Appendix F - Travel Demand Forecasting Methodology and Results Summary Memo

SRF

Memorandum

To:	Jim Meyer, AECOM
From:	Florence Ngai, Senior Associate
	Alen Lau, Associate
Date:	October 25, 2021
Subject:	Central Entrance Project
	Travel Demand Forecasting Methodology and Result Summary

Introduction

The Duluth-Superior Area Travel Demand Model (TDM) was originally developed to support Metropolitan Interstate Council (MIC) and the Duluth Superior Metropolitan Area Long Range Transportation Plan planning studies. The model was updated to incorporate a truck component.in 2019 and was further refined earlier this year to support the I-535 Blatnik Bridge Project. The refined model was recalibrated and validated to Average Weekday Traffic (AWDT) that were estimated based on the MnDOT official Annual Average Daily Traffic (AADT).

In support of the traffic analysis of the Central Entrance project, the MIC TDM Blatnik Bridge version was adopted. The study corridor is Central Entrance (Highway 194) between US 53 / Trinity Road and Rice Lake Road / Mesaba Avenue. The model input assumptions, including the socioeconomic data (households, employments, and school employments) and the highway network (network connectivity, the traffic loading points, and the number of lanes) were reviewed, verified, and updated, where necessary.

This technical memorandum describes the modeling methodology and summarizes the model results.

Current Model Review

The MIC TDM was reviewed with special attention to the Central Entrance corridor. The model is validated well in the corridor. The figure in Appendix A shows the comparison of model estimates and observed. The model review tasks included:

* Reviewing of socioeconomic data in the corridor

* Reviewing the network coding in the corridor

The tasks are briefly discussed below.

Zonal Socioeconomic Data

Traffic Analysis Zone (TAZ) is the unit of geography to store population, employment, and school enrollment data. The TAZ boundary is shown with the highway network in Figure 1. A total of twenty (20) relevant TAZs that are immediately along the corridor were identified. Their TAZ numbers are shown in Figure 1. The current 2018 socioeconomic data (SED) and 2045 future year assumptions of these TAZs were summarized in Table 1. Households in the corridor are projected to increase 2.3% from 2018 to 2045 while the total employment is expected to increase by 4.3%. School enrollment remains unchanged over that period. Details can be found in Appendix B. These assumptions were summarized. MIC approved them on August 17, 2021.

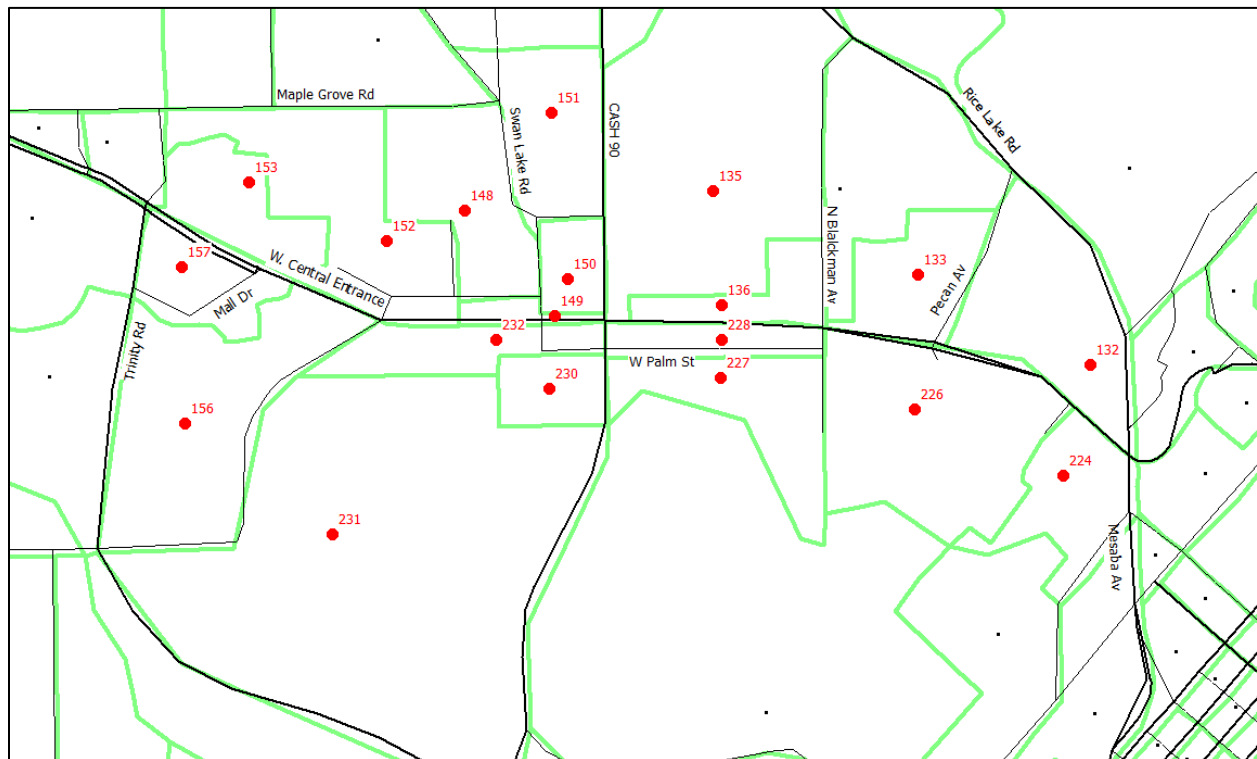**Figure 1. Relevant TAZs along Central Entrance Corridor**

