MAIN AVENUE BRIDGE CLOSURE TRAFFIC IMPACT ANALYSIS

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Prepared for:
Fargo-Moorhead Council of Governments

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The purpose of this report is to discuss the impacts of various alternatives related to the upcoming Main Avenue bridge closure. The Advanced Traffic Analysis Center (ATAC) of North Dakota State University assisted the Fargo-Moorhead Council of Governments (FM Metro COG) in conducting the analysis using several scenarios. ATAC used the calibrated travel demand model recently completed for the FM Metro COG as well as available traffic data.

A draft report was submitted to FM Metro COG for review in the end of April 2003. Comments from local transportation officials were mainly related to the use of *v/c* ratios based on ADT to measure the impacts Main Avenue bridge closure. As a result, this updated report incorporates new analysis using peak hour traffic volumes as well as intersection level-of-service (LOS) for critical intersections heavily impacted by diverted traffic in the downtown area.

1. BACKGROUND

The Main Avenue bridge is one of the major connectors between downtown Fargo and downtown Moorhead. The bridge has been programmed for a major reconstruction during the summer of 2003, continuing into 2004. Given the high traffic levels on the bridge and its vicinity, the FM Metro COG is working with local jurisdictions to develop strategies to alleviate negative impacts on traffic and commerce, especially in the downtown area. Several strategies have been discussed among transportation and policy makers in the metropolitan area. The FM Metro COG is providing information from the results of this analysis to decision makers in order to aide in choosing an appropriate strategy.

ATAC has been working with the FM Metro COG providing various technical analytical assistance on traffic operations and transportation planning. ATAC has recently completed the FM Metro COG's 2000 Travel Demand Model which will be used to develop the long-range metropolitan transportation improvement plan. The model was calibrated for year 2000 data.

The FM Metro COG asked the ATAC to perform the analysis using the calibrated 2000 Travel Demand Model using a 2003 updated network. However, there currently are no traffic count data for 2003. ATAC relied on consultations with local traffic engineering staff for verifying model predictions of traffic levels and the impacts of various scenarios.

2. DESCRIPTION OF THE ANALYSIS

The primary approach to conducting the analysis consists of using the 2000 Travel Demand Model for estimating network performance under several scenarios. These scenarios are discussed in detail in Section 2.2, but generally they aim at changing the toll on the $12^{th}/15^{th}$ Avenue North bridge, which may provide some relief to area traffic when the Main Avenue bridge is closed. In estimating the impacts, the analysis uses key measures of effectiveness (MOE) across the network and for specific corridors that may be directly affected by traffic shifts. Another major factor in the analysis is the construction planned next summer for the Cass County Road 20/Clay County Road 22 bridge. The work on that bridge further reduces the available alternative routes for Main Avenue bridge traffic.

2.1 Scope/Affected Location

The closure of the Main Avenue bridge connecting Fargo and Moorhead will have some implications for the whole metropolitan transportation system. The latest traffic data show that the bridge carries about 25,100 vehicles per day. When the bridge is under construction, that traffic will be shifting to other routes, especially those within a close vicinity to the Main Avenue corridor. Therefore, the adjacent areas will be directly affected by the Main Avenue bridge closure. These areas include the following river crossings:

1. Main Avenue corridor from University Dr. in Fargo to 8th Street in Moorhead
2. The NP/Center Avenue corridor from 4th Street in Fargo to 8th Street in Moorhead
3. The 1st Avenue North corridor from 4th Street in Fargo to 8th Street in Moorhead

Other river crossings in the metropolitan area may also be impacted by the Main Avenue bridge closure. These crossing include:

1. I-94 at Red River Bridge
2. 12th Avenue North Bridge (with 15th Avenue North in Moorhead)
3. Broadway Street in Fargo and Clay 1 Bridge
4. Cass 20/Clay 22 Bridge

It is expected that most of the impacts will be experienced by the two immediate alternative river crossings in the downtown area (NP/Center Avenue and 1st Avenue), and to some extent the I-94 Red River bridge to the south. Table-1 below shows 2003 modeled traffic levels on the river crossings and the distances from those crossings to the Main Avenue bridge. It should be noted that the 12th/15th Avenue bridge currently has a $0.75 toll and carries a modest amount of traffic (about 1,700 vehicles per day). It should also be noted that the majority of the impacted crossings are operating at relatively low volume/capacity (*v/c*) ratios, between 0.13 and 0.37, with Main Avenue having one of the highest ratio, 0.36. These ratios are based on the peak hourly volume divided by hourly capacity of the roadway.

