR USED? No
POPULATION < 10,000? No
N/A Yes

60% THRESHOLDS 1A/1B: 360/540 90/45 90/45

HOUR	MAJOR APP. 1	MAJOR APP. 3	TOTAL 1+3	MAJOR 1A/1B	MINOR APP. 2	MINOR 2 1A/1B	MINOR APP. 4	MINOR 4 (	**MET SAME 1A/1B**
0:00 - 1:00	52	37	89	/	2	/	11	/	**/**
1:00 - 2:00	23	18	41	/	1	/	8	/	**/**
2:00 - 3:00	21	13	34	/	2	/	8	/	**/**
3:00 - 4:00	10	10	20	/	1	/	2	/	**/**
4:00 - 5:00	9	15	24	/	0	/	3	/	**/**
5:00 - 6:00	26	33	59	/	4	/	5	/	**/**
6:00 - 7:00	57	77	134	/	8	/	17	/	**/**
7:00 - 8:00	162	224	386	X/	16	/	75	/X	**/**
8:00 - 9:00	231	207	438	X/	21	/	133	X/X	**X/**
9:00 - 10:00	191	144	335	/	14	/	68	/X	**/**
10:00 - 11:00	168	168	336	/	11	/	71	/X	**/**
11:00 - 12:00	221	193	414	X/	18	/	90	X/X	**X/**
12:00 - 13:00	264	270	534	X/	19	/	98	X/X	**X/**
13:00 - 14:00	231	248	479	X/	25	/	83	/X	**/**
14:00 - 15:00	250	290	540	X/X	33	/	110	X/X	**X/X**
15:00 - 16:00	237	277	514	X/	24	/	121	X/X	**X/**
16:00 - 17:00	338	364	702	X/X	19	/	121	X/X	**X/X**
17:00 - 18:00	355	318	673	X/X	24	/	133	X/X	**X/X**
18:00 - 19:00	263	236	499	X/	19	/	105	X/X	**X/**
19:00 - 20:00	223	198	421	X/	15	/	71	/X	**/**
20:00 - 21:00	188	203	391	X/	17	/	58	/X	**/**
21:00 - 22:00	156	136	292	/	9	/	33	/	**/**
22:00 - 23:00	129	68	197	/	5	/	36	/	**/**
23:00 - 24:00	58	50	108	/	2	/	14	/	**/**

	Met (Hr)	Required (Hr)	
Warrant 1A	**8**	8	**Satisfied**
Warrant 1B	3	8	Not satisfied
Warrant 2	0	4	Not satisfied
Warrant 3	0	1	Not satisfied
Warrant 7	**7**	8	Not satisfied

LOCATION: Broad St St & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description	Lanes
30	Major App1: EASTBOUND - Warren St	2
30	Major App3: WESTBOUND - Warren St	2
30	Minor App2: NORTHBOUND - Broad St	1
30	Minor App4: SOUTHBOUND - Broad St	1

