ALLIANT
ENGINEERING

MEMORANDUM

DATE: January 29, 2016

TO: Amy Marohn,
City of Bloomington Public Works

FROM: Michael R. Anderson, PE, PTOE
Tyler Krage, EIT

PROJECT: 106th Street Follow-up Traffic Operation Study

SUBJECT: **Final Traffic Study Memorandum**

As requested, Alliant Engineering has completed a study of the 106th Street corridor to document the before and after traffic characteristics of the three-lane conversion project completed in October 2014. Prior to the summer of 2014, 106th Street was a four-lane undivided roadway with two motor vehicle lanes in each direction. 106th Street, between Xerxes Avenue and James Road, was converted to a three lane cross-section with one lane for motor vehicles in each direction, and a shared center left turn lane. Due to the change in lane configuration, area residents have expressed concern to the city regarding access delay and traffic flow along 106th Street. The purpose of the field study is to provide quantifiable traffic data to help the City assess the quality of access, and traffic operations along 106th Street to help discern if the three lane conversion negatively impacted traffic conditions. Alliant compared the three-lane conditions (after case) to the prior four-lane conditions (before case) by utilizing available traffic data documented in the previously completed 106th Street Traffic Study[1] and field collected data.

This memorandum is organized into the following sections:

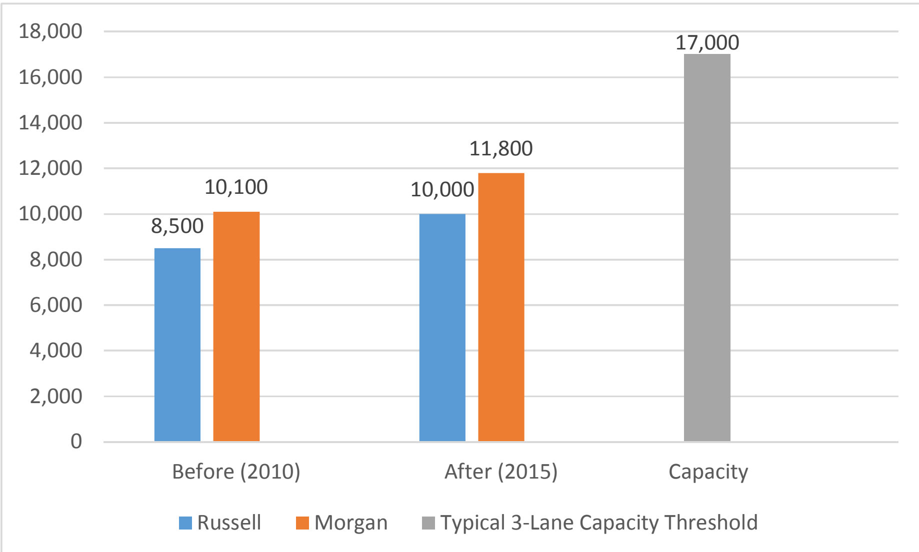
1. Motor Vehicle Traffic Volumes
2. Bike and Pedestrian Volumes
3. Safety Analysis
4. Speed Study
5. Traffic Gap Study
6. Approach Delay Studies
7. Intersection Level of Service
8. Peak Hour Factor Analysis
9. Summary

1. Motor Vehicle Traffic Volumes

Figure 1 below provides a before (year 2010) and after (year 2015) comparison of the daily traffic volumes along 106th Street. The comparison found an increase in motor vehicle volume after the three lane conversion (15%). It should be noted that the before data was collected in June and the after collected in December, therefore some seasonal variability may have occurred. Background growth or traffic pattern changes may have also occurred, since there is a five year span between the traffic volume

[1] West 106th Street Traffic Study, SEH, Inc., August 19, 2011

studies. A typical capacity of a three lane facility ranges between 17,000 and 20,000 vehicles per day. However, this range is dependent upon traffic control devices, traffic signal spacing, percentage of left turns and other characteristics. Given 106th Street has unimpeded flow (i.e., no stop controlled or traffic signal devices) within the study limits, the capacity of this facility is expected to be on the higher end of the range. Both the before and after daily traffic volumes are found to be well within the capacity threshold.