Table-1 Red River Crossings: 2003 Traffic Volumes, Distances, and V/C ratios.

Crossing	ADT	Distance to Main Ave. (miles)	*v/c*
I-94 Eastbound	26,100	1.89	0.33
I-94 Westbound	28,700	1.89	0.37
Main Avenue	25,100	-	0.36
NP/Center Avenue	10,400	0.14	0.17
1st Avenue N	15,500	0.08	0.31
12th / 15th Avenue North	1,700	0.94	0.13
Broadway	2,000	2.40	0.21
Cass 20 / Clay 22	3,600	2.50	0.33

2.2. Analysis scenarios

The scenarios developed for the analysis reflect three distinct toll policies for the 12th/15th Avenue North bridge. These pricing policies are investigated for the base-case (Main Avenue bridge in place) and when the Main Avenue bridge is removed from the network. Since the Cass 20/Clay 22 bridge is also programmed for construction additional cases are added to the analysis, resulting in a total of nine scenarios as outlined below in Table-2.

Table-2 Main Avenue Bridge Analysis Scenarios

	Main Avenue Bridge		
	Open	Closed	
12th/15th Avenue Bridge	Cass 20/Clay 22 Bridge Open	Cass 20/Clay 22 Bridge Open	Cass 20/Clay 22 Bridge Closed
Full Toll	Case 1 (base)	Case 4	Case 7
Half Toll	Case 2	Case 5	Case 8
No toll	Case 3	Case 6	Case 9

2.3. Analysis method

In order to estimate the impacts on traffic operations (and potential user costs) due to the Main Avenue bridge closure, two key measures of effectiveness (MOEs) were used: travel time and link *v/c* ratio. The values of these two MOEs were directly estimated from the FM Metro COG travel demand model for the nine cases included in the analysis. Changes in each MOE from the base-case (Main Avenue bridge is open, full toll on 12th/15th Avenue North, and Cass 20/Clay 22 bridge open) represent the impacts of each scenario. Travel times are directly correlated with user costs and represent a good measure of network performance. However, for the area in the immediate vicinity of the Main Avenue bridge, *v/c* ratios provide more meaningful information about expected traffic congestion effects. Further, intersection LOS analysis were conducted for selected locations in the vicinity of the downtown river crossings as suggested by comments from local transportation officials.

Field travel time studies were conducted on Monday April 8, 2003 for the afternoon peak period (4:00 PM to 5:30 PM) along the downtown river crossing areas. The purpose of these studies was to verify current traffic distribution and traffic delay at major intersections leading to and from the study area (Main Avenue bridge). The observations showed the distribution of traffic among the Main Avenue, NP/Center, and 1st Avenue North to be consistent with the values obtained from the model. Main Avenue carried the largest traffic volumes, followed by 1st Avenue North, and finally NP/Center Avenue.

These observations also indicate that traffic could potentially shift from the Main Avenue bridge to the NP/Center Avenue and the 1st Avenue North bridges with little impact since they currently have low *v/c* ratios. The close proximity of these routes means travelers will only have to shift their routes slightly to proceed across the Red River. It is expected that the 12th/15th Avenue bridge will see little diversion from Main Avenue bridge traffic.

The expected impacts may be classified into the following groups:

1. Travel time (vehicle-hours per selected hour)
   A. Network-wide
   B. Downtown river crossings
2. *v/c* ratios (hourly volume per hourly capacity for selected hour)
   A. Downtown river crossings
   B. Surrounding intersections
3. Intersection LOS
   A. Directly affected intersections
      i. 2nd Street and NP Avenue
      ii. 4th Street and NP Avenue
      iii. 4th Street and Center Avenue

In order to identify links and intersections directly affected by the Main Avenue bridge closure (2.b. above), the travel demand model was used to identify all the routes which use the downtown bridges. This subset of the metropolitan network accounts for all the traffic using the Main Avenue, NP/Center Avenue, and 1st Avenue North bridges. Traffic volumes on these routes were plotted to identify areas of high traffic concentration. These plots were compared for the various cases to show the impact of traffic shifts from the Main Avenue bridge (see Figure 1, 2, 3 in section 3.1 below).