Table 1. 2018 and 2045 Socio-Economic Data Summary

SED	2018	2045
Households	2,647	2,707
Service Employment	1,455	1525
Retail Employment	499	529
Industrial Employment	106	106
Other Employment	266	266
Total Employment	**2,326**	**2,426**
College Enrollment	0	0
High School Enrollment	350	350
Middle School Enrollment	229	229
Elementary School Enrollment	112	112

Source: MIC

Highway Network

It is critical to the overall travel demand model integrity to maintain a roadway network database that is free of obvious errors and inconsistencies that may adversely affect the model results. The highway network was reviewed as described below.

- The network connectivity and attributes (e.g., number of lanes) of the Central Entrance corridor, including the corridor itself and its cross-streets were checked and verified that they are reflective of 2018 conditions.

- The traffic circulation within the study area corridor is heavily influenced by local traffic access/exiting locations. Accordingly, the loading points of the centroid connectors (network links representing local or non-functionally classified roads) were reviewed and reconnected to proper locations, as necessary.

It is confirmed that the general network coding in terms of roadway connectivity and physical attributes in the corridor are reasonable without any obvious inconsistencies. Central Entrance between Basswood Avenue and Blackman Avenue is coded with five lanes. However, several localized highway network details and TAZ loading points were identified for refinement. This refinement effort was primarily focusing on improving the connectivity, to more realistically reflecting the overall magnitude of traffic level under the base year (2018) traffic condition   The changes are reported in Appendix C.

Future Year Model Scenarios

Corridor trips were captured as subarea trip tables for the zone structure depicted in Figure 2 under the 2018 existing and two future year highway network scenarios:

- 2045 No-Build (or E+C)

- 2045 Build

Figure 2. Central Entrance Subarea Zone Map

The No-Build condition reflects the existing highway conditions with committed roadway projects in year 2045. The build condition involves reduced capacity on Central Entrance, between Anderson Road and Pecan Road, to three lanes.

Model Runs

The MIC model was executed for the 2018 existing, 2045 No Build and Build scenarios. The model predicts average weekday trips and traffic. The subarea trip matrices are summarized from Table 2 to Table 4. The results seem reasonable as the total daily vehicle trips increased by approximately 3% from 2018 to 2045 (no-build), which correspond well with the socioeconomic growth. A decrease of approximately 7% is observed from No-Build to Build with reduced roadway capacity in the Central Entrance corridor, which also seem to make sense.

Table 2. 2018 Model Estimated Average Weekday Trips

	1	2	3	4	5	6	7	8	9	10	11	12	Total
1	130	40	110	130	130	430	1,200	670	100	30	560	900	**4,430**
2	40	0	20	10	10	210	30	150	80	0	60	40	**650**
3	110	20	70	80	70	380	50	260	310	0	360	240	**1,950**
4	140	20	80	60	100	760	120	160	200	10	720	530	**2,900**
5	150	10	80	110	490	890	120	20	120	230	1,430	460	**4,110**
6	420	210	390	740	810	0	5,700	730	60	40	3,110	4,380	**16,590**
7	1,250	40	60	130	110	5,460	0	380	10	20	190	470	**8,120**
8	680	160	270	160	20	650	370	0	1,720	0	180	80	**4,290**
9	200	100	420	220	100	60	10	2,140	0	10	40	340	**3,640**
10	30	0	0	10	260	60	20	0	20	0	4,900	740	**6,040**
11	560	30	270	740	1,360	3,510	110	120	50	5,070	0	820	**12,640**
12	760	40	230	480	350	4,170	410	70	290	580	2,240	0	**9,620**
Total	**4,470**	**670**	**2,000**	**2,870**	**3,810**	**16,580**	**8,140**	**4,700**	**2,960**	**5,990**	**13,790**	**9,000**	**74,980**

