Stantec

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I-29 & 40th Ave N (CR 20) Interchange Feasibility Study

Traffic Operations Analysis Report

April 3, 2023

Prepared for:

North Dakota Department of Transportation

Prepared by:

Stantec Consulting Services Inc.

23 U.S.C. § 407 Documents
NDDOT Reserves All Objections

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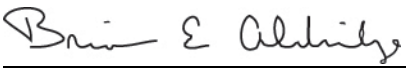
Reviewed by 
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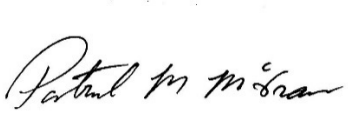

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Pat McGraw, PE

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1.0 INTRODUCTION

The Stantec team is working with the North Dakota Department of Transportation (NDDOT) to complete a preliminary engineering and feasibility study to evaluate improvement alternatives for the 40th Avenue North (Cass County Route 20) interchange with I-29 in Fargo, ND (Exit 69). The impetus for this study is the expectation of significant future traffic growth along the 40th Avenue North corridor as planned residential, commercial and industrial development occurs through the 2045 forecast year horizon.

As part of this study, Stantec performed a traffic operations analysis for the interchange and the approximately 2.1-mile corridor between intersections with 45th Street North on the west and the intersection with 25th Street North on the east. This report presents this analysis of 2022 base year traffic conditions and conditions for 2045 forecast year alternatives, which include five interchange concepts and three corridor concepts. The report provides an overview of the existing interchange and corridor, and summary of and reference to several technical memoranda describing the primary elements of the analysis, including:

- Traffic Count Technical Memorandum
- Traffic Forecast Data Sources and Recommendations
- Existing Conditions Simulation Model Development Memorandum
- Combined No-Build and Primary Corridor Alternatives Models Summary

This report is adapted from these previous technical memoranda and the technical memorandum ***I-29 & 40th Ave N Interchange: Interchange Alternatives Models Summary*** dated March 9, 2023. It is intended to serve as a preliminary planning summary of potential alternatives and does not represent a formal Interchange Justification Report (IJR).

2.0 STUDY AREA

The interchange of I-29 and 40th Avenue North is located on the north side of Fargo in an area transitioning from exurban to suburban levels of density and development. Existing land uses west of I-29 are predominantly agricultural with some residential development. Existing land uses east of I-29 are predominantly commercial and industrial with some agricultural land.

I-29 is a four-lane interstate facility with two lanes in each direction. The adjacent interchanges to 40th Avenue North (Exit 69) are at 76th Street North, approximately 3.4 miles north, and 19th Avenue North, approximately 2.1 miles to the south. The interchange with 40th Avenue North is a standard diamond with single lane ramps and stop control at the exit ramp terminals. The interchange is bordered on the east by a grade separated crossing of a rail line that runs parallel to I-29. The existing interchange is not lighted, but NDDOT has plans to construct ten high mast light poles at and approaching the interchange in the near future.

The 40th Avenue North corridor follows an east-west alignment along a portion of the northern city limits of Fargo and the northern perimeter of the Hector International Airport. It is a two-lane undivided highway,

classified as a major collector highway west of CR 81 and as a two-lane minor arterial highway east of CR 81. The corridor's speed limit is 40 miles per hour (MPH) with stop control for all side streets within the project limits, except for the intersection with CR 81 which has a traffic signal.

Figure 1 presents the study corridor and nine primary intersections within it. **Table 1** presents the existing lane configurations for each of these intersections. A "1" indicates one lane provides the movements as listed in the table heading and an "X" reflects when a movement is not allowed.

Figure 1. I-29 and 40th Avenue North Study Corridor

Table 1. Existing Corridor Intersection Turn Lane Configurations

	Westbound Appr.			Eastbound Appr.			Southbound Appr.			Northbound Appr.		
40th Avenue North at:	**LT**	**TH**	**RT**	**LT**	**TH**	**RT**	**LT**	**TH**	**RT**	**LT**	**TH**	**RT**
1. 45th Street North		1			1			1			1	
2. I-29 Southbound Ramps		1			1			1			X	
3. I-29 Northbound Ramps		1			1			X			1	
4. CR 81	1	1	1	1	1		1		1		1	
5. 37th Street North	1		1	1		1	1		1		1	
6. 33rd Street North	1	1	1	1	1	1		1			1	
7. 32nd Street North	1		1	1		1		1			X	
8. 39 1/2 Avenue North		1		X	1	1		X			1	
9. 25th Street North		1			1			1			1	

The NDDOT documented the crash history at the 40th Avenue N interchange with I-29 in the 2022 Fargo I-29 Exit 69 (Co 20 / 40th Ave N) Interchange Study. Over the five-year study period from September 1, 2016 through August 31, 2021, nine crashes were reported at the I-29 ramp terminals. **Table 2** below summarizes the crashes by type. As shown, nearly all the reported crashes involved rear ends. Four (33 percent) of the crashes resulted in injuries and there were no fatalities.

Table 2. Crash History - 40th Avenue N at I-29 Ramp Terminals

Year	Location	Type	Severity
2018	Between ramps	Rear-end	Injury
2019	Between ramps	Sideswipe (Opposing Dir.)	PDO
2017	40th Ave, I-29 NB Ramps	Angle	Injury
2018	40th Ave, I-29 NB Ramps	Rear-end	PDO
2019	40th Ave, I-29 NB Ramps	Rear-end	PDO
2018	40th Ave, I-29 NB Ramps	Rear-end	Injury
2018	40th Ave, I-29 NB Ramps	Rear-end	PDO
2021	40th Ave, I-29 NB Ramps	Rear-end	PDO
2019	40th Ave, I-29 NB Ramps	Rear-end	PDO

PDO: Property Damage Only

Source: Fargo I-29 Exit 69 (Co 20 / 40th Ave N) Interchange Study (2022); NDDOT Crash History

The interchange report also noted that the crest of the railroad bridge directly east of the northbound interstate ramps can create the mistaken impression among westbound drivers that they have already crossed the I-29 bridge and they could confuse the northbound exit ramp with the southbound entrance ramp. Further, the railroad bridge crest and the 40-mph speed limit on 40th Avenue North result in a dangerous site distance concern for trucks turning left from the northbound exit ramp. Some of the rationale for alternative interchange design is focused on minimizing the potential for wrong turns and reducing interchange conflict points.

3.0 TRAFFIC COUNTS

Quality Counts LLC, under subcontract with Stantec, employed video traffic detection equipment at the nine intersections identified in **Table 1** on Tuesday, December 20, 2022. Thirteen (13) hours of traffic count data (6:00 AM – 7:00 PM) were collected at each intersection, including autos and heavy trucks. While buses, bicyclists, or pedestrians were included in the counts, none traveled through the study area while counts were being collected. The complete traffic count data are included in **Appendix A**. **Figure 2** presents a summary of the rounded AM peak hour and PM peak hour turning movements. The AM peak hour is from 7:15 – 8:15 AM, and the PM peak hour is from 4:30 – 5:30 PM.

Existing base year peak hour traffic volume at the interchange and on the study corridor is moderate and fairly even between the AM and PM peak hours. The highest total peak hour segment volume on 40th Avenue North is 570 vehicles and occurs in the PM peak hour between the I-29 northbound ramps and the intersection with CR 81. The highest directional volume is eastbound 350 vehicles between the southbound and northbound ramp terminals in the PM peak hour. The highest turning movements reflect the movements to and from I-29 south of the interchange and 40th Avenue North east of the interchange - 210 left turns from the northbound exit ramp in the AM peak hour and 220 left turns to the southbound entrance ramp in the PM peak hour.

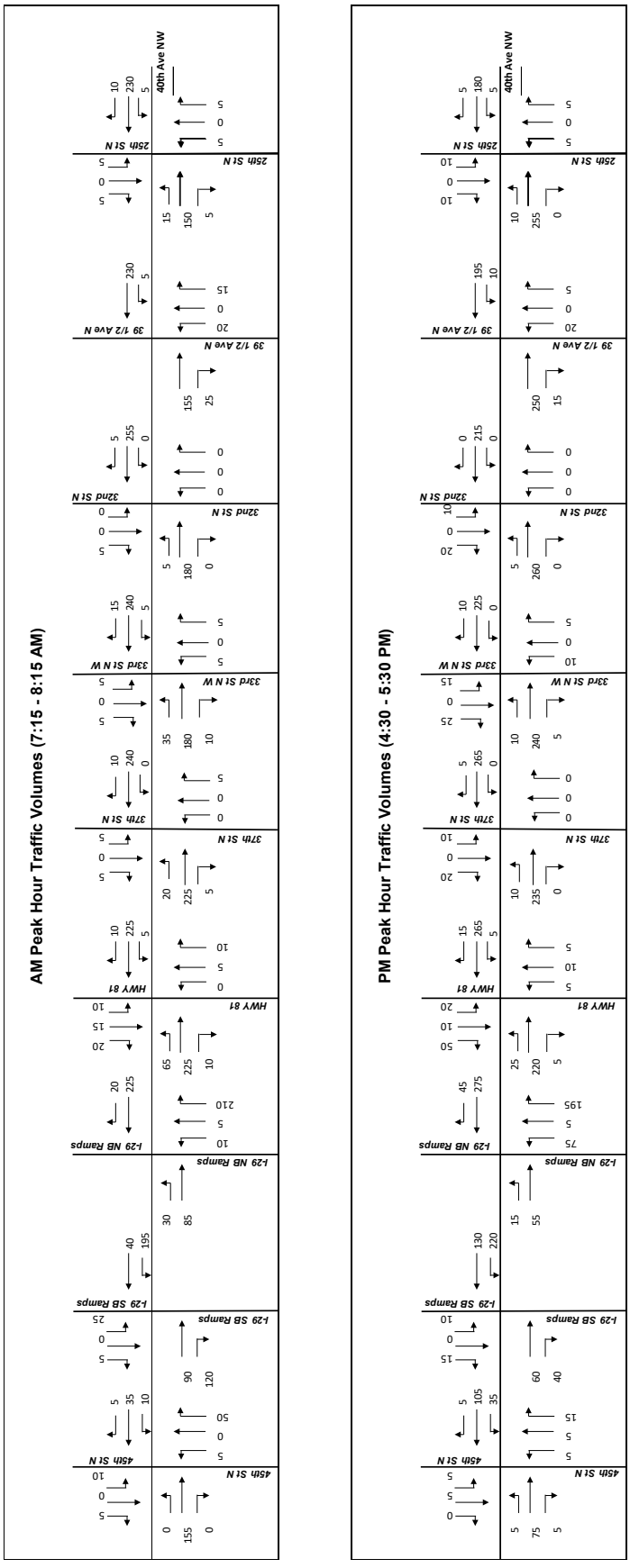


Figure 2. 40th Ave N – AM and PM Peak Hour Traffic Volumes

The peak hour factor (PHF) is a measure of the consistency of traffic through a facility within the peak hour, with a PHF of 1.0 reflecting uniform consistency across the hour. Lower PHFs indicate higher peak traffic volumes within the highest 15-minute period. **Table 3** presents the AM and PM PHFs for each intersection in the corridor.

Table 3. Intersection Peak Hour Factors

	Intersection	AM	PM
1	40th Ave N at 45th Street N	0.88	0.92
2	40th Ave N at I-29 southbound ramps	0.82	0.87
3	40th Ave N at I-29 northbound ramps	0.79	0.92
4	40th Ave N at CR 81	0.79	0.88
5	40th Ave N at 37th Street N	0.75	0.91
6	40th Ave N at 33rd Street N	0.76	0.82
7	40th Ave N at 32nd Street N	0.76	0.84
8	40th Ave N at 391/2 Avenue N	0.80	0.91
9	40th Ave N at 25th Street N	0.84	0.94

In addition to the turning movement counts collected for this study, average daily traffic (ADT) counts from NDDOT were also summarized to provide a baseline understanding of relative traffic levels for the interchange and corridor. **Table 4** presents the historical counts for select locations in the study area.

Table 4. NDDOT Count Station Traffic Average Daily Traffic Volumes

Year	I-29		I-29 Ramps				40th Ave. N.		CR 81	
	Sta. 1686	Sta. 652	Sta. 654	Sta. 655	Sta. 656	Sta. 658	Sta. 657	Sta. 662	Sta. 661	Sta. 660
	north of 40th Ave.	south of 40th Ave.	NB Exit	NB Entrance	SB Exit	SB Entrance	west of I-29	east of CR 81	north of 40th Ave.	south of 40th Ave.
2013		18,975	2,830	455	388	2,691	1,984	6,239	819	468
2014										
2015	15,385		3,653	387	435	3,367	2,372	5,986	1,234	563
2016										
2017										
2018			2,977	459	583	2,796	3,228	7,896	746	528
2019	16,344	21,698								
2020	13,711	20,178								
2021	14,083	21,068	3,554	428	409	3,387	3,208	8,290	1,642	892
2022	14,859	21,582								
% CAGR*	**-0.5%**	**1.4%**	**2.9%**	**-0.8%**	**0.7%**	**2.9%**	**6.2%**	**3.6%**	**9.1%**	**8.4%**
NDDOT 2042		30,850	5,685	955						
% CAGR*		**1.9%**	**2.4%**	**4.1%**						

Source: NDDOT Planning Division - Traffic Information Section

* CAGR reflects annualized growth estimated from the first and last year of available data.

4.0 FORECAST DATA SOURCES AND RECOMMENDATIONS

The impetus for this study is the expectation of significant future traffic growth along the 40th Avenue North corridor as planned residential, commercial, and industrial development occurs through the 2045 forecast year horizon. This growth is a mirror of the strong growth that has occurred throughout the

Fargo-Moorhead metropolitan region over the past several decades. It is also only part of the planned growth that will occur in the northwest quadrant of the metro area as detailed in the Northwest Fargo Small Area Study[1] (January 2022) and the Fargo-Moorhead Metropolitan Council of Governments' (FM MetroCOG) Northwest Metro Transportation Plan Final Report[2].

To develop the growth recommendations for estimating 2045 forecast year traffic, Stantec analyzed the traffic forecasts from the planning documents identified above to estimate compound annual growth rates (CAGRs) for forecast traffic for key network locations in the study area. These rates were compared with CAGRs estimated from NDDOT forecast volumes for I-29, historical population and employment growth, historical traffic counts, and future year traffics assignments from FM MetroCOG's travel demand model. The forecast assumptions and CAGRs from all sources were compared and synthesized to produce recommended CAGRs for specific network locations. **Table 5** presents a summary of the CAGRs by network location for these sources as well as the recommended CAGRs and resulting average daily traffic (ADT) targets from those recommended CAGRs.

Table 5. CAGRs by Data Source and Recommended CAGRs

Source	I-29		I-29 Ramps				40th Ave. N.		CR 81	
	north of 40th Ave.	south of 40th Ave.	NB Exit	NB Entrance	SB Exit	SB Entrance	west of I-29	east of CR 81	north of 40th Ave.	south of 40th Ave.
NDDOT Historical Counts	-0.5%	1.4%	2.9%	-0.8%	0.7%	2.9%	6.2%	3.6%	9.1%	8.4%
NDDOT Forecast (2042)		1.9%	2.4%	4.1%						
Metro COG Model (2045)	1.6%	1.6%	1.3%	0.7%	1.4%	1.4%	1.0%	1.3%	2.3%	4.8%
NW Small Area Study (2030)								6.7%*	14.2%	5.0%
NW Metro Trans. Plan. (2045) "50% Buildout"							7.2%	3.0%	2.3%	7.6%
Recommended CAGR	1.9%	1.9%	2.5%	2.5%	2.5%	2.5%	7.0%	3.5%	7.0%	5.0%
Estimated 2045 ADTs	23,000	33,000	6,500	800	750	6,250	15,200	18,300	4,250	5,000

* Between I-29 and CR 81

The technical memorandum detailing the data sources and the analysis used to develop the forecast growth recommendations is provided as **Appendix B**.

5.0 SIMULATION MODEL DEVELOPMENT

Traffic operations for the existing year and all future year traffic scenarios were analyzed using an AM and PM peak hour traffic simulation model developed in Caliper's TransModeler (Version 6) simulation package. The model simulates the driving behaviors of individual vehicle trips entering and exiting model's network over the course of the AM peak hour (7:15 AM to 8:15 AM) and PM peak hour (4:30 PM – 5:30 PM). The model network includes all active public roadways connecting to the 40th Avenue North study corridor and its interchange with I-29 and was developed from roadway attributes sourced from NDDOT GIS databases and underlying aerial imagery. It is populated by vehicles of various types and classes according to separate auto and heavy truck trip tables estimated from the traffic count data

[1] Transportation Collaborative and Consultants, LLC (2022) *Northwest Fargo Small Area Study.* Report to the City of Fargo.
[2] https://www.fmmetrocog.org/projects-rfps/completed-projects/nwmetro-transportation-plan

summarized in **Section 3**. The model was calibrated to and validated against counts and other available data, including recorded speed from NDDOT and video queue analysis.

To reflect the variation that occurs in real day-to-day traffic conditions, the model uses random seeds to generate slight variation in trip patterns and driver behavior for each scenario model run. Therefore, to establish an accurate representation of average conditions, five model runs are performed and their outputs averaged for each scenario analyzed. **Appendix C** presents the technical memorandum detailing the model development and calibration process for the base year models.

Based on the validated 2022 base year model, 2045 forecast year trip tables were developed using the recommend CAGRs presented in **Table 5**. The AM and PM 2045 trip tables were developed to reflect and reconcile the target growth rates with an emphasis and deference to fully assigning anticipated traffic to the 40th Avenue North corridor. **Table 6** compares the total number of trips in the model trip tables for 2022 and 2045 and demonstrates that total traffic on the 40th Avenue North corridor almost quadruples in both the AM and PM peak hours, in line with the AADT expectations for the corridor, as presented in the Northwest Metro Transportation Plan Final Report for its *50% Buildout* development scenario for the area.

Table 6. Model Trips Summary by Vehicle Class and Scenario Year

	AM Peak Hour				PM Peak Hour			
	I-29 (Through)		40th Ave N (Local)		I-29 (Through)		40th Ave N (Local)	
	2022	**2045**	**2022**	**2045**	**2022**	**2045**	**2022**	**2045**
Auto/Lt.Trk	1,007	1,462	830	2,887	1,223	1,694	835	3,221
SU Truck	102	138	19	98	128	179	28	118
MU Truck	154	208	28	137	193	269	38	171
Total Trips	1,263	1,808	877	3,122	1,544	2,142	901	3,510

Figure 3 presents the output travel demand turning movement assignment for the final 2045 forecast year trip tables, which is comparable to the tuning movement counts presented in **Figure 2.**

6.0 EXISTING AND ALTERNATIVE CORRIDOR CONCEPTS

Prior to analyzing interchange design alternatives, previous studies had recommended implementing traffic signals or roundabouts at the primary intersections throughout the project corridor. To develop a basis for comparison of interchange design alternatives, Stantec created AM and PM peak hour simulation model networks for three corridor concepts distinct from the interchange design alternatives: **existing**, **signalized**, and **roundabouts**. All three corridor concepts focused on the corridor beyond the interchange, which was maintained in the model networks in its existing configuration with a two-lane bridge and two-way stop control at the ramp terminal intersections. Further, away from the interchange, no additional lane capacity was added to the corridor beyond what currently exists.

The **existing** corridor concept maintains all intersections as they currently exist, with two-way stop control except for the intersection with CR 81, which is signalized. The **signalized** concept replaces two-way stop control at the intersections of 45th Street North, 37th Street North, 33rd Street North, and 25th Street North with traffic signals, although NDDOT policy states that a signal warrant must be met for a traffic signal to be installed at an intersection.

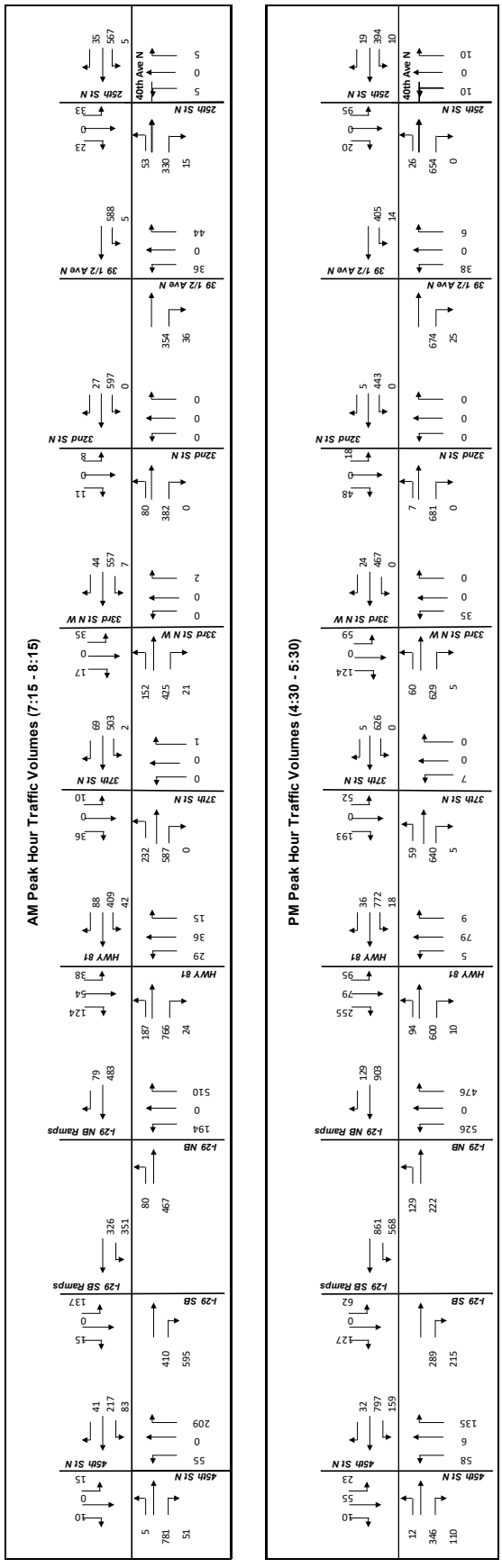


Figure 3. 40th Ave N – 2045 AM and PM Peak Hour Turning Movement Demand Volumes

The **roundabouts** concept replaces the stop-control at these same four intersections and the signal at CR 81 with single lane roundabouts. The intersections at 32nd Street North and 39½th Avenue North remain 2-way stop controlled in all three corridor concepts.

Figures 4 through **17** present the assumed layouts of each of the intersections for each concept.

Figure 4. Existing 45th Street North Intersection

Figure 5. Signalized 45th Street North Intersection

Figure 6. 45th Street North with Roundabout

Figure 7. Existing / Signalized CR 81 Intersection

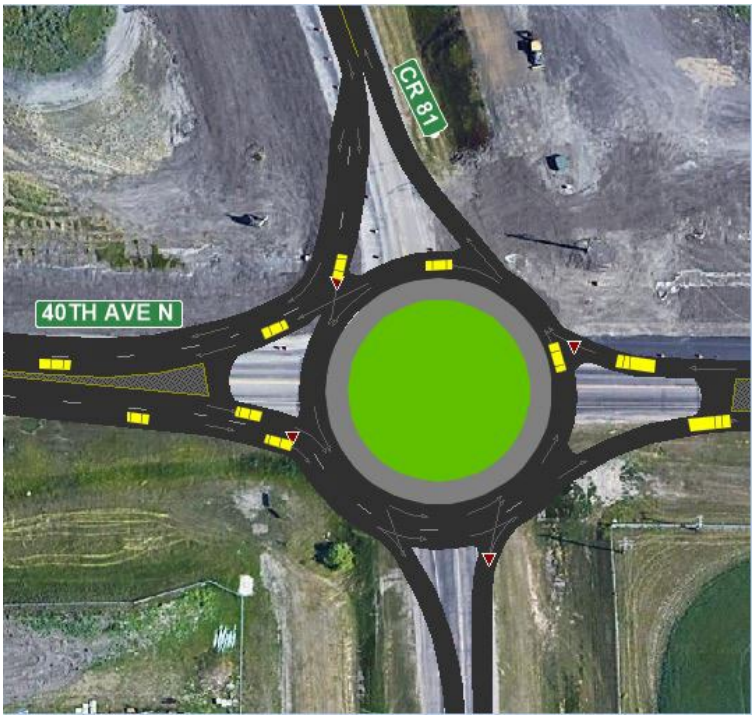


Figure 8. Intersection at CR 81 with Roundabout

Figure 9. Existing 37th Street North Intersection

Figure 10. Signalized 37th Street North Intersection

Figure 11. Intersection at 37th Street North with Roundabout

Figure 12. Existing 33rd Street North Intersection

Figure 13. Signalized 33rd Street North Intersection

Figure 14. 33rd Street North Roundabout

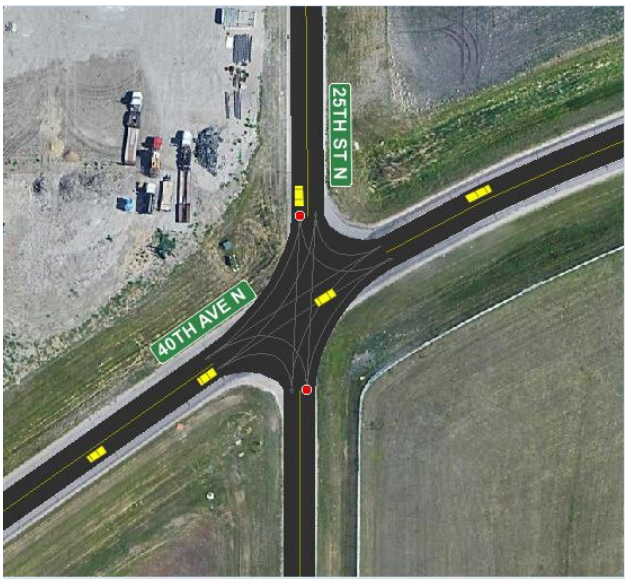


Figure 15. Existing 25th Street North Intersection

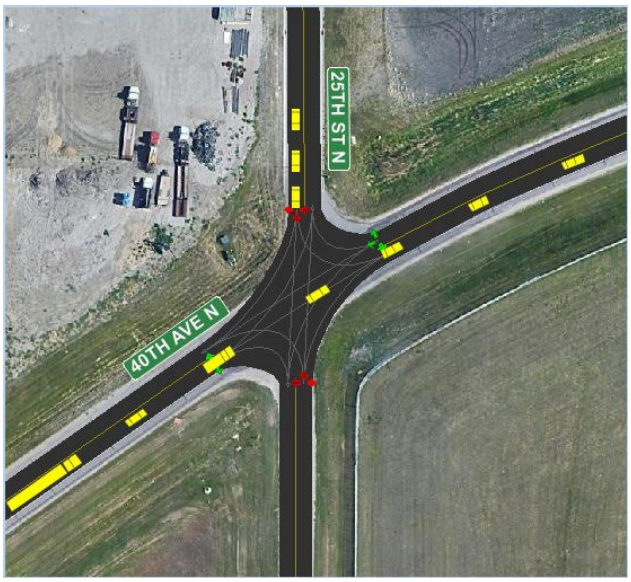


Figure 16. Signalized 25th Street North Intersection

Figure 17. 25th Street North Roundabout

Simulation model runs were performed for each of the three corridor concepts for both the 2022 base year and the 2045 forecast year. Five simulation runs were run for each AM and PM peak hour scenario. Traffic operation outputs related to average intersection delay per vehicle, and intersection or roundabout Level of Service (LOS) were collected and averaged from the output report files generated by TransModeler for each run. LOS is a qualitative measure describing operational conditions within a traffic system, based on service measures such as speed, delay, freedom to maneuver, traffic interruptions, comfort, and convenience. There are six levels of service, presented as letter grades A through F. TransModeler incorporates the standards of LOS as detailed in the *Highway Capacity Manual* (HCM) in its calculations for estimating LOS measures. **Appendix D** provides more details on LOS and the traffic operational metrics used in this analysis.