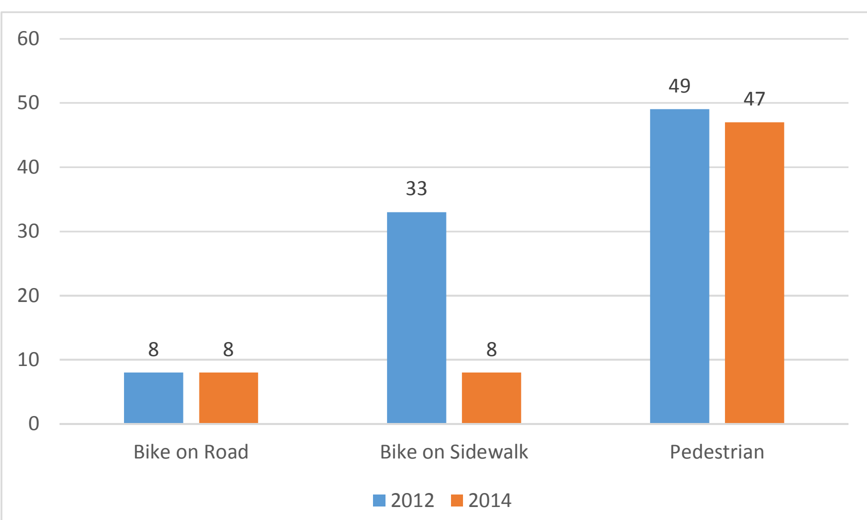


*Before volume data taken in June of 2010 and after volume collected in December of 2015

Figure 1. Average Daily Traffic Volumes

2. Pedestrian and Bicycle Volumes

Figure 2 shows a comparison of the pedestrian and bicycle volumes along 106th Street at Morgan Avenue. The data shows a decrease in bicycle volumes; however, the "after" data was collected immediately upon completion of construction, which likely influenced demand. The data shown in Figure 2 was taken from a biennial bike counting program, which is scheduled to collect new data in 2016. The 2016 count is expected to provide a better indication of the bicycle and pedestrian users along 106th Street.



*Data was taken from September of both 2012 and 2014

Figure 2. Pedestrian and Bicycle Volumes

3. Safety Analysis

A safety analysis was completed to evaluate the before and after crash data. Crash data was provided by MnDOT's Crash Mapping Analysis Tool (CMAT). The Bloomington Police department crash records were also reviewed, since this data can sometimes supplement the evaluation. However the corresponding police crash report information was too incomplete to assess or the crashes were unrelated to the lane striping configuration. Crash occurrence is somewhat random by nature. Therefore 3-5 year study periods are often used to identify statistical trends in crash types. At the time of this report, only a year had passed since the three lane conversion. Therefore, instead of evaluating the traditional 3-5 year crash history data, a two-year comparison (a year both before and after conversion) was used in the analysis. The crash rate analysis is shown in Table 1.

The crash rate analysis shows a decrease in total crashes. Before and after crash types were analyzed to determine the cause of this increase. The before and after crash types are shown below in Figure 3.

Table 1. Three Year Crash Rate Analysis (January 2013-December 2015)

Intersection	Traffic Control	Total Crashes[1]	Average Segment Volume[2]	Crash Rate	Severity Rate[3]
106th Street - Before Condition	Thru-Stop	4	9,381	1.74	2.18
106th Street -After Condition	Thru-Stop	1	10,883	0.38	0.38

[1] Crash data obtained from MnDOT's Crash Mapping Analysis Tool (CMAT)
[2] Before and after ADT data taken from 2010 and 2015
[3] Severity rate factors: 5 for Fatal Crashes, 3 for Noncapacitating Injury, 2 for Possible Injury, and 1 for Property Damage Crashes

