Intersection Control Evaluation (ICE)

U.S. Highway (Hwy) 75 and 20th Avenue

Moorhead, Minnesota
State Project (S.P.): TBD

DRAFT

Minnesota Department of Transportation (MnDOT) – District 4

SRF

April 2020

SRF No. 11649

Intersection Control Evaluation (ICE)

U.S. Highway (Hwy) 75 and 20th Avenue
State Project (S.P.): TBD
Proposed Letting Date: TBD

Report Certification:

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Leif A. Garnass	47153
Print Name	Reg. No.
Signature	Date

Approved By:

MnDOT District 4 Traffic Engineer	Date
MnDOT District 4 State Aid Engineer	Date
City of Moorhead Traffic Engineer	Date

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Introduction

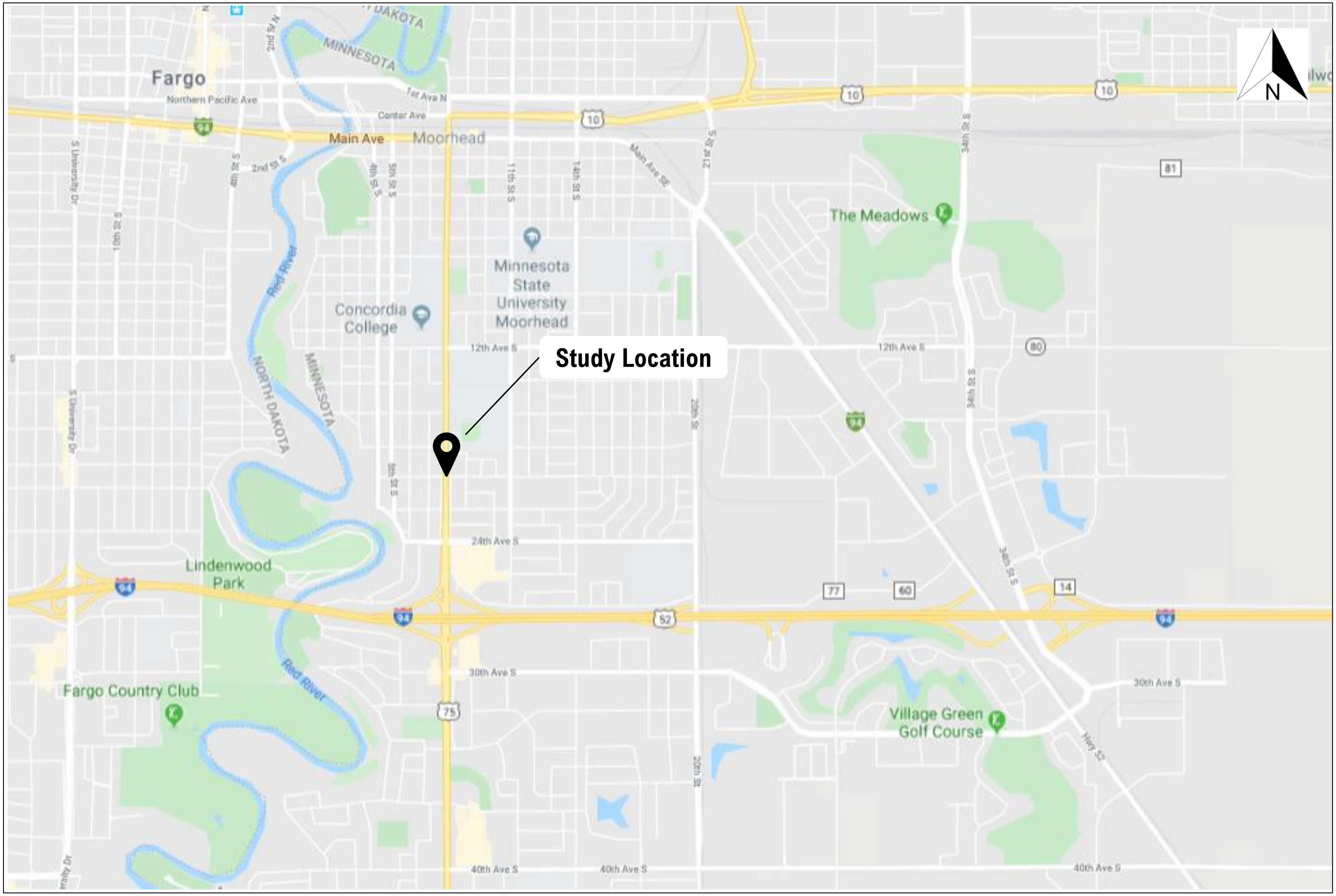
The Fargo-Moorhead Council of Governments (Metro COG) and its partners, the Minnesota Department of Transportation (MnDOT), City of Moorhead, Downtown Moorhead, Inc. and MATBUS completed a study of the U.S. Hwy 10 and U.S. Hwy 75 corridors in Moorhead. The purpose of the study was to develop context-sensitive solutions for the corridors that balance the needs of the City of Moorhead with area stakeholders and users, and ultimately recommend a vision for both corridors to inform the planned reconstruction project in 2025-2026. This report includes the intersection control evaluation results for the U.S. Hwy 75 and 20th Avenue intersection in the City of Moorhead, Minnesota (see Figure 1). The goal of this evaluation was to identify intersection control for the study intersection which would be constructed in Phase 1 of the overall reconstruction project; therefore, the assumed analysis year is 2026.

The MnDOT Intersection Control Evaluation (ICE) is a process that identifies the most appropriate intersection control type through a comprehensive analysis and documentation of the technical (safety, operational, other) and political issues of viable alternatives. The goal of ICE is to select the optimal control for an intersection based on an objective analysis for the existing conditions and future needs. This ICE report was completed to inform the larger corridor study completed (documented separately). The study was guided by the following overarching goals in which the recommended vision needs to:

1. Provide roadways that fit land use (i.e., appropriate access and design).
2. Accommodate appropriate users (i.e., complete streets).
3. Create an environment to stimulate growth.
4. Provide flexibility for near- and long-term transportation needs.
5. Improve "Gateway" feel for the U.S. Hwy 10 and U.S. Hwy 75 corridors.
6. Develop and executes a project that meets the needs for 30+ years.

Defining the purpose and need explains why an agency or agencies are undertaking a project and the main objectives of the project. The "need" describes the transportation deficiencies or problems to be addressed by the project. The "purpose" is a broad statement of the primary intended transportation result and other related objectives to be achieved by the project. The purpose and need act as measuring sticks for the project alternatives, helping determine to what extent each alternative meets the project's needs. Alternatives that do not address the transportation needs of the project and do not meet the purpose of the project are not studied further. Based on the purpose and need documented in the corridor study, the need for improvements at this study intersection is a result of poor pavement conditions.

Detailed warrants, operations, and crash analyses, in combination with engineering judgement, were used to determine recommendations for this ICE.



Study Location

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Intersection Control Evaluation
U.S. Hwy 75 and 20th Avenue
Moorhead, Minnesota