For the 2022 base year simulation model runs, the relatively low level of existing traffic at the interchange and on the corridor results in minimal delays and optimal levels of service for each intersection, in all three corridor concepts. The intersection LOS for each intersection, including the ramp terminal intersections are all A. Intersection or roundabout delay is very low and only differs according to the operational characteristics of the intersection type.

For the 2045 forecast year simulation model runs, total trips on the 40th Avenue North corridor almost quadruple from current levels (see **Table 5**). As the majority of these trips pass through the interchange intersections, the lack of additional intersection and lane capacity at the ramp terminal intersections quickly results in these intersections failing as left turning traffic on 40th Avenue North onto the I-29 entrance ramps stops traffic and creates a gridlock condition. Backup queues quickly propagate from the interchange, expanding gridlock throughout the corridor and on the exit ramps from I-29, which ultimately affects the right lanes of the mainline interstate. As a result, all three corridor concepts have multiple intersections (or roundabouts) with LOS F, particularly for the higher volume PM peak hour.

The practical implication of these runs is that no additional intersection capacity, either at the interchange or on the corridor, is necessary for existing base year traffic. However, by 2045, additional capacity at the interchange will be essential for the effective operation of the corridor, regardless of the intersection concepts implemented at other intersections along the corridor.

The technical memorandum detailing the model results and metrics for each of the corridor concepts is presented as **Appendix D**.

7.0 INTERCHANGE DESIGN ALTERNATIVES

Five alternative interchange designs were selected for evaluation using the simulation model. The design alternatives are:

1. Upgraded Standard Diamond Interchange
2. Dumbbell (Roundabout) Interchange
3. Diverging Diamond Interchange (DDI)
4. Roundabout / DDI Hybrid Interchange
5. Partial Cloverleaf Interchange

Each of these design alternatives was paired with the three corridor concepts described in **Section 6**, resulting in a total of 15 distinct model networks. Each of the five interchange design alternatives was initially developed with single directional lanes for both 40th Avenue North and the interstate ramps. However, additional lane capacity was incrementally added as necessary to maintain LOS D or better for 2045 forecast year traffic at the interchange and approaches. For each alternative, this resulted in two westbound travel lanes on the 40th Avenue North bridge across I-29 and two or three lanes of storage capacity for the interstate exit ramps. Eastbound traffic on 40th Avenue North across the interstate can be served with a single lane. For several alternatives, two directional lanes are required for the 40th Avenue North approaches to the ramp terminals, either for storage or as receiving lanes.

In addition to addressing traffic operational issues, each of the alternative designs provide safety benefits. The relative crash reduction potential for the various interchange types is derived from study data collected and synthesized in the form Crash Modification Factors (CMF), which are catalogued at the Crash Modification Clearinghouse web site.[3] While the application of CMFs is very specific to the exact design distinctions and traffic conditions of a particular location, some general safety benefits are stated for each alternative in the descriptions that follow in this section.

[3] Crash Modification Factors Clearinghouse (cmfclearinghouse.org)

7.1 UPGRADED STANDARD DIAMOND INTERCHANGE

The upgraded standard diamond interchange upgrades the existing diamond interchange to provide coordinated traffic signals at the ramp terminal intersections and dedicated left turn lanes for both 40th Avenue North and the I-29 exit ramps. The 40th Avenue North approaches to the interchange, along with the westbound lanes across the interstate, would be widened to two lanes. One advantage of this alternative is that motorists would follow the same familiar path through the interchange intersections as they do today. Injury and fatal crashes are typically reduced by about 15% compared to an unsignalized interchange.

For the lane configuration shown in **Figure 18**, two westbound approach lanes at the I-29 northbound ramps intersection continue across the bridge and through the southbound ramps intersection before tapering back to a single lane. For eastbound traffic, a single eastbound lane crosses the bridge. Two eastbound lanes continue between the northbound ramps intersection and the intersection at CR 81. The northbound exit ramp approach expands to three lanes with a split center lane for left and right turns.

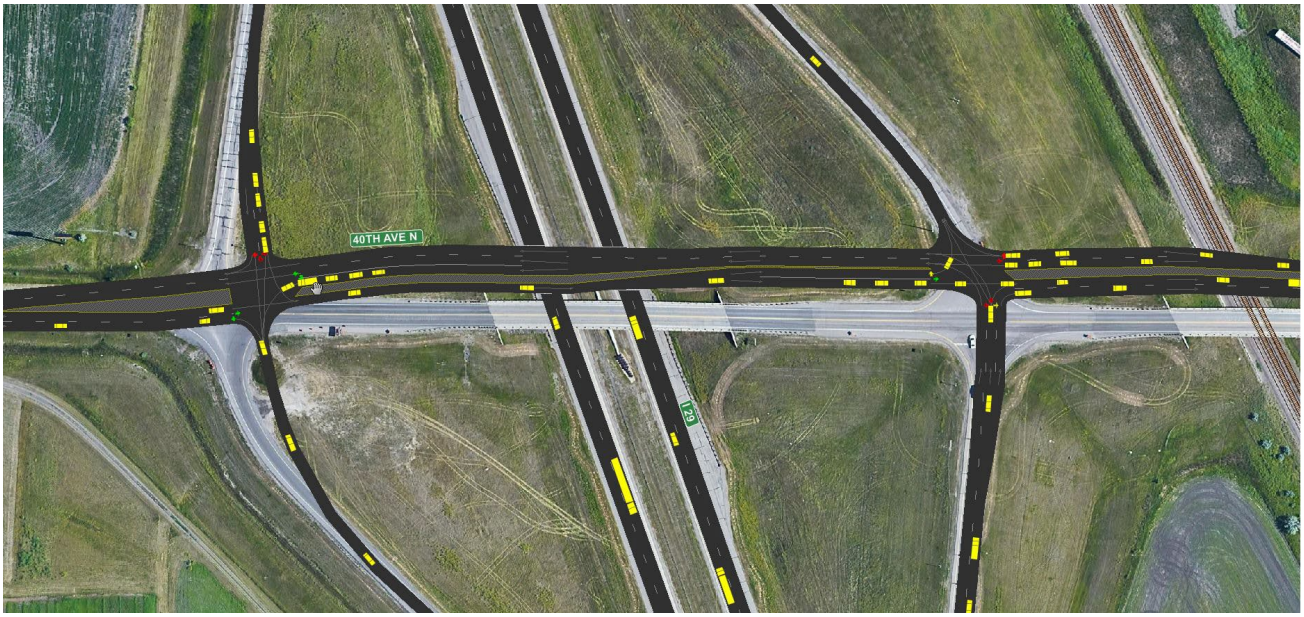


Figure 18. Alternative 1: Upgraded Standard Diamond Interchange

7.2 DUMBBELL (ROUNDABOUT) INTERCHANGE

A dumbbell interchange is created by converting each ramp terminal intersection into a roundabout. **Figure 19** shows an example of a dumbbell interchange in Carmel, Indiana. **Figure 20** presents the simulation model interchange with interior circulating lanes (the section of each roundabout closest to the interstate and bridge.

Figure 19. Dumbbell Interchange in Carmel, Indiana

Although full roundabouts were included in the simulation model of this interchange, circulating lanes are not necessary. Without these interior circulating lanes, the westbound left and through movements at the I-29 southbound ramps, and the eastbound left and through movements at the I-29 northbound ramps would be free-flow instead of yield-controlled.

Roundabouts replace the need for traffic stops with yielding and provide traffic calming that moderates traffic speed. Crossing conflict points are reduced from six to zero, compared to a standard diamond interchange. Total crashes are typically reduced by as much as 33 percent and injury and fatal crashes reduced by as much as 65 percent. Roundabouts also eliminate the potential for wrong way turns from westbound 40th Avenue North onto the I-29 northbound exit ramp.

Stakeholders have noted that the raised center island may cause snow drift accumulation across the circulating lanes. Mitigation strategies to address snow drifts, such as snow fences, may be essential elements of the overall design of this alternative.

As depicted in **Figure 20**, the northbound I-29 exit ramp is widened to two lanes as it approaches the roundabout with both lanes continuing in the eastbound direction of 40th avenue North as it approaches the intersection with CR 81. Westbound traffic on 40th Avenue North is two lanes, with two lanes continuing from the eastern roundabout onto the southbound I-29 entrance ramp, before tapering to one lane.

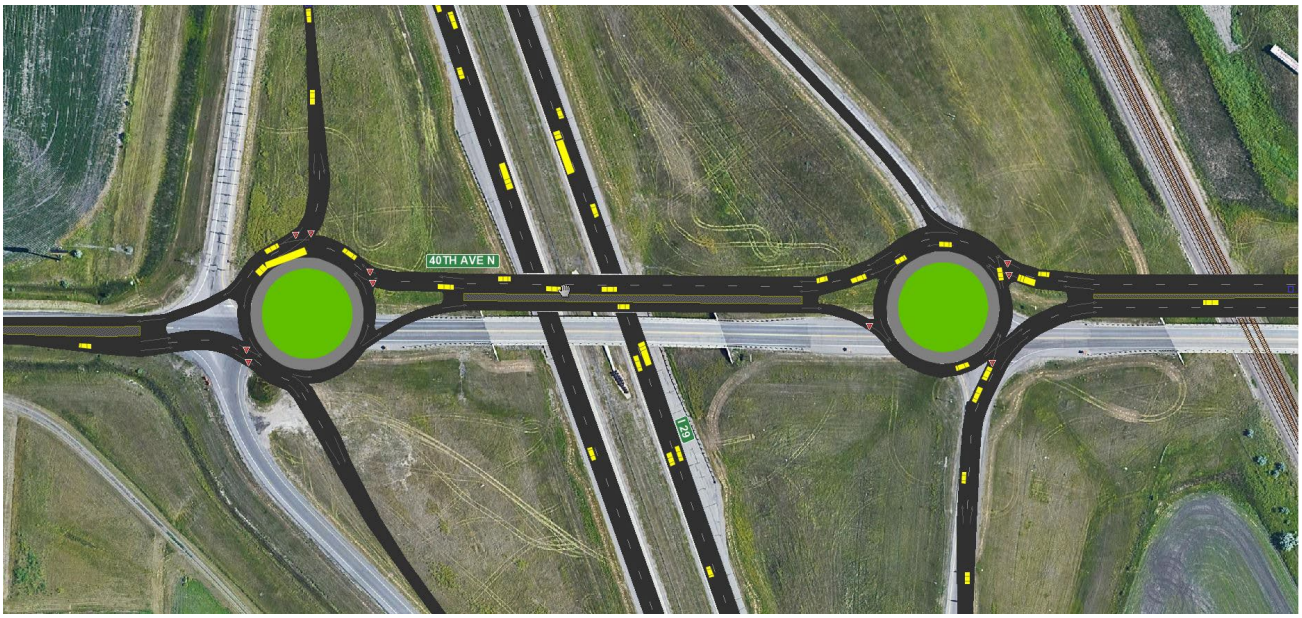


Figure 20. Alternative 2: Dumbbell Interchange

7.3 DIVERGING DIAMOND INTERCHANGE (DDI)

A DDI crosses traffic from the right side of the roadway to the left side through the interchange, eliminating the need for left-turn traffic signal phases and left turns crossing through vehicle paths. DDIs provide more efficient, two-phase traffic signals and free-flowing left turns for the entrance ramps and reduce conflict points where vehicle paths can cross, which reduces crash rates by up to 45 percent and angle or left-turn crashes by as much as 60 percent. The DDI configuration eliminates the potential for wrong way turns from westbound 40th Avenue North onto the I-29 northbound exit ramp.

For the lane configuration presented in **Figure 21**, two westbound lanes are continuous from the intersection with CR 81 to the east and continue through the crossover at the I-29 northbound ramps. At the southbound ramps, the left lane is dedicated for southbound entrance ramp traffic and the right lane crosses back over to the north side of the corridor for westbound traffic. A single lane for eastbound traffic crosses over to the north side of the bridge crossing at the I-29 southbound ramps. At the northbound ramp crossover, this single lane is joined with a second lane for eastbound traffic from the northbound exit ramp, with two eastbound lanes continuing to the intersection at CR 81.

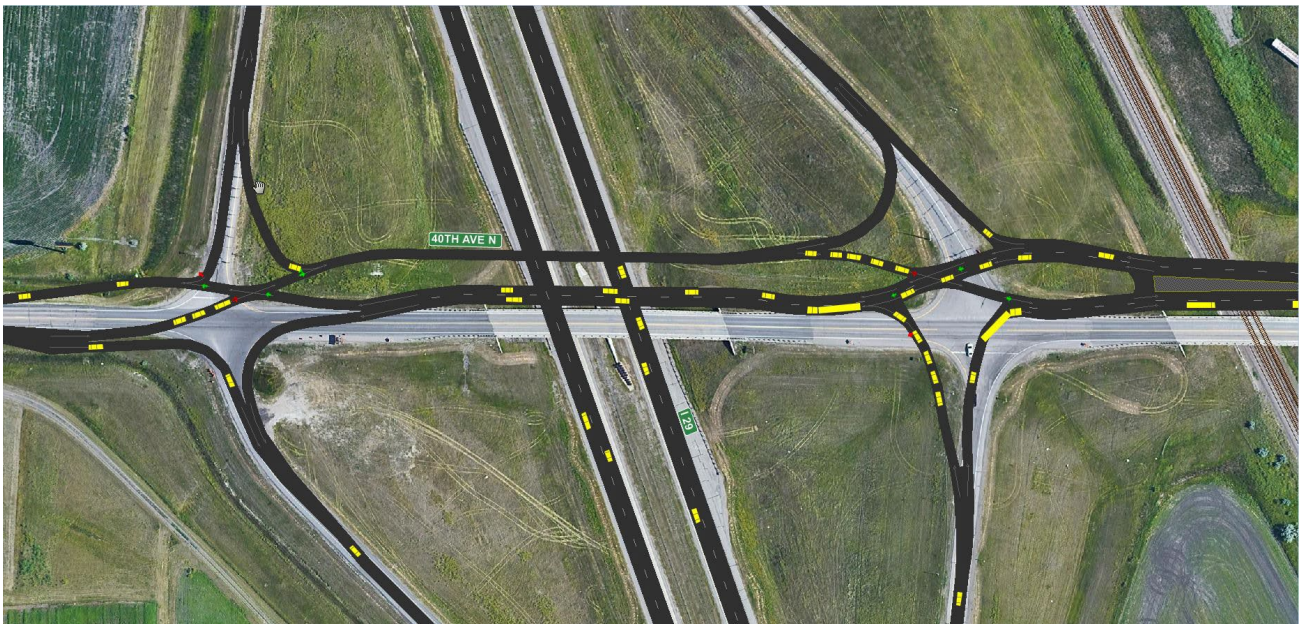


Figure 21. Alternative 3: Diverging Diamond Interchange (DDI)

7.4 ROUNDABOUT/DDI HYBRID INTERCHANGE

The hybrid interchange concept would combine roundabouts at the ramp terminal intersections with the directional flow of a DDI interchange. This would eliminate the need for traffic signals typically associated with DDI interchanges. While there is limited real-world safety experience with this concept, it should combine the safety aspects of roundabouts and DDI interchanges, including eliminating the potential for wrong way turns from westbound 40th Avenue North onto the I-29 northbound exit ramp.

For the lane configuration presented in **Figure 22**, two westbound lanes are continuous from the intersection with CR 81 to the east and continue through the roundabout and crossover at the I-29 northbound ramps. The two westbound lanes continue through the southbound ramp crossover and roundabout and are met by two receiving lanes for westbound 40th Avenue North, and a single lane for the southbound entrance ramp. Traffic from the I-29 northbound exit ramp can use the two-lane connection at the bridge or the roundabout to travel westbound. A single lane for eastbound traffic crosses over to the north side of the corridor at the I-29 southbound ramp roundabout. This single lane continues through the crossover at the northbound ramp roundabout, with a single lane continuing to the intersection at CR 81.

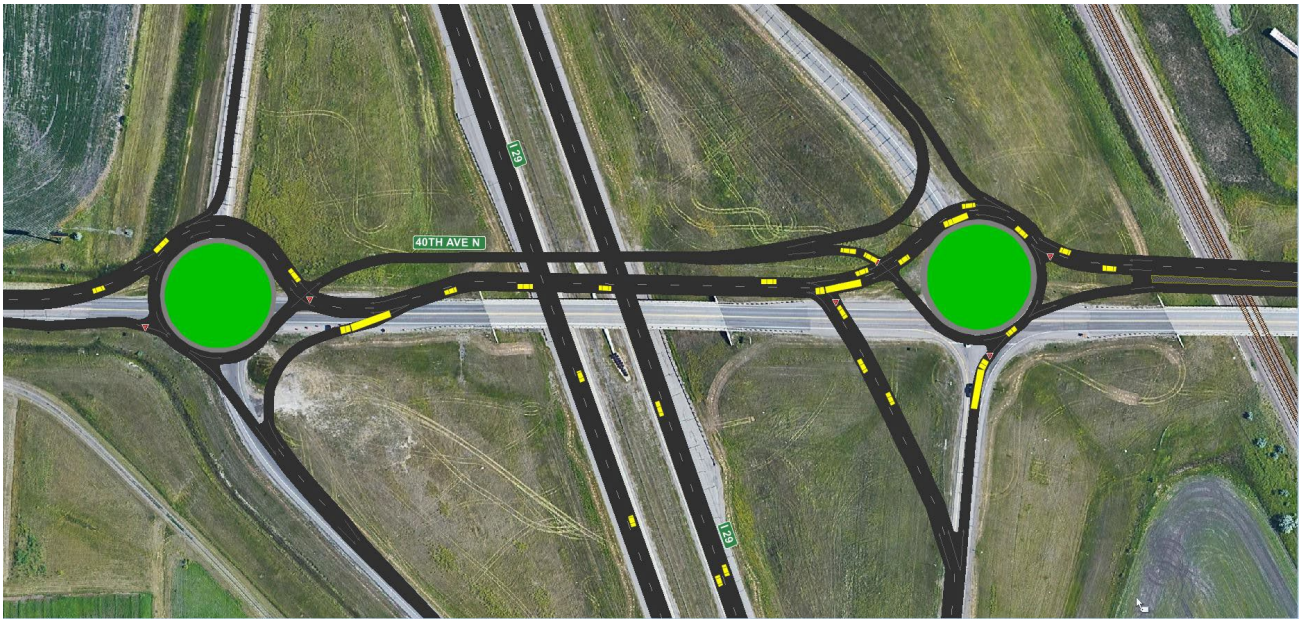


Figure 22. Alternative 4: Roundabout/DDI Hybrid Interchange

7.5 PARTIAL CLOVERLEAF INTERCHANGE

A partial cloverleaf interchange (or parclo) relocates left turns from one or more quadrants to free-flow loop ramps. The loop ramp(s) makes left turns entering the freeway free flow while the exit ramps operate like a normal diamond interchange. Eliminating the major westbound to southbound left turn movement results in greater green time for the through movements on the 40th Avenue North corridor. One downside to parclos is the loop ramps are generally low speed and require long merging or accelerating lanes on the intersecting freeway.

For the lane configuration presented in **Figure 23**, two westbound lanes are continuous from the intersection with CR 81 to the east and split at the I-29 southbound entrance ramp, with one lane continuing westbound. A single lane conveys eastbound traffic across the bridge, with a dedicated left turn lane at the intersection for northbound entrance ramp traffic. Two eastbound lanes connect the northbound ramps intersection with the intersection at CR 81.

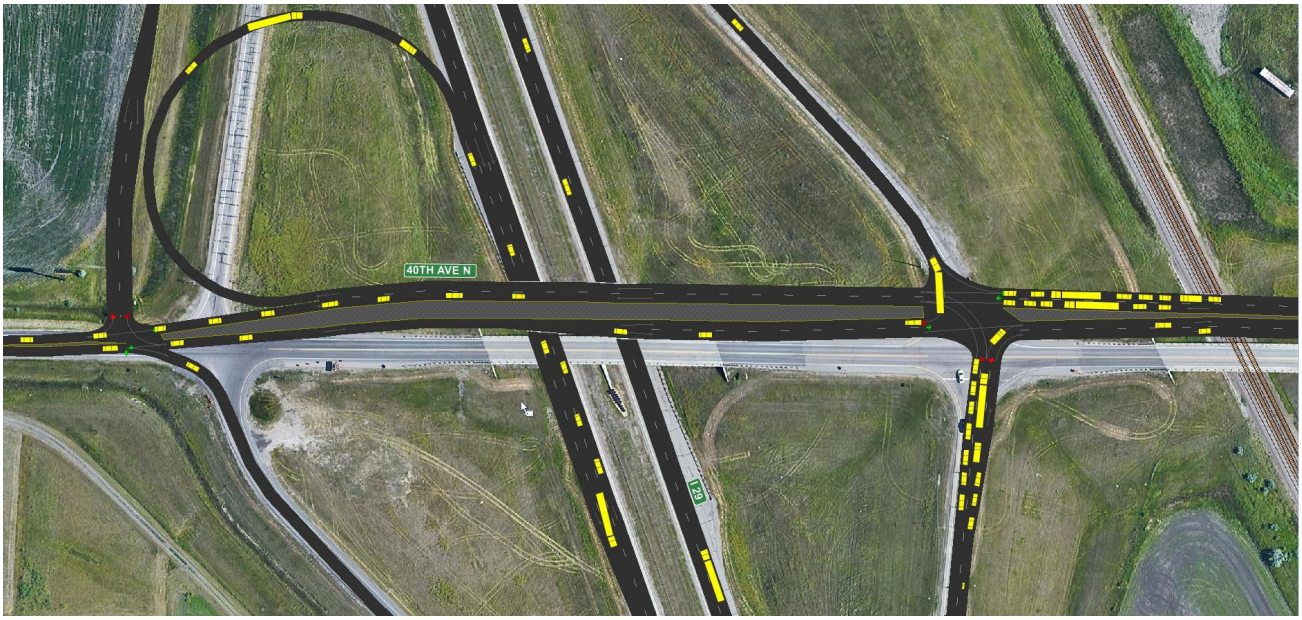


Figure 23. Alternative 5: Partial Cloverleaf (Parclo) Interchange

8.0 INTERCHANGE ALTERNATIVES OPERATIONAL ANALYSIS

8.1 2045 TRIP STATISTICS

Table 7 presents trip statistics from the average of five traffic simulation runs for each combination of interchanges and corridors in the 2045 AM and PM peak hours. The model incorporates a seed generator to create random variations between runs, as evidenced by the variation in the total number of trips recorded by the model in each peak hour. **Table 6** presents the number of trips that were still enroute at the end of the simulation period, as well as trips that were missed or unserved due to congestion. High numbers of such trips reflect congested conditions, or in the case of the scenarios shaded in gray, gridlock conditions (for the AM, PM, or both peak hours). Vehicle Hours Traveled (VHT) represents the total time that all trips recorded on the network or waiting to enter the network.

Table 7 demonstrates interchange alternatives paired with the existing corridor produce significantly more delay and unserved trips than the corridors with signalized intersections or roundabouts, primarily due to delays from side street traffic at two-way stop-controlled intersections, particularly at 45th Street North and 37th Street North.

Table 7. 2045 Peak Hour Model Trip Statistics

		AM Peak Hour (7:15 - 8:15 AM)					PM Peak Hour (4:30-5:30)				
		Trips			VHT	Total Delay (hrs.)	Trips			VHT	Total Delay (hrs.)
Interchange	Corridor	Total	En Route	Missed/ Unserved			Total	En Route	Missed/ Unserved		
Alternative 1: Standard Diamond	Existing	5,021	299	93	321	119	5,767	403	57	398	162
	Signalized	5,026	273	2	293	87	5,768	358	3	346	107
	Roundabouts	5,074	297	11	289	79	5,764	353	15	342	101
Alternative 2: Dumbbell	Existing	5,076	301	175	352	150	5,770	403	211	465	231
	Signalized	5,082	297	2	285	76	5,764	349	5	342	102
	Roundabouts	5,079	288	10	279	67	5,768	340	18	332	89
Alternative 3: Diverging Diamond	Existing	5,069	314	169	355	154	5,759	396	183	453	221
	Signalized	5,071	297	1	290	84	5,757	346	2	339	102
	Roundabouts	5,074	292	10	282	73	5,769	341	17	332	91
Alternative 4: Roundabout DDI	Existing	5,082	304	182	347	145	5,768	386	209	446	213
	Signalized	5,070	291	16	286	79	5,773	349	17	338	99
	Roundabouts	5,079	296	23	281	70	5,768	335	34	326	83
Alternative 5: Partial Cloverleaf	Existing	5,078	308	158	345	142	5,764	404	192	467	233
	Signalized	5,077	309	1	292	84	5,758	354	2	349	109
	Roundabouts	5,068	291	8	282	72	5,771	346	16	338	96

8.2 CORRIDOR TRAVEL TIME AND URBAN STREETS LEVEL OF SERVICE

TransModeler output tables provide all LOS metrics used in this analysis. TransModeler estimates Urban Street LOS according to corridor attributes and conditions described in the Highway Capacity Manual, including average operational speed on the corridor compared to the corridor's free flow speed. While the relationship between speed and LOS is indirect and varies according to the free flow speed, **Table 8** presents the general thresholds TransModeler uses for corridors with a free flow speed of 50 mph.