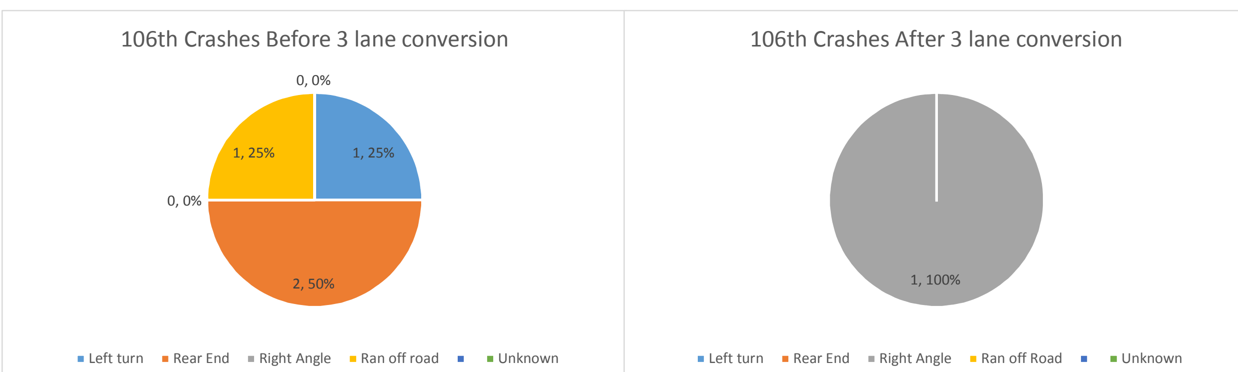


Figure 3. Crash Types by Roadway Configuration

In addition to the crash analysis of the before and after cases of the conversion, data was analyzed in 5 year periods since 2005. Table 2 shows the most recent 5 year data in comparison to the 2005-2009 period evaluated in the 2011 106th Street Traffic Study.

Table 2. Ten Year Crash Rate Analysis (2005-2014)

Intersection	Traffic Control	Total Crashes[1]	Average Segment Volume[2]	Crash Rate
106th Street - (1/1/05-12/31/09)	Thru-Stop	14	10,200	1.12
106th Street -(1/1/10-12/31/14)	Thru-Stop	14	10,883	1.05

[1] Crash Data obtained from MnDOT's Crash Mapping Analysis Tool (CMAT)
[2] ADT from aggregate tube counts of Russell and Morgan 48 hour studies

4. Speed Study

A 48-hour speed study was conducted in December 2015. The speed studies were obtained by two pneumatic road tubes placed between Russell Avenue and Sheridan Avenue and just to the east of Morgan Avenue. The speed profiles for each location are shown in Figure 4 and Figure 5.