It is important to point out that the current travel demand model does not allow for estimating impacts on specific intersections. It uses a constant intersection cost based on the control, geometry, and functional class of the intersecting roadways (independent of actual traffic volumes). However, the *v/c* ratio may be used as a proxy for intersection performance (higher *v/c* ratios indicate higher traffic delay values that would negatively impact intersection level of service).

3. DISCUSSION OF RESULTS

This section summarizes the changes in key MOEs for the various scenarios included in the analysis. The information in this section is mainly based on the FM Metro COG's 2000 Travel Demand Model with appropriate network changes to reflect the nine scenarios included in the analysis. In addition, field travel time measurements for key intersections in the vicinity of the downtown bridges are summarized in Section 3.3. Intersection LOS analysis results are shown in Section 3.4.

For the purposes of this analysis, baseline conditions refer to the 2003 network (with year 2000 travel demand) and Main Avenue bridge still open. There were nine possible scenarios analyzed in this study which accounted for changes in toll pricing as well as bridge closings. For purposes of keeping the information concise, only cases which resulted in significant impact (i.e., changes in travel time and *v/c* ratios) are presented. In addition to the base case (existing 2003 network) two cases resulted in the most significant impacts:

1. Case 4: only Main Avenue bridge closed, Cass 20/Clay 22 bridge open, and full toll on the 12th/15th Avenue North bridge, and
2. Case 7: both Main Avenue and Cass 20/Clay 22 bridges closed, full toll on the 12th/15th Avenue North bridge

The results suggest that changes in pricing the 12th/15th Avenue North bridge have little impact on traffic diversion patterns from Main Avenue bridge. Therefore, analysis cases involving different toll values are not discussed in this summary.

3.1. Traffic Shifts

Figure-1 shows the distribution of traffic using the downtown bridges for the base case. The link colors indicate the concentration of traffic that crosses downtown bridges. Main Avenue carries most of the traffic using the downtown bridges, collecting traffic from West Fargo all the way through downtown Fargo. Additionally, 4th Street and 2nd Street feed significant traffic to the downtown bridges.

Figures 2 and 3 show the redistribution of the downtown bridge traffic when the Main Avenue bridge is closed and when both Main Avenue and Cass 20/Clay 22 bridges are closed respectively. As you can see from the figures, one of the routes most significantly impacted by the traffic shifts is 2nd Street in Fargo.

3.2. Travel Time

Network travel time may be used to examine the aggregate impact of closing the Main Avenue bridge on traffic operations. Travel time values were obtained from the travel demand model for cases 1, 4, and 7. The model allows for estimating travel time for peak and off peak conditions.

Generally, there was minimal impact on the network's overall travel times as a result of the Main Avenue Bridge closure. It is important to remember that the travel time differences do not account for additional intersection delay on routes experiencing additional traffic diverted from the Main Avenue bridge. Therefore, the analysis was supplemented by field travel time measurements to examine the current delay levels for intersections in the vicinity of the downtown bridges. Table 3 below shows the changes in network travel times among the various cases. There were negligible effects on model-produced travel times.

Table 3 Travel time (vehicle-hours per selected hour)

Scenario	Off peak	%	peak	%
Case 1	5,675	-	8,938	-
Case 4	5,674	0.02%	8,950	0.13%
Case 7	5,676	0.02%	8,950	0.13%

Figure 1 : Case 1, Existing Network 2003 (Full Toll)