0.70 FACTOR USED? No
POPULATION < 10,000? No

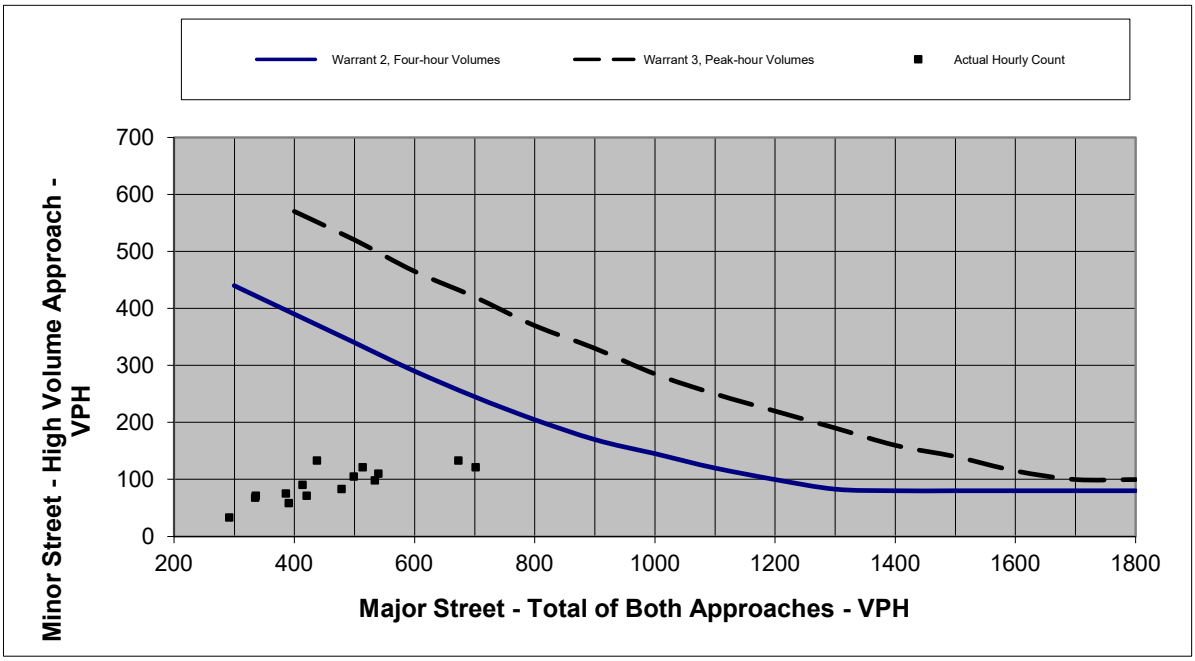

Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria			Actual Hourly Count	
Major	Warrant 2, F	Warrant 3, Pe	Major	Actual Hourly Count
200			89	11
300	440		41	8
400	390	570	34	8
500	340	520	20	2
600	290	465	24	3
700	245	420	59	5
800	205	370	134	17
900	170	330	386	75
1000	145	285	438	133
1100	120	250	335	68
1200	100	220	336	71
1300	83	190	414	90
1400	80	160	534	98
1500	80	140	479	83
1600	80	115	540	110
1700	80	100	514	121
1800	80	100	702	121
			673	133
			499	105
			421	71
			391	58
			292	33
			197	36
			108	14

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SIGNAL WARRANTS ANALYSIS FOR

Glenwood Ave & Warren St

LOCATION: Glenwood Ave & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description		Lanes
30	Major App1:	EASTBOUND - Warren St	2
30	Major App3:	WESTBOUND - Warren St	2
30	Minor App2:	SOUTHBOUND - Glenwood Ave	1
	Minor App4:		

0.70 FACTOR USED? No
POPULATION < 10,000? No
N/A No
THRESHOLDS 1A/1B: 600/900 150/75

HOUR	MAJOR APP. 1	MAJOR APP. 3	TOTAL 1+3	MAJOR 1A/1B	MINOR APP. 2	MINOR 2 1A/1B	MINOR APP. 4	MINOR 4 (	**MET SAME 1A/1B**
0:00 - 1:00	31	23	54	/	10	/			/
1:00 - 2:00	24	16	40	/	3	/			/
2:00 - 3:00	13	12	25	/	6	/			/
3:00 - 4:00	15	18	33	/	11	/			/
4:00 - 5:00	34	26	60	/	15	/			/
5:00 - 6:00	84	84	168	/	18	/			/
6:00 - 7:00	255	241	496	/	71	/			/
7:00 - 8:00	371	246	617	X/	129	/X			/
8:00 - 9:00	282	161	443	/	64	/			/
9:00 - 10:00	262	190	452	/	84	/X			/
10:00 - 11:00	280	225	505	/	92	/X			/
11:00 - 12:00	363	287	650	X/	124	/X			/
12:00 - 13:00	297	271	568	/	114	/X			/
13:00 - 14:00	322	320	642	X/	137	/X			/
14:00 - 15:00	323	312	635	X/	140	/X			/
15:00 - 16:00	412	385	797	X/	149	/X			/
16:00 - 17:00	461	305	766	X/	180	X/X			**X/**
17:00 - 18:00	321	258	579	/	141	/X			/
18:00 - 19:00	282	187	469	/	119	/X			/
19:00 - 20:00	243	236	479	/	107	/X			/
20:00 - 21:00	191	140	331	/	79	/X			/
21:00 - 22:00	169	90	259	/	52	/			/
22:00 - 23:00	77	65	142	/	27	/			/
23:00 - 24:00	60	55	115	/	18	/			/