Table 8. TransModeler Threshold Speeds for Urban Streets LOS

Level of Service	Travel Speed Threshold (mph)
Free Flow	50
A	40
B	30
C	25
D	20
E	15
F	0

Table 9 presents the average travel time, travel speed, and LOS for traffic traveling on the 40th Avenue North corridor from 45th Street North to 25th Street North for both the eastbound and westbound directions, for each interchange alternative and corridor combination. The statistics in **Table 9** reflect only this east-west through traffic, and therefore do not reflect the delay experienced by traffic on side street approaches. This is particularly notable for the **existing** corridor, where through traffic on 40th Avenue North is continuous through every intersection except at the signal at CR 81. As a result, the travel times depicted in **Table 9** for the **existing** corridor is notably lower than the **signalized** and **roundabout** corridors, despite the fact that side street traffic is extremely delayed.

Table 9. 40th Avenue North Corridor Travel Times and LOS

		AM Peak Hour						PM Peak Hour					
		Eastbound			Westbound			Eastbound			Westbound		
Interchange	Corridor	Travel Time (min.)	Travel Speed (mph)	LOS	Travel Time (min.)	Travel Speed (mph)	LOS	Travel Time (min.)	Travel Speed (mph)	LOS	Travel Time (min.)	Travel Speed (mph)	LOS
Alternative 1: Standard Diamond	Existing	4.6	32	C	4.2	35	B	4.7	31	C	4.4	33	C
	Signalized	5.3	28	C	4.6	32	C	5.3	28	C	5.0	29	C
	Roundabouts	5.1	29	C	4.8	31	B	5.2	28	C	4.8	30	B
Alternative 2: Dumbbell	Existing	4.6	32	B	4.7	32	B	4.8	31	B	5.1	29	C
	Signalized	5.0	29	C	4.7	31	B	5.0	29	C	5.4	27	C
	Roundabouts	4.9	30	B	4.8	31	B	4.9	30	B	5.1	29	C
Alternative 3: Diverging Diamond	Existing	4.7	31	C	5.0	30	C	5.2	28	C	4.9	30	C
	Signalized	5.2	28	C	5.1	29	C	5.7	26	C	5.1	28	C
	Roundabouts	5.2	29	C	5.0	29	C	5.5	29	C	5.0	29	C
Alternative 4: Roundabout DDI	Existing	4.6	32	B	4.6	32	B	4.8	31	B	4.6	32	B
	Signalized	5.1	29	C	4.8	30	B	5.5	27	C	5.1	29	C
	Roundabouts	5.0	29	C	4.9	30	B	5.3	28	C	4.9	30	B
Alternative 5: Partial Cloverleaf	Existing	4.2	34	B	4.5	33	C	4.3	34	B	4.7	31	C
	Signalized	4.8	30	C	4.7	31	C	4.7	31	C	5.1	28	C
	Roundabouts	4.7	31	B	4.7	31	B	4.6	32	B	4.9	30	C

8.3 FREEWAY LEVEL OF SERVICE

Freeway LOS is relevant to this project in that any change to the interchange must not negatively affect the operation of the main interstate facility. Each alternative interchange design was adjusted to avoid

that outcome, if possible, by limiting ramp queues at 40th Avenue North from extending to the interstate mainline. The service measure freeway LOS is density as measured by the number of vehicles (passenger car equivalents) per mile, per lane. **Table 10** presents the LOS density thresholds for the three types of freeway facilities present at this interchange. The diverge area occurs before an exit ramp and the merge area occurs past the entrance ramp merge point. The basic segment in this scenario is between the ramps.

Table 10. Freeway LOS Density Thresholds

Level of Service	Diverge	Basic	Merge
A	< 10	< 11	< 10
B	< 20	< 18	< 20
C	< 28	< 26	< 28
D	< 35	< 35	< 35
E	< 43	< 45	< 43
Demand Exceeds Capacity			
F	> 43	> 45	> 43

Density: (pc/mi/hr)

Table 11 illustrates that all alternatives provide the same LOS for each of the adjacent freeway segments, within the desired threshold for peak hour performance of an urban interstate facility.

Table 11. Freeway LOS by Interchange Alternative

	AM Peak Hour							PM Peak Hour						
	Southbound				Northbound			Southbound				Northbound		
Interchange	Diverge (North of Exit)	Merge (ParClo Ramp)	Basic (Between Ramps)	Merge (South of Exit)	Diverge (South of Exit)	Basic (Between Ramps)	Merge (North of Exit)	Diverge (North of Exit)	Merge (ParClo Ramp)	Basic (Between Ramps)	Merge (South of Exit)	Diverge (South of Exit)	Basic (Between Ramps)	Merge (North of Exit)
1. Diamond	A		A	B	B	A	A	A		A	B	C	B	B
2. Dumbell	A		A	B	B	A	A	A		A	B	C	B	B
3. Diverging Diamond	A		A	B	B	A	A	A		A	B	C	B	B
4. Roundabout DDI	A		A	B	B	A	A	A		A	B	C	B	B
5. Partial Cloverleaf	A	B	A	B	B	A	A	A	B	A	B	C	B	B

8.4 INTERSECTION LEVEL OF SERVICE

Tables 12 and **13** present the AM peak hour and PM peak hour LOS and average vehicular delay for each alternative interchange and corridor combination. LOS and delay are provided for each intersection approach. Average delay for each approach does not necessarily reflect the volume of a particular approach as much as the volumes of competing movements that may adversely increase delay for minor movements. TransModeler was unable to provide metrics for the exit ramp approaches for the DDI alternatives in its output statistics, presumably because TransModeler sees these approaches as separate and downstream from the primary intersection points. However, these approaches have reasonably short queues, averaging below four vehicles with a maximum average queue length of no more than eight vehicles.

Tables 12 and **13** indicate that all intersections and intersection approaches for each interchange-corridor concept, operate acceptably.

Table 12. Interchange and Approach Level of Service: 40th Avenue North and I-29 Southbound Ramps

Interchange	Corridor	Approach	AM Peak			PM Peak		
			Vehicles	LOS	Delay	Vehicles	LOS	Delay
Alternative 1: Standard Diamond	Existing	SB Ramp	111	D	39.9	191	C	21.3
		EB 40th Ave.	910	B	14.0	449	C	26.9
		WB 40th Ave.	674	B	10.0	1,429	A	3.3
		Total	1,695	**B**	14.1	2,068	**B**	10.1
	Signalized	SB Ramp	189	C	21.7	189	C	21.7
		EB 40th Ave.	501	C	28.8	501	C	28.8
		WB 40th Ave.	1,437	A	3.5	1,437	A	3.5
		Total	1,785	**C**	23.1	2,127	**B**	11.1
	Roundabouts	SB Ramp	113	D	42.3	192	C	20.5
		EB 40th Ave.	1,012	B	15.3	508	C	27.1
		WB 40th Ave.	674	A	9.6	1,434	A	4.9
		Total	1,799	**B**	14.8	2,133	**B**	11.6
Alternative 2: Dumbbell	Existing	SB Ramp	115	A	6.3	191	C	22.1
		EB 40th Ave.	856	B	10.2	359	B	14.2
		WB 40th Ave.	675	A	2.4	1,433	A	2.7
		Total	1,647	**A**	6.5	1,983	**A**	6.2
	Signalized	SB Ramp	117	A	6.6	190	C	22.3
		EB 40th Ave.	1,009	B	12.6	506	B	14.1
		WB 40th Ave.	679	A	2.2	1,433	A	2.7
		Total	1,805	**A**	8.2	2,129	**A**	6.8
	Roundabouts	SB Ramp	113	A	5.8	190	C	23.1
		EB 40th Ave.	1,010	A	2.6	504	A	4.7
		WB 40th Ave.	682	A	0.6	1,436	A	0.7
		Total	1,805	**A**	1.9	2,130	**A**	3.4
Alternative 3: Diverging Diamond	Existing	EB 40th Ave.	344	B	16.2	217	C	25.4
		WB 40th Ave.	314	B	17.7	865	B	13.9
		Total	658	**B**	16.9	1,082	**B**	16.2
	Signalized	EB 40th Ave.	407	B	19.1	288	C	27.1
		WB 40th Ave.	313	B	17.9	870	B	14.9
		Total	720	**B**	18.6	1,157	**B**	17.9
	Roundabouts	EB 40th Ave.	407	B	17.1	290	C	24.7
		WB 40th Ave.	315	B	13.7	866	A	6.7
		Total	722	**B**	15.6	1,155	**B**	11.2
Alternative 4: Roundabout DDI	Existing	SB Ramp	114	A	3.6	191	A	6.0
		EB 40th Ave.	863	A	9.0	379	B	12.2
		WB 40th Ave.	313	B	12.6	862	A	9.3
		Total	1,290	**A**	9.4	1,431	**A**	9.6
	Signalized	SB Ramp	112	A	3.5	190	A	6.6
		EB 40th Ave.	1,008	B	13.1	506	B	14.5
		WB 40th Ave.	313	B	14.8	867	B	11.9
		Total	1,434	**B**	12.7	1,563	**B**	12.1
	Roundabouts	SB Ramp	112	A	3.8	191	A	5.9
		EB 40th Ave.	1,027	A	4.6	523	A	3.1
		WB 40th Ave.	314	B	12.4	864	B	10.8
		Total	1,452	**A**	6.2	1,577	**A**	7.6
Alternative 5: Partial Cloverleaf	Existing	SB Ramp	112	C	26.6	189	B	13.1
		EB 40th Ave.	872	A	2.1	373	A	2.0
		WB 40th Ave.	313	A	0.7	858	A	3.5
		Total	1,296	**A**	3.9	1,420	**A**	4.4
	Signalized	SB Ramp	114	C	25.8	189	B	12.4
		EB 40th Ave.	1,001	A	3.0	507	A	1.7
		WB 40th Ave.	315	A	0.4	861	A	3.6
		Total	1,430	**A**	4.3	1,557	**A**	4.0
	Roundabouts	SB Ramp	111	C	24.6	188	B	12.9
		EB 40th Ave.	1,012	A	2.7	505	A	2.1
		WB 40th Ave.	312	A	0.8	866	A	3.5
		Total	1,435	**A**	4.0	1,559	**A**	4.2

Table 13. Interchange and Approach Level of Service: 40th Avenue North and I-29 Northbound Ramps

Interchange	Corridor	Approach	AM Peak			PM Peak		
			Vehicles	LOS	Delay	Vehicles	LOS	Delay
Alternative 1: Standard Diamond	Existing	NB Ramp	681	B	14.4	997	B	16.1
		EB 40th Ave.	468	A	6.6	323	C	32.6
		WB 40th Ave.	570	B	17.2	1,029	C	21.5
		Total	1,720	**B**	13.2	2,348	**C**	20.8
	Signalized	NB Ramp	526	C	21.5	526	C	21.5
		EB 40th Ave.	351	D	35.7	351	D	35.7
		WB 40th Ave.	1,039	C	21.3	1,039	C	21.3
		Total	1,257	**B**	13.0	1,915	**C**	24.0
	Roundabouts	NB Ramp	683	B	14.0	999	B	13.1
		EB 40th Ave.	514	A	7.2	355	C	32.4
		WB 40th Ave.	570	B	17.8	1,037	B	18.3
		Total	1,767	**B**	13.3	2,391	**B**	11.6
Alternative 2: Dumbbell	Existing	NB Ramp	685	A	4.1	998	A	4.3
		EB 40th Ave.	447	A	4.3	270	A	3.7
		WB 40th Ave.	580	A	6.0	1,039	D	32.6
		Total	1,712	**A**	4.1	2,307	**C**	16.8
	Signalized	NB Ramp	688	A	4.7	996	A	4.8
		EB 40th Ave.	513	A	3.9	350	A	3.9
		WB 40th Ave.	289	A	6.6	1,038	D	32.6
		Total	1,778	**A**	4.4	2,383	**C**	18.5
	Roundabouts	NB Ramp	686	A	3.6	999	A	3.4
		EB 40th Ave.	510	A	0.7	348	A	0.7
		WB 40th Ave.	578	A	2.7	1,037	B	10.2
		Total	1,053	**A**	4.4	1,213	**A**	5.5
Alternative 3: Diverging Diamond	Existing	EB 40th Ave.	384	B	16.8	164	C	29.9
		WB 40th Ave.	504	C	20.7	909	B	19.0
		Total	888	**B**	19.0	1,073	**C**	20.7
	Signalized	EB 40th Ave.	431	B	18.5	217	C	33.7
		WB 40th Ave.	498	C	22.3	915	C	20.4
		Total	929	**C**	20.6	1,132	**C**	22.9
	Roundabouts	EB 40th Ave.	426	B	13.4	221	C	30.0
		WB 40th Ave.	505	B	10.3	912	A	7.8
		Total	932	**B**	11.7	1,133	**B**	12.1
Alternative 4: Roundabout DDI	Existing	NB Ramp	505	B	11.0	477	A	4.4
		EB 40th Ave.	368	B	12.7	146	C	20.7
		WB 40th Ave.	584	A	4.1	1,032	A	5.1
		Total	1,457	**A**	8.7	1,655	**C**	6.3
	Signalized	NB Ramp	505	B	11.5	472	A	4.8
		EB 40th Ave.	413	C	19.6	205	E	38.0
		WB 40th Ave.	578	A	4.3	1,045	A	5.3
		Total	1,496	**B**	10.9	1,722	**B**	9.1
	Roundabouts	NB Ramp	505	B	13.7	475	A	5.2
		EB 40th Ave.	429	A	8.6	222	D	26.6
		WB 40th Ave.	577	A	1.3	1,039	A	1.4
		Total	1,511	**A**	7.5	1,736	**A**	5.7
Alternative 5: Partial Cloverleaf	Existing	NB Ramp	682	A	5.9	991	B	12.3
		EB 40th Ave.	457	A	9.8	281	B	19.7
		WB 40th Ave.	568	B	11.1	1,036	C	24.0
		Total	1,706	**A**	8.7	2,308	**B**	18.4
	Signalized	NB Ramp	683	A	6.4	993	B	12.3
		EB 40th Ave.	511	A	9.5	355	B	19.5
		WB 40th Ave.	574	B	13.2	1,037	C	25.5
		Total	1,767	**A**	9.5	2,384	**B**	19.1
	Roundabouts	NB Ramp	686	A	9.2	996	B	10.2
		EB 40th Ave.	512	B	10.6	353	C	20.4
		WB 40th Ave.	572	B	11.0	1,040	C	23.2
		Total	1,770	**B**	10.2	2,389	**B**	17.4

Tables 14 through **18** present the intersection LOS for each of the other corridor intersections that were either signalized or converted to roundabouts in the respective corridor concepts. Unless otherwise noted, the signalized concept added traffic signals only and otherwise maintain the current roadway geometry. The roundabout concept includes single lane roundabouts.

For the intersection at 45th Street North, a left turn lane from westbound 40th Avenue to southbound 45th Street, and a right turn lane from northbound 45th Street North to eastbound 40th Avenue North were added to the signalized intersection. As **Table 13** indicates, the increased traffic expected in 2045 from west and south of this intersection will cause the existing stop-controlled intersection to fail.

Table 14. Intersection Level of Service: 40th Avenue North and 45th Street North

Intersection	Interchange Type	Corridor	AM Peak			PM Peak		
			Vehicles	LOS	Delay	Vehicles	LOS	Delay
40th Ave. N at 45th St. North	Alternative 1: Standard Diamond	Existing	1,310	E	45.6	1,642	F	69.1
		Signalized	1,428	B	8.7	1,743	A	9.3
		Roundabouts	1,436	A	4.1	1,436	A	4.1
	Alternative 2: Dumbbell	Existing	1,246	E	46.4	1,484	F	55.4
		Signalized	1,441	B	9.8	1,739	A	8.3
		Roundabouts	1,441	A	4.1	1,739	A	4.0
	Alternative 3: Diverging Diamond	Existing	1,250	F	52.2	1,508	F	75.9
		Signalized	1,438	B	11.2	1,734	B	10.6
		Roundabouts	1,439	A	4.2	1,439	A	4.2
	Alternative 4: Roundabout DDI	Existing	1,257	F	53.6	1,517	F	65.0
		Signalized	1,438	A	9.7	1,746	A	9.5
		Roundabouts	1,455	A	4.2	1,754	A	4.5
	Alternative 5: Partial Cloverleaf	Existing	1,267	E	52.4	1,497	F	67.1
		Signalized	1,432	C	27.3	1,731	A	10.1
		Roundabouts	1,442	A	4.4	1,442	A	4.4

For the intersection at CR 81 with roundabout, dual lanes are required for the southern segments of the roundabout to accommodate high eastbound to northbound movement volumes, specifically when combined with eastbound through volumes. The southbound approach from CR 81 requires a separate lane to store through and eastbound traffic waiting to enter the roundabout so that the high PM peak hour westbound traffic is not impeded. (A separated westbound/right turn bypass lane would also be appropriate.) Without these modifications, a single lane roundabout at CR 81 ultimately results in a gridlock condition with an LOS F, regardless of the interchange combination. With the modifications described above and presented in **Figure 8**, acceptable operations can be achieved as shown in **Table 15**.

Table 15.Intersection Level of Service: 40th Avenue North and CR 81

Intersection	Interchange Type	Corridor	AM Peak			PM Peak		
			Vehicles	LOS	Delay	Vehicles	LOS	Delay
40th Ave. N at CR 81	Alternative 1: Standard Diamond	Existing	1,811	B	14.4	2,015	C	20.4
		Signalized	1,834	B	22.2	2,050	C	22.2
		Roundabouts	1,851	A	7.4	1,851	A	7.4
	Alternative 2: Dumbbell	Existing	1,816	B	16.2	1,988	C	20.3
		Signalized	1,865	B	15.7	2,049	C	21.2
		Roundabouts	1,856	A	6.0	2,050	A	9.0
	Alternative 3: Diverging Diamond	Existing	1,805	C	20.7	1,992	C	23.2
		Signalized	1,438	C	21.2	2,047	C	23.3
		Roundabouts	1,858	A	5.9	1,858	A	5.9
	Alternative 4: Roundabout DDI	Existing	1,794	C	15.6	1,981	B	19.8
		Signalized	1,830	C	15.6	2,039	C	21.1
		Roundabouts	1,853	A	5.7	2,055	A	8.3
	Alternative 5: Partial Cloverleaf	Existing	1,814	B	15.1	1,989	C	20.2
		Signalized	1,856	B	15.0	2,045	C	20.8
		Roundabouts	1,853	A	7.7	1,853	A	7.7

Tables 16 through **18** illustrate that each of the three most eastern intersections operate optimally regardless of the corridor concept employed.

Table 16. Intersection Level of Service: 40th Avenue North and 37th Street

Intersection	Interchange Type	Corridor	AM Peak			PM Peak		
			Vehicles	LOS	Delay	Vehicles	LOS	Delay
40th Ave. N at 37th St. North	Alternative 1: Standard Diamond	Existing	1,353	A	2.5	1,557	A	2.5
		Signalized	1,370	A	8.7	1,587	A	5.9
		Roundabouts	1,377	A	5.9	1,377	A	5.9
	Alternative 2: Dumbbell	Existing	1,350	A	3.0	1,539	A	2.7
		Signalized	1,387	A	5.9	1,590	A	5.9
		Roundabouts	1,386	A	5.7	1,587	A	5.4
	Alternative 3: Diverging Diamond	Existing	1,347	A	2.5	1,537	A	2.4
		Signalized	1,384	A	6.2	1,586	A	6.0
		Roundabouts	1,385	A	5.6	1,385	A	5.6
	Alternative 4: Roundabout DDI	Existing	1,343	A	2.6	1,526	A	2.4
		Signalized	1,363	A	5.8	1,577	A	6.0
		Roundabouts	1,382	A	5.6	1,593	A	5.4
	Alternative 5: Partial Cloverleaf	Existing	1,353	A	2.9	1,538	A	2.5
		Signalized	1,384	A	6.4	1,592	A	7.1
		Roundabouts	1,379	A	6.0	1,379	A	6.0

Table 17. Intersection Level of Service: 40th Avenue North and 33rd Street

Intersection	Interchange Type	Corridor	AM Peak			PM Peak		
			Vehicles	LOS	Delay	Vehicles	LOS	Delay
40th Ave. N at 33rd St. North	Alternative 1: Standard Diamond	Existing	1,206	A	3.5	1,370	D	29.8
		Signalized	1,218	A	8.7	1,402	A	9.0
		Roundabouts	1,232	A	5.5	1,232	A	5.5
	Alternative 2: Dumbbell	Existing	1,210	A	3.7	1,355	D	25.7
		Signalized	1,237	A	8.9	1,402	A	8.7
		Roundabouts	1,231	A	5.7	1,402	A	5.2
	Alternative 3: Diverging Diamond	Existing	1,205	A	4.1	1,350	D	26.1
		Signalized	1,235	A	8.6	1,397	A	8.9
		Roundabouts	1,238	A	5.4	1,238	A	5.4
	Alternative 4: Roundabout DDI	Existing	1,203	A	4.2	1,339	C	17.7
		Signalized	1,217	A	8.4	1,389	A	8.6
		Roundabouts	1,233	A	5.6	1,404	A	5.1
	Alternative 5: Partial Cloverleaf	Existing	1,211	A	3.3	1,352	D	32.4
		Signalized	1,236	A	9.1	1,404	A	9.1
		Roundabouts	1,228	A	5.7	1,228	A	5.7

Table 18. Intersection Level of Service: 40th Avenue North and 25th Street

Intersection	Interchange Type	Corridor	AM Peak			PM Peak		
			Vehicles	LOS	Delay	Vehicles	LOS	Delay
40th Ave. N at 25th St. North	Alternative 1: Standard Diamond	Existing	1,033	A	5.1	1,191	A	4.4
		Signalized	1,042	B	8.7	1,212	A	8.7
		Roundabouts	1,436	A	4.1	1,436	A	4.1
	Alternative 2: Dumbbell	Existing	1,035	A	7.0	1,168	A	5.6
		Signalized	1,049	A	9.3	1,215	A	8.8
		Roundabouts	1,053	A	4.4	1,213	A	5.5
	Alternative 3: Diverging Diamond	Existing	1,037	A	5.0	1,167	A	5.4
		Signalized	1,046	A	8.5	1,209	A	9.8
		Roundabouts	1,439	A	4.2	1,439	A	4.2
	Alternative 4: Roundabout DDI	Existing	1,037	A	5.6	1,158	A	4.5
		Signalized	1,043	A	8.1	1,198	A	8.2
		Roundabouts	1,053	A	4.3	1,214	A	5.5
	Alternative 5: Partial Cloverleaf	Existing	1,040	A	6.1	1,164	A	4.2
		Signalized	1,054	A	10.0	1,211	A	9.6
		Roundabouts	1,442	A	4.4	1,442	A	4.4

Appendix A

2022 40th Avenue Corridor Intersection Turning Movement Counts

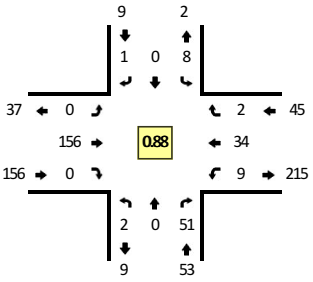
Type of peak hour being reported: Intersection Peak

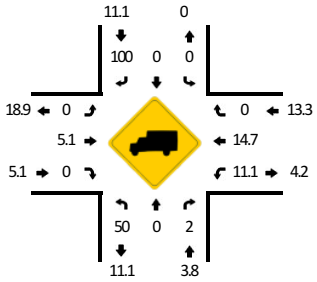
Method for determining peak hour: Total Entering Volume

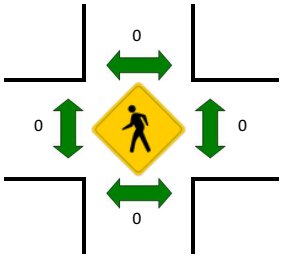
LOCATION: 45th St N -- CR 20/40th Ave N
CITY/STATE: Fargo, ND

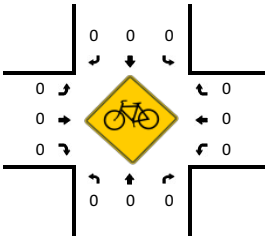
QC JOB #: 16038301
DATE: Tue, Dec 20 2022

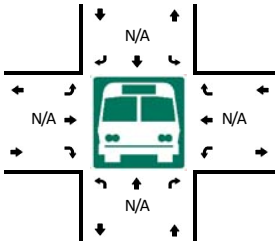
Peak-Hour: 7:15 AM -- 8:15 AM
Peak 15-Min: 7:30 AM -- 7:45 AM