Figure 1

Intersection Characteristics

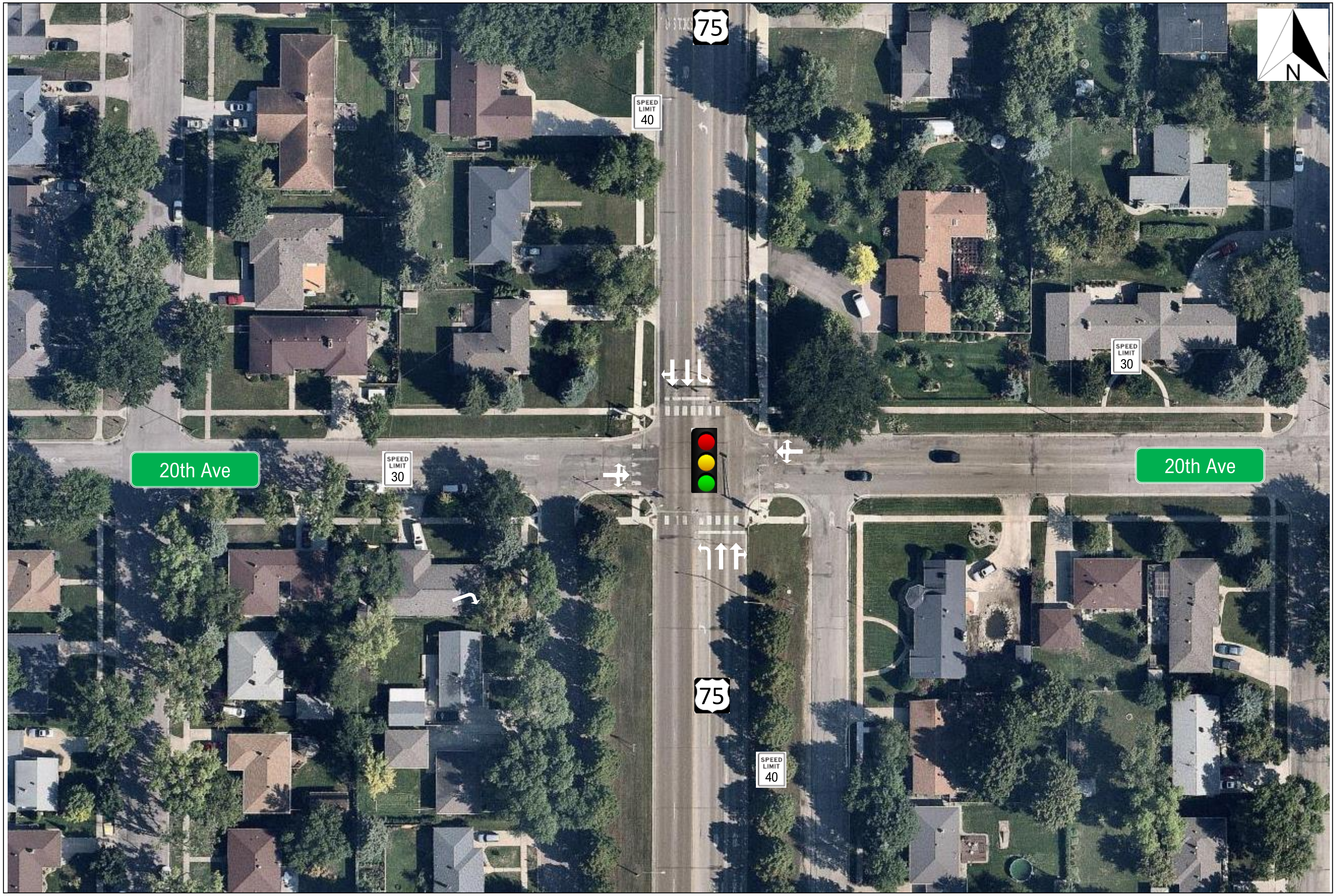
Existing Conditions

The U.S. Hwy 75 and 20th Avenue intersection is a four-way intersection with traffic signal control. U.S. Hwy 75 is a five-lane undivided highway with a posted speed limit of 40 mph and is functionally classified as a Principal Arterial. 20th Avenue is a two-lane undivided roadway with a speed limit of 30 mph and functionally classified as a Minor Collector east of the intersection and a Local Roadway west of the intersection. The land adjacent to the intersection includes primarily residential properties. Current intersection geometrics are shown in Figure 2.

Crash History

Historical crash data were obtained from MnDOT for a five-year period from 2013 through 2017. Detailed crash data is included in Appendix A. Nineteen crashes were reported during the analysis period resulting in a crash rate of 0.38 crashes per million entering vehicles, which is below the statewide average of 0.70 for a signalized intersection, as well as below the critical crash rate of 1.01. 68 percent of the crashes reported were rear end crashes. A summary of the data is shown below:

- 9 – Property Damage Only (PDO) Crashes
- 8 – Possible Injury (C) Crashes
- 2 – Suspected Minor Injury Crash
- 0 – Suspected Serious Injury Crash
- 0 – Fatality (K) Crash
- Observed Crash Rate – 0.38 (crashes/million entering vehicles)
- Critical Crash Rate – 1.01 (crashes/million entering vehicles)



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Existing Conditions

Intersection Control Evaluation
U.S. Hwy 75 at 20th Avenue
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Figure 2

Traffic Volumes

Existing Volumes

During the data collection efforts (September 2018 thru October 2018) there was ongoing construction in the study area that impacted travel patterns and traffic volumes at the study intersection. Construction included:

- 12th Avenue/15th Avenue bridge closed between mid-September and early October 2018
- US 10 (Main Avenue) between 7th Street/8th Street closed early to mid-October 2018
- SE Main Avenue/20th Street/21st Street intersection closed mid-October 2018 to 2021
    - Detour route includes US 10/34th Street/12th Avenue/US 75

Peak periods intersection turning movement counts were collected at the study intersection. The traffic count data was collected from 7:00 to 9:00 a.m. and from 4:00 to 6:00 p.m. All modes collected were grouped by pedestrians, bicyclists, passenger vehicles, transit vehicles/trucks.

The year 2018 traffic count data was supplemented by recently collected traffic volumes (year 2015/2016) provided by the City of Moorhead. Using a combination of the year 2018 and recently collected traffic volumes, an existing a.m. and p.m. peak hour volume set was developed. The peak hour turning movement volumes are summarized in Figure 3.

Future Volumes

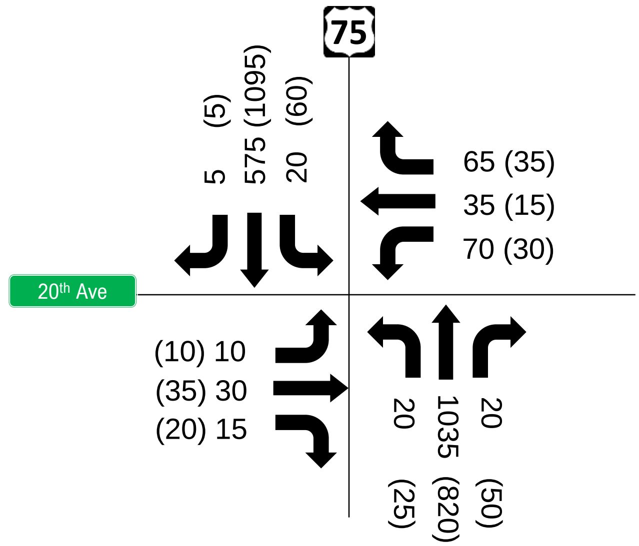
The Advanced Traffic Analysis Center (ATAC) provided the travel demand model that was used to determine the expected daily traffic forecast volumes along the U.S. Hwy 10 and U.S. Hwy 75 corridors. As part of this study, the year 2045 socio-economic (SE) data in the traffic analysis zones (TAZs) near downtown Moorhead were reviewed and updated based on input provided by the Metro COG and the City of Moorhead to be consistent with current development expectations in the downtown area. Additionally, the external growth rate was modified in the Travel Demand Model from 2.5 percent to 0.25 percent. A growth rate of 0.25 percent is more consistent with the historical traffic volume growth along roadways external to the Fargo-Moorhead area. Results of this analysis indicate that an annual growth rate of approximately one (1) percent is expected; however, historical traffic volumes in Moorhead (see Figure 4) have remained relatively unchanged and data reviewed in downtown Fargo suggests that a mode shift has occurred. Therefore, for this study the 2045 analysis assuming a one (1) percent growth rate was used to assess the risk of the implementation of the alternatives if assumptions were to change. Based on historical data in both downtown Moorhead and Fargo, we do not expect a growth rate of one (1) percent to occur.

Results of this analysis indicate that an annual growth rate of approximately one (1) percent is expected. Projected Opening Day Year 2026 and Projected Design Year 2045 volumes are shown in Figure 3. Further details are included in Appendix B.