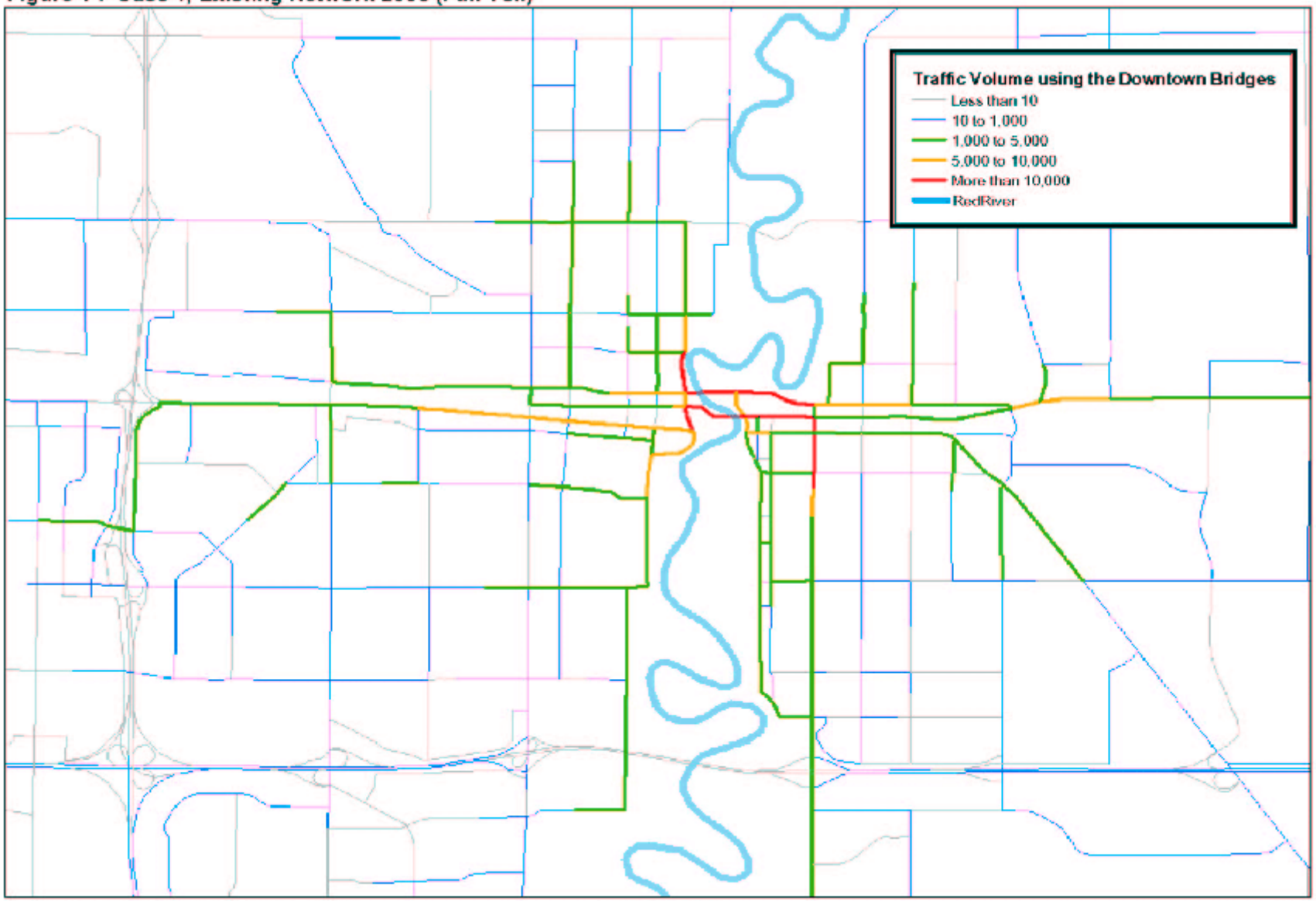


Figure 2 : Case 4, No Main Avenue Bridge (Full Toll)