Table 3. 2045 Model Estimated Average Weekday Trips, No Build Scenario

	1	2	3	4	5	6	7	8	9	10	11	12	Total
1	130	40	120	140	130	440	1,230	660	140	30	520	900	**4,480**
2	40	0	20	10	10	210	30	150	120	0	20	40	**650**
3	120	30	100	90	80	450	70	290	600	0	260	360	**2,450**
4	140	20	90	70	100	780	120	160	250	10	630	540	**2,910**
5	140	10	100	110	500	900	120	20	120	230	1,310	480	**4,040**
6	430	220	460	760	810	0	6,250	640	60	40	3,220	4,530	**17,420**
7	1,270	40	90	140	120	5,750	0	380	10	20	170	500	**8,490**
8	680	160	300	160	20	650	370	0	1,920	0	120	90	**4,470**
9	200	100	560	280	100	60	10	2,230	0	10	50	330	**3,930**
10	40	0	10	10	260	60	20	0	20	0	4,810	760	**5,990**
11	560	30	330	700	1,540	3,760	130	120	60	5,070	0	920	**13,220**
12	750	40	340	480	360	4,360	500	70	320	590	1,460	0	**9,270**
Total	**4,500**	**690**	**2,520**	**2,950**	**4,030**	**17,420**	**8,850**	**4,720**	**3,620**	**6,000**	**12,570**	**9,450**	**77,320**

Table 4. 2045 Model Estimated Average Weekday Trips, Build Scenario

	1	2	3	4	5	6	7	8	9	10	11	12	Total
1	420	190	70	120	110	450	1,670	560	10	10	390	730	**4,730**
2	220	0	30	10	10	280	40	160	120	0	20	30	**920**
3	50	30	490	50	40	300	50	140	240	0	120	160	**1,670**
4	120	20	50	80	80	680	90	210	310	0	580	550	**2,770**
5	120	10	40	90	630	700	90	60	100	250	1,320	490	**3,900**
6	480	250	350	680	640	0	6,560	430	70	20	2,620	3,180	**15,280**
7	1,780	40	60	90	80	6,080	0	70	0	0	50	180	**8,430**
8	610	160	150	210	50	430	70	0	2,530	0	180	180	**4,570**
9	10	100	220	310	90	60	0	2,810	0	0	0	230	**3,830**
10	10	0	0	10	280	30	0	0	0	0	4,720	940	**5,990**
11	410	30	140	680	1,640	3,070	30	240	0	4,950	0	1,190	**12,380**
12	540	30	140	470	360	2,920	160	170	210	770	2,040	0	**7,810**
Total	**4,770**	**860**	**1,740**	**2,800**	**4,010**	**15,000**	**8,760**	**4,850**	**3,590**	**6,000**	**12,040**	**7,860**	**72,280**

2018 to 2045 No Build and 2045 No Build to Build growth factors of approach and exit volumes at the following intersections were calculated based on model results.

- W Central Entrance at Trinty Road

- W Central Entrance at Mall Drive

- W Central Entrance at Anderson Road

- W Central Entrance at Basswood Avenue

- E Central Entrance at S. Arlington Avenue (CSAH 90)

- E Central Entrance at H Countney Drive

- E Central Entrance at Mesaba Avenue

The growth factors are reported in Appendix D.

The predicted average weekday traffic (AWDT) was factored to Annual Average Daily Traffic (AADT). The resulting AADT under the 2018 existing, 2045 No Build, and Build scenarios are presented in Appendix D. The changes in AADT can also be found in Appendix E.