Existing 2018 Traffic Volumes

XX = AM Peak Hour

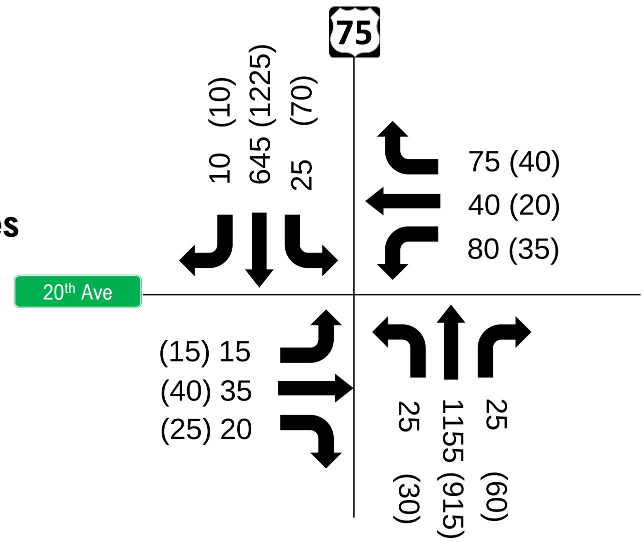
(XX) = PM Peak Hour



Opening Day Year 2026 Traffic Volumes

XX = AM Peak Hour

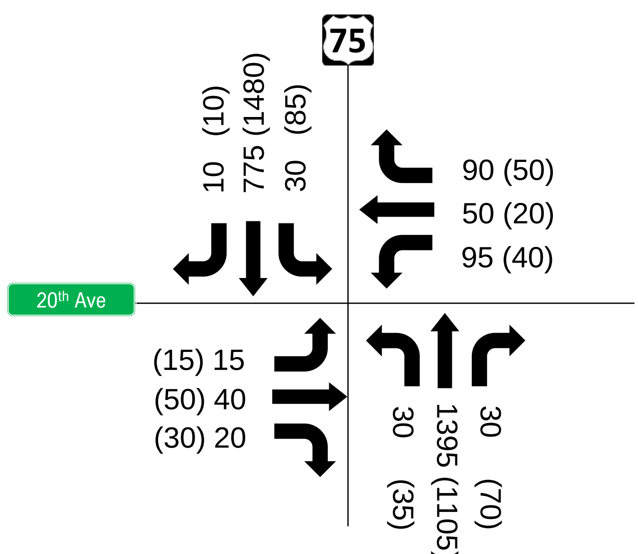
(XX) = PM Peak Hour



Year 2045 Traffic Volumes

XX = AM Peak Hour

(XX) = PM Peak Hour



Traffic Volumes

Intersection Control Evaluation

U.S. Hwy 75 at 20th Avenue

Moorhead, Minnesota

Figure 3

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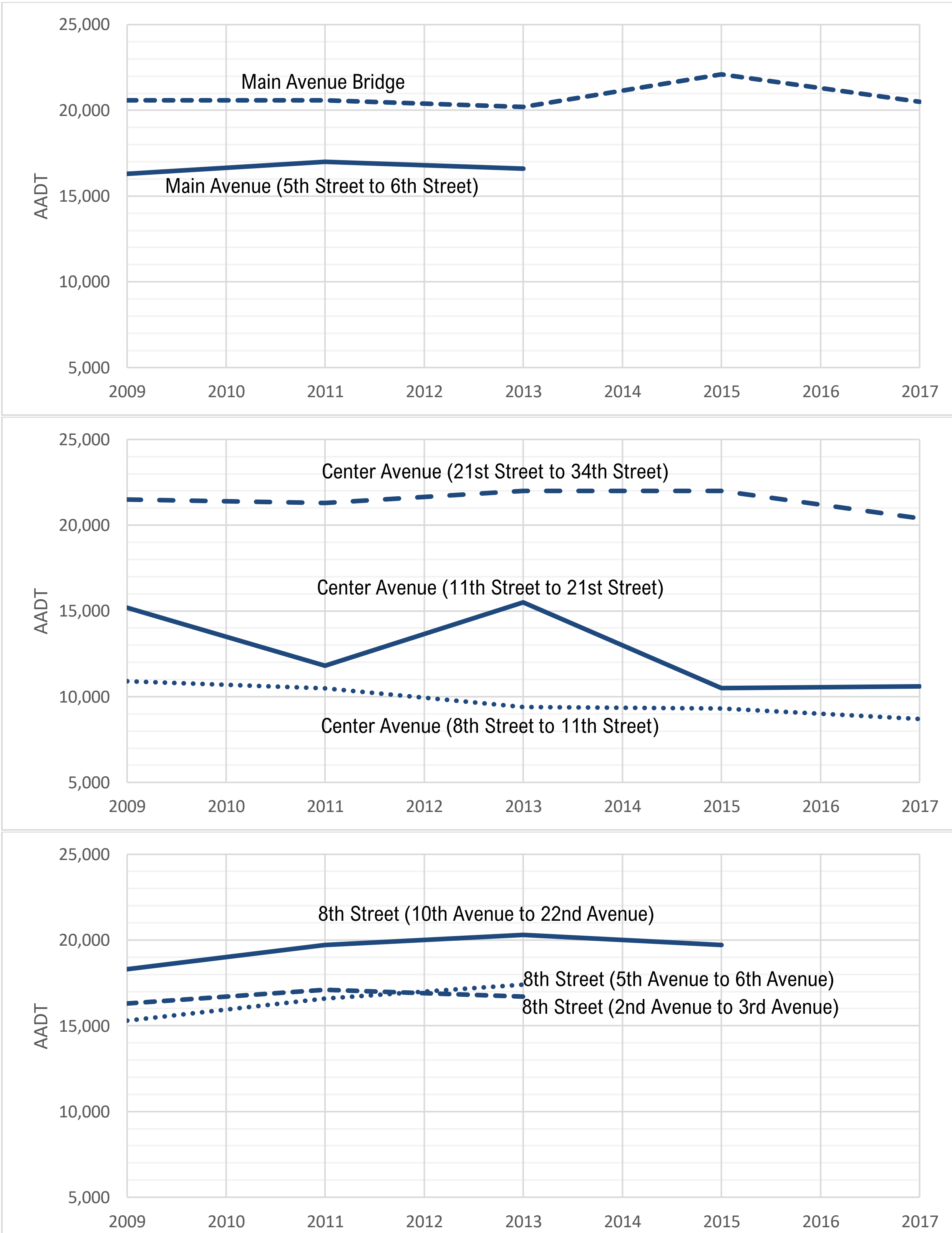
Figure 4. Historical Traffic Volumes



Alternatives

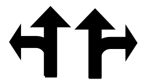
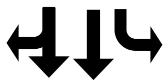
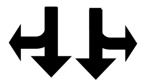
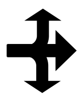
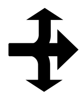
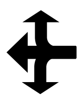
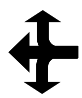
With a solid understanding of the existing issues and deficiencies, alternatives were developed. Federal Highway Administration (FHWA) has developed a planning-level tool called CAP-X, which can be used to screen potential alternatives based on traffic volumes. The metric used is the volume-to-capacity (V/C) ratio, which indicates how well the alternative can handle the traffic levels. A V/C approaching or greater than 1.0 indicates the alternative is not sufficient from a traffic perspective. Intersection and corridor constraints (i.e., property impacts) also need to be considered to ensure corridor context is considered when recommending alternatives. Based on existing (2018) p.m. peak hour volumes, Table 1 summarizes the alternatives considered and justification as to why or why not alternatives were carried forward in this ICE for further evaluation and consideration.

Table 1. Alternatives Considered

Alternative	V/C	Carried Forward?	Justification
Two-way Stop Control	> 1.5	No	Insufficent capacity
All-way Stop Control	> 1.5	No	Insufficent capacity
Traffic Signal Control	< 0.5	**Yes**	Sufficent capacity, low risk for property impacts
Quadrant Roadway	< 0.5	No	Prohibitive property impacts, not consistent with vision
Displaced Left-turns	< 0.5	No	Prohibitive property impacts, not consistent with vision
Signalized RCUT	< 0.5	No	Prohibitive property impacts, not consistent with vision
Unsignalized RCUT	< 0.5	No	Prohibitive property impacts, not consistent with vision
Median U-Turn	< 0.5	No	Prohibitive property impacts, not consistent with vision
Single-lane Roundabout	< 1.0	No	Nearing capacity limits
Multi-lane Roundabout	0.5	**Yes**	Sufficient capacity, potentail risk for property impacts

Lane configurations for the traffic signal control and multi-lane roundabout alternatives were developed to accommodate projected traffic volumes. The assumed lane configurations for the alternatives are shown in Table 2. A concept sketch for the traffic signal is shown and Figure 5 and the multi-lane roundabout is shown in Figure 6. While this ICE refers to the alternative as a "multi-lane" roundabout, only U.S. Hwy. 75 (8th Street) is multi-lane, which includes two lanes in each direction where 20th Avenue only has one lane in each direction.

Table 2. Future Intersection Lane Configurations

Approach	Traffic Signal Control	Roundabout
Northbound U.S. Hwy 75		
Southbound U.S. Hwy 75		
Eastbound 20th Ave		
Westbound 20th Ave		

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Concept Layout for Traffic Signal

Intersection Control Evaluation
U.S. Hwy 75 at 20th Avenue
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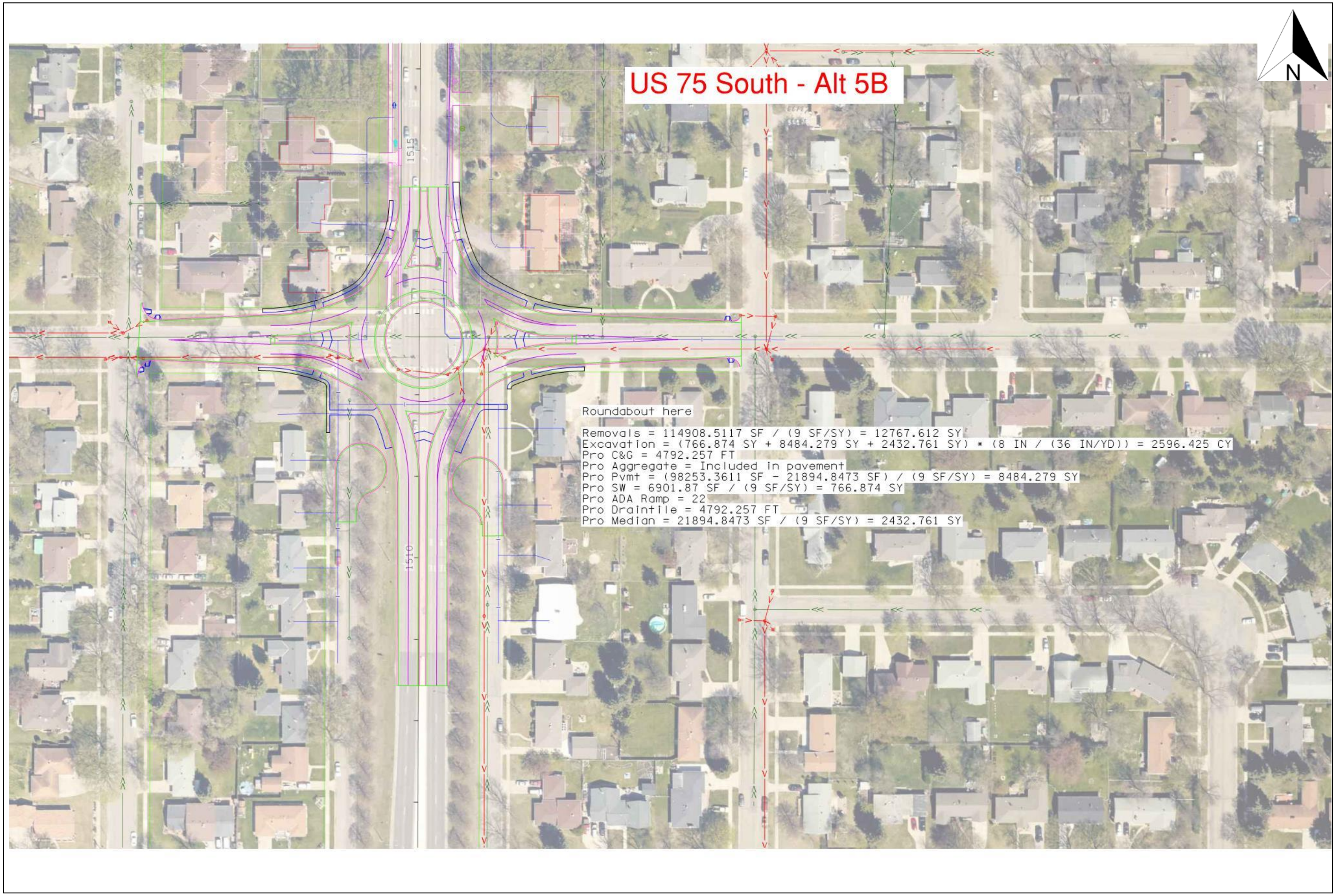
Figure 5