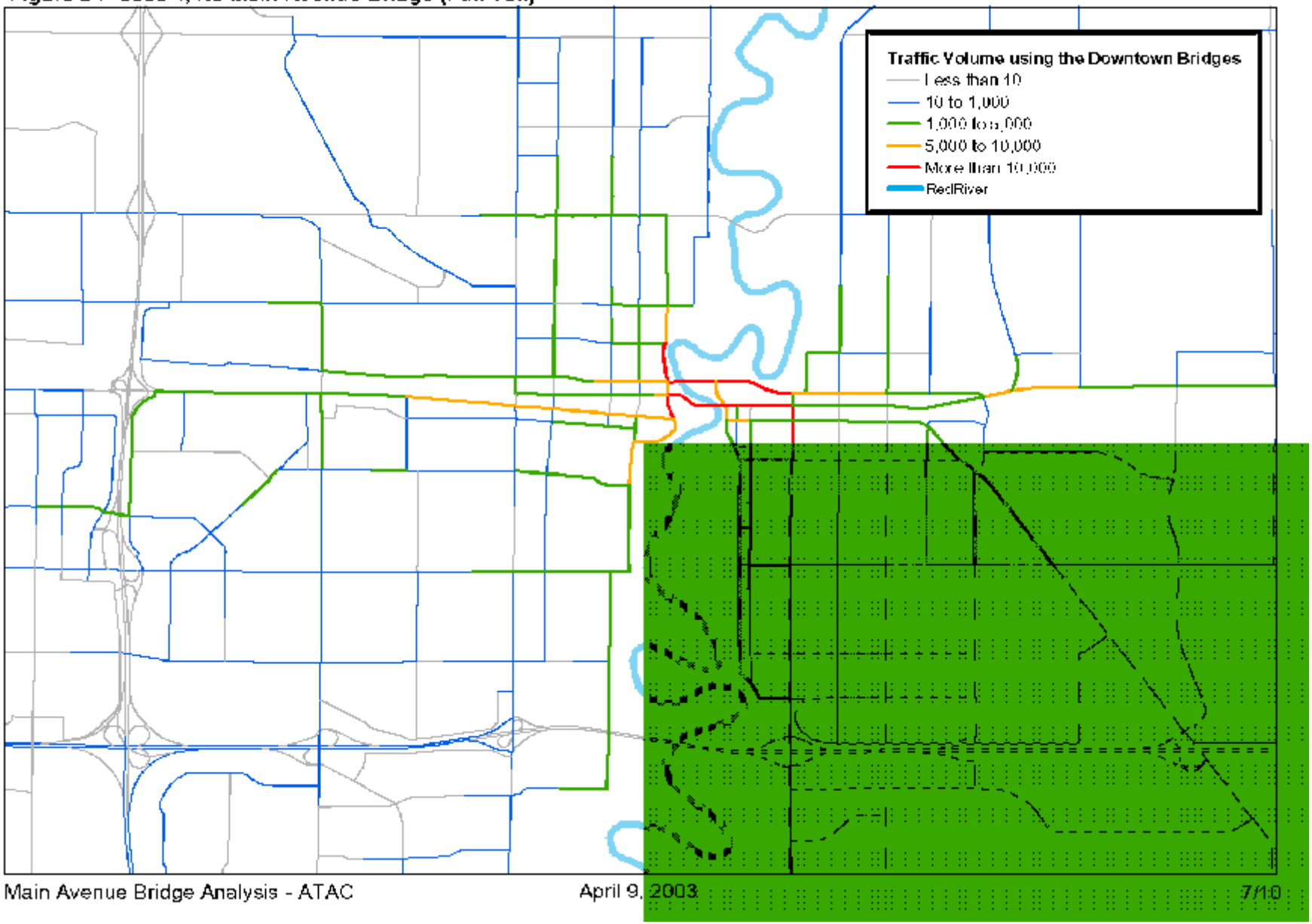
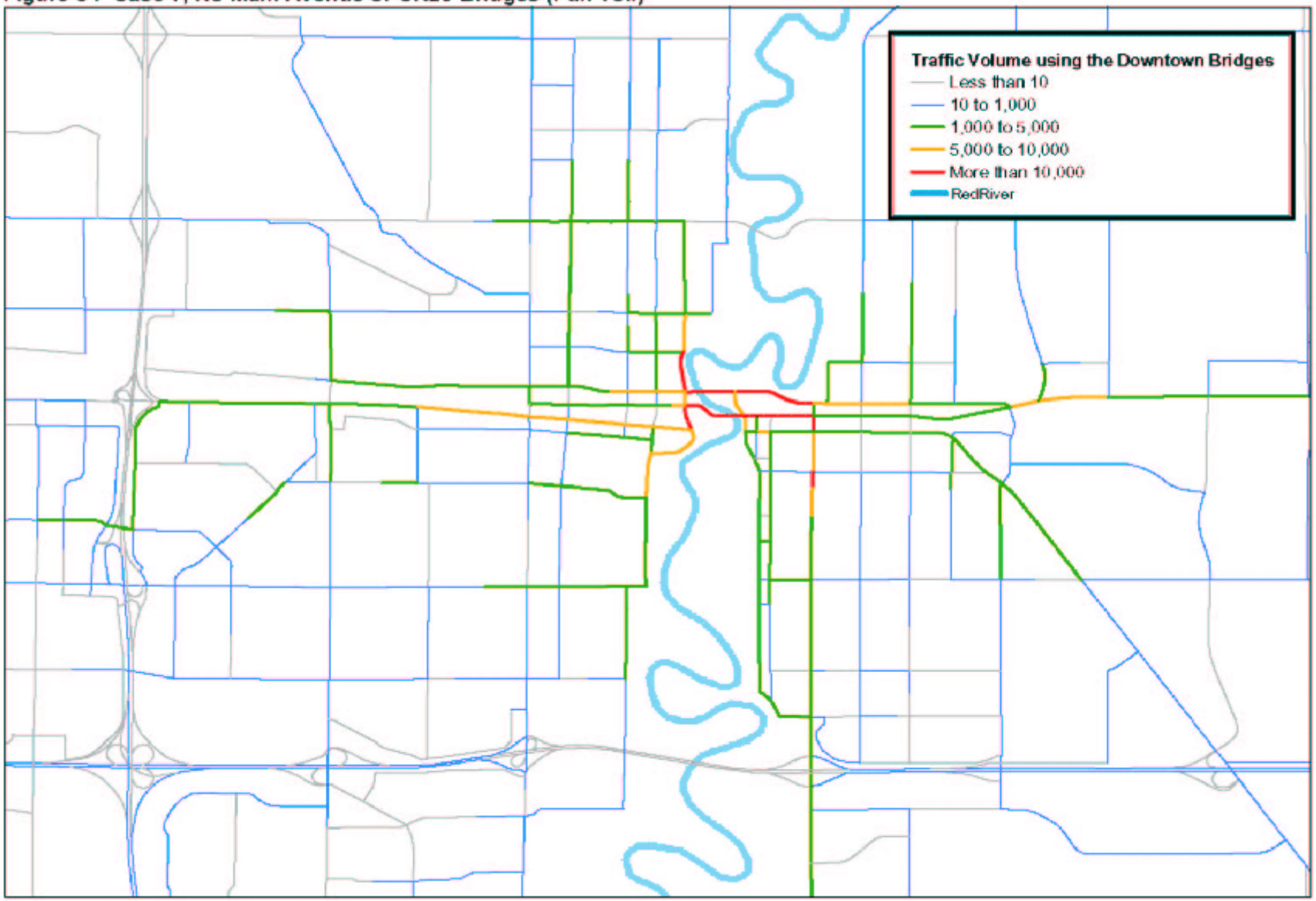