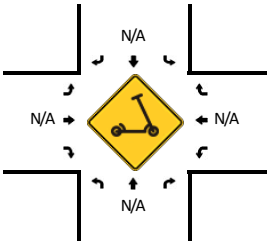












15-Min Count Period Beginning At	45th St N (Northbound)				45th St N (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
6:00 AM	0	0	4	0	0	0	0	0	0	8	0	0	1	3	0	0	16	
6:15 AM	0	0	4	0	0	0	0	0	0	8	0	0	0	5	0	0	17	
6:30 AM	0	0	7	0	0	0	1	0	0	16	1	0	2	5	0	0	32	
6:45 AM	0	0	3	0	2	0	0	0	0	29	0	0	0	13	0	0	47	112
7:00 AM	1	0	4	0	1	0	0	0	0	23	0	0	1	11	0	0	41	137
7:15 AM	2	0	14	0	0	0	0	0	0	27	0	0	3	9	0	0	55	175
7:30 AM	0	0	12	0	3	0	0	0	0	51	0	0	2	7	0	0	75	218
7:45 AM	0	0	18	0	1	0	1	0	0	46	0	0	2	6	0	0	74	245
8:00 AM	0	0	7	0	4	0	0	0	0	32	0	0	2	12	2	0	59	263
8:15 AM	0	0	6	0	2	0	0	0	0	20	0	0	2	11	2	0	43	251
8:30 AM	0	0	6	0	2	0	0	0	0	10	0	0	1	5	0	0	24	200
8:45 AM	0	0	3	0	0	0	0	0	0	14	0	0	2	9	0	0	28	154
9:00 AM	0	0	6	0	0	0	0	0	0	11	0	0	6	5	1	0	29	124
9:15 AM	0	0	2	0	0	0	0	0	0	7	1	0	1	7	0	0	18	99
9:30 AM	0	0	1	0	1	0	0	0	0	7	0	0	1	7	0	0	17	92
9:45 AM	0	0	1	0	1	0	0	0	0	11	0	0	1	7	1	0	22	86
10:00 AM	0	0	3	0	1	0	0	0	0	11	0	0	3	6	0	0	24	81
10:15 AM	0	0	0	0	1	0	0	0	1	7	0	0	2	8	1	0	20	83
10:30 AM	0	0	2	0	1	0	0	0	0	8	0	0	1	5	1	0	18	84
10:45 AM	0	0	2	0	2	0	0	0	0	8	0	0	1	10	1	0	24	86
11:00 AM	0	1	1	0	0	1	0	0	0	8	0	0	2	6	0	0	19	81
11:15 AM	0	0	4	0	0	0	0	0	0	10	1	0	3	6	1	0	25	86
11:30 AM	0	0	2	0	0	0	0	0	1	10	1	0	2	11	1	0	28	96
11:45 AM	0	0	3	0	1	0	1	0	0	6	0	0	2	4	0	0	17	89
12:00 PM	0	0	4	0	1	0	0	0	0	13	0	0	0	14	0	0	32	102
12:15 PM	0	0	3	0	2	0	0	0	0	4	0	0	4	6	1	0	20	97
12:30 PM	1	0	3	0	0	0	0	0	0	15	1	0	0	8	0	0	28	97
12:45 PM	0	1	2	0	1	0	1	0	0	9	0	0	4	14	2	0	34	114
1:00 PM	0	0	4	0	1	0	0	0	0	7	0	0	4	9	0	0	25	107
1:15 PM	0	1	2	0	2	1	0	0	0	10	0	0	3	6	0	0	25	112
1:30 PM	0	0	1	0	0	0	0	0	0	10	0	0	2	3	4	0	20	104
1:45 PM	0	0	2	0	2	0	0	0	0	4	0	0	4	12	1	0	25	95
2:00 PM	0	1	0	0	2	0	0	0	0	8	0	0	4	8	1	0	24	94
2:15 PM	0	1	1	0	2	0	0	0	0	6	0	0	2	7	1	1	21	90
2:30 PM	0	0	4	0	1	0	0	0	0	9	1	0	5	6	0	0	26	96
2:45 PM	0	0	5	0	0	0	0	0	0	13	0	0	1	9	1	0	29	100
3:00 PM	0	0	3	0	1	0	0	0	0	13	0	0	3	10	1	0	31	107
3:15 PM	1	0	1	0	0	0	0	0	0	14	0	0	7	13	3	0	39	125

15-Min Count Period Beginning At	45th St N (Northbound)				45th St N (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:30 PM	1	1	3	0	2	0	0	0	1	12	0	0	4	15	3	0	42	141
3:45 PM	0	0	3	0	0	1	0	0	1	9	0	0	3	27	1	0	45	157
4:00 PM	0	0	3	0	0	1	0	0	0	8	0	0	8	31	0	0	51	177
4:15 PM	0	0	2	0	2	0	0	0	0	14	0	0	4	28	3	0	53	191
4:30 PM	1	0	5	0	1	0	0	0	0	13	0	0	8	31	0	0	59	208
4:45 PM	0	0	6	0	3	0	0	0	0	20	0	0	9	23	1	0	62	225
5:00 PM	0	1	2	0	2	1	0	0	0	20	1	0	8	29	4	0	68	242
5:15 PM	0	0	3	0	0	0	0	0	1	22	2	0	12	20	0	0	60	249
5:30 PM	0	0	4	0	0	0	0	0	0	18	0	0	8	25	0	0	55	245
5:45 PM	0	0	5	0	0	0	0	0	0	21	1	0	3	23	1	0	54	237
6:00 PM	0	0	2	0	0	0	0	0	0	11	0	0	2	13	1	0	29	198
6:15 PM	0	0	8	0	1	0	0	0	0	12	0	0	7	18	0	0	46	184
6:30 PM	0	0	3	0	1	0	0	0	0	9	0	0	2	14	1	0	30	159
6:45 PM	0	1	1	0	0	0	0	0	0	8	0	0	3	14	1	0	28	133

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	0	0	48	0	12	0	0	0	0	204	0	0	8	28	0	0	300
Heavy Trucks	0	0	0		0	0	0		0	4	0		0	4	0		8
Buses																	
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Scooters																	

Comments:

Report generated on 12/30/2022 8:01 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

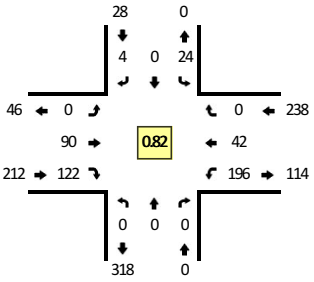
Type of peak hour being reported: Intersection Peak

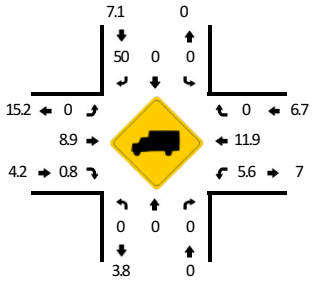
Method for determining peak hour: Total Entering Volume

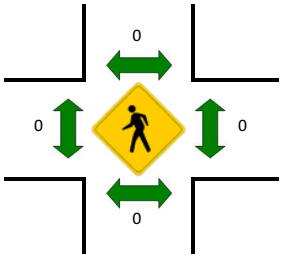
LOCATION: I- 29 SB Ramps -- CR 20/40th Ave N
CITY/STATE: Fargo, ND

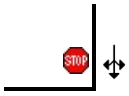
QC JOB #: 16038302
DATE: Tue, Dec 20 2022

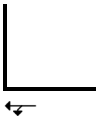
Peak-Hour: 7:15 AM -- 8:15 AM
Peak 15-Min: 7:45 AM -- 8:00 AM

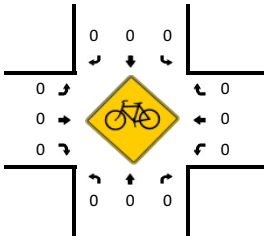


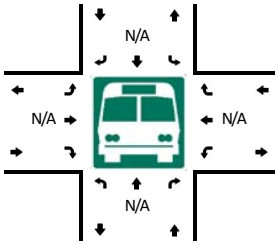


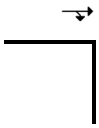


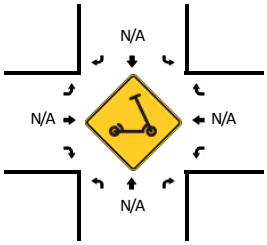












15-Min Count Period Beginning At	I- 29 SB Ramps (Northbound)				I- 29 SB Ramps (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
6:00 AM	0	0	0	0	6	0	0	0	0	6	6	0	14	4	0	0	36	
6:15 AM	0	0	0	0	1	0	0	0	0	6	5	0	19	6	0	0	37	
6:30 AM	0	0	0	0	3	0	0	0	0	14	10	0	25	6	0	0	58	
6:45 AM	0	0	0	0	12	0	1	0	0	18	13	0	26	13	0	0	83	214
7:00 AM	0	0	0	0	5	2	0	0	0	12	19	0	48	12	0	0	98	276
7:15 AM	0	0	0	0	6	0	1	0	0	19	22	0	42	12	0	0	102	341
7:30 AM	0	0	0	0	7	0	1	0	0	27	37	0	48	7	0	0	127	410
7:45 AM	0	0	0	0	8	0	0	0	0	31	35	0	60	12	0	0	146	473
8:00 AM	0	0	0	0	3	0	2	0	0	13	28	0	46	11	0	0	103	478
8:15 AM	0	0	0	0	3	0	1	0	0	17	15	0	38	14	0	0	88	464
8:30 AM	0	0	0	0	3	0	1	0	0	7	10	0	49	6	0	0	76	413
8:45 AM	0	0	0	0	3	0	0	0	0	6	11	0	34	12	0	0	66	333
9:00 AM	0	0	0	0	3	0	1	0	0	11	7	0	35	13	0	0	70	300
9:15 AM	0	0	0	0	4	0	0	0	0	2	6	0	23	7	0	0	42	254
9:30 AM	0	0	0	0	0	0	1	0	0	5	5	0	32	10	0	0	53	231
9:45 AM	0	0	0	0	1	0	0	0	0	7	6	0	26	9	0	0	49	214
10:00 AM	0	0	0	0	2	0	0	0	0	9	5	0	23	8	0	0	47	191
10:15 AM	0	0	0	0	5	0	2	0	0	6	3	0	33	8	0	0	57	206
10:30 AM	0	0	0	0	2	0	0	0	0	6	5	0	37	8	0	0	58	211
10:45 AM	0	0	0	0	1	0	2	0	0	4	8	0	33	9	0	0	57	219
11:00 AM	0	0	0	0	4	0	1	0	0	3	5	0	45	5	0	0	63	235
11:15 AM	0	0	0	0	3	0	0	0	0	5	10	0	34	10	0	0	62	240
11:30 AM	0	0	0	0	3	0	1	0	0	8	6	0	40	14	0	0	72	254
11:45 AM	0	0	0	0	1	0	0	0	0	8	5	0	37	9	0	0	60	257
12:00 PM	0	0	0	0	8	0	1	0	0	14	4	0	38	10	0	0	75	269
12:15 PM	0	0	0	0	7	1	0	0	0	1	6	0	29	11	0	1	56	263
12:30 PM	0	0	0	0	8	0	1	0	0	8	11	0	28	9	0	0	65	256
12:45 PM	0	0	0	0	6	0	1	0	0	5	6	0	37	18	0	0	73	269
1:00 PM	0	0	0	0	1	0	0	0	0	9	4	0	26	14	0	0	54	248
1:15 PM	0	0	0	0	1	0	0	0	0	6	7	0	32	9	0	0	55	247
1:30 PM	0	0	0	0	5	0	1	0	0	7	5	0	41	11	0	0	70	252
1:45 PM	0	0	0	0	3	0	0	0	0	4	7	0	31	19	0	0	64	243
2:00 PM	0	0	0	0	5	0	2	0	0	5	6	0	34	12	0	0	64	253
2:15 PM	0	0	0	0	5	1	1	0	0	9	3	0	27	10	0	0	56	254
2:30 PM	0	0	0	0	3	1	1	0	0	8	6	0	41	8	0	0	68	252
2:45 PM	0	0	0	0	5	0	0	0	0	10	6	0	42	11	0	0	74	262
3:00 PM	0	0	0	0	2	0	2	0	0	10	9	0	47	13	0	0	83	281
3:15 PM	0	0	0	0	5	0	0	0	0	10	4	0	39	23	0	0	81	306

15-Min Count Period Beginning At	I- 29 SB Ramps (Northbound)				I- 29 SB Ramps (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:30 PM	0	0	0	0	3	0	0	0	0	11	5	0	73	22	0	0	114	352
3:45 PM	0	0	0	0	1	0	4	0	0	7	3	0	48	28	0	0	91	369
4:00 PM	0	0	0	0	9	0	4	0	0	6	10	0	47	33	0	0	109	395
4:15 PM	0	0	0	0	1	0	0	0	0	10	8	0	46	35	0	0	100	414
4:30 PM	0	0	0	0	3	0	3	0	0	14	6	0	75	36	0	0	137	437
4:45 PM	0	0	0	0	3	0	5	0	0	13	13	0	57	30	0	0	121	467
5:00 PM	0	0	0	0	3	0	6	0	0	12	11	0	48	32	0	0	112	470
5:15 PM	0	0	0	0	2	0	3	0	0	19	12	0	39	30	0	0	105	475
5:30 PM	0	0	0	0	7	0	2	0	0	14	8	0	74	33	0	0	138	476
5:45 PM	0	0	0	0	4	0	2	0	0	14	12	0	41	24	0	0	97	452
6:00 PM	0	0	0	0	1	0	1	0	0	5	7	0	72	17	0	0	103	443
6:15 PM	0	0	0	0	1	0	1	0	0	10	12	0	42	22	0	0	88	426
6:30 PM	0	0	0	0	3	1	1	0	0	3	8	0	27	17	0	0	60	348
6:45 PM	0	0	0	0	3	0	1	0	0	5	5	0	20	16	0	0	50	301

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	0	0	0	0	32	0	0	0	0	124	140	0	240	48	0	0	584
Heavy Trucks	0	0	0		0	0	0		0	20	0		16	8	0		44
Buses																	
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Scooters																	

Comments:

Report generated on 12/30/2022 8:01 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

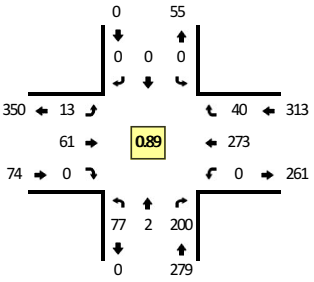
Type of peak hour being reported: Intersection Peak

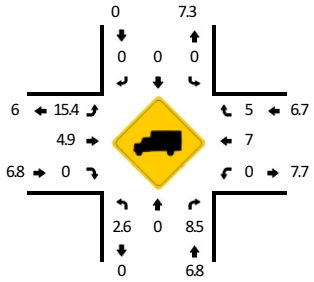
Method for determining peak hour: Total Entering Volume

LOCATION: I- 29 NB Ramps -- CR 20/40th Ave N
CITY/STATE: Fargo, ND

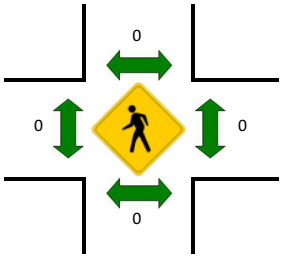
QC JOB #: 16038303
DATE: Tue, Dec 20 2022

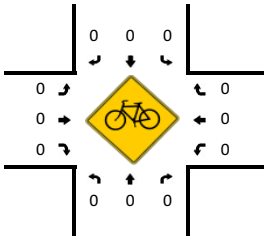
Peak-Hour: 4:45 PM -- 5:45 PM
Peak 15-Min: 5:30 PM -- 5:45 PM

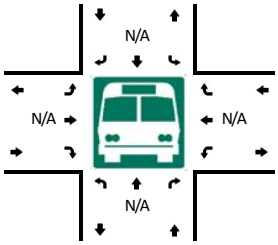


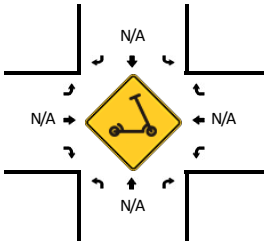


Quality Counts
DATA THAT DRIVES COMMUNITIES









15-Min Count Period Beginning At	I- 29 NB Ramps (Northbound)				I- 29 NB Ramps (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
6:00 AM	1	0	22	0	0	0	0	0	1	11	0	0	0	17	0	0	52	
6:15 AM	0	0	30	0	0	0	0	0	1	5	0	0	0	25	2	0	63	
6:30 AM	3	0	46	0	0	0	0	0	1	17	0	0	0	31	4	0	102	
6:45 AM	4	0	86	0	0	0	0	0	2	28	0	0	0	32	2	0	154	371
7:00 AM	6	0	53	0	0	0	0	0	0	17	0	0	0	55	5	0	136	455
7:15 AM	2	0	51	0	0	0	0	0	6	19	0	0	0	52	3	0	133	525
7:30 AM	0	0	40	0	0	0	0	0	9	25	0	0	0	54	3	0	131	554
7:45 AM	6	1	63	0	0	0	0	0	11	27	0	0	0	67	9	0	184	584
8:00 AM	4	0	55	0	0	0	0	0	3	15	0	0	0	52	4	0	133	581
8:15 AM	7	2	41	0	0	0	0	0	0	19	0	0	0	44	3	0	116	564
8:30 AM	2	0	33	0	0	0	0	0	2	10	0	0	0	53	5	0	105	538
8:45 AM	6	0	35	0	0	0	0	0	0	8	0	0	0	40	8	0	97	451
9:00 AM	9	0	24	0	0	0	0	0	1	12	0	0	0	42	4	0	92	410
9:15 AM	2	1	24	0	0	0	0	0	0	6	0	0	0	29	2	0	64	358
9:30 AM	4	0	23	0	0	0	0	0	0	6	0	0	0	34	3	0	70	323
9:45 AM	1	0	26	0	0	0	0	0	1	7	0	0	0	33	3	0	71	297
10:00 AM	4	0	28	0	0	0	0	0	0	11	0	0	0	27	5	0	75	280
10:15 AM	5	0	32	0	0	0	0	0	2	9	0	0	0	36	3	0	87	303
10:30 AM	7	0	33	0	0	0	0	0	0	8	0	0	0	38	4	0	90	323
10:45 AM	8	1	32	0	0	0	0	0	0	3	0	0	0	35	7	0	86	338
11:00 AM	1	0	25	0	0	0	0	0	1	8	0	0	0	49	2	0	86	349
11:15 AM	8	0	34	0	0	0	0	0	0	8	0	0	0	38	6	0	94	356
11:30 AM	12	0	20	0	0	0	0	0	1	9	0	0	0	39	4	0	85	351
11:45 AM	7	0	32	0	0	0	0	0	1	8	0	0	0	40	3	0	91	356
12:00 PM	9	0	30	0	0	0	0	0	0	22	0	0	0	40	4	0	105	375
12:15 PM	8	0	28	0	0	0	0	0	0	9	0	0	0	32	4	0	81	362
12:30 PM	6	0	31	0	0	0	0	0	1	15	0	0	0	29	2	0	84	361
12:45 PM	14	0	34	0	0	0	0	0	0	11	0	0	0	41	8	0	108	378
1:00 PM	9	1	35	0	0	0	0	0	1	10	0	0	0	35	4	0	95	368
1:15 PM	3	0	32	0	0	0	0	0	0	7	0	0	0	34	2	0	78	365
1:30 PM	12	0	35	0	0	0	0	0	0	12	0	0	0	43	5	0	107	388
1:45 PM	10	0	35	0	0	0	0	0	1	6	0	0	0	35	6	0	93	373
2:00 PM	5	0	24	0	0	0	0	0	0	9	0	0	0	42	4	0	84	362
2:15 PM	5	0	44	0	0	0	0	0	1	13	0	0	0	32	4	0	99	383
2:30 PM	4	0	34	0	0	0	0	0	2	9	0	0	0	49	6	0	104	380
2:45 PM	7	0	37	0	0	0	0	0	3	13	0	0	0	41	1	0	102	389
3:00 PM	8	0	43	0	0	0	0	0	2	10	0	0	0	52	2	0	117	422
3:15 PM	13	0	37	0	0	0	0	0	0	15	0	0	0	50	8	0	123	446
3:30 PM	10	0	40	0	0	0	0	0	3	11	0	0	0	86	6	0	156	498

15-Min Count Period Beginning At	I- 29 NB Ramps (Northbound)				I- 29 NB Ramps (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:45 PM	16	0	38	0	0	0	0	0	2	6	0	0	0	61	4	0	127	523
4:00 PM	14	0	31	0	0	0	0	0	0	14	0	0	0	63	11	0	133	539
4:15 PM	24	0	57	0	0	0	0	0	1	12	0	0	0	58	8	0	160	576
4:30 PM	17	1	41	0	0	0	0	0	4	12	0	0	0	95	9	0	179	599
4:45 PM	18	0	41	0	0	0	0	0	5	11	0	0	0	68	15	0	158	630
5:00 PM	20	1	49	0	0	0	0	0	2	13	0	0	0	60	8	0	153	650
5:15 PM	19	0	63	0	0	0	0	0	3	18	0	0	0	52	12	0	167	657
5:30 PM	20	1	47	0	0	0	0	0	3	19	0	0	0	93	5	0	188	666
5:45 PM	13	1	45	0	0	0	0	0	4	14	0	0	0	51	6	0	134	642
6:00 PM	12	0	39	0	0	0	0	0	1	5	0	0	0	78	4	0	139	628
6:15 PM	12	0	40	0	0	0	0	0	1	10	0	0	0	47	4	0	114	575
6:30 PM	10	0	28	0	0	0	0	0	0	5	0	0	0	34	9	0	86	473
6:45 PM	9	2	19	0	0	0	0	0	0	9	0	0	0	26	7	0	72	411

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	80	4	188	0	0	0	0	0	12	76	0	0	0	372	20	0	752
Heavy Trucks	4	0	0		0	0	0		0	4	0		0	12	0		20
Buses																	
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Scooters																	

Comments:

Report generated on 12/30/2022 8:01 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

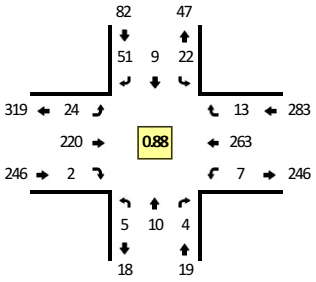
Type of peak hour being reported: Intersection Peak

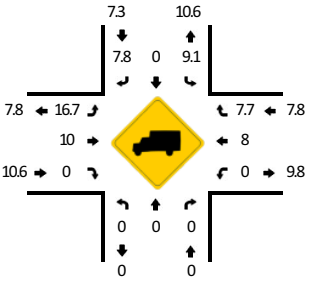
Method for determining peak hour: Total Entering Volume

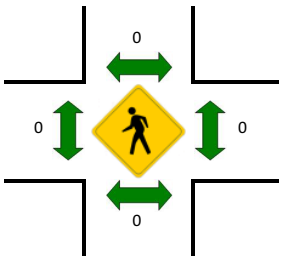
LOCATION: Hwy 81 -- CR 20/40th Ave N
CITY/STATE: Fargo, ND

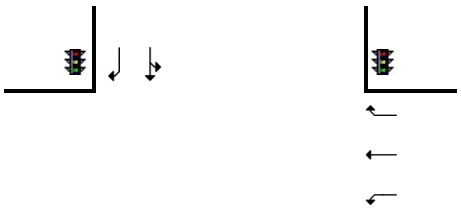
QC JOB #: 16038304
DATE: Tue, Dec 20 2022

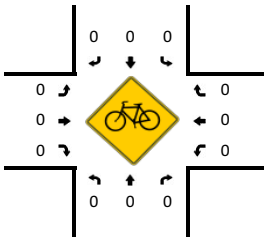
Peak-Hour: 4:30 PM -- 5:30 PM
Peak 15-Min: 4:30 PM -- 4:45 PM

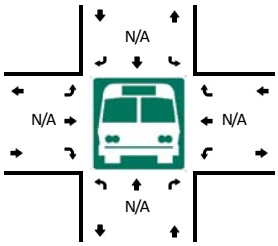


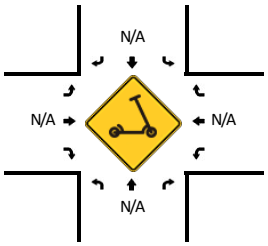












15-Min Count Period Beginning At	Hwy 81 (Northbound)				Hwy 81 (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
6:00 AM	0	0	2	0	0	1	2	0	4	25	2	0	1	15	1	0	53	
6:15 AM	0	2	0	0	3	0	1	0	12	24	1	0	1	26	0	0	70	
6:30 AM	0	3	0	0	0	3	3	0	18	40	0	0	0	33	3	0	103	
6:45 AM	2	5	1	0	1	1	6	0	54	62	1	0	2	31	6	0	172	398
7:00 AM	2	1	3	0	2	5	6	0	29	41	1	0	0	47	6	0	143	488
7:15 AM	0	1	1	0	0	2	1	0	27	37	1	0	0	54	3	0	127	545
7:30 AM	0	1	2	0	2	4	5	0	12	57	2	0	1	52	2	0	140	582
7:45 AM	0	3	4	0	5	4	3	0	10	77	4	0	1	74	3	0	188	598
8:00 AM	0	1	1	0	4	3	11	0	14	53	1	0	3	44	4	0	139	594
8:15 AM	2	1	1	0	2	3	1	0	7	55	0	1	5	43	1	0	122	589
8:30 AM	0	3	9	0	3	3	5	0	3	38	2	0	3	54	2	0	125	574
8:45 AM	0	3	4	0	3	2	2	0	7	38	0	0	2	48	1	0	110	496
9:00 AM	0	0	5	0	0	3	6	0	4	34	1	0	5	38	1	0	97	454
9:15 AM	0	1	5	0	2	3	4	0	2	28	0	0	3	28	1	0	77	409
9:30 AM	0	1	5	0	1	2	3	0	3	25	0	0	6	34	1	0	81	365
9:45 AM	0	3	3	0	2	3	4	0	6	24	0	0	6	34	2	0	87	342
10:00 AM	0	2	6	0	3	3	4	0	7	31	0	0	3	30	1	0	90	335
10:15 AM	0	0	1	0	3	0	6	0	13	31	1	0	5	28	2	0	90	348
10:30 AM	1	1	3	0	5	4	7	0	7	34	0	0	3	41	2	0	108	375
10:45 AM	0	0	3	0	1	3	3	0	8	25	0	0	3	38	2	0	86	374
11:00 AM	1	4	4	0	0	1	5	0	10	26	0	0	6	41	2	0	100	384
11:15 AM	0	1	4	0	1	2	6	0	4	34	0	0	2	39	3	0	96	390
11:30 AM	0	2	5	0	1	5	4	0	1	33	1	0	5	43	0	0	100	382
11:45 AM	1	0	3	0	5	3	5	0	5	34	0	0	3	33	2	0	94	390
12:00 PM	0	1	4	0	5	2	2	0	6	45	3	0	2	43	0	0	113	403
12:15 PM	0	0	0	0	1	0	4	0	5	29	1	0	0	32	4	0	76	383
12:30 PM	0	1	5	0	3	0	2	0	5	44	1	0	6	30	1	0	98	381
12:45 PM	2	2	3	0	1	2	5	0	2	42	0	0	3	42	2	0	106	393
1:00 PM	0	1	5	0	1	3	8	0	7	39	0	0	5	33	4	1	107	387
1:15 PM	0	0	1	0	0	2	1	0	2	37	0	0	2	33	1	0	79	390
1:30 PM	0	1	8	0	0	2	3	0	4	42	0	0	4	45	2	0	111	403
1:45 PM	0	1	3	0	3	1	3	0	10	32	0	0	3	42	0	0	98	395
2:00 PM	0	1	4	0	5	1	9	0	5	27	1	0	2	34	4	0	93	381
2:15 PM	0	5	3	0	3	2	4	0	10	46	0	0	4	36	2	0	115	417
2:30 PM	0	2	5	0	1	2	7	0	12	29	1	0	3	45	2	0	109	415
2:45 PM	0	3	5	0	0	1	5	0	11	46	0	0	2	38	5	0	116	433
3:00 PM	2	4	3	0	4	3	10	0	13	37	0	0	4	44	2	0	126	466
3:15 PM	0	1	2	0	3	0	7	0	16	36	2	0	4	50	3	0	124	475
3:30 PM	0	1	2	0	4	0	37	0	7	40	0	0	3	54	2	0	150	516