Concept Layout for Multi-Lane Roundabout

Intersection Control Evaluation
U.S. Hwy 75 at 20th Avenue
Moorhead, Minnesota

Figure 6

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Analysis of Alternatives

Warrants Analysis

The December 2019 *Minnesota Manual on Uniform Traffic Control Devices* (MnMUTCD) provides guidance on when it may appropriate to use all-way stop or traffic signal control at an intersection. This guidance is provided in the form of "warrants", or criteria, and engineering analysis of the intersection's design factors, to determine when all-way stop or traffic signal control may be justified. All-way stop or traffic signal control should not be installed at an intersection unless a MnMUTCD warrant is met but meeting a warrant does not itself require the installation of a control. The control type also needs an engineering analysis of the intersection's design for it to be justified. Under the MnDOT ICE process, roundabouts are warranted if traffic volumes meet the warrant requirements for either all-way stop or traffic signal control. For this ICE, analysis of signal Warrants 1-3 was conducted for Opening Day Year 2026 and Design Year 2045 volumes. Right-turns were not removed from the minor approaches since there is only one lane proposed. The lane geometry and approach speeds assumed for the warrants analysis are shown in Table 3.

Table 3. Warrants Analysis Assumptions

Approach	Geometry	Speed Limit
Northbound U.S. Hwy 75	Two or more approach lanes	40 mph
Southbound U.S. Hwy 75	Two or more approach lanes	40 mph
Eastbound 20th Ave	One approach lane	30 mph
Westbound 20th Ave	One approach lane	30 mph

Table 4 provides a summary of the warrants analysis results and the detailed volume-based results are included in Appendix C.

Table 4. Warrant Analysis Summary

MnMUTCD Signal Warrant	Hours Required	Opening Day Year 2020 Volumes		Year 2045 Volumes	
		Hours Met	Warrant Met?	Hours Met	Warrant Met?
Warrant 1A: Minimum Vehicular Volume	8	1	No	3	No
Warrant 1B: Interruption of Continuous Traffic	8	8	Yes	12	Yes
Warrant 1C: Combination of Warrants	8	3	No	4	No
Warrant 2: Four-Hour Volume	4	6	Yes	10	Yes
Warrant 3B: Peak Hour Volume	1	1	Yes	6	Yes
Warrants 4-9	Not Evaluated				

The results of the analysis indicate that the intersection meets MnMUTCD signal warrants 1B, 2, and 3B under both Year 2026 and Year 2045 volume conditions. For traffic signal installation, MnDOT typically requires Warrant 1 to be met, which requires 8-hours of combined major approach volumes and the maximum minor approach volume to meet MnMUTCD thresholds. This means if either Warrant 1A or 1B are met, Warrant 1 itself is considered met.

Traffic Operations Analysis

The traffic operations analysis identified a Level of Service (LOS) which indicates how well an intersection is operating based on average delay per vehicle. Delay is calculated based on procedures outlined in the Highway Capacity Manual (HCM). Intersections are given a ranking from LOS A to LOS F. LOS A indicates the best traffic operation and LOS F indicates an intersection where demand exceeds capacity. LOS A through LOS D are considered acceptable because the intersection would be operating under capacity.

Operational analysis of the traffic signal control alternative was performed using PTV VISSIM (Version 11.00-02). VISSIM can calculate various measures of effectiveness such as control delay, queuing, and total travel time impacts. Operational analysis of the roundabout alternative was performed using RODEL software as this is a requirement of MnDOT. RODEL can calculate various measures of effectiveness such as delay and queuing.

Results of the traffic operations analysis indicate that all alternatives would perform at acceptable levels of service under Year 2026 volumes and proposed lane configurations. Table 5 provides a summary of the Year 2026 traffic operations analysis. The Year 2026 detailed results are included in Appendix D.

Table 5. Opening Day Year 2026 Traffic Operations Analysis Results

Alternative	AM Peak Hour		PM Peak Hour	
	Overall Delay	LOS	Overall Delay	LOS
Traffic Signal	8 sec.	A	11 sec.	B
Multi-lane Roundabout	6 sec.	A	7 sec.	A

Table 6 provides a summary of the Year 2045 operations analysis. Results of the traffic operations analysis indicate that all alternatives would continue to operate at acceptable levels of service under Year 2045 volumes and proposed lane configurations. Detailed results can be found in Appendix E.

Table 6. Design Year 2040 Traffic Operations Analysis Results

Alternative	AM Peak Hour		PM Peak Hour	
	Overall Delay	LOS	Overall Delay	LOS
Traffic Signal	8 sec.	A	13 sec.	B
Multi-lane Roundabout	8 sec.	A	9 sec.	A

Crash Analysis

A crash analysis was performed to determine the projected crashes per year for each traffic control alternative for the Opening Day Year 2026 and Year 2045 conditions. The existing intersection crash rate was used for the traffic signal control alternative.

Crash Modification Factors (CMFs) were used to determine predicted crashes for the alternatives. CMFs are estimates of the resulting change in crash rates after a change to an intersection or roadway segment. A CMF of 0.75 indicates that the crash rate after the change is expected to be 75% of the existing crash rate (i.e., a 25% reduction in crashes is expected). For this analysis, CMFs were obtained from the CMF Clearinghouse website. This website is funded by the FHWA and provides a searchable database of CMFs from various studies.

For the roundabout alternative, a CMF of 1.06 for all crashes and 0.37 for injury crashes was assumed. A summary of the crash analysis is shown in Table 7.

Table 7. Crash Analysis Results

Alternative	Intersection ADT		Crash Modification Factor(s)	Average Crash Rate (1)	Projected Crashes/Year	
	Opening Day Year 2026	Design Year 2045			Opening Day Year 2027	Forecast Year 2045
Traffic Signal	30,400	36,700	N/A	0.38 (3)	4.2	5.1
Multi-lane Roundabout			1.06 / 0.37	0.40 (3)	4.4	5.4

(1) Per million entering vehicles.
(2) Assumed to match the observed crash rate.
(3) Based on adjusting the observed crash rate with a crash modification factor.

While the existing crash was assumed for the traffic signal control alternative, constructing a new traffic signal with the most current design and safety features, along with updating signal timing to reflect traffic volume conditions at the day of opening, safety benefits are expected.

Alternatives Assessment

Right of Way Considerations

The multi-lane roundabout is expected to require right of way from all four quadrants of the intersection, while potentially impacting the homes in the northwest and southwest quadrants. Also, property owners would need to access U.S. Hwy 75 at 24th Avenue, which is a congested corridor. These impacts illustrated in Figure 4. The re-installation of traffic signal control is not expected to require any major right of way. Final design details would determine if any modifications are needed to the corners of the intersection to meet current design standards.

Corridor Functionality Considerations

Roundabouts are most appropriate where the traffic flows are balanced on all approaches as roundabouts introduce delay to all movements, essentially treating each movement equally. For the study intersection, over 80 percent of the intersection entering traffic is on U.S. Hwy 75 (8th Street); therefore, a roundabout would cause undue delay to mainline traffic on U.S. Hwy 75. However, traffic signals can provide progression along a corridor and can be used to interrupt heavy traffic to allow other traffic, vehicular or pedestrians, to complete their movements.

Pedestrian and Bicycle Considerations

Both traffic signal and multi-lane roundabout control adequately accommodate pedestrians and bicycles. With traffic signals, pedestrian phases can be built into the signal timing to allow for protected pedestrian crossings at the designated crosswalks. Bicycles would cross like vehicles unless there is an adjacent shared-use path. However, conflicts exist between turning vehicles and pedestrians/bikes and crashes that involve vehicles that run red lights are severe. Roundabout control benefits pedestrians and bicycles by:

- Making drivers slow down driving through the intersection.
- Reducing the distance pedestrians and bikes need to cross.
- Raised medians provide a refuge for those crossing.
- Pedestrians and bikes only need to look at one direction of traffic at a time.

While the multi-lane roundabout provides additional conflicts for pedestrians/bikes with vehicles (compared to a single-lane roundabout), vehicles are traveling slow through the roundabout so potential crashes tend to be less severe.

Conclusions and Recommendations

Based on the results of this intersection control evaluation, and in support of the overall US 10/ US 75 Corridor Study goals with input from study partners and community, traffic signal control is recommended for the intersection of U.S. Hwy 75 (8th Street) and 20th Avenue in Moorhead. The following supports this recommendation:

Traffic signal control meets MnMUTCD traffic signal warrant requirements under existing and future volume conditions. Traffic signal control accommodates existing and future traffic levels while providing progression along a corridor and can be used to interrupt heavy traffic to allow other traffic, vehicular or pedestrians, to complete their movements.

Multi-lane roundabout control would have major property impacts and require traffic along the adjacent frontage roads to head south to 24th Avenue, which is a congested corridor. Also, roundabouts are most appropriate where the traffic flows are balanced on all approaches as roundabouts introduce delay to all movements, essentially treating each movement equally. For the study intersection, over 80 percent of the intersection entering traffic is on U.S. Hwy 75 (8th Street); therefore, a roundabout would cause undue delay to mainline traffic on U.S. Hwy 75.