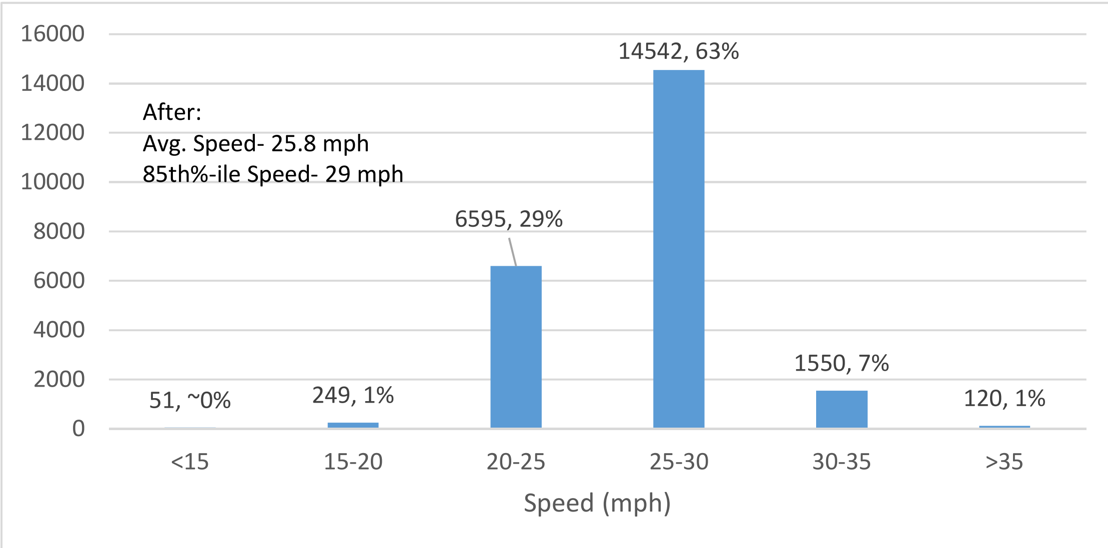


Figure 4. 48-hour Speed Study – Russell Avenue to Sheridan Avenue

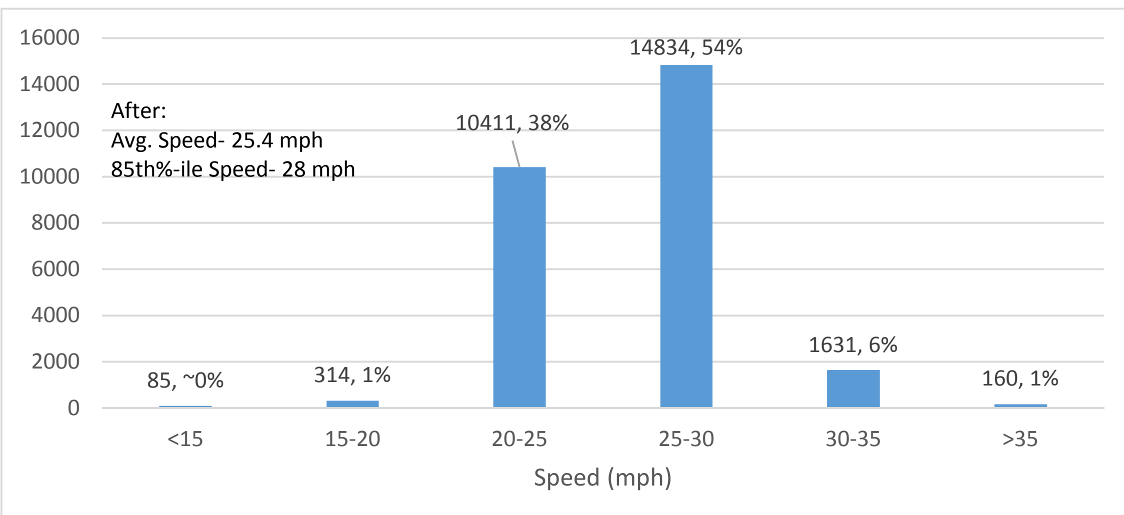


Figure 5. 48-hour Speed Study – East of Morgan Avenue

The speed data shows that the 85th percentile speed is below the posted limit of 30 mph and a very small percentage of motorists are traveling at an "excessive" speed (less than 1% traveling greater than 35 mph).

5. Traffic Gap Study

The ability to access 106th Street from any one of the north/south residential streets is dependent upon the availability and length of traffic gaps. When many gaps are present, a motorist should experience a short delay before crossing or entering 106th Street; and vice versa, the lack of traffic gaps should result in longer delays. To measure the performance of 106th Street, traffic gap studies were performed at four locations along 106th Street (two per location, AM and PM peak hours). A comparison to the previous four-lane undivided section is also made at the Russell Avenue and Morgan Avenue locations. Data was both measured in the field and extrapolated from 48-hour tube count data. The following four locations were selected as key representative locations along the corridor:

1. 106th Street & Thomas Avenue
2. 106th Street & Russell Avenue
3. 106th Street & Penn Avenue
4. 106th Street & Morgan Avenue

Table 3 shows the eastbound and westbound vehicle volume, average gap time, number of gaps greater than 7.5 seconds, and number of gaps greater than 16-18 seconds along 106th Street. Acceptable passenger car gap (7.5 seconds) was obtained from the AASHTO Green Book[2]. Acceptable pedestrian gap (16-18 s) was calculated based on the corresponding crossing distance of the location along 106th Street and a pedestrian speed walking of 3.5 feet per second. Variation in volume data during the studies is attributed to collecting data on different days.