15-Min Count Period Beginning At	Hwy 81 (Northbound)				Hwy 81 (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:45 PM	1	3	4	0	3	0	12	0	3	45	2	0	3	52	4	0	132	532
4:00 PM	2	2	2	0	3	3	13	0	1	42	2	0	0	62	4	0	136	542
4:15 PM	0	1	1	0	1	3	8	0	6	61	2	0	6	56	5	0	150	568
4:30 PM	3	2	2	0	7	2	22	0	1	51	1	0	2	86	1	0	180	598
4:45 PM	0	4	1	0	4	1	5	0	9	44	0	0	2	70	1	0	141	607
5:00 PM	1	3	1	0	7	4	13	0	8	55	0	0	2	54	4	0	152	623
5:15 PM	1	1	0	0	4	2	11	0	6	70	1	0	1	53	7	0	157	630
5:30 PM	4	1	1	0	6	3	52	0	8	57	1	0	1	41	3	0	178	628
5:45 PM	2	2	0	0	2	5	19	0	11	48	0	0	1	37	5	0	132	619
6:00 PM	0	1	1	0	3	6	39	0	11	33	1	0	2	42	2	0	141	608
6:15 PM	2	2	0	0	8	1	13	0	18	34	1	0	0	37	2	0	118	569
6:30 PM	1	2	1	0	4	0	7	0	12	21	0	0	0	35	4	0	87	478
6:45 PM	0	1	1	0	0	6	11	0	4	22	2	0	0	23	4	0	74	420

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	12	8	8	0	28	8	88	0	4	204	4	0	8	344	4	0	720
Heavy Trucks	0	0	0		0	0	4		4	24	0		0	24	0		56
Buses																	
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Scooters																	

Comments:

Report generated on 12/30/2022 8:01 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

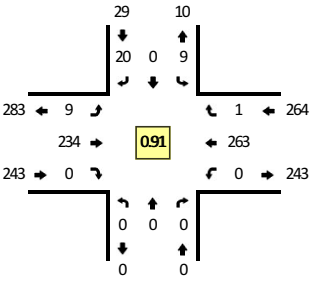
Type of peak hour being reported: Intersection Peak

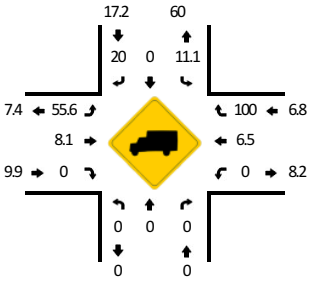
Method for determining peak hour: Total Entering Volume

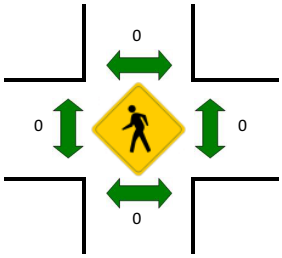
LOCATION: 37th St N -- CR 20/40th Ave N
CITY/STATE: Fargo, ND

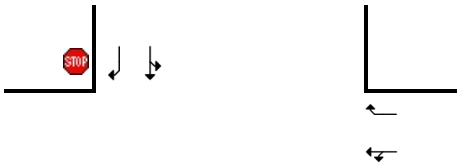
QC JOB #: 16038305
DATE: Tue, Dec 20 2022

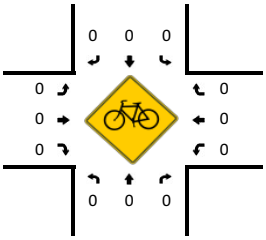
Peak-Hour: 4:30 PM -- 5:30 PM
Peak 15-Min: 4:30 PM -- 4:45 PM

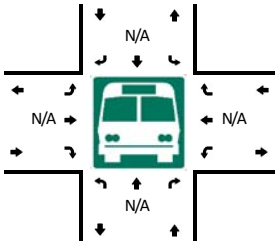


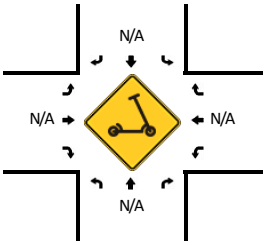












15-Min Count Period Beginning At	37th St N (Northbound)				37th St N (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
6:00 AM	0	0	0	0	0	0	1	0	5	23	0	0	0	17	0	0	46	
6:15 AM	0	0	0	0	1	0	1	0	6	23	0	0	0	26	1	0	58	
6:30 AM	0	0	0	0	0	0	1	0	4	34	0	0	0	37	1	0	77	
6:45 AM	0	0	0	0	0	0	1	0	3	56	0	0	0	36	10	0	106	287
7:00 AM	0	0	0	0	2	0	2	0	4	45	0	0	0	49	7	0	109	350
7:15 AM	0	0	0	0	1	0	0	0	4	35	0	0	0	56	1	0	97	389
7:30 AM	0	0	0	0	0	0	0	0	4	56	1	0	0	60	2	0	123	435
7:45 AM	0	0	1	0	1	0	1	0	6	77	0	0	0	74	4	0	164	493
8:00 AM	0	0	0	0	0	0	2	0	4	55	0	0	0	49	1	0	111	495
8:15 AM	0	0	0	0	0	0	2	0	4	53	0	0	0	47	1	0	107	505
8:30 AM	0	0	0	0	0	0	1	0	6	45	0	0	0	59	3	0	114	496
8:45 AM	0	0	0	0	0	0	2	0	5	38	0	0	0	47	0	0	92	424
9:00 AM	0	0	1	0	1	0	7	0	5	31	0	0	0	39	1	0	85	398
9:15 AM	0	0	0	0	2	0	6	0	6	27	1	0	0	27	2	0	71	362
9:30 AM	0	0	0	0	1	0	4	0	4	28	0	0	0	38	2	0	77	325
9:45 AM	0	0	0	0	0	0	1	0	1	28	0	0	0	41	1	0	72	305
10:00 AM	0	0	0	0	2	0	4	0	4	33	0	0	0	32	2	0	77	297
10:15 AM	0	0	0	0	0	0	2	0	4	30	0	0	0	34	4	0	74	300
10:30 AM	0	0	0	0	2	0	8	0	4	35	0	0	0	34	0	0	83	306
10:45 AM	0	0	0	0	3	0	3	0	4	28	0	0	0	40	3	0	81	315
11:00 AM	0	0	0	0	3	0	8	0	1	28	0	0	0	44	0	0	84	322
11:15 AM	0	0	0	0	0	0	10	0	3	37	0	0	0	37	0	0	87	335
11:30 AM	0	0	0	0	1	0	3	0	4	33	0	0	0	39	1	0	81	333
11:45 AM	0	0	0	0	2	0	7	0	6	37	0	0	0	32	0	0	84	336
12:00 PM	0	0	0	0	3	0	6	0	4	49	0	0	0	40	0	0	102	354
12:15 PM	0	0	0	0	0	0	4	0	3	27	0	0	0	29	1	0	64	331
12:30 PM	0	0	0	0	0	0	4	0	4	48	0	0	0	38	6	0	100	350
12:45 PM	0	0	0	0	0	0	8	0	4	40	0	0	1	36	1	0	90	356
1:00 PM	0	0	0	0	1	0	6	0	5	43	0	0	0	38	1	0	94	348
1:15 PM	0	0	1	0	4	0	1	0	8	30	0	0	0	36	1	0	81	365
1:30 PM	0	0	0	0	1	0	1	0	3	48	0	0	0	49	0	0	102	367
1:45 PM	0	0	0	0	1	0	1	0	8	31	0	0	0	46	3	0	90	367
2:00 PM	0	0	0	0	1	0	5	0	3	35	0	0	0	31	1	0	76	349
2:15 PM	0	0	0	0	1	0	4	0	2	50	0	2	0	36	1	0	96	364
2:30 PM	1	0	0	0	3	0	10	0	5	29	1	0	0	39	0	0	88	350
2:45 PM	1	0	0	0	1	0	8	0	5	46	0	0	0	34	0	0	95	355
3:00 PM	0	0	0	0	1	0	14	0	4	38	0	0	0	36	3	0	96	375
3:15 PM	0	0	0	0	2	0	9	0	3	39	0	0	0	49	2	0	104	383
3:30 PM	0	0	0	0	5	0	3	0	3	43	0	0	0	54	1	0	109	404

15-Min Count Period Beginning At	37th St N (Northbound)				37th St N (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:45 PM	0	0	0	0	2	0	1	0	6	43	0	0	0	58	4	0	114	423
4:00 PM	0	0	0	0	2	0	6	0	5	46	0	0	0	63	2	0	124	451
4:15 PM	0	0	0	0	1	0	7	0	2	61	0	0	0	58	0	0	129	476
4:30 PM	0	0	0	0	1	0	5	0	0	58	0	0	0	84	0	0	148	515
4:45 PM	0	0	0	0	1	0	6	0	3	49	0	0	0	65	0	0	124	525
5:00 PM	0	0	0	0	4	0	4	0	2	61	0	0	0	59	0	0	130	531
5:15 PM	0	0	0	0	3	0	5	0	4	66	0	0	0	55	1	0	134	536
5:30 PM	0	0	0	0	3	0	1	0	1	62	0	0	0	45	2	0	114	502
5:45 PM	0	0	0	0	6	0	2	0	2	50	0	0	0	39	3	0	102	480
6:00 PM	0	0	0	0	6	0	3	0	1	38	0	0	0	43	1	0	92	442
6:15 PM	0	0	0	0	1	0	1	0	1	41	0	0	0	36	1	0	81	389
6:30 PM	0	0	0	0	3	0	1	0	1	25	0	0	0	39	0	0	69	344
6:45 PM	0	0	0	0	0	0	2	0	1	21	0	0	0	24	0	0	48	290

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	0	0	0	0	4	0	20	0	0	232	0	0	0	336	0	0	592
Heavy Trucks	0	0	0		0	0	4		0	20	0		0	16	0		40
Buses																	
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Scooters																	

Comments:

Report generated on 12/30/2022 8:01 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

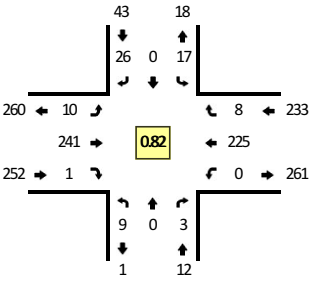
Type of peak hour being reported: Intersection Peak

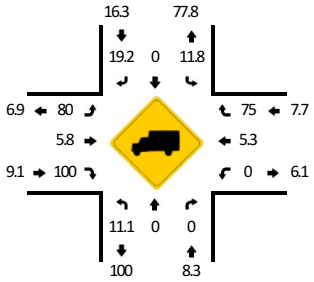
Method for determining peak hour: Total Entering Volume

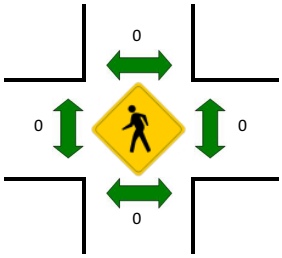
LOCATION: 33rd St N W -- CR 20/40th Ave N
CITY/STATE: Fargo, ND

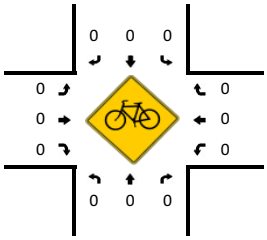
QC JOB #: 16038306
DATE: Tue, Dec 20 2022

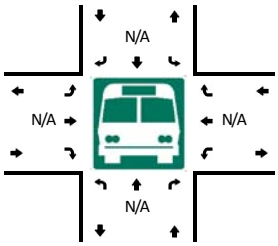
Peak-Hour: 4:30 PM -- 5:30 PM
Peak 15-Min: 4:30 PM -- 4:45 PM

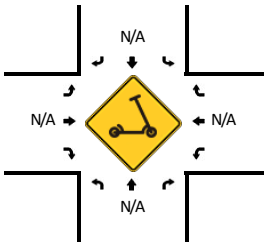












15-Min Count Period Beginning At	33rd St N W (Northbound)				33rd St N W (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
6:00 AM	0	0	0	0	0	0	3	0	4	20	0	0	0	15	2	0	44	
6:15 AM	0	0	0	0	0	0	1	0	5	17	0	0	0	26	1	0	50	
6:30 AM	0	0	0	1	1	0	2	0	11	24	0	0	0	34	4	0	77	
6:45 AM	0	0	0	2	2	0	5	0	21	35	1	0	0	43	8	0	117	288
7:00 AM	0	0	0	0	2	0	8	0	11	34	1	0	0	52	3	0	111	355
7:15 AM	0	0	0	0	1	0	0	0	5	23	2	0	0	58	1	0	90	395
7:30 AM	1	0	1	0	2	0	2	0	9	46	3	0	2	56	4	0	126	444
7:45 AM	0	0	0	0	0	0	1	0	11	61	3	0	3	77	5	0	161	488
8:00 AM	0	0	1	0	0	0	2	0	8	52	2	0	0	47	3	0	115	492
8:15 AM	1	0	0	0	2	0	6	0	11	38	1	0	1	45	2	0	107	509
8:30 AM	1	0	0	0	5	0	5	0	3	44	1	0	1	56	3	0	119	502
8:45 AM	2	0	1	0	2	0	2	0	5	27	3	0	0	46	2	0	90	431
9:00 AM	1	0	0	0	2	0	4	0	0	37	0	0	0	32	0	0	76	392
9:15 AM	1	0	0	0	0	0	1	0	6	25	0	0	0	26	3	0	62	347
9:30 AM	0	0	0	0	1	0	6	0	7	23	0	0	0	38	1	0	76	304
9:45 AM	1	0	0	0	1	0	6	0	5	22	1	0	0	30	4	0	70	284
10:00 AM	0	0	0	0	2	0	4	0	3	31	1	0	0	29	3	0	73	281
10:15 AM	0	0	0	0	2	0	5	0	2	30	0	0	0	34	6	0	79	298
10:30 AM	3	0	0	0	3	0	2	0	3	34	1	0	0	27	1	0	74	296
10:45 AM	1	0	0	0	2	0	7	0	6	24	1	0	0	36	0	0	77	303
11:00 AM	0	0	0	0	2	0	5	0	5	24	0	0	0	35	1	0	72	302
11:15 AM	0	0	1	0	3	0	3	0	9	27	0	0	0	35	5	0	83	306
11:30 AM	0	0	0	0	1	1	5	0	6	25	0	0	0	34	0	0	72	304
11:45 AM	0	0	3	0	4	1	5	0	4	37	1	0	0	30	1	0	86	313
12:00 PM	0	0	0	0	1	0	4	0	6	42	0	0	0	31	1	0	85	326
12:15 PM	0	0	1	0	0	0	2	0	6	16	0	0	1	31	4	0	61	304
12:30 PM	0	0	0	0	2	0	6	0	14	36	0	0	1	38	1	0	98	330
12:45 PM	0	0	0	0	3	0	7	0	6	31	0	0	1	31	5	0	84	328
1:00 PM	0	0	0	0	2	0	9	0	9	35	1	0	0	29	1	0	86	329
1:15 PM	1	0	0	0	4	0	5	0	4	30	0	0	0	34	2	0	80	348
1:30 PM	1	0	0	0	7	0	20	0	10	39	1	0	0	28	4	0	110	360
1:45 PM	0	0	0	0	3	0	11	0	5	29	0	0	1	38	3	0	90	366
2:00 PM	0	0	1	0	6	0	1	0	2	26	1	0	0	33	0	0	70	350
2:15 PM	0	0	0	0	0	0	7	0	7	44	0	0	0	30	2	0	90	360
2:30 PM	0	0	0	0	1	0	9	0	2	32	1	0	0	31	1	0	77	327
2:45 PM	0	0	0	0	3	0	6	0	2	44	0	0	0	30	4	0	89	326
3:00 PM	4	0	0	0	2	0	1	0	7	29	2	0	0	32	1	0	78	334
3:15 PM	4	0	0	0	3	0	6	0	4	40	0	0	0	42	2	0	101	345
3:30 PM	0	0	1	0	14	0	20	0	3	43	0	0	0	34	1	0	116	384

15-Min Count Period Beginning At	33rd St N W (Northbound)				33rd St N W (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:45 PM	2	0	0	0	4	0	12	0	2	40	0	0	1	47	2	0	110	405
4:00 PM	1	0	0	0	9	0	18	0	3	41	0	0	2	50	2	0	126	453
4:15 PM	1	0	2	0	6	0	8	0	6	47	1	0	1	49	0	0	121	473
4:30 PM	5	0	2	0	7	0	9	0	4	66	0	0	0	68	3	0	164	521
4:45 PM	1	0	0	0	2	0	7	0	1	48	1	0	0	55	1	0	116	527
5:00 PM	2	0	1	0	4	0	7	0	2	63	0	0	0	52	3	0	134	535
5:15 PM	1	0	0	0	4	0	3	0	3	64	0	0	0	50	1	0	126	540
5:30 PM	0	0	0	0	1	0	6	0	0	68	0	0	0	42	1	0	118	494
5:45 PM	0	0	0	0	2	0	3	0	1	55	0	0	0	40	1	0	102	480
6:00 PM	0	0	0	0	3	0	10	0	1	42	0	0	0	35	0	0	91	437
6:15 PM	0	0	0	0	2	0	5	0	0	42	0	0	0	31	0	0	80	391
6:30 PM	0	0	0	0	0	0	1	0	0	26	1	0	0	37	0	0	65	338
6:45 PM	1	0	0	0	0	0	2	0	0	24	0	0	0	21	0	0	48	284

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	20	0	8	0	28	0	36	0	16	264	0	0	0	272	12	0	656
Heavy Trucks	0	0	0		0	0	8		8	20	0		0	8	8		52
Buses																	
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Scooters																	

Comments:

Report generated on 12/30/2022 8:01 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

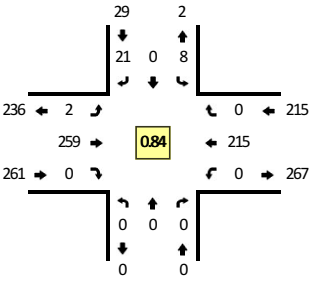
Type of peak hour being reported: Intersection Peak

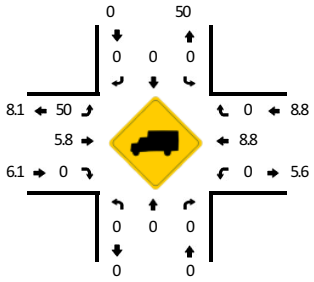
Method for determining peak hour: Total Entering Volume

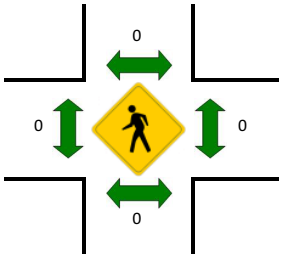
LOCATION: 32nd St N -- CR 20/40th Ave N
CITY/STATE: Fargo, ND

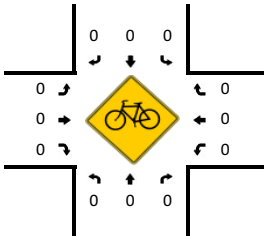
QC JOB #: 16038307
DATE: Tue, Dec 20 2022

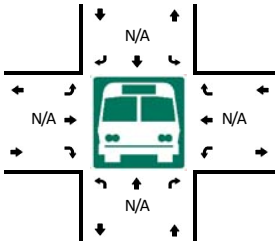
Peak-Hour: 4:30 PM -- 5:30 PM
Peak 15-Min: 4:30 PM -- 4:45 PM

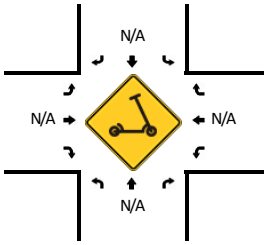












15-Min Count Period Beginning At	32nd St N (Northbound)				32nd St N (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
6:00 AM	0	0	0	0	0	0	0	0	7	12	0	0	0	18	0	0	37	
6:15 AM	0	0	0	0	0	0	0	0	0	18	0	0	0	26	0	0	44	
6:30 AM	0	0	0	0	0	0	0	0	1	24	0	0	0	39	0	0	64	
6:45 AM	0	0	0	0	0	0	0	0	1	34	0	0	0	51	0	0	86	231
7:00 AM	0	0	0	0	0	0	0	0	2	35	0	0	0	55	0	0	92	286
7:15 AM	0	0	0	0	0	0	1	0	1	23	0	0	0	58	0	0	83	325
7:30 AM	0	0	0	0	0	0	0	0	3	43	0	0	0	68	0	0	114	375
7:45 AM	0	0	0	0	0	0	1	0	1	63	0	0	0	80	1	0	146	435
8:00 AM	0	0	0	0	0	0	0	0	1	52	0	0	0	47	2	0	102	445
8:15 AM	0	0	0	0	0	0	0	0	2	38	0	0	0	47	2	0	89	451
8:30 AM	0	0	0	0	0	0	1	0	2	45	0	0	0	60	3	0	111	448
8:45 AM	0	0	0	0	0	0	0	0	5	27	0	0	0	48	0	0	80	382
9:00 AM	0	0	0	0	1	0	0	0	1	35	0	0	0	30	1	0	68	348
9:15 AM	0	0	0	0	0	0	0	0	1	25	0	0	0	30	2	0	58	317
9:30 AM	0	0	0	0	1	0	0	0	0	26	0	0	0	37	0	0	64	270
9:45 AM	0	0	0	0	2	0	1	0	1	22	0	0	0	30	0	0	56	246
10:00 AM	0	0	0	0	1	0	1	0	0	31	0	0	0	32	2	0	67	245
10:15 AM	0	0	0	0	1	0	4	0	1	28	0	0	0	34	1	0	69	256
10:30 AM	0	0	0	0	0	0	1	0	1	36	0	0	0	28	0	0	66	258
10:45 AM	0	0	0	0	0	0	0	0	2	23	0	1	0	36	1	0	63	265
11:00 AM	0	0	0	0	3	0	2	0	3	25	0	0	0	33	0	0	66	264
11:15 AM	0	0	0	0	1	0	4	0	2	29	0	0	0	37	2	0	75	270
11:30 AM	0	0	0	0	2	0	1	0	3	25	0	0	0	32	3	0	66	270
11:45 AM	0	0	0	0	0	0	2	0	4	39	0	0	0	31	0	0	76	283
12:00 PM	0	0	0	0	4	0	0	0	2	45	0	0	0	31	1	0	83	300
12:15 PM	0	0	0	0	3	0	0	0	0	19	0	0	0	34	0	0	56	281
12:30 PM	0	0	0	0	0	0	1	0	0	37	0	0	0	42	0	0	80	295
12:45 PM	0	0	0	0	1	0	0	0	2	33	0	0	0	36	2	0	74	293
1:00 PM	0	0	0	0	2	0	0	0	1	36	0	0	0	28	3	0	70	280
1:15 PM	0	0	0	0	1	0	0	0	1	34	0	0	0	35	0	0	71	295
1:30 PM	0	0	0	0	0	0	1	0	2	43	0	0	0	32	0	0	78	293
1:45 PM	0	0	0	0	0	0	1	0	1	33	0	0	0	38	1	0	74	293
2:00 PM	0	0	0	0	1	0	1	0	2	28	0	0	0	32	0	0	64	287
2:15 PM	0	0	0	0	0	0	0	0	0	48	0	0	0	30	1	0	79	295
2:30 PM	0	0	0	0	0	0	0	0	0	32	0	0	0	34	1	0	67	284
2:45 PM	0	0	0	0	0	0	0	0	2	43	0	0	0	32	1	0	78	288
3:00 PM	0	0	0	0	0	0	1	0	2	29	0	0	0	32	0	0	64	288
3:15 PM	0	0	0	0	0	0	1	0	0	43	0	0	0	43	0	0	87	296
3:30 PM	0	0	0	0	2	0	2	0	3	57	0	0	0	35	2	0	101	330