Findings from this ICE will inform MnDOT's 2025-2026 reconstruction of the corridors.

Appendices

Appendix A: 2013-2017 Crash History

Appendix B: Historical Trends

Appendix C: Opening Day Year 2026 All-way Stop and Traffic Signal Warrants Analysis
Year 2045 All-way Stop and Traffic Signal Warrants Analysis

Appendix D: Opening Day Year 2026 Detailed Traffic Operations Analysis

Appendix E: Year 2045 Detailed Traffic Operations Analysis

Appendix A

2013-2017 Crash History

US 10 / US 75 Corridor Study

Intersection Crash History (2013-2017)

Intersection Name	Traffic Control	Major 1	Major 2	Minor 1	Minor 2	ADT	Expected Crash Rate*	Facility Type	Actual Crash Rate	Critical Crash Rate	Severity Rate	Total Crashes	Total Severe Crashes
I-94 Bus/Main Ave & 4th St	Signalized	22100	16600	3200	1750	21,825	0.70	Signalized High Vol Low Speed	0.35	1.05	0.68	14	1
I-94 Bus/Main Ave & 5th St	Signalized	16600	16600	300	1850	17,675	0.70	Signalized High Vol Low Speed	0.47	1.09	0.59	15	0
I-94 Bus/Main Ave & 6th St	Signalized	16600	16600	1300	1300	17,900	0.70	Signalized High Vol Low Speed	0.28	1.09	0.43	9	0
I-94 Bus/Main Ave & 7th St	Thru Stop	16600	16600	890		17,045	0.18	Urban Thru/Stop	0.13	0.40	0.16	4	0
I-94 Bus/Main Ave & US Hwy 75/8th St	Signalized	16600	10600	16700	10000	26,950	0.70	Signalized High Vol Low Speed	0.57	1.01	0.77	28	0
I-94 Bus/Main Ave & 10th St	Thru Stop	10600	10600	200	200	10,800	0.18	Urban Thru/Stop	0.10	0.46	0.20	2	0
I-94 Bus/Main Ave & 11th St	Signalized	10600	9500	3300	3300	13,350	0.52	Signalized Low Vol Low Speed	0.70	0.91	0.99	17	0
US Hwy 75/8th St & US Hwy 10/Center Ave	Signalized	10000	4700	7000	8700	15,200	0.70	Signalized High Vol Low Speed	0.79	1.12	1.15	22	0
US Hwy 10/Center Ave & 11th St	Signalized	8700	9100	3300	4600	12,850	0.52	Signalized Low Vol Low Speed	0.60	0.92	0.68	14	0
US Hwy 10/Center Ave & 14th St	Signalized	9100	10000	3300	1650	12,025	0.52	Signalized Low Vol Low Speed	0.32	0.93	0.59	7	0
US Hwy 10/Center Ave & 21st St	Signalized	10000	20400	13000	11000	27,200	0.70	Signalized High Vol Low Speed	0.73	1.01	0.97	36	0
US Hwy 10/Center Ave & US Hwy 75	Signalized	20400	20400		7200	24,000	0.70	Signalized High Vol Low Speed	0.32	1.03	0.41	14	0
US Hwy 10 & 24th St	Thru Stop	20400	20400	400	600	20,900	0.18	Urban Thru/Stop	0.16	0.38	0.34	6	0
US Hwy 10 & 26th St	Thru Stop	20400	20400	30	300	20,565	0.18	Urban Thru/Stop	0.03	0.38	0.03	1	0
US Hwy 10 & 28th St	Thru Stop	20400	18400	500	980	20,140	0.18	Urban Thru/Stop	0.30	0.38	0.41	11	0
US Hwy 10 & 30th St	Thru Stop	18400	18400	650	2200	19,825	0.18	Urban Thru/Stop	0.17	0.38	0.25	6	0
US Hwy 10 & 32nd St	Signalized	18400	18400	2700	1500	20,500	0.70	Signalized High Vol Low Speed	0.27	1.06	0.37	10	0
US Hwy 10 & 34th St	Signalized	18400	18400	15600	10200	31,300	0.70	Signalized High Vol Low Speed	1.12	0.99	1.61	64	0
US Hwy 75/8th St & 2nd Ave	Thru Stop	16700	16700	2250	1500	18,575	0.18	Urban Thru/Stop	0.47	0.39	0.47	16	0
US Hwy 75/8th St & 3rd Ave	Thru Stop	16700	16700	850	850	17,550	0.18	Urban Thru/Stop	0.12	0.39	0.22	4	0
US Hwy 75/8th St & 4th Ave	Thru Stop	17400	16700	750	1100	17,975	0.18	Urban Thru/Stop	0.27	0.39	0.30	9	0
US Hwy 75/8th St & 5th Ave	Thru Stop	17400	17400	500	750	18,025	0.18	Urban Thru/Stop	0.00	0.39	0.00	0	0
US Hwy 75/8th St & 6th Ave	Thru Stop	17400	17400	1000	150	17,975	0.18	Urban Thru/Stop	0.15	0.39	0.18	5	0
US Hwy 75/8th St & 7th Ave	Signalized	17400	17400	2200	880	18,940	0.70	Signalized High Vol Low Speed	0.41	1.08	0.49	14	0
US Hwy 75/8th St & 9th Ave (Old Main Bldg)	Thru Stop	17400	17400	100		17,450	0.18	Urban Thru/Stop	0.03	0.39	0.03	1	0
US Hwy 75/8th St & 10th Ave	Signalized Stop	17400	17400	1100		17,950	0.18	Urban Thru/Stop	0.24	0.39	0.34	8	0
US Hwy 75/8th St & 12th Ave	Signalized	19700	17400	3800	6000	23,450	0.70	Signalized High Vol Low Speed	0.51	1.04	0.72	22	0
US Hwy 75/8th St & 14th Ave	Thru Stop	19700	19700	450		19,925	0.18	Urban Thru/Stop	0.08	0.38	0.11	3	0
US Hwy 75/8th St & 16th Ave	Thru Stop	19700	19700	900	100	20,200	0.18	Urban Thru/Stop	0.00	0.38	0.00	0	0
US Hwy 75/8th St & 18th Ave (West)	Thru Stop	19700	19700	500	300	20,100	0.18	Urban Thru/Stop	0.08	0.38	0.08	3	0
US Hwy 75/8th St & 20th Ave	Signalized	33000	19700	710	2100	27,755	0.70	Signalized High Vol Low Speed	0.38	1.01	0.61	19	0

Intersection Name	K	A	B	C	PD	Rear End	Sideswipe Passing	Runoff Road	Angle	Head On	Sideswipe Opposing	Other	Day	Dawn/Dusk	Dark with Streetlights	Dark	Other/ Unknown	Dry	Wet	Snow/Slush	Other	Single Vehicle Crashes	Multi-Vehicle Crashes
I-94 Bus/Main Ave & 4th St	0	1	2	6	5	4	2	1	3	0	3	1	11	0	3	0	0	7	2	5	0	3	11
I-94 Bus/Main Ave & 5th St	0	0	1	2	12	6	2	0	7	0	0	0	15	0	0	0	0	9	0	6	0	0	15
I-94 Bus/Main Ave & 6th St	0	0	1	3	5	3	2	0	2	0	0	2	8	0	1	0	0	5	2	2	0	2	7
I-94 Bus/Main Ave & 7th St	0	0	0	1	3	2	1	0	1	0	0	0	4	0	0	0	0	4	0	0	0	0	4
I-94 Bus/Main Ave & US Hwy 75/8th St	0	0	1	8	19	11	3	0	8	3	0	3	26	1	1	0	0	21	3	4	0	1	27
I-94 Bus/Main Ave & 10th St	0	0	1	0	1	0	0	0	2	0	0	0	2	0	0	0	0	1	0	1	0	0	2
I-94 Bus/Main Ave & 11th St	0	0	1	5	11	3	1	0	12	0	0	1	14	0	3	0	0	12	1	3	1	0	17
US Hwy 75/8th St & US Hwy 10/Center Ave	0	0	3	4	15	5	6	1	9	1	0	0	18	0	4	0	0	12	2	8	0	0	22
US Hwy 10/Center Ave & 11th St	0	0	0	2	12	1	1	1	10	0	0	1	10	0	4	0	0	6	3	5	0	1	13
US Hwy 10/Center Ave & 14th St	0	0	2	2	3	1	1	0	3	1	1	0	6	0	1	0	0	7	0	0	0	1	6
US Hwy 10/Center Ave & 21st St	0	0	2	8	26	13	2	0	10	2	2	7	28	1	7	0	0	25	1	10	0	3	32
US Hwy 10/Center Ave & US Hwy 75	0	0	1	2	11	8	1	0	4	0	0	1	12	0	2	0	0	11	1	2	0	0	14
US Hwy 10 & 24th St	0	0	3	1	2	0	0	0	5	0	1	0	5	0	1	0	0	4	1	1	0	0	6
US Hwy 10 & 26th St	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	1	0
US Hwy 10 & 28th St	0	0	1	2	8	0	0	0	8	0	0	3	10	0	1	0	0	8	1	1	1	2	9
US Hwy 10 & 30th St	0	0	1	1	4	0	0	0	5	0	0	1	6	0	0	0	0	6	0	0	0	1	5
US Hwy 10 & 32nd St	0	0	1	3	5	7	0	1	2	0	0	0	9	0	1	0	0	7	2	1	0	2	9
US Hwy 10 & 34th St	0	0	5	18	41	24	6	0	25	2	3	4	46	2	16	0	0	44	7	11	2	3	61
US Hwy 75/8th St & 2nd Ave	0	0	0	0	16	1	1	0	11	0	0	3	12	0	4	0	0	11	4	0	1	1	15
US Hwy 75/8th St & 3rd Ave	0	0	1	1	2	1	0	0	2	0	0	1	3	0	1	0	0	3	0	1	0	0	4
US Hwy 75/8th St & 4th Ave	0	0	0	1	8	0	1	0	6	0	0	2	7	1	1	0	0	5	0	4	0	1	8
US Hwy 75/8th St & 5th Ave	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
US Hwy 75/8th St & 6th Ave	0	0	0	1	4	3	0	0	2	0	0	0	4	0	1	0	0	1	2	2	0	0	5
US Hwy 75/8th St & 7th Ave	0	0	0	3	11	5	1	2	5	1	0	0	12	0	2	0	0	5	4	5	0	3	11
US Hwy 75/8th St & 9th Ave (Old Main Bldg)	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1
US Hwy 75/8th St & 10th Ave	0	0	1	1	6	7	1	0	0	0	0	0	8	0	0	0	0	6	1	1	0	0	7
US Hwy 75/8th St & 12th Ave	0	0	2	5	15	12	1	1	4	2	2	0	19	0	3	0	0	11	1	10	0	0	22
US Hwy 75/8th St & 14th Ave	0	0	0	1	2	1	1	0	1	0	0	0	3	0	0	0	0	2	0	1	0	0	3
US Hwy 75/8th St & 16th Ave	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
US Hwy 75/8th St & 18th Ave (West)	0	0	0	0	3	3	0	0	0	0	0	0	3	0	0	0	0	2	1	0	0	0	3
US Hwy 75/8th St & 20th Ave	0	0	2	8	9	13	0	0	5	1	0	0	16	0	3	0	0	14	3	2	0	0	19
	0%	0%	9%	24%	66%	31%	10%	1%	41%	3%	4%	9%	82%	1%	16%	0%	0%	68%	10%	21%	1%		