Table 3. AM and PM Peak Hour Gap Study Summary

	4 Lane Configuration				3 Lane Configuration				Percent Change		
Location	East/West Volume	Average Gap (s)	> 7.5 Second Gap	> 16 to 18 Second Gap	East/West Volume	Average Gap (s)	> 7.5 Second Gap	> 16 to 18 Second Gap	Gap Length (s)	>7.5 second gaps	>16 to 18 second gaps
106th Street and Thomas Avenue-AM	--	--	--	--	809	4.54	155	37	--	--	--
106th Street and Russell Avenue-AM	963	3.47	150	34	839	4.29	121	25	24%	-19%	-26%
106th Street and Penn Avenue-AM	--	--	--	--	949	3.93	138	22	--	--	--
106th Street and Morgan Avenue-AM	1182	2.78	137	18	1003	3.63	105	21	31%	-23%	17%
106th Street and Thomas Avenue-PM	--	--	--	--	1509	2.87	54	11	--	--	--
106th Street and Russell Avenue-PM	1342	2.68	28	1	1247	2.84	59	6	6%	111%	500%
106th Street and Penn Avenue-PM	--	--	--	--	1150	3.14	87	4	--	--	--
106th Street and Morgan Avenue-PM	1445	2.49	24	1	1893	2.38	65	6	-5%	171%	500%

*Data field collected 7:30 to 8:30 a.m. and 4:45 to 5:45 p.m.

In general, the data indicates there is a considerable number of opportunities for a motorist to access 106th Street. The morning study period shows a decrease in acceptable gaps since the conversion and the afternoon period shows an increase in acceptable gaps. Based on the current available gaps over the peak hours it could be estimated that the average wait time is between 30 and 70 seconds, assuming all motorists are waiting for a 7.5 second traffic gap. In reality, most motorists can comfortable access the traffic flow with a gap less than 7.5 seconds, thus reducing the stopped delay. The following section will document the actual observed delays waiting to access 106th Street.

During the peak hours, there are far fewer traffic gaps of sufficient length for a pedestrian to completely cross 106th Street without requiring a motor vehicle to yield. However, there are plenty of sufficient gaps for pedestrians to safely enter the street enacting the pedestrian right of way law requiring motorists to yield. In this regard, the three lane cross-section provides a safer environment, as the “double threat” safety issue found with four-lane undivided roadways is removed.

6. Approach Delay Studies

On-site field observations and stopped approach delays were collected at six locations (the four previously mentioned gap study locations, plus Vincent Avenue and Sheridan Avenue) during the month

[2] A Policy on Geometric Design of Highways and Streets (AASHTO Green Book), 2011, 6th Edition, page 9-37, Table 9-5

of January 2016. The delay study data consisted of timestamps of every vehicle's arrival and departure time. The vehicle volume, vehicle minimum delay, vehicle maximum delay, and average vehicle delay are calculated using this information. The field collected data was analyzed and conclusions were made from the analysis.

The field studies were conducted between 4:45-5:45 pm. on a weekday, which is the highest hourly traffic volume that occurs. Eight delay studies were performed at the six locations to obtain an accurate representation of delay. The data is shown in Table 4.

Table 4. Stopped Approach Delay Study Summary

Location	Northbound Approach				Southbound Approach			
	Volume	Min Delay (s)	Max Delay (s)	Avg Delay (s)	Volume	Min Delay (s)	Max Delay (s)	Avg Delay (s)
106th Street and Vincent Avenue S	--	--	--	--	22	1	65	18.1
106th Street and Thomas Avenue S	15	1	50	15.3	--	--	--	--
106th Street and Sheridan Avenue S	10	3	44	18.9	41	2	49	20.2
106th Street and Russell Avenue S	17	1	77	17.0	--	--	--	--
106th Street and Penn Avenue S	75	2	74	20.0	9	5	52	25.2
106th Street and Morgan Avenue S	21	3	62	15.1	--	--	--	--

*Data field collected 7:30 to 8:30 a.m. and 4:45 to 5:45 p.m.

As shown, the average time a motorist is waiting to access 106th Street ranges between 15 and 25 seconds. The maximum delay observed was 77 seconds at Russell Avenue. Given the average delay is so much lower than the maximum observed delay, the data suggests that the predominant number of motorists are experiencing shorter wait times.