APPENDIX A. Validation – Comparison of Model Estimates and Observed Volumes

Figure A1. Comparison of Model Estimates and Observed Volumes
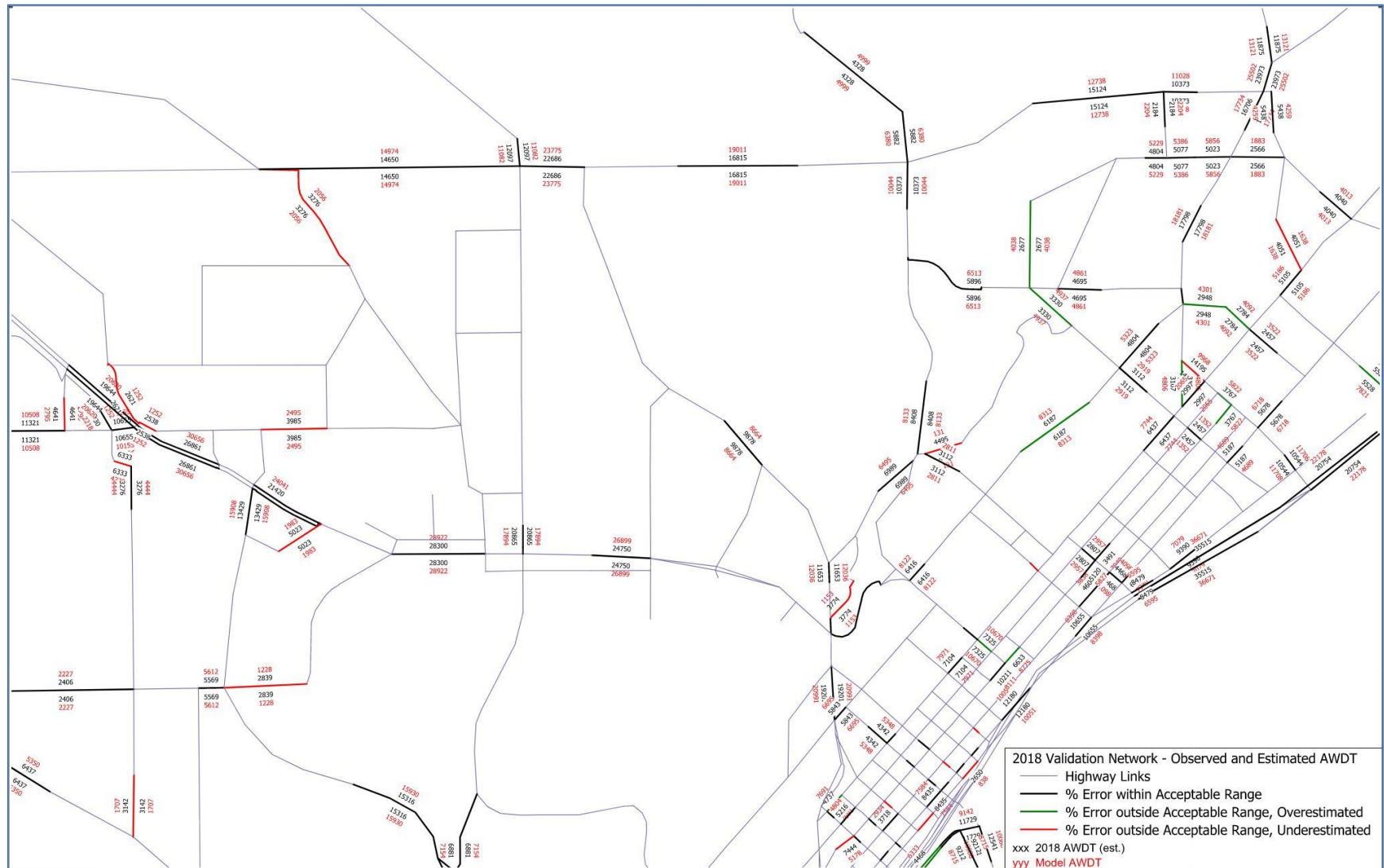
APPENDIX B. TAZ Socioeconomic Data

Central Entrance Corridor

2018 and 2045 Population, Employment and School Emplyments

TAZ	Year 2018 (1)										Year 2045 E+C (2)									
	HH	SERVICE	RETAIL	IND	OTHER	TOTAL	C	H	M	E	HH	SERVICE	RETAIL	IND	OTHER	TOTAL	C	H	M	E
132	51	537	0	63	224	824	0	261	161	0	51	537	0	63	224	824	0	261	161	0
133	296	9	0	0	0	9	0	0	0	0	296	9	0	0	0	9	0	0	0	0
134	841	65	0	0	0	65	0	0	0	0	841	65	0	0	0	65	0	0	0	0
135	282	12	0	0	0	12	0	0	0	0	282	12	0	0	0	12	0	0	0	0
136	24	82	4	5	1	92	0	0	0	0	24	82	4	5	1	92	0	0	0	0
148	150	0	0	0	0	0	0	0	0	0	150	0	0	0	0	0	0	0	0	0
149	26	15	75	2	1	93	0	89	68	112	86	55	105	2	1	163	0	89	68	112
150	27	4	0	0	0	4	0	0	0	0	27	4	0	0	0	4	0	0	0	0
151	30	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0
152	113	54	0	0	0	54	0	0	0	0	113	54	0	0	0	54	0	0	0	0
153	0	129	188	8	0	325	0	0	0	0	0	129	188	8	0	325	0	0	0	0
156	104	16	0	0	0	16	0	0	0	0	104	16	0	0	0	16	0	0	0	0
157	0	150	125	0	0	275	0	0	0	0	0	150	125	0	0	275	0	0	0	0
224	231	0	0	0	0	0	0	0	0	0	231	0	0	0	0	0	0	0	0	0
226	41	182	0	7	0	189	0	0	0	0	41	212	0	7	0	219	0	0	0	0
227	20	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0
228	4	125	72	19	39	255	0	0	0	0	4	125	72	19	39	255	0	0	0	0
230	65	0	0	0	0	0	0	0	0	0	65	0	0	0	0	0	0	0	0	0
231	245	17	7	2	1	27	0	0	0	0	245	17	7	2	1	27	0	0	0	0
232	97	58	28	0	0	86	0	0	0	0	97	58	28	0	0	86	0	0	0	0
Total	2,647	1,455	499	106	266	2,326	0	350	229	112	2,707	1,525	529	106	266	2,426	0	350	229	112

Note: C - College

H - High school

M - Middle school

E - Elmentary school

(1) source .\ModelRun\Base\Yr2018\CntrEntrance\Inputs\emp&school.dbf

(2) source .\ModelRun\Base\Yr2045EnC\CntrEntrance\Inputs\emp&school.dbf

file: Q:\Projects\13501\WO_2\1_SEdata\[SEdata.xlsx]Sheet1

APPENDIX C. Highway Network Refinement

The changes in the highway network are depicted in the following figures, showing the TAZ centroid locations prior (in green) and after (in red) the refinements, as well as corresponding the loading points.