	Met (Hr)	Required (Hr)	
Warrant 1A	1	8	Not satisfied
Warrant 1B	0	8	Not satisfied
Warrant 2	0	4	Not satisfied
Warrant 3	0	1	Not satisfied
Warrant 7	7	8	Not satisfied

LOCATION: Glenwood Ave & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description	Lanes
30	Major App1: EASTBOUND - Warren St	2
30	Major App3: WESTBOUND - Warren St	2
30	Minor App2: SOUTHBOUND - Glenwood Ave	1
	Minor App4:	

0.70 FACTOR USED? No
POPULATION < 10,000? No

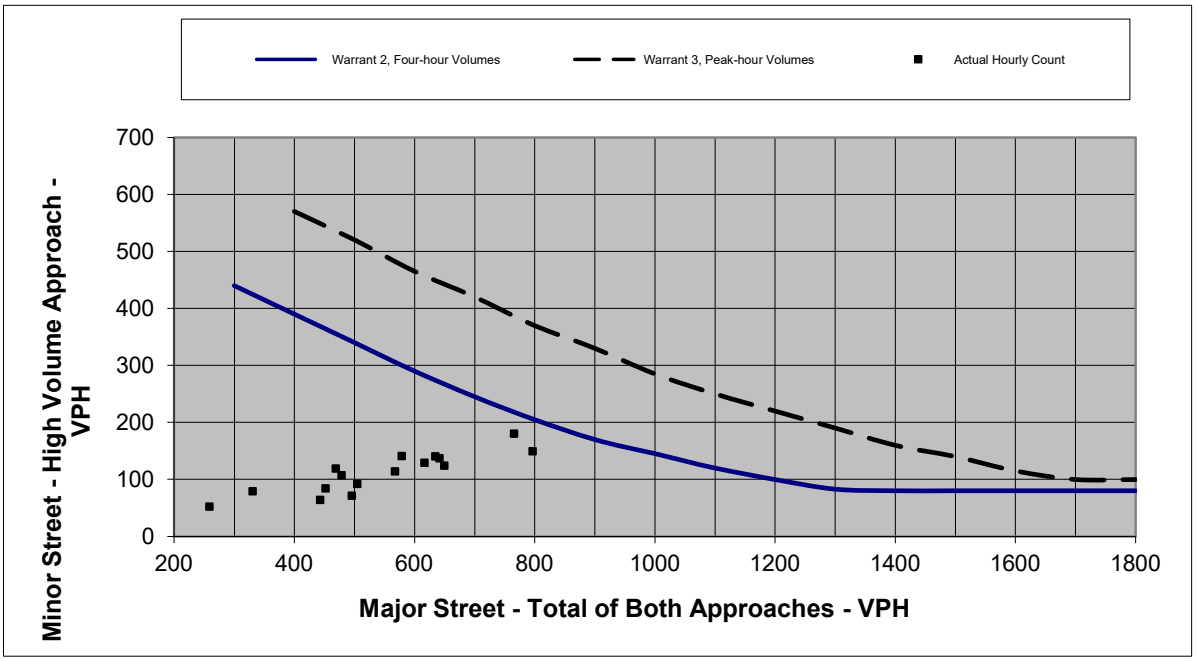

Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria		
Major	Warrant 2, F	Warrant 3, Pe
200		
300	440	
400	390	570
500	340	520
600	290	465
700	245	420
800	205	370
900	170	330
1000	145	285
1100	120	250
1200	100	220
1300	83	190
1400	80	160
1500	80	140
1600	80	115
1700	80	100
1800	80	100

Actual Hourly Count	
Major	Actual Hourly Count
54	10
40	3
25	6
33	11
60	15
168	18
496	71
617	129
443	64
452	84
505	92
650	124
568	114
642	137
635	140
797	149
766	180
579	141
469	119
479	107
331	79
259	52
142	27
115	18