Figure 3 : Case 7, No Main Avenue or CR20 Bridges (Full Toll)



Field travel time measurements were conducted for one afternoon peak period between 4:00 PM and 5:30 PM. The area included in the analysis consisted of the 2nd Street in Fargo to 3rd Street in Moorhead for the following bridges:

1. Main Avenue from (5 runs EB, 7 runs WB)
2. NP/Center Avenue (6 runs EB, 6 runs WB)
3. 1st Avenue North (5 runs EB, 4 runs WB)

Free flow speeds equaled or exceeded posted speed limits through the study area. There was little delay experienced entering the bridge approaches, typically one cycle length. There was more delay for the eastbound direction on all approaches. Detailed results from the travel time studies are shown in Appendix A.

3.3. Changes in Peak Traffic Volumes and *v/c* Ratios

The *v/c* ratio is generally used as a measure of the level of service for a particular link since it can be indicative of traffic congestion levels on that link. Higher *v/c* ratios correlate with potential reductions in travel speeds and increases in delay. In the absence of detailed intersection delay measurement in the travel demand model, these *v/c* ratios may supplement the travel time analysis by identifying routes that will see increases in traffic levels and potentially experience delay at signalized intersections. Table 4 shows ADT and *v/c* ratios for selected locations included in the cases analyzed. Table 5 shows the changes in hourly peak traffic volumes for the same locations. Off-peak hourly volumes for the same locations are shown in Table 6.

3.4. Intersection LOS

In addition to *v/c* ratios, three intersections were analyzed, upon suggestions from local transportation officials, to estimate changes in LOS due to shifting traffic patterns in the river crossing areas. These intersections will carry much of the diverted traffic, and include: 4th Street and NP Avenue, 4th Street and Center Avenue, and 2nd Street and NP Avenue.

The FM Metro COG travel demand model was used to calculate hourly traffic volumes for off-peak, AM peak, and PM peak conditions in order to estimate approach traffic volumes. These volumes were then analyzed using Synchro to come up with approach LOS.