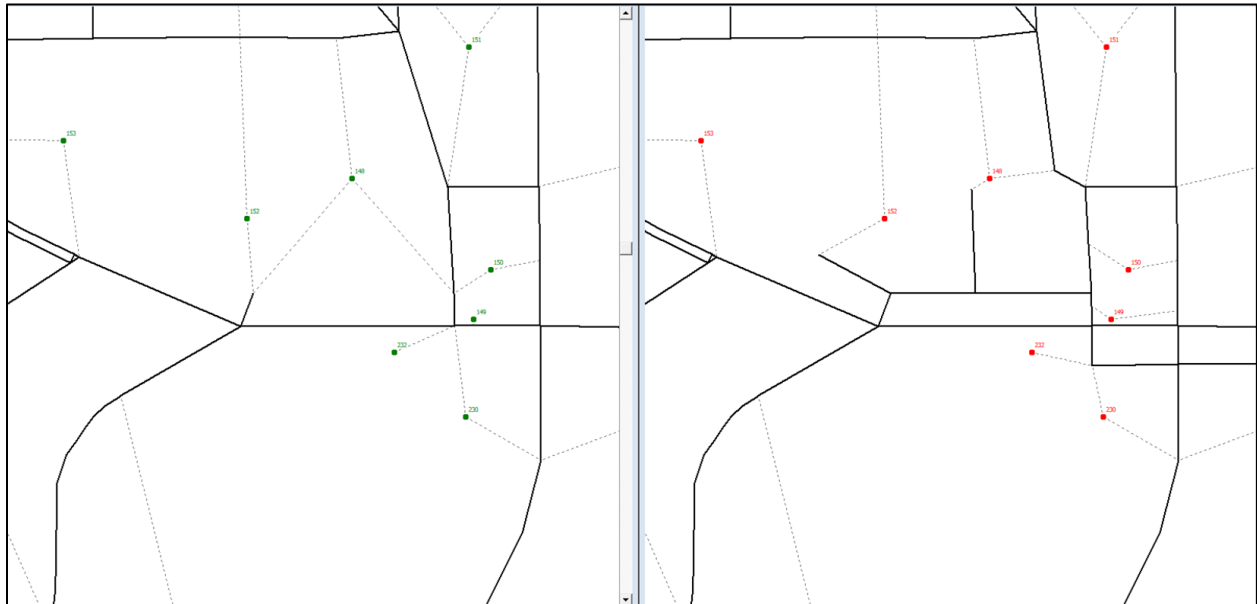**Figure C1. Central Entrance Corridor between Anderson Rd and CSAH 