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ALL WAY STOP WARRANT ANALYSIS
FOR
Glenwood Ave & Warren St

LOCATION: Glenwood Ave & Warren St
COUNTY: Blue Earth
REF. POINT:
DATE: 1/14/2020
OPERATOR: KR

Speed	Approach Description	Lanes
30	Major App1: EASTBOUND - Warren St	2
30	Major App3: WESTBOUND - Warren St	2
30	Minor App2: SOUTHBOUND - Glenwood Ave	1
	Minor App4:	

0.70 FACTOR USED? No

					300	200	
HOUR	MAJOR	MAJOR	MINOR	MINOR	MAJOR TOTAL Σ (APP. 1 & APP. 3)	MINOR TOTAL APP. 2 + APP. 4	WARRANT MET
0:00 - 1:00	31	23	10		54	10	/
1:00 - 2:00	24	16	3		40	3	/
2:00 - 3:00	13	12	6		25	6	/
3:00 - 4:00	15	18	11		33	11	/
4:00 - 5:00	34	26	15		60	15	/
5:00 - 6:00	84	84	18		168	18	/
6:00 - 7:00	255	241	71		496	71	X/
7:00 - 8:00	371	246	129		617	129	X/
8:00 - 9:00	282	161	64		443	64	X/
9:00 - 10:00	262	190	84		452	84	X/
10:00 - 11:00	280	225	92		505	92	X/
11:00 - 12:00	363	287	124		650	124	X/
12:00 - 13:00	297	271	114		568	114	X/
13:00 - 14:00	322	320	137		642	137	X/
14:00 - 15:00	323	312	140		635	140	X/
15:00 - 16:00	412	385	149		797	149	X/
16:00 - 17:00	461	305	180		766	180	X/
17:00 - 18:00	321	258	141		579	141	X/
18:00 - 19:00	282	187	119		469	119	X/
19:00 - 20:00	243	236	107		479	107	X/
20:00 - 21:00	191	140	79		331	79	X/
21:00 - 22:00	169	90	52		259	52	/
22:00 - 23:00	77	65	27		142	27	/
23:00 - 24:00	60	55	18		115	18	/

	Met (Hr)	Required (Hr)	
Allway Stop Warrant:	0	8	Not satisfied

REMARKS:

Appendix H: Evaluation Matrices

Warren Street Corridor Study
Concept Evaluation
Typical Section Alternatives
February 2020

Goals	2041 No Build	2 Lane with Shared Use Side Path	3 Lane with Buffered Bikeway	3 Lane with Alternate Route Bikeway
GOAL A: Provide efficient and reliable vehicle mobility.	++	+	++	++
GOAL B: Safely accommodate all system users.	-	+	++	+
GOAL C: Provide infrastructure improvements compatible with social, environmental, and economic resources.	-	++	++	+
GOAL D: Develop a financially responsible implementation plan.	N/A	+	+	+

Legend			
-	0	+	++
Does Not Meet Measure	Minimally Meets Measure	Meets Measure	Exceeds Measure

Warren Street Corridor Study
Concept Evaluation
Intersection Alternatives
February 2020

Goals	4th St at Warren St			Glenwood Ave at Warren St			
	No Build	Three Lane		No Build	Three Lane		
	Full Access	Full Access	Right-In/Right-Out	Side Street Stop Controlled	Side Street Stop Controlled	All Way Stop Controlled	Roundabout
GOAL A: Provide efficient and reliable vehicle mobility.	+	+	++	+	+	0	++
GOAL B: Safely accommodate all system users.	-	+	++	-	0	++	++
GOAL C: Provide infrastructure improvements compatible with social, environmental, and economic resources.	-	+	+	-	++	++	0
GOAL D: Develop a financially responsible implementation plan.	N/A	+	+	N/A	+	+	-

Legend			
-	0	+	++
Does Not Meet Measure	Minimally Meets Measure	Meets Measure	Exceeds Measure

Appendix I: Recommended Alternative

Warren St Corridor Study

Recommended Alternative Bicycle Route With 3-Lane Roadway
Mankato, MN