15-Min Count Period Beginning At	32nd St N (Northbound)				32nd St N (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:45 PM	0	0	0	0	0	0	0	0	1	43	0	0	0	48	0	0	92	344
4:00 PM	0	0	0	0	1	0	2	0	1	52	0	0	0	50	0	0	106	386
4:15 PM	0	0	0	0	0	0	1	0	2	55	0	0	0	50	0	0	108	407
4:30 PM	0	0	0	0	4	0	19	0	1	74	0	0	0	53	0	0	151	457
4:45 PM	0	0	0	0	3	0	0	0	0	49	0	0	0	54	0	0	106	471
5:00 PM	0	0	0	0	1	0	1	0	0	67	0	0	0	54	0	0	123	488
5:15 PM	0	0	0	0	0	0	1	0	1	69	0	0	0	54	0	0	125	505
5:30 PM	0	0	0	0	0	0	1	0	0	69	0	0	0	37	1	0	108	462
5:45 PM	0	0	0	0	1	0	0	0	1	56	0	0	0	41	0	0	99	455
6:00 PM	0	0	0	0	2	0	1	0	0	44	0	0	0	34	1	0	82	414
6:15 PM	0	0	0	0	0	0	0	0	0	43	0	0	0	30	0	0	73	362
6:30 PM	0	0	0	0	0	0	0	0	0	28	0	0	0	38	0	0	66	320
6:45 PM	0	0	0	0	0	0	0	0	0	25	0	0	0	20	0	0	45	266

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	0	0	0	0	16	0	76	0	4	296	0	0	0	212	0	0	604
Heavy Trucks	0	0	0		0	0	0		0	20	0		0	16	0		36
Buses																	
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Scooters																	

Comments:

Report generated on 12/30/2022 8:01 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

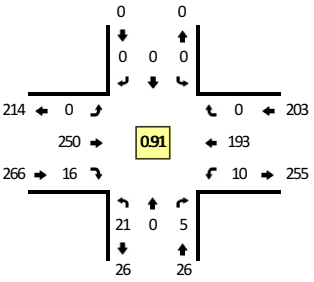
Type of peak hour being reported: Intersection Peak

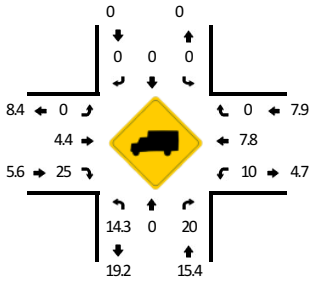
Method for determining peak hour: Total Entering Volume

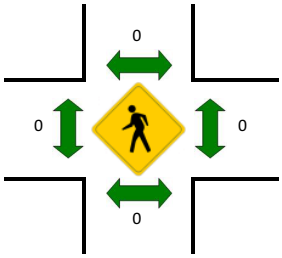
LOCATION: 39 1/2 Ave N -- CR 20/40th Ave N
CITY/STATE: Fargo, ND

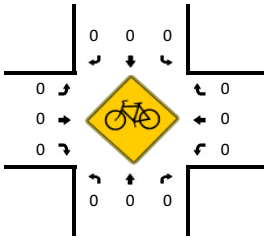
QC JOB #: 16038308
DATE: Tue, Dec 20 2022

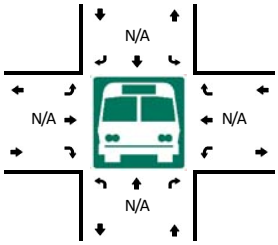
Peak-Hour: 4:30 PM -- 5:30 PM
Peak 15-Min: 4:30 PM -- 4:45 PM

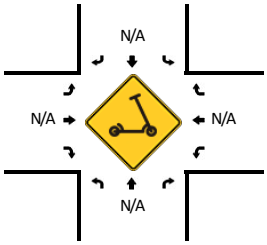












15-Min Count Period Beginning At	39 1/2 Ave N (Northbound)				39 1/2 Ave N (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
6:00 AM	1	0	1	0	0	0	0	0	0	12	1	0	2	17	0	0	34	
6:15 AM	2	0	2	0	0	0	0	0	0	11	6	0	2	24	0	0	47	
6:30 AM	0	0	0	0	0	0	0	0	0	16	9	0	4	39	0	0	68	
6:45 AM	0	0	0	0	0	0	0	0	0	23	8	0	3	51	0	0	85	234
7:00 AM	1	0	2	0	0	0	0	0	0	31	6	0	1	55	0	0	96	296
7:15 AM	3	0	2	0	0	0	0	0	0	22	2	0	0	47	0	0	76	325
7:30 AM	1	0	1	0	0	0	0	0	0	34	8	0	2	67	0	0	113	370
7:45 AM	6	0	1	0	0	0	0	0	0	53	7	0	0	74	0	0	141	426
8:00 AM	8	0	13	0	0	0	0	0	0	48	8	0	3	41	0	0	121	451
8:15 AM	15	0	3	0	0	0	0	0	0	30	5	0	1	33	0	0	87	462
8:30 AM	10	0	8	0	0	0	0	0	0	38	9	0	2	54	0	0	121	470
8:45 AM	12	0	6	0	0	0	0	0	0	25	1	0	1	35	0	0	80	409
9:00 AM	5	0	0	0	0	0	0	0	0	31	8	0	1	26	0	0	71	359
9:15 AM	2	0	0	0	0	0	0	0	0	19	4	0	1	29	0	0	55	327
9:30 AM	6	0	3	0	0	0	0	0	0	25	1	0	0	32	0	0	67	273
9:45 AM	1	0	1	0	0	0	0	0	0	21	4	0	1	29	0	0	57	250
10:00 AM	0	0	4	0	0	0	0	0	0	27	2	0	0	34	0	0	67	246
10:15 AM	4	0	0	0	0	0	0	0	0	24	4	0	0	31	0	0	63	254
10:30 AM	2	0	2	0	0	0	0	0	0	37	1	0	1	26	0	0	69	256
10:45 AM	4	0	2	0	0	0	0	0	0	20	1	0	1	33	0	0	61	260
11:00 AM	5	0	1	0	0	0	0	0	0	26	3	0	1	29	0	0	65	258
11:15 AM	2	0	5	0	0	0	0	0	0	27	1	0	2	36	0	0	73	268
11:30 AM	6	0	3	0	0	0	0	0	0	25	1	0	0	28	0	0	63	262
11:45 AM	3	0	2	0	0	0	0	0	0	34	4	0	1	28	0	0	72	273
12:00 PM	8	0	2	0	0	0	0	0	0	43	5	0	3	23	0	0	84	292
12:15 PM	3	0	6	0	0	0	0	0	0	21	3	0	2	32	0	0	67	286
12:30 PM	2	0	2	0	0	0	0	0	0	32	3	0	2	38	0	0	79	302
12:45 PM	3	0	2	0	0	0	0	0	0	31	3	0	1	35	0	0	75	305
1:00 PM	1	0	1	0	0	0	0	0	0	37	1	0	4	31	0	0	75	296
1:15 PM	3	0	1	0	0	0	0	0	0	29	4	0	3	32	0	0	72	301
1:30 PM	1	0	0	0	0	0	0	0	0	40	3	0	1	32	0	0	77	299
1:45 PM	1	0	0	0	0	0	0	0	0	28	4	0	5	37	0	0	75	299
2:00 PM	6	0	2	0	0	0	0	0	0	26	3	0	0	26	0	0	63	287
2:15 PM	4	0	2	0	0	0	0	0	0	38	7	0	3	27	0	0	81	296
2:30 PM	2	0	2	0	0	0	0	0	0	28	4	0	3	33	0	0	72	291
2:45 PM	5	0	0	0	0	0	0	0	0	36	8	0	9	29	0	0	87	303
3:00 PM	0	0	3	0	0	0	0	0	0	30	0	0	2	32	0	0	67	307
3:15 PM	2	0	1	0	0	0	0	0	0	39	3	0	4	40	0	0	89	315
3:30 PM	6	0	3	0	0	0	0	0	0	54	4	0	4	34	0	0	105	348

15-Min Count Period Beginning At	39 1/2 Ave N (Northbound)				39 1/2 Ave N (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:45 PM	9	0	2	0	0	0	0	0	0	36	2	0	0	36	0	0	85	346
4:00 PM	5	0	2	0	0	0	0	0	0	56	2	0	1	45	0	0	111	390
4:15 PM	5	0	3	0	0	0	0	0	0	50	4	0	0	46	0	0	108	409
4:30 PM	12	0	3	0	0	0	0	0	0	72	6	0	3	40	0	0	136	440
4:45 PM	5	0	1	0	0	0	0	0	0	48	4	0	4	49	0	0	111	466
5:00 PM	1	0	0	0	0	0	0	0	0	64	2	0	1	53	0	0	121	476
5:15 PM	3	0	1	0	0	0	0	0	0	66	4	0	2	51	0	0	127	495
5:30 PM	3	0	0	0	0	0	0	0	0	63	6	0	0	34	0	0	106	465
5:45 PM	1	0	0	0	0	0	0	0	0	52	6	0	0	42	0	0	101	455
6:00 PM	5	0	0	0	0	0	0	0	0	43	2	0	0	29	0	0	79	413
6:15 PM	3	0	3	0	0	0	0	0	0	41	4	0	1	27	0	0	79	365
6:30 PM	3	0	0	0	0	0	0	0	0	26	1	0	0	35	0	0	65	324
6:45 PM	3	0	0	0	0	0	0	0	0	23	3	0	1	17	0	0	47	270

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	48	0	12	0	0	0	0	0	0	288	24	0	12	160	0	0	544
Heavy Trucks	4	0	4		0	0	0		0	20	4		0	8	0		40
Buses																	
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Scooters																	

Comments:

Report generated on 12/30/2022 8:01 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

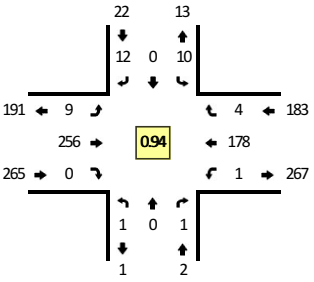
Type of peak hour being reported: Intersection Peak

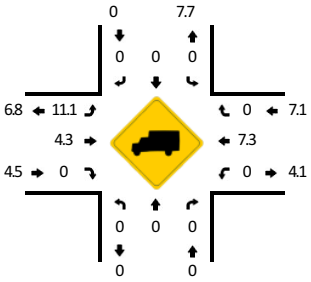
Method for determining peak hour: Total Entering Volume

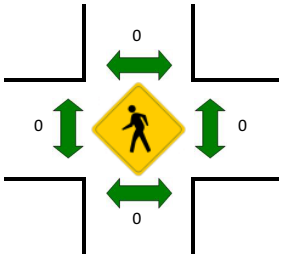
LOCATION: 25th St N -- CR 20/40th Ave N
CITY/STATE: Fargo, ND

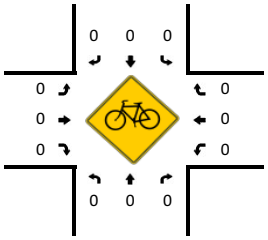
QC JOB #: 16038309
DATE: Tue, Dec 20 2022

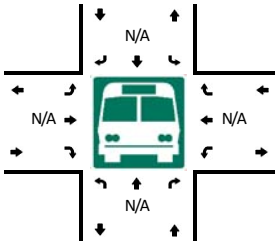
Peak-Hour: 4:30 PM -- 5:30 PM
Peak 15-Min: 4:30 PM -- 4:45 PM

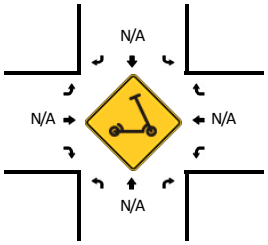












15-Min Count Period Beginning At	25th St N (Northbound)				25th St N (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
6:00 AM	0	0	0	0	0	0	1	0	0	10	1	0	0	20	0	0	32	
6:15 AM	0	0	2	0	0	0	1	0	2	10	0	0	0	25	0	0	40	
6:30 AM	0	0	0	0	1	0	0	0	2	15	0	0	0	49	2	0	69	
6:45 AM	0	0	0	0	0	0	0	0	3	20	0	0	0	51	3	0	77	218
7:00 AM	0	0	1	0	2	0	3	0	3	28	0	0	0	57	5	0	99	285
7:15 AM	0	0	0	0	2	0	1	0	1	23	0	0	0	48	1	0	76	321
7:30 AM	0	0	0	0	2	0	0	0	1	32	0	0	0	76	2	0	113	365
7:45 AM	0	0	0	0	2	0	0	0	4	42	2	0	0	69	7	1	127	415
8:00 AM	1	0	1	0	1	0	4	0	8	52	1	0	2	38	2	0	110	426
8:15 AM	0	0	0	0	1	0	0	0	1	26	1	0	0	34	2	0	65	415
8:30 AM	0	0	1	0	1	0	11	0	5	38	1	0	0	40	3	0	100	402
8:45 AM	0	0	0	0	4	0	3	0	6	25	0	0	0	30	1	0	69	344
9:00 AM	0	0	0	0	5	0	4	0	5	28	0	0	0	18	3	0	63	297
9:15 AM	1	0	0	0	0	0	1	0	3	16	0	0	0	25	5	0	51	283
9:30 AM	0	0	0	0	5	0	7	0	4	23	0	0	0	25	2	0	66	249
9:45 AM	0	0	0	0	0	0	1	0	3	16	0	0	0	22	4	0	46	226
10:00 AM	0	0	0	0	1	0	5	0	4	27	1	0	0	26	3	0	67	230
10:15 AM	0	0	0	0	2	0	3	0	4	18	0	0	0	27	0	0	54	233
10:30 AM	0	0	1	0	0	0	5	0	5	32	0	0	0	21	3	0	67	234
10:45 AM	0	0	0	0	2	0	2	0	5	17	0	0	1	33	0	0	60	248
11:00 AM	0	0	0	0	1	0	5	0	6	20	1	0	0	23	0	0	56	237
11:15 AM	0	1	0	0	1	0	4	0	4	32	0	0	0	28	0	0	70	253
11:30 AM	0	0	0	0	1	0	0	0	3	27	0	0	0	29	0	0	60	246
11:45 AM	0	0	1	0	1	0	6	0	3	28	0	0	0	25	2	0	66	252
12:00 PM	0	0	2	0	4	0	2	0	3	46	0	0	1	23	2	0	83	279
12:15 PM	0	0	3	0	1	0	6	0	2	22	0	0	0	25	0	0	59	268
12:30 PM	1	0	0	0	4	0	5	0	4	31	0	0	2	37	1	0	85	293
12:45 PM	0	0	0	0	2	0	4	0	2	29	0	0	0	33	2	0	72	299
1:00 PM	0	0	0	0	1	0	1	0	7	33	0	0	1	31	1	0	75	291
1:15 PM	0	0	0	0	1	0	5	0	2	26	1	0	0	27	0	0	62	294
1:30 PM	0	0	0	0	2	0	1	0	3	34	0	0	0	29	0	0	69	278
1:45 PM	0	0	0	0	2	0	2	0	0	27	0	0	0	42	2	0	75	281
2:00 PM	1	0	1	0	1	0	1	0	2	26	0	0	0	21	1	0	54	260
2:15 PM	1	0	1	0	2	0	0	0	6	32	0	0	1	26	2	0	71	269
2:30 PM	0	0	1	0	1	1	3	0	2	28	0	0	0	31	0	0	67	267
2:45 PM	0	0	1	0	3	0	3	0	2	32	0	0	0	33	6	0	80	272
3:00 PM	0	0	1	0	4	1	3	0	1	30	0	0	1	30	2	0	73	291
3:15 PM	0	0	0	0	2	0	2	0	2	36	0	0	0	35	2	0	79	299
3:30 PM	0	0	0	0	2	0	3	0	3	56	0	0	3	34	2	0	103	335

15-Min Count Period Beginning At	25th St N (Northbound)				25th St N (Southbound)				CR 20/40th Ave N (Eastbound)				CR 20/40th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:45 PM	0	0	0	0	2	0	3	0	2	36	0	0	0	30	0	0	73	328
4:00 PM	0	0	1	0	2	0	1	0	1	59	0	0	1	45	3	0	113	368
4:15 PM	0	0	1	0	3	0	1	0	3	47	0	0	0	42	1	0	98	387
4:30 PM	0	0	1	0	4	0	2	0	4	81	0	0	0	33	0	0	125	409
4:45 PM	1	0	0	0	2	0	2	0	2	46	0	0	0	52	1	0	106	442
5:00 PM	0	0	0	0	1	0	4	0	2	65	0	0	1	46	2	0	121	450
5:15 PM	0	0	0	0	3	0	4	0	1	64	0	0	0	47	1	0	120	472
5:30 PM	0	0	0	0	0	0	0	0	2	63	0	0	0	32	5	0	102	449
5:45 PM	0	0	0	0	4	0	8	0	4	50	0	0	0	34	0	0	100	443
6:00 PM	0	0	0	0	4	0	6	0	1	42	0	0	0	18	2	0	73	395
6:15 PM	0	0	0	0	1	0	3	0	2	36	0	0	0	27	2	0	71	346
6:30 PM	0	0	0	0	0	0	4	0	3	29	0	0	0	30	1	0	67	311
6:45 PM	0	0	0	0	1	0	0	0	2	21	0	0	0	16	1	0	41	252

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	0	0	4	0	16	0	8	0	16	324	0	0	0	132	0	0	500
Heavy Trucks	0	0	0		0	0	0		4	20	0		0	8	0		32
Buses																	
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Scooters																	

Comments:

Report generated on 12/30/2022 8:01 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

Appendix B

Technical Memorandum: I-29 and 40th Avenue North Interchange Preliminary Engineering and Feasibility Study Traffic Forecast Data Sources and Recommendations

Stantec

Memo

To:	Jennifer Kern, PE North Dakota Department of Transportation	From:	Mark Butler, AICP Stantec Consulting Services
File:	193805997	Date:	January 23, 2023

Reference: I-29 and 40th Avenue North Interchange Preliminary Engineering and Feasibility Study
Traffic Forecast Data Sources and Recommendations

INTRODUCTION

The North Dakota Department of Transportation (NDDOT) has contracted with Stantec Consulting Services Inc. to perform a Preliminary Engineering and Feasibility Study for the I-29 interchange with 40th Avenue North and the adjacent 40th Avenue North corridor in the City of Fargo and Cass County. As part of this study, Stantec will prepare a traffic operations analysis for the interchange and the approximately 2.1-mile corridor, which is located between the intersection with 45th Street North on the west and the intersection with 25th Street North on the east. This memorandum reviews data sources and presents forecast recommendations to be used in the development of traffic estimates for 2045 forecast year traffic analyses.

STUDY AREA

The 40th Avenue North corridor (County Road 20) follows an east-west alignment along a portion of the northern city limits of Fargo and the northern perimeter of the Hector International Airport. It is primarily a two-lane undivided highway with turn lanes and/or bypass lanes at several intersections. The corridor's speed limit is 40 miles per hour (MPH) with stop control for all side streets within the project limits, except for the intersection with CR 81, which has a traffic signal. 40th Avenue North's standard diamond interchange with I-29, which runs in a 20° skewed northwest-southeast alignment, is bordered on the east by a grade separated crossing of a rail line that runs parallel to I-29. On the east side of the I-29 interchange, 40th Avenue North is classified as a minor arterial highway serving light commercial industrial developments. It is classified as a major collector west of the interchange and is currently bordered by agricultural land. Residential development west of 45th Street North is anticipated to grow substantially over the next 20 years. **Figure 1** presents the study area, along with the nine intersections where turning movement counts were collected in December 2022[1]:

1. 40th Avenue N at 45th Street N
2. 40th Avenue N at I-29 southbound ramps
3. 40th Avenue N at I-29 northbound ramps
4. 40th Avenue N at CR 81
5. 40th Avenue N at 37th Street N
6. 40th Avenue N at 33rd Street N
7. 40th Avenue N at 32nd Street N
8. 40th Avenue N at 391/2 Avenue N
9. 40th Avenue N at 25th Street N

[1] A January 4, 2023 **Traffic Count Technical Memorandum** presents the peak hour counts and count statistics for these intersections.

Figure 1. Project Corridor and Turn Movement Count Locations

HISTORICAL TRAFFIC VOLUMES AND GROWTH

Historical count data from ten NDDOT count stations[2] in proximity to the I-29 interchange with 40th Avenue North were analyzed to identify historical traffic growth trends. The stations include total mainline volumes on I-29 north and south of the interchange, all four interchange ramps, and count stations on 40th Avenue North and CR 81. **Figure 2** presents the location of each count station. The average daily traffic (ADT) volumes and compound annual growth rates (CAGR) for the ten stations are summarized in **Table 1**.

The counts included in **Table 1** range from 2013 to 2021. While counts can fluctuate significantly from year to year for many reasons, they provide an opportunity to identify general growth trends and patterns. It is important to recognize that the most recent counts include the period between 2020 and 2021 when COVID-19 disruptions were at their peak. The counts indicate strong growth of interstate traffic to and from the south of the interchange. Further, traffic growth on 40th Avenue North and CR 81 illustrate the strong growth associated with a rapidly developing exurban area.

NDDOT also provided traffic estimates and 2042 forecasts for I-29 south of the 40th Avenue North interchange and for the northbound exit and entrance ramps. **Table 1** presents these forecasts along with the estimated annual growth rate these forecast volumes imply.

[2] https://gis.dot.nd.gov/external/ge_html/?viewer=ext_transinfo

Figure 2. NDDOT Count Station Locations

Table 1. NDDOT Count Station Traffic Volumes and Growth

Year	I-29		I-29 Ramps				40th Ave. N.		CR 81	
	Sta. 1686	Sta. 652	Sta. 654	Sta. 655	Sta. 656	Sta. 658	Sta. 657	Sta. 662	Sta. 661	Sta. 660
	north of 40th Ave.	south of 40th Ave.	NB Exit	NB Entrance	SB Exit	SB Entrance	west of I-29	east of CR 81	north of 40th Ave.	south of 40th Ave.
2013		18,975	2,830	455	388	2,691	1,984	6,239	819	468
2014										
2015	15,385		3,653	387	435	3,367	2,372	5,986	1,234	563
2016										
2017										
2018			2,977	459	583	2,796	3,228	7,896	746	528
2019	16,344	21,698								
2020	13,711	20,178								
2021	14,083	21,068	3,554	428	409	3,387	3,208	8,290	1,642	892
2022	14,859	21,582								
% CAGR*	**-0.5%**	**1.4%**	**2.9%**	**-0.8%**	**0.7%**	**2.9%**	**6.2%**	**3.6%**	**9.1%**	**8.4%**
NDDOT 2042		30,850	5,685	955						
% CAGR*		**1.9%**	**2.4%**	**4.1%**						

Source: NDDOT Planning Division - Traffic Information Section

* CAGR reflects annualized growth estimated from the first and last year of available data.

TRAVEL DEMAND MODEL ANALYSIS

Stantec reviewed traffic assignments from the Fargo-Moorhead Metropolitan Council of Governments (Metro COG) regional travel demand model and the corresponding Traffic Analysis Zone (TAZ) data files that include its assumptions for population and employment. The model assignments represent the 2015 base year and the 2045 future year with the "LRTP" network, which includes projects from Metro COG's 2045 Long Range Transportation Plan. There were no notable network attribute differences between the 2015 and 2045 networks for the links on I-29 or 40th Avenue North relevant to this study. The only notable network distinction found was on 45th Street North between 40th Avenue North and 19th Avenue North, where the free flow speed was lowered from 45 MPH in the 2015 network to 30 MPH in the 2045 LRTP network.

The primary distinction between the 2015 base year and 2045 LRTP model assignments for the study corridor is the growth of the household and employment values between assignment years in the model's TAZs. However, while total regional households grow from 92,007 households in 2015 to 128,757 households in 2045, the number of households in the twelve (12) TAZs directly adjacent to the 40th Avenue North corridor does not change from its total of 254 in 2015. In contrast, total employment grows in these zones from 605 employees in 2015 to 1,614 employees in 2045. However, this growth occurs exclusively in three TAZs east of I-29, in the existing industrial zones. **Figure 3** presents the location of the twelve adjacent TAZs.

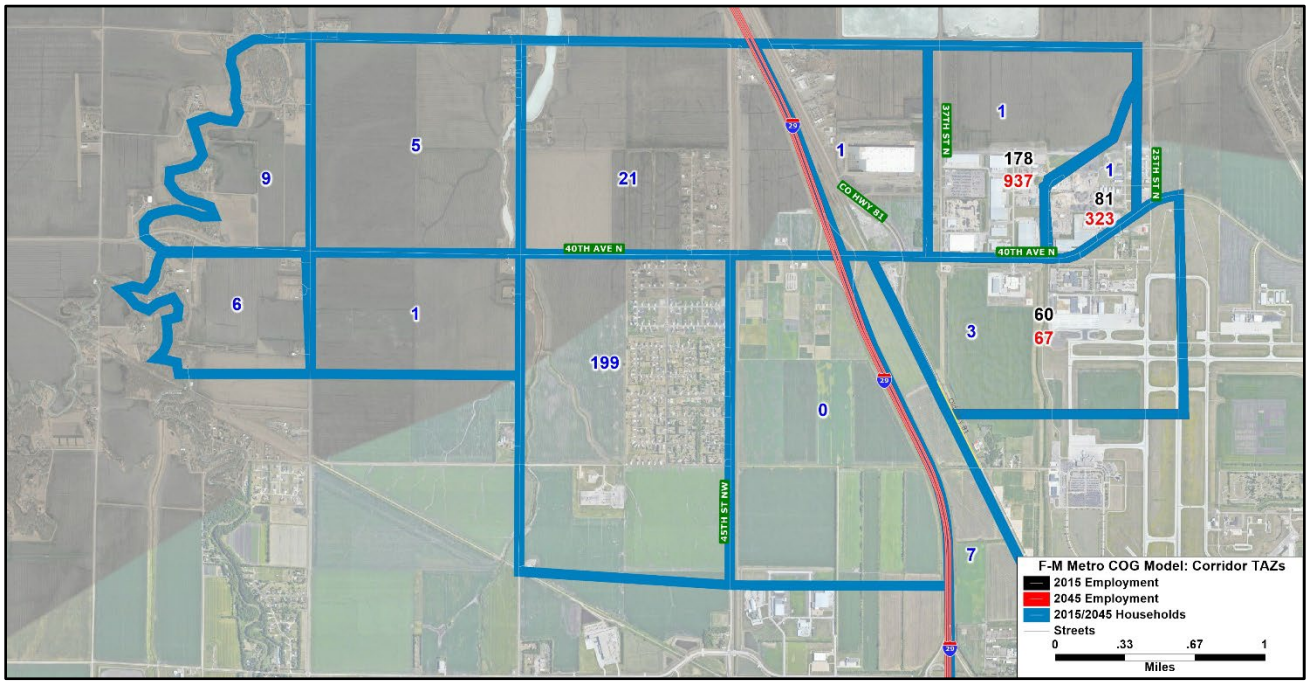


Figure 3. F-M Metro COG Corridor TAZs

Table 2 presents the demand model assignments for 2015 and 2045, and the estimated CAGR between assignment years, at the same ten locations used to report historical counts. While the moderately high growth of interstate traffic reasonably reflects the general expectations of a growing metropolitan area, the growth for the interchange ramps and on 40th Avenue North and CR 81 illustrate the lack of residential growth on the west side of the interstate and relatively robust employment growth on the east side of the interstate.