90/S. Arlington Ave.**
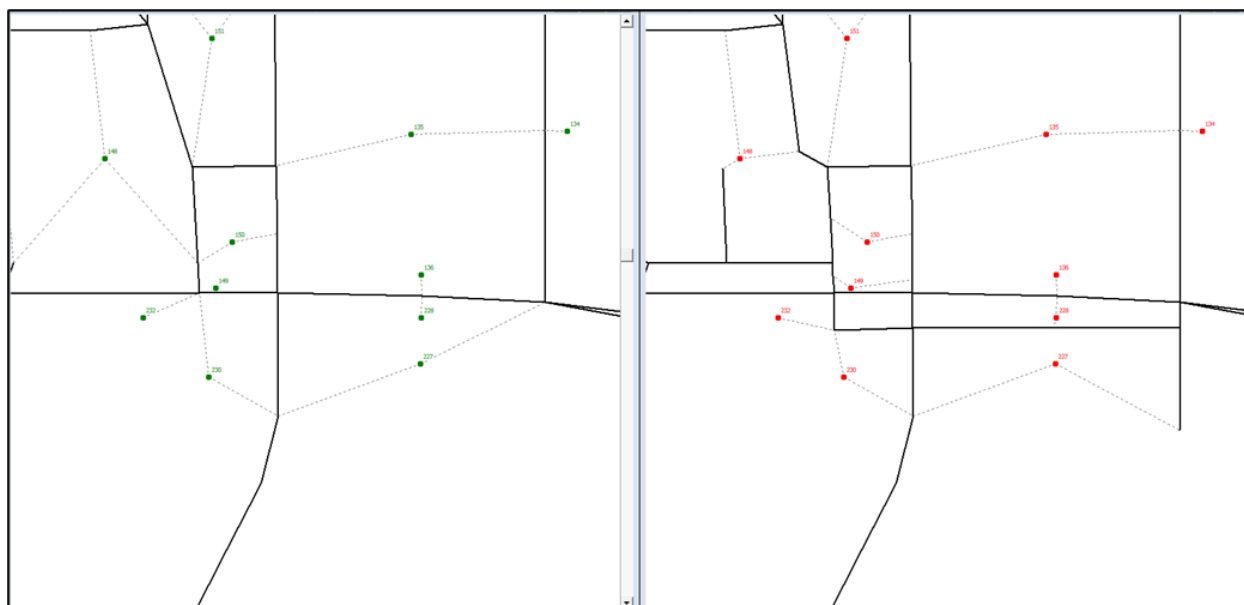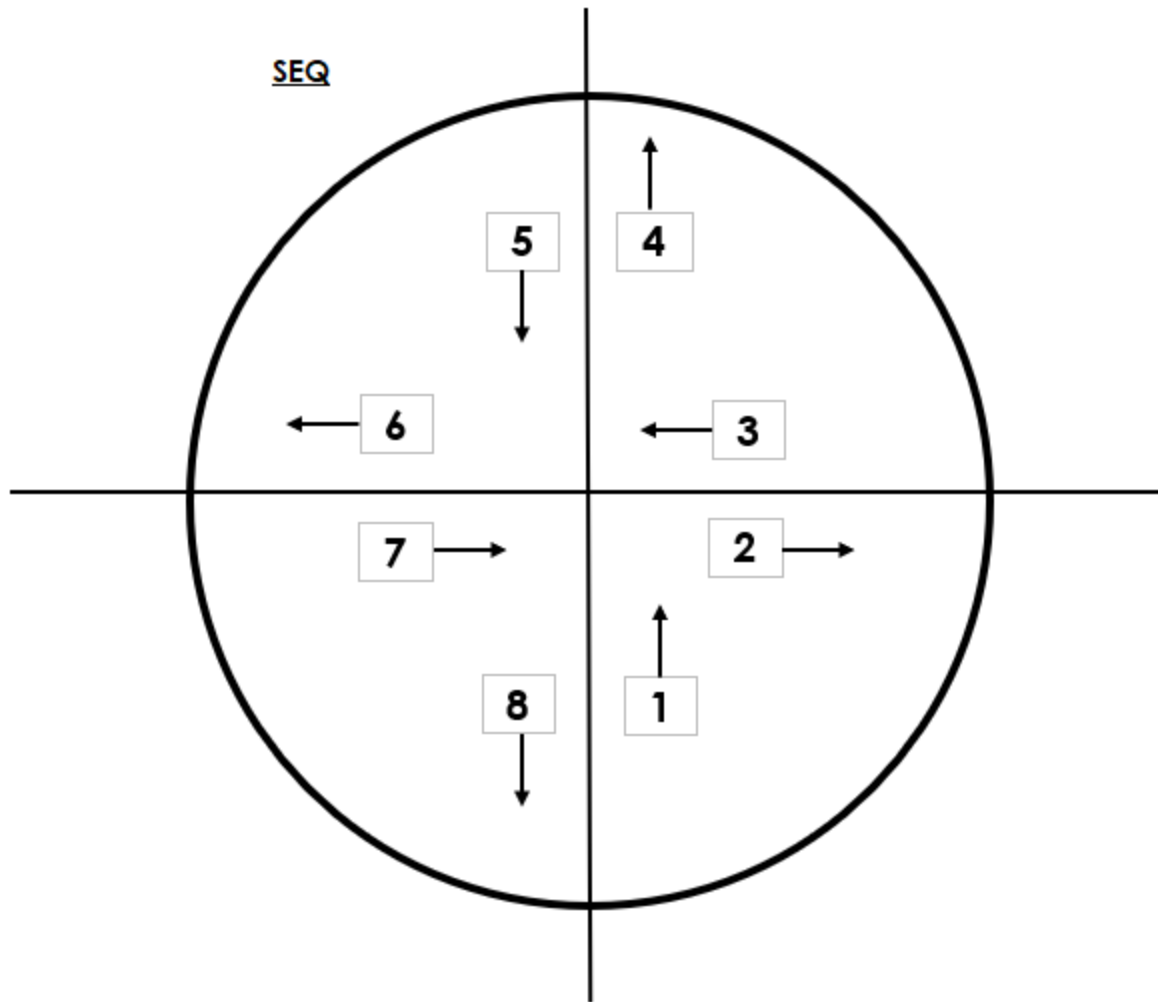