Notes:

*Expected rates from MnDOT's 2015 Intersection Green Sheets

MnDOT Traffic Monitoring Products website was used for segment ADT information

Crash Rate < Expected Crash Rate

Expected Crash Rate < Crash Rate < Critical Crash Rate

Crash Rate > Critical Crash Rate

Intersections using 200 ft Radius

Appendix B

Historical Trends

Moorhead

1 US 10 (Main Avenue) Bridge

2009	20600	
2011	20600	
2013	20200	0.32%
2015	22100	
2017	20500	

2 US 10 (Main Avenue) 5th Street to 6th Street

2009	16300	
2011	17000	0.45%
2013	16600	

3 US 10/75 (Center Avenue) 8th Street to 11th

2009	10900	
2011	10500	
2013	9400	-3.22%
2015	9300	
2017	8700	

4 US 10/75 (Center Avenue) 11th Street to 1st

2009	15200	
2011	11800	
2013	15500	-4.95%
2015	10500	
2017	10600	

5 US 10 (Center Avenue) 1st Avenue/21st Street to 34th Street

2009	21500	
2011	21300	
2013	22000	-0.37%
2015	22000	
2017	20400	

6 US 75 (8th Street) 2nd Avenue to 3rd Avenue

2009	16300	
2011	17100	0.60%
2013	16700	

7 US 75 (8th Street) 5th Avenue to 6th Avenue

2009	15300	
2011	16600	3.02%
2013	17400	

8 US 75 (8th Street) 10th Avenue to 22nd Avenue

2009	18300	
2011	19700	1.22%
2013	20300	
2015	19700	

Average Growth Rate **-0.37%**

Appendix C

Opening Day Year 2026 and Year 2045
All-way Stop and Traffic Signal Warrants Analysis

SRF Consulting Group, Inc.

WARRANTS ANALYSIS

Year 2026

U.S. Hwy 75/20th Ave
US Hwy 10/US Hwy 75 Corridor Study
Moorhead, MN

Background Information					Speed (mph)	Lanes	Approach	
	Location :	Moorhead, MN						
	Date:	12/30/2019			40	2 or more	Major Approach 1:	Northbound U.S. Hwy 75
	Analysis Prepared By:		M.Knight		40	2 or more	Major Approach 3:	Southbound U.S. Hwy 75
	Population Less than 10,000:			No	30	1	Minor Approach 2:	Eastbound 20th Avenue
	Seventy Percent Factor Used:			No	30	1	Minor Approach 4:	Westbound 20th Avenue

Warrants Analysis: Warrants 1A, 1B and 1C

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met		Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met		Met Same Hours		Combination		MWSA (C)	
				600	900				150	75	Condition A	Condition B	A	B	300	200
6 - 7 AM	563	318	881	X		33	91	91		X				X	X	
7 - 8 AM	1205	680	1885	X	X	70	195	195	X	X	X	X	X	X	X	X
8 - 9 AM	896	506	1402	X	X	52	145	145		X		X	X	X	X	
9 - 10 AM	649	366	1015	X	X	38	105	105		X		X		X	X	
10 - 11 AM	799	451	1250	X	X	46	129	129		X		X	X	X	X	
11 - 12 AM	611	793	1404	X	X	49	58	58							X	
12 - 1 PM	801	1040	1841	X	X	64	76	76		X		X		X	X	
1 - 2 PM	687	892	1579	X	X	55	65	65						X	X	
2 - 3 PM	753	978	1731	X	X	60	71	71						X	X	
3 - 4 PM	977	1269	2246	X	X	78	92	92		X		X		X	X	
4 - 5 PM	1005	1305	2310	X	X	80	95	95		X		X		X	X	
5 - 6 PM	994	1290	2284	X	X	79	94	94		X		X		X	X	
6 - 7 PM	736	955	1691	X	X	59	70	70						X	X	
											1	8	3	12	1	

Warrant Summary

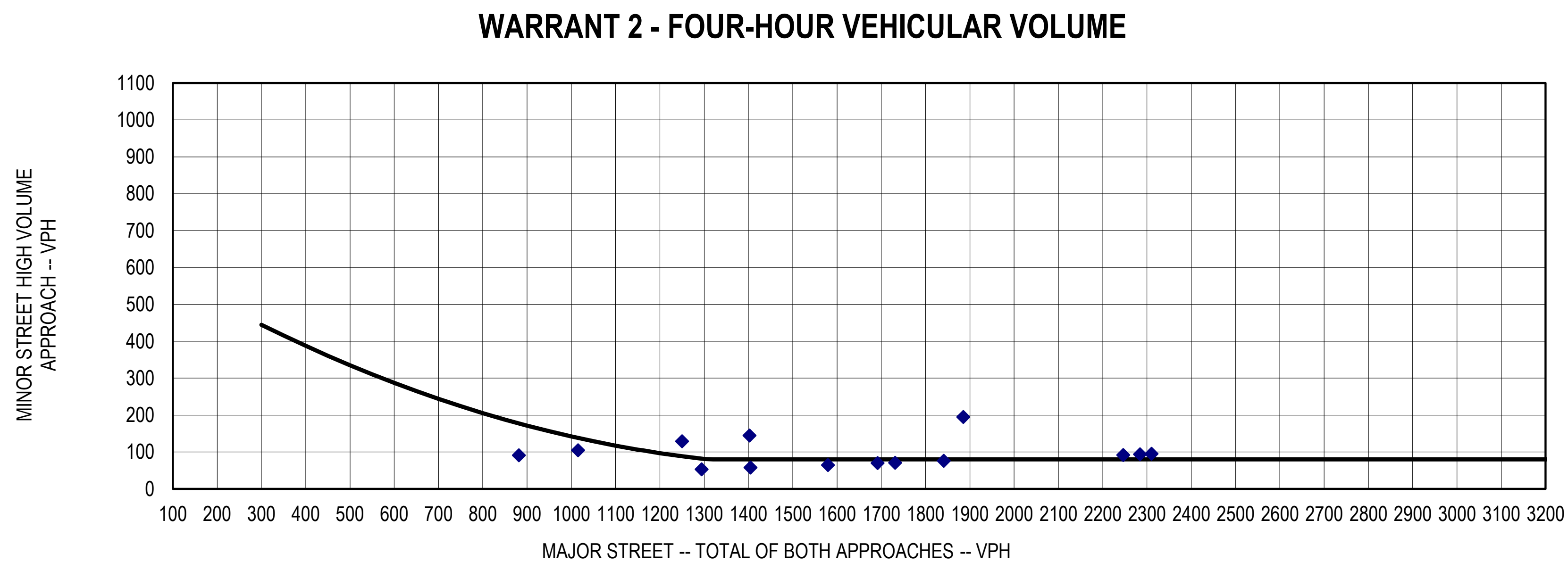
Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	1	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	8	8	Met - Warrant 1B Satisfied
Warrant 1C:	Combination of Warrants	3	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	6	4	Met - Warrant 2 Satisfied
Warrant 3B:	Peak Hour	1	1	Met - Warrant 3B Satisfied
MWSA (C):	Multiway Stop Applications Condition C	1	8	Not Met