Table 2. FM Metro COG Travel Demand Model Traffic Assignments

Year	I-29		I-29 Ramps				40th Ave. N.		CR 81	
	north of 40th Ave.	south of 40th Ave.	NB Exit	NB Entrance	SB Exit	SB Entrance	west of I-29	east of CR 81	north of 40th Ave.	south of 40th Ave.
2015 ADT	11,935	18,088	3,927	849	700	3,775	4,473	11,532	662	599
2045 ADT	19,169	28,724	5,802	1,053	1,053	5,802	6,113	17,178	1,303	2,475
% CAGR	**1.6%**	**1.6%**	**1.3%**	**0.7%**	**1.4%**	**1.4%**	**1.0%**	**1.3%**	**2.3%**	**4.8%**

Source: F-M Metro COG Regional Travel Demand Model

POPULATION AND EMPLOYMENT TRENDS

Historical population data were obtained from the U.S. Census. State and county population projections for 2040 were obtained from the North Dakota Department of Commerce. These estimates and projections are summarized in **Table 3**. Population projections for the year 2040 are used to estimate a CAGR for the years between 2020 and 2040. Since 2000, Fargo metropolitan area population growth has been among the fastest in the nation. By 2040, Cass County is expected to grow by more than 44,000 people, almost a quarter of its 2020 population.

Table 3. Population Projections

Area	U.S. Census Population			CAGR	2040* Projection	CAGR
	2000	2010	2020	2000 - 2020		2020 - 2040
Cass County, ND	123,138	149,778	184,525	2.0%	228,895	1.1%
Clay County, MN	51,229	58,999	65,318	1.2%	--	--
North Dakota	642,200	672,591	779,094	1.0%	991,522	1.2%

*Source: North Dakota Census Office Population Projections of the State, Regions and Counties, 2016

The U.S. Bureau of Economic Analysis (BEA) reports employment statistics for individual states and counties. **Table 4** presents the total employment for North Dakota, Cass County, and Clay County in Minnesota, from 2000 to 2020. Similar to population growth, Cass County's 2.0% annual rate of employment growth has been significantly greater than the rate growth seen in North Dakota and the national average. Assuming job growth continues at this rate, Cass County may have almost 72,000 more jobs by 2040, a 48% increase.

Table 4. Total Employment

Area	Total Employment			CAGR	2040* Projection
	2000	2010	2020	2000 - 2020	
Cass County, ND	101,452	124,472	149,984	2.0%	221,732
Clay County, MN	24,988	27,827	28,546	0.7%	--
North Dakota	440,643	503,813	560,682	1.2%	

*Source: U.S. BEA; 2040 employment estimated.

NORTHWEST FARGO SMALL AREA TRAFFIC STUDY

The Northwest Fargo Small Area Study[3] (January 2022) analyzed additional traffic growth expected to occur in the industrial zone located in the northeast quadrant of 40th Avenue North and I-29. In addition to a new Amazon distribution center which opened in 2021, this study contemplates the potential development of up to 4.2 million square feet of new industrial space over 585 acres across six sites adjacent to 40th Avenue North and CR 81. At full buildout, the report estimated the new development would create up to 760 additional PM peak hour and 7,200 daily trips. While the phasing and final year of full build out was not explicitly established, the report used 2030 as the full buildout year for analysis. **Table 5** presents the 2021 existing year and 2030 forecast year ADTs, and the associated growth rates, for several locations along the 40th Avenue North corridor.

Table 5. Northwest Small Area Traffic Study Daily Traffic Forecasts

Year	40th Ave. N. between I-29 & CR 81	CR 81 north of 40th Ave.	CR 81 south of 40th Ave.	37th St. north of 40th Ave.	33rd St. north of 40th Ave.	32nd St. north of 40th Ave.	25th St. north of 40th Ave.	40th Ave. N. east of 25th St.
Existing 2021 ADT	7,800	1,000	550	800	750	550	1,000	6,000
Buildout 2030 ADT	14,000	3,300	850	3,200	2,100	650	2,800	9,400
% CAGR	**6.7%**	**14.2%**	**5.0%**	**16.7%**	**12.1%**	**1.9%**	**12.1%**	**5.1%**

Source: Northwest Fargo Small Area Study, 2022

The Fargo I-29 Exit 69 (Co 20 / 40th Ave N) Interchange Study (May 2022) prepared by NDDOT analyzed the traffic impact of the new Amazon development and an industrial distribution center under construction on one of the six sites included in the Small Area Study. This analysis focused on the I-29 interchange ramp terminals but limited its analysis to 2022 volumes.

NORTHWEST METRO TRANSPORTATION PLAN

In September 2020, Metro COG released the Northwest Metro Transportation Plan Final Report[4]. This plan is one of several plans that directly address the anticipated development that will accompany the significant population and employment growth expected through 2045. The plan specifically includes areas of currently undeveloped agricultural land adjacent to 40th Avenue North. **Figure 4** presents the boundaries of the study area, which includes 40th Avenue North labeled as CR 20. While the study area covers an area significantly larger than the land directly served by 40th Avenue North, with its direct connection to I-29, 40th Avenue is expected to be a primary corridor serving the anticipated development.

[3] Transportation Collaborative and Consultants, LLC (2022) *Northwest Fargo Small Area Study.* Report to the City of Fargo.
[4] https://www.fmmetrocog.org/projects-rfps/completed-projects/nwmetro-transportation-plan

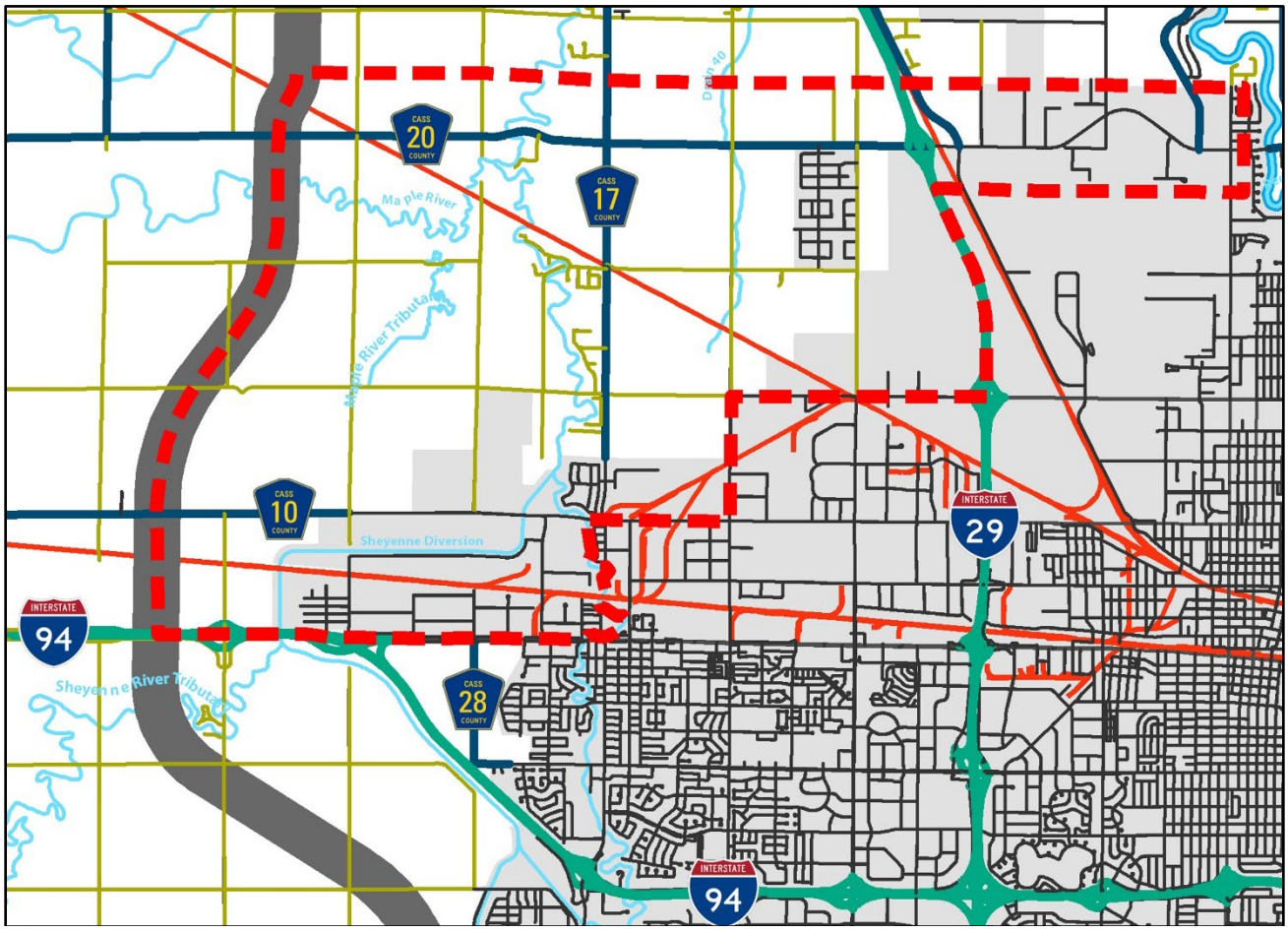


Figure 4. Northwest Metro Transportation Plan Study Area

Source: https://www.fmmetrocog.org/application/files/1115/5983/5057/Thumbnail_Image_Northwest_Metro_Transportation_Plan_1.jpg

The Northwest Metro Transportation Plan presents "*25 percent*", "*50 percent*", and "*Full*" buildout scenarios for the purpose of analyzing expected traffic impacts and required mitigation strategies. The report uses 2045 as the forecast year for these scenarios, although it states that full buildout is not expected to occur within that time period. **Table 6** presents the study's household, population, and job allocations for the study area, for each of these scenarios.

Table 6. Northwest Metro Transportation Plan Development Scenarios

Sub Area Totals	2045 Base Model	25% Buildout	50% Buildout	Full Buildout
Households	1,952	+6,606	+18,097	+27,772
Population	4,898	+13,664	+37,342	+56,816
Jobs	9,519	+28,658	+56,959	+90,015

Source: Table 10, Northwest Metro Transportation Plan, page. 46

While high, of the three scenarios, the allocations presented for the "*50 percent*" scenario compares most closely to the historically high growth rates in population and employment discussed in this memorandum. In fact, the "*50 percent*" scenario implies that 85 percent of all population growth and 80 percent of all

employment growth expected in Cass County by 2040 will occur in this northwest quadrant of the city. This allocated growth will occur across the study area beyond the area directly served by 40th Avenue North.

The Northwest plan used the Metro COG travel demand model to estimate 2045 ADTs based on the scenario allocations of households and employment. **Table 7** presents the assignments along 40th Avenue North for the 2045 "*50 percent"* scenario presented in Figure 39 (page 53) of the report. **Table 7** also presents the comparable 2021 ADTs from Metro COG's rural and urban count maps[5] and the associated growth rates between counts and forecast assignments.

Table 7. Northwest Metro Transportation Plan 2045 "50% Buildout" ADT Forecast

Year	40th Ave. N.				45th St. N.	CR 81	
	west of 45th St. N	east of 45th St. N	east of CR 81	east of 37th St.	south of 40th Ave N.	north of 40th Ave.	south of 40th Ave.
Existing 2021 ADT	1,410	3,210	8,290	7,640	400	1,640	890
50% Buildout 2045 ADT	15,000	16,900	16,800	15,500	4,000	2,800	5,200
% CAGR	**10.4%**	**7.2%**	**3.0%**	**3.0%**	**10.1%**	**2.3%**	**7.6%**

Source: 2021 Metro COG AADT Maps; Northwest Metro Transportation Plan, 2020

GROWTH RATE RECOMMENDATION

This memorandum has summarized the various data sources informing traffic growth on 40th Avenue North corridor. Historical growth demonstrated through counts can be difficult to assess for an exurban area at the beginning phase of rapid development as historically low volume counts can grow exponentially with relatively little additional traffic. For travel model assignments to be valid along specific corridors, they must reflect the new development expected. In this case, the model recognizes significant employment growth on the corridor east of the I-29 interchange but does not include any new residential development west of the interchange. Fortunately, the two recent studies referenced in this memorandum, the Northwest Small Area Study and the Northwest Metro Transportation Plan provides specific details and associated forecasts for new future development on both sides of the corridor.

Table 8 summarizes the annual growth rates estimated and presented in the previous tables in this memorandum. The historical count data, Metro COG model and NDDOT's forecast for the mainline volumes on I-29 south of the 40th Avenue interchange all reflect reasonable rates of growth for a high-volume facility serving a growing metropolitan area. Given the immediate drop in traffic volume north of the interchange leaving the metro area, it is reasonable to conclude that the COVID pandemic disruption at least partially accounts for the recent drop in total volume for interstate traffic north of the interchange. Therefore, it is likely that this traffic will revert to the rate of growth indicated by Metro COG's model assignments. Regarding growth on the interchange ramps, both historical growth and NDDOT's forecast growth appear to best reflect the expected traffic pattern for trips to and from the south, as compared to the model, which does not incorporate the full extent of expected growth, particularly residential growth. From a practical perspective, the volumes of ramp traffic serving interstate traffic to the north are low enough that it is safe to apply similar rates, as the resulting forecast volumes will still be relatively low.

The historical count data aligns well with the projected growth rates estimated from the Northwest Metro Transportation Plan's *50% Buildout* scenario for significant residential development to be served by the corridor to the west of the interchange. An annual growth rate of 7% is extremely high. However, it is rational if the development expectations of the study occur. East of the interchange, the Northwest Small Area Study

[5] https://www.fmmetrocog.org/resources/traffic-counts

provides the most detail for industrial development growth in this area of the corridor. The Study's 2030 full build out forecast ADTs align with 2045 ADTs that grow at rates estimated from historical counts. They also generally align with Northwest Metro Transportation Plan's forecast ADTs for 40th Avenue North in 2045.

Table 8 presents the recommended CAGRs to apply to the 2022 existing year trip tables of the traffic simulation model to use in the 2045 forecast year traffic simulation analysis. Based on a synthesis of the available data sources, these recommended rates will result in future ADTs that reflect historical trends, regional model and population growth assumptions, and specific development expectations along the corridor.

Table 8. CAGRs by Data Source and Recommended CAGRs

Source	I-29		I-29 Ramps				40th Ave. N.		CR 81	
	north of 40th Ave.	south of 40th Ave.	NB Exit	NB Entrance	SB Exit	SB Entrance	west of I-29	east of CR 81	north of 40th Ave.	south of 40th Ave.
NDDOT Historical Counts	-0.5%	1.4%	2.9%	-0.8%	0.7%	2.9%	6.2%	3.6%	9.1%	8.4%
NDDOT Forecast (2042)		1.9%	2.4%	4.1%						
Metro COG Model (2045)	1.6%	1.6%	1.3%	0.7%	1.4%	1.4%	1.0%	1.3%	2.3%	4.8%
NW Small Area Study (2030)								6.7%*	14.2%	5.0%
NW Metro Trans. Plan. (2045) "50% Buildout"							7.2%	3.0%	2.3%	7.6%
Recommended CAGR	1.9%	1.9%	2.5%	2.5%	2.5%	2.5%	7.0%	3.5%	7.0%	5.0%
Estimated 2045 ADTs	23,000	33,000	6,500	800	750	6,250	15,200	18,300	4,250	5,000

* Between I-29 and CR 81

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Appendix C

Technical Memorandum: Existing Conditions Simulation Model Development Memorandum

Stantec

Memo

To:	Jennifer Kern, PE Chad Frisinger, PE North Dakota Department of Transportation	From:	Mark Butler, AICP Pat McGraw, PE Stantec Consulting Services Inc.
File:	Preliminary Engineering and Feasibility Study Services for Project 8-029(213)069 NDDOT PCN 23596	Date:	January 26, 2023

Reference: Existing Conditions Simulation Model Development Memorandum

PROJECT DESCRIPTION

The Stantec team is working with the North Dakota Department of Transportation (NDDOT) to complete a preliminary engineering and feasibility study to evaluate and compare retention and reconstruction alternatives for the 40th Avenue North (Cass County Route 20) interchange with I-29 in Fargo, ND (Exit 69). The purpose of the study is to determine potential interchange configurations, roadway alignments, and bridge type and sizes based on an operational, geometric, stakeholder, and environmental evaluation. This study will focus on identifying locations of and need for potential crash countermeasure treatments and will assess future traffic demand along the corridor.

As part of this study, Stantec has developed a traffic simulation model depicting existing peak hour conditions using Caliper's TransModeler (Version 6) simulation package. This memorandum presents the methodology and associated data related to the development and calibration of the model.

STUDY AREA

The 40th Avenue North corridor follows an east-west alignment along a portion of the northern city limits of Fargo and the northern perimeter of the Hector International Airport. It is primarily a two-lane undivided highway with turn lanes at several intersections. The corridor's speed limit is 40 miles per hour (MPH) with stop control for all side streets within the project limits, except for the intersection with CR 81 which has a traffic signal. The 40th Avenue North interchange with I-29 is a standard diamond and is bordered on the east by a grade separated crossing of a rail line that runs parallel to I-29. East of the CR 81, 40th Avenue North is classified as a minor arterial highway serving light commercial industrial developments. It is classified as a collector west of CR 81. Residential development west of 45th Street North is anticipated to grow substantially over the next 20 years. **Figure 1** presents the model network and study area**.**

Reference: **Existing Conditions Simulation Model Development Memorandum**

Figure 1. Simulation Model Network Study Area

Reference: **Existing Conditions Simulation Model Development Memorandum**

NETWORK DEVELOPMENT

The simulation model network was created by importing the corresponding network links of the study area from Fargo-Moorhead Metro COG's regional travel demand model into TransModeler. Additional side street or driveways not included in the Metro COG regional model were manually added in TransModeler. The network was refined to reflect the specific roadway configuration for all lanes, intersections, and traffic control, using an underlying aerial from Google Earth as reference. Other link level attributes, such as road names, functional classification, and count data were also added to the link layer for reference. Capacities and speeds for each network link are managed and coordinated via model parameters established for each functional class.

Turning movement files for the AM and PM peak hours were input into the model based on the turning movement counts (TMCs) presented in the *Traffic Count Technical Memorandum*. Based on these counts, the AM peak hour was determined to be 7:15 AM to 8:15 AM and the PM peak was determined to be 4:30 PM – 5:30 PM.

Traffic control for traffic traveling on 40th Avenue North is limited to a single, actuated traffic signal at the intersection with CR 81. The AM and PM signal plans for this intersection were coded for the existing conditions model based on a detailed review of the signal operations during AM and PM peak hour video recorded on December 20, 2022. All other intersections are two-way stop-controlled.

MODEL TRIP TABLES

Trip tables for the AM and PM peak hours were developed with rows and columns representing eighteen individual entry and exit points for traffic onto the network. These eighteen points reflect each traffic movement captured by the nine intersection TMCs collected in December 2022. The TMCs for both the AM and PM peak hours were used as input for TransModeler's Origin-Destination Matrix Estimation (ODME) function to estimate the origin and destination of every vehicle trip through the network, with separate tables for autos, single-unit trucks, and multi-unit trucks. All trip tables were factored by 1.02 to reflect a generalized seasonal adjustment factor applied across all road functional classes, based on the average trip volume for Tuesdays in December as compared to the Annual Average Daily Traffic (AADT). This factor was derived from count station data reported in NDDOT's *Seasonal Adjustment Factors & ADT by Station, All Vehicles – 2022.*[1]

Table 1 presents a summary of the trips included in the model trip tables. Most trips in the model are through trips on I-29 with no interaction with the 40th Avenue North corridor. They have been distinguished from the remaining model trips that directly use the model corridor.

[1] North Dakota Department of Transportation, *Seasonal Adjustment Factors & ADT by Station, All Vehicles – 2022.* Printed: 1/10/2023.

Reference: **Existing Conditions Simulation Model Development Memorandum**

Table 1. Model Trips by Peak Hour and Vehicle Class

	AM Peak Hour		PM Peak Hour	
	I-29 (Through)	40th Ave N (Local)	I-29 (Through)	40th Ave N (Local)
Auto/Lt.Trk	1,007	830	1,223	835
SU Truck	102	19	128	28
MU Truck	154	28	193	38
Total Trips	1,263	877	1,544	901

The TMCs, which were collected in 15-minute intervals, were also used to develop the time distribution curve of the traffic in the trip tables. **Table 2** presents the time distribution of traffic for the AM and PM peak hours.

Table 2. Peak Hour Time Distributions

AM Peak Hour		PM Peak Hour	
Time	**% of Total**	**Time**	**% of Total**
7:15	19.9%	4:30	28.1%
7:30	25.1%	4:45	22.9%
7:45	31.5%	5:00	24.4%
8:00	23.5%	5:15	24.6%

VEHICLE FLEET

The distribution of vehicle types reflects count data from NDDOT's *Basic Axle Classification Report:360 E*[2], which reported classification counts on 40th Avenue North taken May 17-19, 2021. TransModeler's default distribution of car performance reflecting three distinct acceleration and speed profiles was applied to autos single- and multi-unit trucks are represented in separate trip tables. **Table 3** presents the vehicle fleet distribution used in the model.

Table 3. Model Vehicles Fleet Distribution

Vehicle Type	FHWA Class	Distribution
Motorcycle	1	0.8%
Car, Low Performance	2	4.1%
Car, Medium Performance	2	19.4%
Car, High Performance	2	23.8%
Pickup/SUV	3	36.7%
Bus	4	0.1%
Single-unit Truck	5-7	6.0%
Multi-unit trucks	8-13	9.0%

[2]North Dakota Department of Transportation, *Basic Axle Classification Report:360 E.* Printed: 5/20/2021.

Reference: **Existing Conditions Simulation Model Development Memorandum**

CALIBRATION

Intersections were checked to ensure that the turning movement and link-based counts were accurate. TransModeler's 'error checking' function was run to identify link connectivity and traffic signal coding issues Network links flow volumes were reviewed to identify areas where the traffic might be inconsistent with expected volumes, but no significant inconsistencies were found.

The criteria used to confirm that the simulation model has been sufficiently calibrated were taken from the Federal Highway Administration's (FHWA) *Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software, July 2004 (FHWA Publication No. FHWA-HRT-04-040).* The criteria, originally developed by the Wisconsin Department of Transportation, are in Table 4 on page 64 of that document. The criteria consist of three general metrics: 1) visual audits, 2) traffic flow, and 3) travel speeds. Traffic flow and travel speeds are quantifiable based on observed data and the model output while the guidance says that visual audits are to be conducted to the "analyst's satisfaction."

Visual audits were performed throughout the calibration process. Given the relatively low volume on the corridor and side streets, as well as the minimal traffic control at intersections, model observation focused on the operation of each intersection and queue lengths for turning movements at the I-29 interchange ramps and at the signalized CR 81 intersection. All other intersections had minimal cross street traffic, with a single vehicle queuing on rare occasion during the peak hour periods of observation.

A video review of the ramp terminals during both the AM and PM peak hours on December 20, 2022 demonstrated that most turning movements were single vehicles turning unimpeded, resulting in no queuing. The AM northbound exit right turning movement and the PM northbound left turning movement generated relatively minimal queues, with most queues being one or two vehicles, although two AM outlier queues involving heavy vehicles did create longer queues of four and nine vehicles. In comparison, model output reports 95th percentile average queue lengths of one vehicle or less for all ramp related turning movements. A visual audit indicates that in most cases, turns can be made without opposing traffic and queues that do form are typically one to three vehicles that dissipate quickly.

At the signal at CR 81, queue lengths observed for 40th Avenue North ranged from one to seven vehicles, with a mode of one and an average 2.2 vehicles for both AM and PM. This corresponded well with the 95th percentile average queue lengths reported for 40th Avenue North by the model, which was 2 vehicles in both directions for AM and PM. Observed queues on CR 81 southbound averaged 1.5 vehicles in the AM peak and 1.9 vehicles in the PM peak, compared to a 95th percentile average queue length of one vehicle as reported by the model. While slightly higher than the model average queue length, the observed sample of queues was very small.

Overall, the visual audit of traffic operation in the simulation model compared to the observed videos concluded that no movements were notably misrepresented in the model.

To compare traffic flows, link-based trip volumes for ten simulation runs were averaged and compiled for each direction of each link and compared to the aggregated TMC volumes recorded for each network link associated with the nine intersections where TMCs were collected. Several statistical measures can measure model assignment volumes against observed counts. The most relevant of these measures is percent root-mean-square error (RMSE) with a target threshold of 10 percent or lower to confirm the model was sufficiently calibrated for assigned volumes. **Table 4** presents the validation statistics for both the AM and PM models. As shown, both the AM and PM simulation models have volumes with RMSE less than 10 percent, indicating a

good match to the existing counts, which have also been factored by the 1.02 seasonal adjustment factor to ensure an accurate comparison.