Figure C2. Central Entrance Corridor between CSAH 90/S. Arlington Ave. and Blackman Ave.

Figure C3. Central Entrance Corridor between Blackman Ave. and Rice Lake Rd/Mesaba Ave.

APPENDIX D. Intersection Growth Factors

SEQ

Intersection	Descriptions	Growth Factor		Orientation	Appr/Exit	SEQ
		2045 ENC/ 2018 BY	2045 S1 / 2045 ENC			
1	W Central Entrance at Trinty Road	1.048	0.994	NB	APPR	1
1	W Central Entrance at Trinty Road	1.057	0.729	WB	APPR	3
1	W Central Entrance at Trinty Road	1.032	1.274	SB	APPR	5
1	W Central Entrance at Trinty Road	1.049	0.877	EB	APPR	7
2	W Central Entrance at Mall Drive	0.997	0.968	NB	APPR	1
2	W Central Entrance at Mall Drive	1.051	0.743	WB	APPR	3
2	W Central Entrance at Mall Drive	0.994	0.719	SB	APPR	5
2	W Central Entrance at Mall Drive	1.026	0.744	EB	APPR	7
3	W Central Entrance at Anderson Rd	0.997	0.850	NB	APPR	1
3	W Central Entrance at Anderson Rd	1.048	0.708	WB	APPR	3
3	W Central Entrance at Anderson Rd	1.010	0.930	SB	APPR	5
3	W Central Entrance at Anderson Rd	1.023	0.759	EB	APPR	7
4	W Central Entrance at Basswood Ave	0.960	0.547	NB	APPR	1
4	W Central Entrance at Basswood Ave	1.062	0.644	WB	APPR	3
4	W Central Entrance at Basswood Ave	1.284	0.332	SB	APPR	5
4	W Central Entrance at Basswood Ave	1.022	0.727	EB	APPR	7
5	E Central Entrance at S Arlington Ave (CSAH 90)	1.083	1.064	NB	APPR	1
5	E Central Entrance at S Arlington Ave (CSAH 90)	1.066	0.727	WB	APPR	3
5	E Central Entrance at S Arlington Ave (CSAH 90)	1.036	1.085	SB	APPR	5
5	E Central Entrance at S Arlington Ave (CSAH 90)	1.035	0.663	EB	APPR	7
6	E Central Entrance at H Countney Dr	1.109	1.000	NB	APPR	1
6	E Central Entrance at H Countney Dr	1.059	0.748	WB	APPR	3
6	E Central Entrance at H Countney Dr	1.013	0.817	SB	APPR	5
6	E Central Entrance at H Countney Dr	1.004	0.755	EB	APPR	7
7	E Central Entrance at Mesaba Ave	1.046	0.938	NB	APPR	1
7	E Central Entrance at Mesaba Ave	0.965	0.841	WB	APPR	3
7	E Central Entrance at Mesaba Ave	0.970	0.997	SB	APPR	5
7	E Central Entrance at Mesaba Ave	1.006	0.760	EB	APPR	7

Intersection	Descriptions	Growth Factor		Orientation	Appr/Exit	SEQ
		2045 ENC / 2018 BY	2045 S1 / 2045 ENC			
1	W Central Entrance at Trinty Road	1.022	1.272	NB	EXIT	4
1	W Central Entrance at Trinty Road	1.052	0.862	WB	EXIT	6
1	W Central Entrance at Trinty Road	1.090	0.991	SB	EXIT	8
1	W Central Entrance at Trinty Road	1.026	0.744	EB	EXIT	2
2	W Central Entrance at Mall Drive	0.996	0.711	NB	EXIT	4
2	W Central Entrance at Mall Drive	1.057	0.729	WB	EXIT	6
2	W Central Entrance at Mall Drive	0.997	0.944	SB	EXIT	8
2	W Central Entrance at Mall Drive	1.023	0.759	EB	EXIT	2
3	W Central Entrance at Anderson Rd	1.003	0.812	NB	EXIT	4
3	W Central Entrance at Anderson Rd	1.051	0.743	WB	EXIT	6
3	W Central Entrance at Anderson Rd	0.999	0.831	SB	EXIT	8
3	W Central Entrance at Anderson Rd	1.022	0.727	EB	EXIT	2
4	W Central Entrance at Basswood Ave	1.287	0.318	NB	EXIT	4
4	W Central Entrance at Basswood Ave	1.048	0.708	WB	EXIT	6
4	W Central Entrance at Basswood Ave	1.002	0.541	SB	EXIT	8
4	W Central Entrance at Basswood Ave	1.035	0.663	EB	EXIT	2
5	E Central Entrance at S Arlington Ave (CSAH 90)	1.007	1.088	NB	EXIT	4
5	E Central Entrance at S Arlington Ave (CSAH 90)	1.062	0.644	WB	EXIT	6
5	E Central Entrance at S Arlington Ave (CSAH 90)	1.223	1.068	SB	EXIT	8
5	E Central Entrance at S Arlington Ave (CSAH 90)	1.018	0.750	EB	EXIT	2
6	E Central Entrance at H Countney Dr	1.001	0.850	NB	EXIT	4
6	E Central Entrance at H Countney Dr	1.056	0.738	WB	EXIT	6
6	E Central Entrance at H Countney Dr	1.111	1.000	SB	EXIT	8
6	E Central Entrance at H Countney Dr	1.006	0.763	EB	EXIT	2
7	E Central Entrance at Mesaba Ave	1.024	1.011	NB	EXIT	4
7	E Central Entrance at Mesaba Ave	1.060	0.744	WB	EXIT	6
7	E Central Entrance at Mesaba Ave	0.911	0.958	SB	EXIT	8
7	E Central Entrance at Mesaba Ave	1.048	0.834	EB	EXIT	2