WARRANTS ANALYSIS

Year 2026

U.S. Hwy 75/20th Ave
US Hwy 10/US Hwy 75 Corridor Study
Moorhead, MN

Warrants Analysis: Warrant 2



Number of Hours Satisfying Requirements:	6

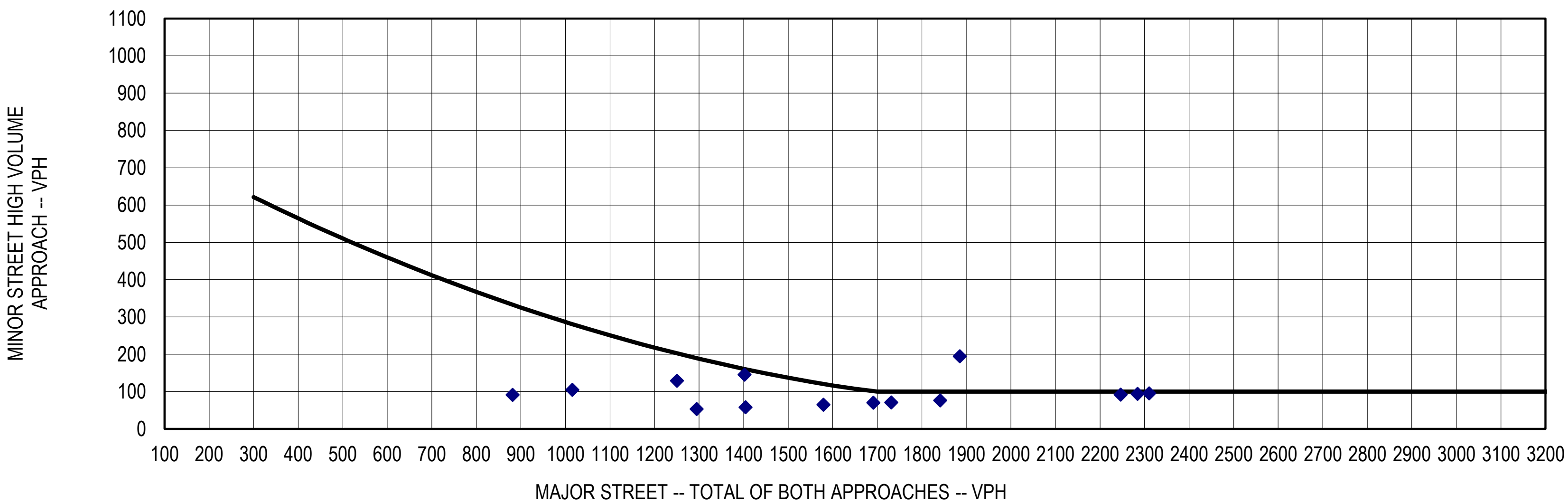
Notes: 1. 115 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 80 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

WARRANTS ANALYSIS **Year 2026**

U.S. Hwy 75/20th Ave
US Hwy 10/US Hwy 75 Corridor Study
Moorhead, MN

Warrants Analysis: Warrant 3

WARRANT 3 - PEAK HOUR



Number of Hours Satisfying Requirements:	1

Notes: 1. 150 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 100 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

WARRANTS ANALYSIS

Year 2045

U.S. Hwy 75/20th Ave
US Hwy 10/US Hwy 75 Corridor Study
Moorhead, MN

Background Information

		Speed (mph)	Lanes	Approach	
Location :	Moorhead, MN				
Date:	12/30/2019	40	2 or more	Major Approach 1:	Northbound U.S. Hwy 75
Analysis Prepared By:	M.Knight	40	2 or more	Major Approach 3:	Southbound U.S. Hwy 75
Population Less than 10,000:	No	30	1	Minor Approach 2:	Eastbound 20th Avenue
Seventy Percent Factor Used:	No	30	1	Minor Approach 4:	Westbound 20th Avenue

Warrants Analysis: Warrants 1A, 1B and 1C

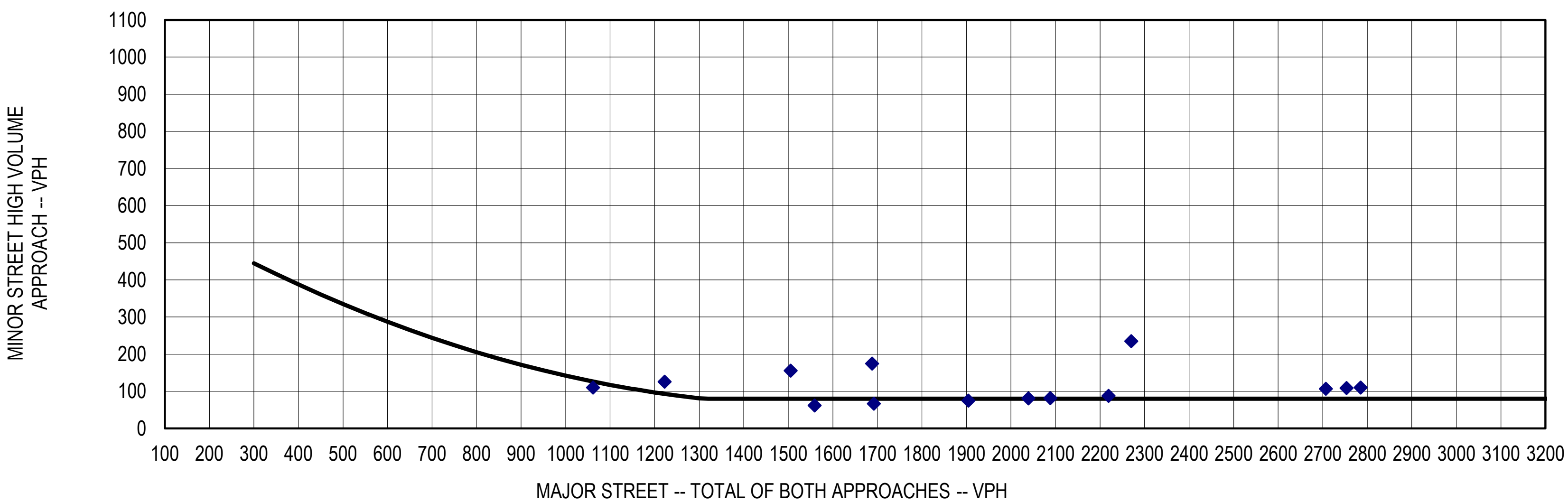
Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 600	Warrant Met 900	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 150	Warrant Met 75	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 300	MWSA (C) 200
6 - 7 AM	680	381	1061	X	X	35	110	110		X		X		X	X	
7 - 8 AM	1455	815	2270	X	X	75	235	235	X	X	X	X	X	X	X	X
8 - 9 AM	1082	606	1688	X	X	56	175	175	X	X	X	X	X	X	X	X
9 - 10 AM	783	439	1222	X	X	40	126	126		X		X	X	X	X	
10 - 11 AM	965	540	1505	X	X	50	156	156	X	X	X	X	X	X	X	X
11 - 12 AM	735	957	1692	X	X	58	67	67						X	X	
12 - 1 PM	964	1255	2219	X	X	76	88	88		X		X		X	X	
1 - 2 PM	827	1077	1904	X	X	65	75	75		X		X		X	X	
2 - 3 PM	907	1181	2088	X	X	71	82	82		X		X		X	X	
3 - 4 PM	1176	1531	2707	X	X	92	107	107		X		X		X	X	
4 - 5 PM	1210	1575	2785	X	X	95	110	110		X		X		X	X	X
5 - 6 PM	1196	1557	2753	X	X	94	109	109		X		X		X	X	X
6 - 7 PM	886	1153	2039	X	X	70	81	81		X		X		X	X	
											3	12	4	14	5	

Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	3	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	12	8	Met - Warrant 1B Satisfied
Warrant 1C:	Combination of Warrants	4	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	10	4	Met - Warrant 2 Satisfied
Warrant 3B:	Peak Hour	6	1	Met - Warrant 3B Satisfied
MWSA (C):	Multiway Stop Applications Condition C	5	8	Not Met

Warrants Analysis: Warrant 2

WARRANT 2 - FOUR-HOUR VEHICULAR VOLUME



Number of Hours Satisfying Requirements:	10

Notes: 1. 115 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 80 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

Consulting Group, Inc.

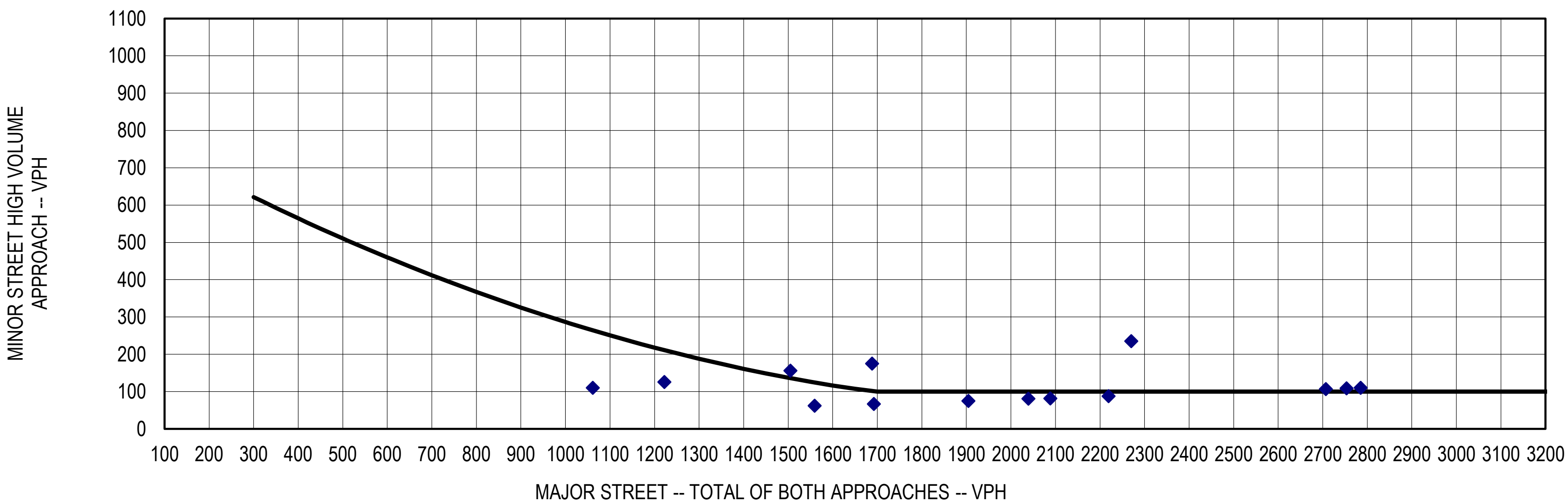
WARRANTS ANALYSIS

Year 2045

U.S. Hwy 75/20th Ave
US Hwy 10/US Hwy 75 Corridor Study
Moorhead, MN

Warrants Analysis: Warrant 3

WARRANT 3 - PEAK HOUR



Number of Hours Satisfying Requirements:	6

Notes: 1. 150 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 100 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