The results of the LOS are tabulated for off-peak, AM, and PM periods for the various analysis cases, and are shown in tables 7, 8, and 9, respectively. The results indicate that these intersections operate at a LOS C or better for the AM and off-peak periods. However, the PM peak period experiences significant delays at the 2nd Street and NP intersection (see Table 9).

Table 4: Projected Traffic and *v/c* Ratios on the River Crossings

Location	With Main Avenue				Without Main Avenue							
	With Cass County 20/Clay County 22								Without County Road 20/22			
	Full Toll		No Toll		Full Toll		No Toll		Full Toll		No Toll	
	ADT	*v/c*	ADT	*v/c*	ADT	*v/c*	ADT	*v/c*	ADT	*v/c*	ADT	*v/c*
I-94	54800	0.37	54700	0.4	57000	0.4	56900	0.38	56900	0.39	57100	0.38
Main Ave	25100	0.36	25000	0.4	-	-	-	-	-	-	-	-
NP/Center Ave	10400	0.17	8900	0.2	23300	0.4	23100	0.36	23400	0.38	22500	0.36
1st Avenue N	15500	0.31	13200	0.3	23200	0.5	19700	0.41	23500	0.46	20500	0.41
12th/15th Ave N	1700	0.13	8300	0.4	1700	0.1	8200	0.44	1700	0.13	8400	0.46
Broadway	2000	0.21	1200	0.2	1900	0.2	1200	0.15	3800	0.35	2800	0.27
Cass 20/Clay 22	3600	0.33	3200	0.3	3600	0.3	3200	0.31	-	-	-	-
	Case 1 (base)		**Case 3**		**Case 4**		**Case 6**		**Case 7**		**Case 9**	

Table 5: Projected Peak Traffic Volume on Red River Crossings

Location	With Main Avenue			Without Main Avenue					
	With Cass County 20/Clay County 22						Without County Road 20/22		
	Full Toll	No Toll		Full Toll	No Toll		Full Toll	No Toll	
	Peak	Peak	Percentage (%)	Peak	Peak	Percentage (%)	Peak	Peak	Percentage (%)
I-94	4256	4246	-0.23%	4413	4397	-0.36%	4434	4421	-0.29%
Main Ave	1913	1890	-1.20%	-	-	-	-	-	-
NP/Center Ave	714	688	-3.64%	1695	1657	-2.24%	1713	1656	-3.33%
1st Ave N	1516	1340	-11.61%	2206	1996	-9.52%	2176	2011	-7.58%
12th/15th Ave N	201	690	243.28%	207	685	230.92%	208	700	236.54%
Broadway	271	185	-31.73%	245	184	-24.90%	423	316	-25.30%
Cass 20/Clay 22	334	307	-8.08%	338	309	-8.58%	-	-	-
4th Street (Main & NP Ave)	1192	1117	-6.29%	781	775	-0.77%	708	778	9.89%
NP. Ave (4th St. & 2nd St.)	621	603	-2.90%	989	1170	18.30%	1216	1177	-3.21%

Table 6: Projected Off Peak Traffic Volume on Red River Crossings

	With Main Avenue			Without Main Avenue					
	With Cass County 20/Clay County 22						Without County Road 20/22		
	Full Toll	No Toll		Full Toll	No Toll		Full Toll	No Toll	
	Peak	Peak	Percentage (%)	Peak	Peak	Percentage (%)	Peak	Peak	Percentage (%)
I-94	3137	3129	-0.26%	3259	3269	0.31%	3264	3282	0.55%
Main Ave	1414	1413	-0.07%	-	-	-	-	-	-
NP/Center Ave	486	389	-19.96%	1282	1272	-0.78%	1279	1229	-3.91%
1st Ave N	1090	953	-12.57%	1538	1321	-14.11%	1561	1375	-11.92%
12th/15th Ave N	133	534	301.50%	134	530	295.52%	136	538	295.59%
Broadway	178	134	-24.72%	164	133	-18.90%	284	227	-20.07%
Cass 20/Clay 22	211	187	-11.37%	215	188	-12.56%	-	-	-
4th Street (Main Ave.& NP Ave)	743	741	-0.27%	524	517	-1.34%	514	517	0.58%
NP Ave (4th St. & 2nd St.)	386	386	0.00%	749	722	-3.60%	753	730	-3.05%

Table 7 LOS for Selected Intersection/Approaches (OFF-PEAK)