APPENDIX E. Model Estimated Annual Average Daily Traffic

Figure E1. Model Annual Average Daily Traffic Estimates, 2018 Existing

Figure E2. Model Annual Average Daily Traffic Estimates, 2045 No Build Scenario

Figure E3. Model Annual Average Daily Traffic Estimates, 2045 Build Scenario

Figure E4. Changes in Annual Average Daily Traffic, 2018 Existing vs. 2045 No Build

Central Entrance Corridor
Changes in Daily Traffic Volume (Year 2018 v 2045 ENC)
Bandwidth

- Change in AADT =1250
- Change in AADT = 2500
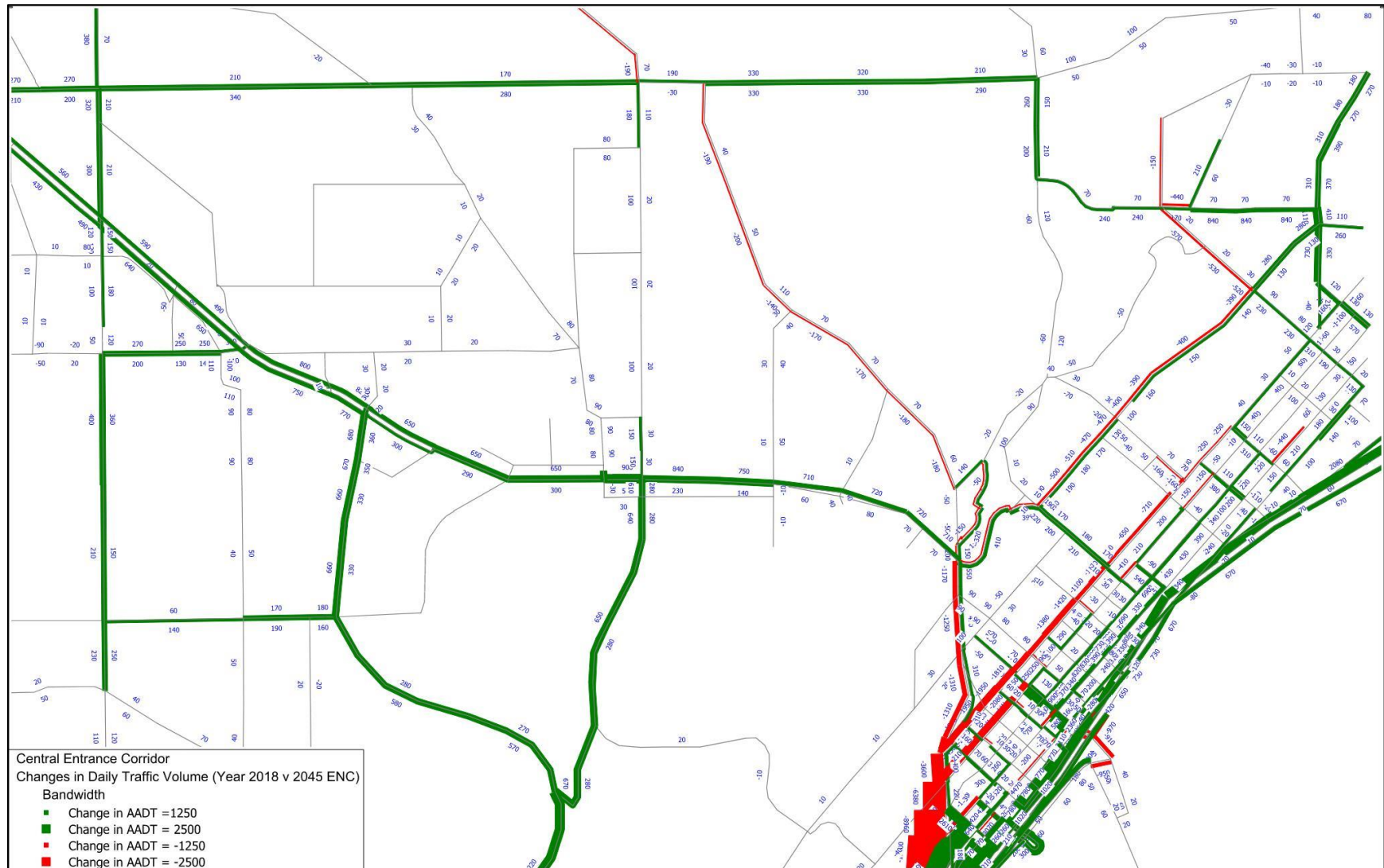- Change in AADT = -1250
- Change in AADT = -2500

Figure E5. Changes in Annual Average Daily Traffic, 2045 No Build vs. 2045 Build

Central Entrance Corridor
Change in Daily Traffic Volume (2045 EnC v 2045 Build)
  Bandwidth
  ▪ Change in AADT=1250
  ▪ Change in AADT= 2500
  ▪ Change in AADT= -1250
  ▪ Change in AADT= -2500