Table 4. Volume Validation Statistics

Total Volume to Count:	AM Peak	PM Peak
Target: within 5% of count	102.6%	101.1%
Sum of flow	6,956	7,332
Sum of counts	6,781	7,250
Percent Root Mean Square Error	**AM Peak**	**PM Peak**
Target: < 10.0%	6.7%	7.5%

Travel speed data was limited to NDDOT's *Basic Axle Classification Report:360 E*, which provided a distribution of individual vehicle speeds at a single location, with average speeds ranging between 44 to 48 mph by direction for each of the two days in May 2021 when counts were collected. The *Northwest Fargo Small Area Study*[3] from January 2022 noted that the speed limit on 40th Avenue North had recently changed to 40 mph. The free flow speed for the "Minor Arterial" and "Major Collector" road classes within TransModeler's road parameters were revised to 50 mph, which resulted in consistent corridor travel speeds in the mid to upper 40's mph for all links not approaching the traffic signal at CR 81.

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[3] Transportation Collaborative and Consultants, LLC (2022) *Northwest Fargo Small Area Study.* Report to the City of Fargo.

Appendix D

Technical Memorandum: Combined No-Build and Primary Corridor Alternatives Models Summary

Stantec

Memo

To:	Jennifer Kern, PE, Chad Frisinger, PE North Dakota Department of Transportation	From:	Mark Butler, AICP Pat McGraw, PE Stantec Consulting Services
File:	Preliminary Engineering and Feasibility Study Services for Project 8-029(213)069 NDDOT PCN 23596	Date:	February 17, 2023

Reference: I-29 & 40th Ave N Interchange: Combined No-Build and Primary Corridor Alternatives Models Summary

PROJECT DESCRIPTION

The Stantec team is working with the North Dakota Department of Transportation (NDDOT) to complete a preliminary engineering and feasibility study to evaluate improvement alternatives for the 40th Avenue North (Cass County Route 20) interchange with I-29 in Fargo, ND (Exit 69). Previous studies have recommended implementing traffic signals or roundabouts at the primary intersections throughout the project corridor. To further develop a basis for comparison of interchange alternatives, Stantec developed a corridor alternative with traffic signals and a corridor alternative with roundabouts at seven intersections along the corridor. As an initial comparison, base year (2022) and future year (2045) AM and PM peak hour simulation models were created for the **existing** corridor configuration, the **signalized** corridor alternative, and the **roundabout** corridor alternative. The existing interchange and roadway geometry was otherwise maintained as a single directional lane corridor.

STUDY AREA

The study area includes the 40th Avenue North interchange with I-29 and 40th Avenue North between the connecting streets from 45th Street North to 25th Street North. The 40th Avenue North corridor is classified as a two-lane major collector highway west of CR 81 and as a two-lane minor arterial highway east of CR 81. The corridor's speed limit is 40 miles per hour (MPH) with stop control for all side streets within the project limits, except for the intersection with CR 81, which has a traffic signal. **Figure 1** presents the study area.

Figure 1: Corridor Study Area

CORRIDOR CONCEPTS

Three corridor concepts have been developed to pair with each interchange design alternative. The first of these three corridor concepts is the existing corridor configuration. The existing corridor configuration contains a single traffic signal at CR 81and stop control for all other side streets and driveways. In the existing corridor, There are currently no turns lanes at the intersections at 45th Street North and the I-29 ramp terminals, and various lane configurations for the intersections east of I-29, as depicted in **Table 1**. A "1" indicates one lane provides the movements as listed in the table heading and an "X" reflects when a movement is not allowed.

Table 1. Existing Corridor Intersection Turn Lane Configurations

	Westbound Appr.			Eastbound Appr.			Southbound Appr.			Northbound Appr.		
40th Avenue North at:	**LT**	**TH**	**RT**	**LT**	**TH**	**RT**	**LT**	**TH**	**RT**	**LT**	**TH**	**RT**
45th Street North	1			1			1			1		
I-29 Southbound Ramps	1			1			1			X		
I-29 Northbound Ramps	1			1			X			1		
CR 81	1	1	1	1	1		1		1	1		
37th Street North	1		1	1		1	1		1	1		
33rd Street North	1	1	1	1	1	1	1			1		
32nd Street North	1		1	1		1	1			X		
39 1/2 Avenue North	1			X	1	1	X			1		
25th Street North	1			1			1			1		

In addition to the existing corridor concept, traffic signal and roundabout intersection control improvement concepts were developed for seven intersections along the 40th Avenue North corridor. These two corridor concepts were developed with improved intersection control based on "No Build" corridor geometry (i.e. traffic signals were added to the existing roadway configuration). These intersections include:

1. 45th Street North
2. Southbound I-29 Ramps
3. Northbound I-29 Ramps
4. County Route 81 (CR 81)
5. 37th Street North
6. 33rd Street North
7. 25th Street North

As directed by the project scope, for this analysis the traffic signal and roundabout concepts generally maintain the existing roadway geometry of the corridor where possible. Existing turn lanes were maintained in the signalized corridor, although all roundabout approaches are single lane. Additional lane capacity improvements on the corridor may be added as deemed necessary in the proceeding alternative interchange models.

EXISTING 2022 NETWORK INTERSECTION DELAY AND LEVEL OF SERVICE

Each of the three corridor concepts was simulated with existing 2022 traffic for AM and PM peak hour traffic. **Attachment A** presents the turning movement counts that were the basis for the existing year trips. Traffic analyses were performed using the TransModeler traffic simulation program which replicates analysis procedures included within the Highway Capacity Manual (HCM). TransModeler provides a number of performance measures as output, including level of service (LOS). LOS is a qualitative measure describing operational conditions within a traffic system, based on service measures such as speed, delay, freedom to maneuver, traffic interruptions, comfort, and convenience. There are six levels of service, having letter grades A through F. In regard to intersections, the performance measure for LOS is average delay per vehicle. **Table 2** presents the LOS criteria (in seconds per vehicle) for control delay at unsignalized intersections / roundabouts and at signalized intersections.

Table 2. Intersection LOS Scale

LOS	Unsignalized Intersection / Roundabout	Signalized Intersection
A	≤10 sec	≤10 sec
B	10–15 sec	10–20 sec
C	15–25 sec	20–35 sec
D	25–35 sec	35–55 sec
E	35–50 sec	55–80 sec
F	>50 sec	>80 sec

Table 3 presents the base year 2022 intersection delay and LOS for the seven identified intersections on the corridor for the existing configuration of traffic control on the corridor, with a single signal at the intersection at CR 81. These statistics were estimated from the average of five model simulation runs for both the AM peak hour and the PM peak hour, using TransModeler's standard output report function, which incorporates the basic methodological principles of the Highway Capacity Manual (HCM). **Table 3** illustrates that the low volume on the corridor in 2022 does not warrant any intersection improvements, as all intersections operate at LOS A with minimal intersection delay.

Table 3. Existing Intersection 2022 Average Delay and LOS

Intersection	AM Peak Hour			PM Peak Hour		
	Vehicles	Avg Delay (sec.)	LOS	Vehicles	Avg Delay	LOS
45th Street North	273	1.0	A	234	0.5	A
Southbound I-29 Ramps	488	3.9	A	485	2.4	A
Northbound I-29 Ramps	581	4.8	A	706	4.9	A
County Route 81 (CR 81)*	622	6.9	A	694	8.3	A
37th Street North	527	0.2	A	584	0.5	A
33rd Street North	524	0.3	A	560	1.1	A
25th Street North	459	0.9	A	486	0.6	A

*Intersection with Traffic Signal

SIGNALIZED INTERSECTIONS

As **Table 3** illustrates, no capacity improvements are necessary for the seven identified intersections to operate with acceptable LOS for existing 2022 traffic volumes. While these intersections do not warrant signals under existing traffic conditions, the signalized intersections were analyzed with the base year 2022 trip tables as a test to ensure all movements and functionality work correctly. All signal timings plans were optimized to minimize average delay using TransModeler's optimization function and existing turning movement counts. As is typical of diamond interchanges, the traffic signal timing plans at the northbound and southbound ramp terminal intersections are coordinated with each other. The remaining five intersections operate independently. These intersections are shown in **Figure 2**.

Figure 2: Conceptual Signalized Intersection Locations

Table 4 presents a summary of average intersection delay and LOS for existing 2022 traffic conditions for the signalized corridor concept. As expected, all intersections operate at LOS A, although delay increases slightly due to the introduction of signals at intersections where free flow on 40th Avenue North currently exists.

Table 4. 2022 Average Intersection Delay and LOS with Traffic Signals

Intersection	AM Peak Hour			PM Peak Hour		
	Vehicles	Avg Delay (sec.)	LOS	Vehicles	Avg Delay	LOS
45th Street North	271	2.7	A	231	1.5	A
Southbound I-29 Ramps	485	7.8	A	483	6.7	A
Northbound I-29 Ramps	579	6.3	A	705	8.3	A
County Route 81 (CR 81)	622	6.6	A	693	8.1	A
37th Street North	524	0.6	A	585	1.3	A
33rd Street North	517	1.8	A	559	4.7	A
25th Street North	456	2.2	A	482	1.9	A

ROUNDABOUTS

The roundabout corridor alternative converts each of the seven intersections into roundabouts. Conceptual single-lane roundabouts were coded into the model network and analyzed with the base year 2022 trip tables as a test to ensure all movements and functionality work correctly. Based on existing traffic volumes, single-lane roundabouts, shown in **Figure 3**, sufficiently serve base year traffic.

Figure 3: Conceptual Roundabout Locations

Table 5 presents a summary of average intersection delay and LOS for existing conditions for this concept.

Table 5. 2022 Average Delay and LOS with Roundabouts

	AM Peak Hour			PM Peak Hour		
Roundabout	Vehicles	Avg Delay (sec.)	LOS	Vehicles	Avg Delay	LOS
45th Street North	277	3.2	A	236	2.3	A
Southbound I-29 Ramps	493	4.2	A	486	4.1	A
Northbound I-29 Ramps	585	3.8	A	710	3.7	A
County Route 81 (CR 81)	631	4.2	A	698	4.0	A
37th Street North	531	3.8	A	594	3.7	A
33rd Street North	527	3.6	A	569	3.3	A
25th Street North	461	2.1	A	496	1.5	A

CORRIDOR LEVEL OF SERVICE

TransModeler also reports LOS at the corridor level, generally based on operational speed compared to free flow speed. This metric reflects the overall LOS from 45th Street North to 25th Street North. The free flow speed established for this corridor is 50 MPH. **Table 6** presents the corridor LOS for each corridor type for the 2022 base year. With low traffic volumes, the LOS of the corridor in the 2022 base year reflect optimal conditions.

Table 6. Base year 2022 Corridor LOS

AM Peak Hour			
Direction	Network	Average Speed (MPH)	LOS
Westbound	Existing	39	B
	Signalized	37	B
	Roundabouts	33	B
Eastbound	Existing	41	A
	Signalized	41	A
	Roundabouts	33	B
PM Peak Hour			
Direction	Network	Average Speed (MPH)	LOS
Westbound	Existing	40	A
	Signalized	37	B
	Roundabouts	33	B
Eastbound	Existing	41	A
	Signalized	40	B
	Roundabouts	32	B

2045 FUTURE TRAFFIC

Future year 2045 AM and PM peak hour trip tables were developed for the simulation models based on growth assumptions developed from an analysis of count data and FM Metro COG travel demand model assignments, and from the **Northwest Fargo Small Area Study**[1] and Metro COG's **Northwest Metro Transportation Plan Final Report**.[2] These assumptions were synthesized in a previous memorandum[3] to identify growth rates that reflected the general average daily traffic (ADT) expected in 2045, given the local development anticipated to occur. **Table 7** presents the summary of compound annual growth rates (CAGRs) from that technical memorandum.

Table 7. CAGRs by Data Source and Recommended CAGRs

Source	I-29		I-29 Ramps				40th Ave. N.		CR 81	
	north of 40th Ave.	south of 40th Ave.	NB Exit	NB Entrance	SB Exit	SB Entrance	west of I-29	east of CR 81	north of 40th Ave.	south of 40th Ave.
NDDOT Historical Counts	-0.5%	1.4%	2.9%	-0.8%	0.7%	2.9%	6.2%	3.6%	9.1%	8.4%
NDDOT Forecast (2042)		1.9%	2.4%	4.1%						
Metro COG Model (2045)	1.6%	1.6%	1.3%	0.7%	1.4%	1.4%	1.0%	1.3%	2.3%	4.8%
NW Small Area Study (2030)								6.7%*	14.2%	5.0%
NW Metro Trans. Plan. (2045) "50% Buildout"							7.2%	3.0%	2.3%	7.6%
Recommended CAGR	1.9%	1.9%	2.5%	2.5%	2.5%	2.5%	7.0%	3.5%	7.0%	7.0%
Estimated 2045 ADTs	23,000	33,000	6,500	800	750	6,250	15,200	18,300	4,250	7,750

* Between I-29 and CR 81

The AM and PM 2045 trip tables were developed to reflect and reconcile the target growth rates with an emphasis and deference to fully assigning anticipated traffic to the 40th Avenue North corridor. **Table 8** compares the total number of trips in the model trip tables for 2022 and 2045 and demonstrates that total traffic on the 40th Avenue North corridor almost quadruples in both the AM and PM peak hours, in line with the AADT expectations for the corridor, as presented in the **Northwest Metro Transportation Plan Final Report** for its *50% Buildout* development scenario for the area.

Table 8. Model Trips Summary by Vehicle Class and Scenario Year

	AM Peak Hour				PM Peak Hour			
	I-29 (Through)		40th Ave N (Local)		I-29 (Through)		40th Ave N (Local)	
	2022	**2045**	**2022**	**2045**	**2022**	**2045**	**2022**	**2045**
Auto/Lt.Trk	1,007	1,462	830	2,887	1,223	1,694	835	3,221
SU Truck	102	138	19	98	128	179	28	118
MU Truck	154	208	28	137	193	269	38	171
Total Trips	1,263	1,808	877	3,122	1,544	2,142	901	3,510

Attachment B presents the unrounded output 2045 demand turning movements derived from the 2045 trip tables.

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[1] Transportation Collaborative and Consultants, LLC (2022) *Northwest Fargo Small Area Study.* Report to the City of Fargo.
[2] https://www.fmmetrocog.org/projects-rfps/completed-projects/nwmetro-transportation-plan
[3] Mark Butler, Pat McGraw. Stantec (January 23, 2023) *I-29 and 40th Avenue North Interchange Preliminary Engineering and Feasibility Study Traffic Forecast Data Sources and Recommendations,* Technical memorandum to NDDOT.

FUTURE TRAFFIC COMPARISON

Model simulations of the three corridor models were run with the future 2045 trip tables. These test simulations are intended to assess the anticipated corridor function should no other improvements be made to the interchange. As may be expected, the **existing network configuration** fails immediately with the introduction of thousands of additional peak hour vehicles. Traffic queues form on both exit ramps, along 40th Avenue North, and on the side streets. Backups beyond the limits of the model network result in a significant number of scheduled trips that cannot be loaded onto the network before the simulation period ends. The independent performance of the other intersections away from the interchange are impossible to determine given the bottleneck created at the interchange.

Similar failed results occur with the **signalized corridor**. Without left turn lanes to store left turning vehicles at the interchange ramp intersections, the single through lanes on the bridge quickly congest and create queues that ultimately spread to include the entire 40th Avenue North corridor. As with the existing configuration, the performance of the signalized intersections away from the interchange cannot be accurately assessed.

The results for the **roundabout corridor** concept appear more promising overall, but still fail to adequately serve all movements. The ramp terminal roundabouts process significantly more vehicles than the other intersection alternatives and overall delay is much lower. However, in the AM peak hour, eastbound traffic on 40th Avenue North between 45th Street North and the southbound ramp terminal roundabout queues almost to 45th Street due to westbound-to-southbound traffic consistently flowing through the roundabout. Similar examples exist in the PM peak hour in the opposite direction as westbound traffic on 40th Avenue North must yield to northbound-to-westbound interstate exit ramp traffic inside the northbound I-29 ramp terminal roundabout. Similar queues exist for southbound CR 81 and 37th Street North traffic. These delays are reflected in the overall system delay, but not specifically in the delay recorded at the corresponding roundabouts.

Tables 9, 10, and **11** present the recorded delay and LOS for each of the corridor alternatives applying the future year 2045 trip tables. **Table 12** presents the corridor LOS for the 2045 future year for each network type.

Table 9. Existing Intersection Configuration 2045 Average Delay and LOS

	AM Peak Hour			PM Peak Hour		
Intersection	Vehicles	Avg Delay (sec.)	LOS	Vehicles	Avg Delay	LOS
45th Street North	1,081	57	F	998	10	F
Southbound I-29 Ramps	1,121	83	F	1,033	155	F
Northbound I-29 Ramps	815	251	F	890	252	F
County Route 81 (CR 81)*	904	169	F	925	223	F
37th Street North	696	163	F	655	331	F
33rd Street North	662	79	F	653	183	F
25th Street North	648	63	F	665	53	F

*Intersection with Traffic Signal

Table 10. 2045 Average Intersection Delay and LOS for Signalized Corridor

	AM Peak Hour			PM Peak Hour		
Intersection	Vehicles	Avg Delay (sec.)	LOS	Vehicles	Avg Delay	LOS
45th Street North	1,241	15	B	1,056	85	F
Southbound I-29 Ramps	1,335	88	F	1,073	189	F
Northbound I-29 Ramps	987	196	F	1,099	278	F
County Route 81 (CR 81)	1,061	154	F	1,000	232	F
37th Street North	786	122	F	703	308	F
33rd Street North	718	63	E	725	165	F
25th Street North	689	35	D	719	59	E

Table 11. 2045 Average Delay and LOS for Roundabout Corridor

	AM Peak Hour			PM Peak Hour		
Roundabout	Vehicles	Avg Delay (sec.)	LOS	Vehicles	Avg Delay	LOS
45th Street North	1,330	37	E	1,643	5	A
Southbound I-29 Ramps	1,661	50	E	1,797	13	B
Northbound I-29 Ramps	1,692	10	A	2,019	86	F
County Route 81 (CR 81)	1,792	9	A	1,545	81	F
37th Street North	1,333	5	A	1,359	62	F
33rd Street North	1,192	5	A	1,303	4	A
25th Street North	1,025	3	A	1,111	2	A

Table 12. 2045 Future Year Corridor LOS

AM Peak Hour			
Direction	Network	Average Speed (MPH)	LOS
Westbound	Existing	9	F
	Signalized	10	F
	Roundabouts	31	B
Eastbound	Existing	38	B
	Signalized	25	C
	Roundabouts	24	C
PM Peak Hour			
Direction	Network	Average Speed (MPH)	LOS
Westbound	Existing	6	F
	Signalized	6	F
	Roundabouts	16	E
Eastbound	Existing	38	B
	Signalized	9	F
	Roundabouts	31	B

MODEL TRIP STATISTICS

Table 13 presents the total trip statistics for each of the 2045 model simulations. As the table illustrates, both the existing network and signalized network produce severe delay and leave a significant number of trips either stuck on the network by the end of the simulation period (en route trips), redirected from their destination due to congestion (missed trips) or unable to enter the network entirely (unserved trips). By comparison, the roundabout corridor served significantly more trips, but still produced significant total delay.

Table 13. 2045 Model Trip Statistics

AM Peak Hour									
Metric	Trips			Total Delay (Hours)			Vehicle Hours Traveled (VHT)		
Corridor Type	Existing	Signalized	Roundabout	Existing	Signalized	Roundabout	Existing	Signalized	Roundabout
Completed	3,058	3,391	4,616	255	191	89	382	332	291
En Route	1,149	1,062	332	419	315	18	438	330	25
Missed / Unserved	829	577	72	130	79	10	133	80	10
Total	5,036	5,030	5,020	804	585	118	953	743	326
PM Peak Hour									
Metric	Trips			Total Delay (Hours)			Vehicle Hours Traveled (VHT)		
Corridor Type	Existing	Signalized	Roundabouts	Existing	Signalized	Roundabouts	Existing	Signalized	Roundabouts
Completed	2,667	3,111	4,853	361	561	161	466	690	380
En Route	1,215	1,215	441	634	475	80	654	493	89
Missed / Unserved	1,860	1,440	467	493	280	175	499	281	175
Total	5,742	5,766	5,762	1,488	1,316	416	1,619	1,465	645

NEXT STEPS

The next step is to prepare simulation model networks for each of the approved alternative interchange concepts described in the *Interchange Alternatives Development Technical Memorandum* dated January 25, 2023. These alternatives will be paired with each of the three corridor concepts and will be refined as necessary to determine appropriate lane and capacity requirements for each alternative to effectively serve the 2045 future year traffic tested on the corridors presented in this memorandum. All geometric considerations will be coordinated with the interchange design team to develop the optimal designs for each alternative. Once final alternative designs are established, traffic operation metrics will be prepared for each alternative. This work will be documented in the future *Interchange Alternatives Models Analysis and Technical Memorandum.*

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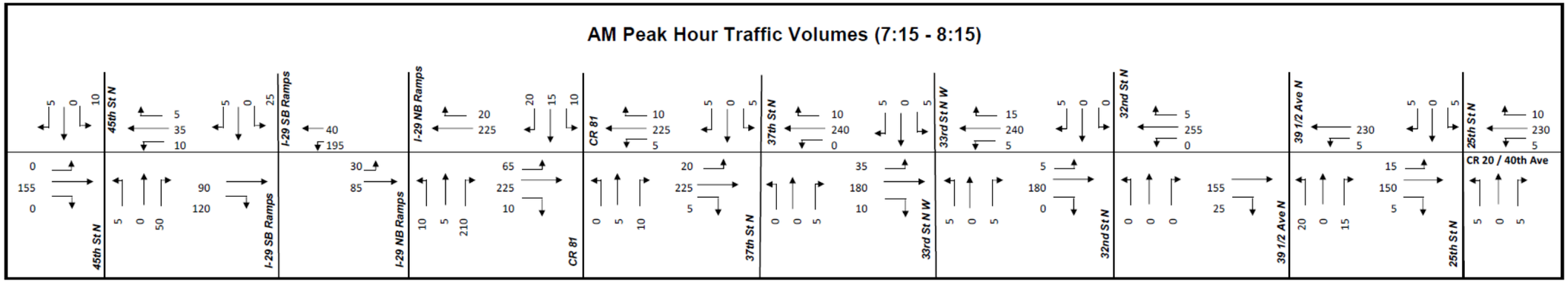
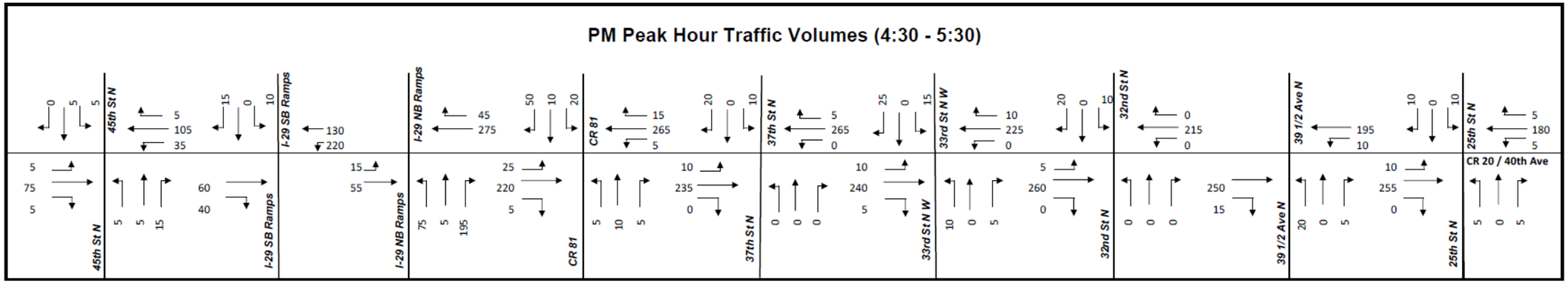
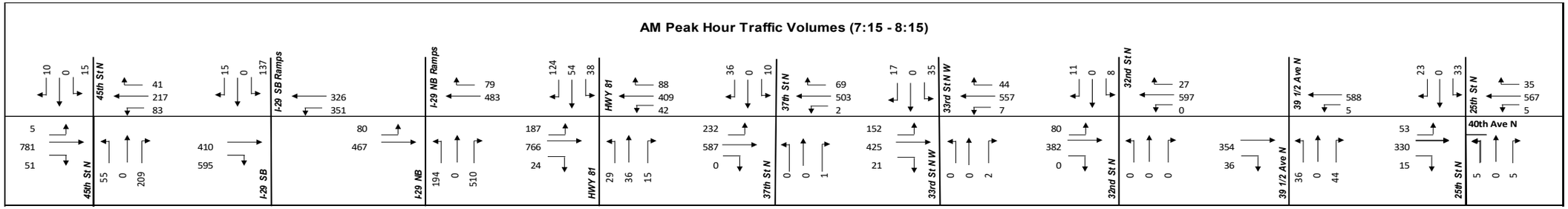
I-29 & 40th Ave N Interchange: Interchange Alternatives Models Summary **March 9, 2023**

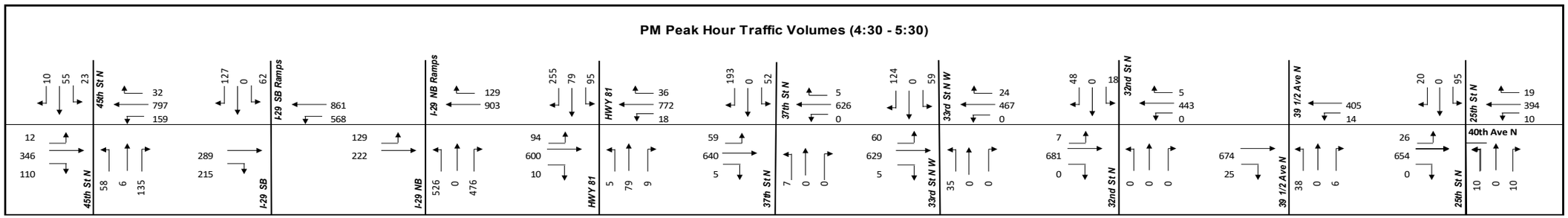




Attachment A: 2022 Existing Peak Hour Turning Movement Counts

I-29 & 40th Ave N Interchange: Interchange Alternatives Models Summary **March 9, 2023**





Attachment B: 2045 Forecast Peak Hour Demand Turning Movement Counts