4th and NP LOS				
Network	EB	WB	NB	SB
Base AM	C	B	A	A
Base PM	C	B	A	B
Forecasted	A	C	A	A
Forecasted - 25	A	C	A	A
Forecasted - 50	A	C	A	A
No Main	C	C	A	A
No Main - 25	C	C	A	A
No Main - 50	C	C	A	A
No Main, No County	C	C	A	A
No Main, No County - 25	C	C	A	A
No Main, No County - 50	C	C	A	A
2nd and NP LOS				
Base AM	D	C	A	A
Base PM	A	A	B	B
Forecasted	C	A	A	A
Forecasted - 25	C	A	A	A
Forecasted - 50	C	A	A	A
No Main	B	B	A	B
No Main - 25	B	B	A	B
No Main - 50	B	B	A	B
No Main, No County	B	B	A	B
No Main, No County - 25	B	B	A	B
No Main, No County - 50	B	B	A	B
4th and Center LOS				
Base AM	A	A	B	B
Base PM	A	A	B	B
Forecasted	A	A	B	B
Forecasted - 25	A	A	B	B
Forecasted - 50	A	A	B	B
No Main	A	A	C	A
No Main - 25	A	A	C	A
No Main - 50	A	A	C	A
No Main, No County	A	A	C	A
No Main, No County - 25	A	A	C	A
No Main, No County - 50	A	A	C	A

Table 8 LOS for Selected Intersection/Approaches (AM-PEAK)

4th and NP LOS				
Network	EB	WB	NB	SB
Base AM	C	B	A	A
Base PM	C	B	A	B
Forecasted	A	C	A	A
Forecasted - 25	A	C	A	A
Forecasted - 50	A	C	A	A
No Main	C	C	A	A
No Main - 25	C	C	A	A
No Main - 50	C	C	A	A
No Main, No County	C	C	A	A
No Main, No County - 25	C	C	A	A
No Main, No County - 50	C	C	A	A
2nd and NP LOS				
Base AM	D	C	A	A
Base PM	A	A	B	B
Forecasted	C	A	A	A
Forecasted - 25	C	A	A	A
Forecasted - 50	C	A	A	A
No Main	B	C	A	C
No Main - 25	B	C	A	B
No Main - 50	B	C	A	C
No Main, No County	B	C	A	B
No Main, No County - 25	B	C	A	B
No Main, No County - 50	B	C	A	B
4th and Center LOS				
Base AM	A	A	B	B
Base PM	A	A	B	B
Forecasted	A	A	B	B
Forecasted - 25	A	A	B	B
Forecasted - 50	A	A	B	B
No Main	B	A	C	A
No Main - 25	B	A	C	A
No Main - 50	B	A	C	A
No Main, No County	B	A	C	A
No Main, No County - 25	B	A	C	A
No Main, No County - 50	B	A	C	A

Table 9 LOS for Selected Intersection/Approaches (PM-PEAK)

4th and NP LOS				
Network	EB	WB	NB	SB
Base AM	C	B	A	A
Base PM	C	B	A	B
Forecasted	B	C	A	B
Forecasted - 25	B	C	A	A
Forecasted - 50	B	C	A	A
No Main	C	C	A	A
No Main - 25	C	C	A	A
No Main - 50	C	C	A	A
No Main, No County	C	C	A	A
No Main, No County - 25	C	C	A	A
No Main, No County - 50	C	C	A	A
2nd and NP LOS				
Base AM	D	C	A	A
Base PM	A	A	B	B
Forecasted	C	A	A	A
Forecasted - 25	C	A	A	A
Forecasted - 50	C	A	A	A
No Main	B	F	B	B
No Main - 25	B	F	B	B
No Main - 50	B	F	B	B
No Main, No County	B	F	B	B
No Main, No County - 25	B	F	B	B
No Main, No County - 50	B	F	B	B
4th and Center LOS				
Base AM	A	A	B	B
Base PM	A	A	B	B
Forecasted	A	A	B	C
Forecasted - 25	A	A	B	C
Forecasted - 50	A	A	B	B
No Main	B	A	C	A
No Main - 25	B	A	C	A
No Main - 50	B	A	C	A
No Main, No County	B	A	C	A
No Main, No County - 25	B	A	C	A
No Main, No County - 50	B	A	C	A

Appendices

Appendix A Field Travel Time Measurements

Appendix B Traffic Levels and *v/c* Ratios for Study Area