Appendix D

Opening Day Year 2026 Detailed Traffic Operations Analysis

2026 AM No Build
US 10/US 75 VISSIM Analysis
MOE Results

8th St/20th Ave **Signal**

Approach	Movement	Volume (vph)	Average Queue (ft)	Maximum Queue (ft)	Movement Delay (sec/veh)	Movement LOS	Approach Delay (sec/veh)	Approach LOS	Overall Delay (sec/veh)	Overall LOS
Northbound	Left	21	0	10	6	A	2.8	A	7.5	A
	Thru	1,154	7	158	2.7	A				
	Right	25	7	162	3.2	A				
Southbound	Left	20	0	21	13.3	B	6.1	A		
	Thru	623	10	150	5.8	A				
	Right	5	11	158	5.3	A				
Eastbound	Left	12	10	75	36.6	**D**	30.8	C		
	Thru	36	10	77	36.1	**D**				
	Right	16	11	81	14.6	B				
Westbound	Left	76	36	186	39.6	**D**	34.8	C		
	Thru	37	36	186	41.8	**D**				
	Right	73	39	190	26.3	C				

2026 No Build PM
US 10/US 75 VISSIM Analysis
MOE Results

8th St/20th Ave **Signal**

Approach	Movement	Volume (vph)	Average Queue (ft)	Maximum Queue (ft)	Movement Delay (sec/veh)	Movement LOS	Approach Delay (sec/veh)	Approach LOS	Overall Delay (sec/veh)	Overall LOS
Northbound	Left	28	0	27	13	B	9.7	A	10.6	B
	Thru	917	28	310	9.6	A				
	Right	59	29	316	9.6	A				
Southbound	Left	66	2	49	13.1	B	9.1	A		
	Thru	1,200	33	350	8.9	A				
	Right	5	37	358	11.4	B				
Eastbound	Left	11	10	80	35.1	**D**	28.5	C		
	Thru	41	10	80	33.4	C				
	Right	21	12	84	15.6	B				
Westbound	Left	28	11	91	37.8	**D**	26.3	C		
	Thru	18	11	92	35.6	**D**				
	Right	38	12	96	13.5	B				

Operational Data

Main Geometry (ft)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	SB US 75	0	0	24.00	2	28.00	2	50.00	75.00	35.00
2	EB 20th Ave	90	0	12.00	1	14.00	1	50.00	75.00	35.00
3	NB US 75	180	0	24.00	2	28.00	2	50.00	75.00	35.00
4	WB 20th Ave	270	0	12.00	1	14.00	1	50.00	75.00	35.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	SB US 75	180.00	15.00	1	28.00	2	24.00	2
2	EB 20th Ave	180.00	30.00	2	14.00	1	12.00	1
3	NB US 75	180.00	15.00	1	28.00	2	24.00	2
4	WB 20th Ave	180.00	30.00	2	14.00	1	12.00	1

Operational Results

2026 AM Peak - 60 minutes

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	SB US 75	None	4.84		4.84	1.32		A		A
2	EB 20th Ave	None	5.14		5.14	0.25		A		A
3	NB US 75	None	6.80		6.80	3.31		A		A
4	WB 20th Ave	None	8.93		8.93	1.13		A		A

Operational Data

Main Geometry (ft)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	SB US 75	0	0	24.00	2	28.00	2	50.00	75.00	35.00
2	EB 20th Ave	90	0	12.00	1	14.00	1	50.00	75.00	35.00
3	NB US 75	180	0	24.00	2	28.00	2	50.00	75.00	35.00
4	WB 20th Ave	270	0	12.00	1	14.00	1	50.00	75.00	35.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	SB US 75	180.00	15.00	1	28.00	2	24.00	2
2	EB 20th Ave	180.00	30.00	2	14.00	1	12.00	1
3	NB US 75	180.00	15.00	1	28.00	2	24.00	2
4	WB 20th Ave	180.00	30.00	2	14.00	1	12.00	1

Operational Results

2026 PM Peak - 60 minutes

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	SB US 75	None	7.50		7.50	4.15		A		A
2	EB 20th Ave	None	7.06		7.06	0.41		A		A
3	NB US 75	None	6.16		6.16	2.51		A		A
4	WB 20th Ave	None	6.11		6.11	0.39		A		A

Appendix E

Year 2045 Detailed Traffic Operations Analysis

2045 AM No Build
US 10/US 75 VISSIM Analysis
MOE Results

8th St/20th Ave **Signal**

Approach	Movement	Volume (vph)	Average Queue (ft)	Maximum Queue (ft)	Movement Delay (sec/veh)	Movement LOS	Approach Delay (sec/veh)	Approach LOS	Overall Delay (sec/veh)	Overall LOS
Northbound	Left	27	0	14	7	A	3.2	A	8.1	A
	Thru	1,379	9	184	3.1	A				
	Right	28	9	185	3.4	A				
Southbound	Left	28	1	20	16.3	B	6.4	A		
	Thru	749	12	172	6.1	A				
	Right	6	13	175	5.7	A				
Eastbound	Left	12	12	83	42.1	**D**	32.0	C		
	Thru	42	12	83	37.7	**D**				
	Right	20	14	88	14.0	B				
Westbound	Left	93	48	223	42.9	**D**	37.6	**D**		
	Thru	45	48	222	39.5	**D**				
	Right	89	51	226	31.0	C				

2040 No Build
US 10/US 75 VISSIM Analysis
MOE Results

8th St/20th Ave **Signal**

Approach	Movement	Volume (vph)	Average Queue (ft)	Maximum Queue (ft)	Movement Delay (sec/veh)	Movement LOS	Approach Delay (sec/veh)	Approach LOS	Overall Delay (sec/veh)	Overall LOS
Northbound	Left	33	1	29	17	B	9.4	A	12.7	B
	Thru	1,108	33	380	9.2	A				
	Right	70	34	385	9.9	A				
Southbound	Left	78	3	75	18.6	B	13.2	B		
	Thru	1,430	195	585	12.9	B				
	Right	6	209	608	9.6	A				
Eastbound	Left	12	13	98	33.3	C	29.2	C		
	Thru	48	13	99	34.7	C				
	Right	26	15	102	17.0	B				
Westbound	Left	35	15	114	41.1	D	28.8	C		
	Thru	18	16	115	36.7	D				
	Right	46	17	118	16.4	B				

Operational Data

Main Geometry (ft)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	SB US 75	0	0	24.00	2	28.00	2	50.00	75.00	35.00
2	EB 20th Ave	90	0	12.00	1	14.00	1	50.00	75.00	35.00
3	NB US 75	180	0	24.00	2	28.00	2	50.00	75.00	35.00
4	WB 20th Ave	270	0	12.00	1	14.00	1	50.00	75.00	35.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	SB US 75	180.00	15.00	1	28.00	2	24.00	2
2	EB 20th Ave	180.00	30.00	2	14.00	1	12.00	1
3	NB US 75	180.00	15.00	1	28.00	2	24.00	2
4	WB 20th Ave	180.00	30.00	2	14.00	1	12.00	1

Operational Results

2045 AM Peak - 60 minutes

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	SB US 75	None	5.43		5.43	1.78		A		A
2	EB 20th Ave	None	5.57		5.57	0.29		A		A
3	NB US 75	None	8.32		8.32	5.36		A		A
4	WB 20th Ave	None	11.45		11.45	1.86		B		B

Operational Data

Main Geometry (ft)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	SB US 75	0	0	24.00	2	28.00	2	50.00	75.00	35.00
2	EB 20th Ave	90	0	12.00	1	14.00	1	50.00	75.00	35.00
3	NB US 75	180	0	24.00	2	28.00	2	50.00	75.00	35.00
4	WB 20th Ave	270	0	12.00	1	14.00	1	50.00	75.00	35.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	SB US 75	180.00	15.00	1	28.00	2	24.00	2
2	EB 20th Ave	180.00	30.00	2	14.00	1	12.00	1
3	NB US 75	180.00	15.00	1	28.00	2	24.00	2
4	WB 20th Ave	180.00	30.00	2	14.00	1	12.00	1

Operational Results

2045 PM Peak - 60 minutes

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	SB US 75	None	9.51		9.51	7.22		A		A
2	EB 20th Ave	None	8.85		8.85	0.61		A		A
3	NB US 75	None	7.28		7.28	3.75		A		A
4	WB 20th Ave	None	7.07		7.07	0.53		A		A