7. Intersection Delay and Level of Service

SimTraffic 8.0 was used to evaluate the delay (an approximation of the length of time that a motorist waits at the intersection) and Level of Service (LOS) at the 106th Street/Penn Avenue intersection. The LOS is typically presented in the form of a letter grade (A-F) that provides a qualitative indication of the operational efficiency or effectiveness. By definition, LOS A conditions represents high-quality operations (low motor vehicle delays) and LOS F conditions represent very poor operations (long motor vehicle delays). It was compared to the previous four-lane section analysis completed as part of the 2011 106th Street Traffic Study. The intersection level of service comparison of before and after is shown in Table 5. LOS was not analyzed at the 106th Street and Xerxes Avenue intersection as there were no lane configuration changes at the intersection that would influence its function or capacity.

Table 5. Intersection Delay Summary – 106th Street at Penn Avenue

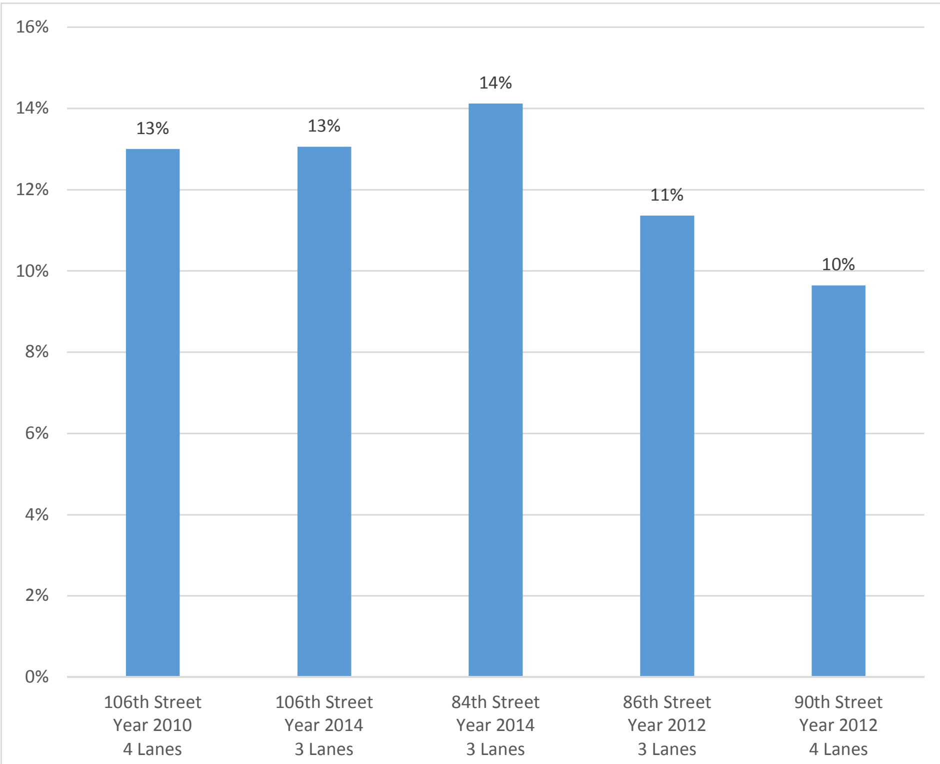
		Before	After
AM PEAK	Delay (s/veh)	2.9 / 16.3	3.7 / 17.5
	LOS	A / C	A / C
PM PEAK	Delay (s/veh)	3.1 / 18.9	5.9 / 13.9
	LOS	A / C	A / B

XX / XX = Overall Intersection Delay (LOS) / Worst Performing Movement Delay (LOS)

8. Peak Hour Factor Analysis

The 2011 106th Street Traffic Study found that the PM peak hour carried approximately 13% of the ADT, which is generally considered higher than typical streets. The study theorized that the higher PM peak percentage was occurring because of a large number of vehicles using 106th Street as a diversion route. A comparison was made to determine if the conversion to a three-lane section had any effect on the peak hour factor. Based on the December 2015 48 hour speed tube data, it was found that on average the PM peak hour percentage has remained at 13% of the ADT.

To assess how 106th Street compares to other east/west routes through Bloomington, the peak hour factor was evaluated on 84th Street, 86th Street and 90th Street. Figure 6 illustrates the comparison.



*Each roadway denoted by year of traffic data and number of travel lanes

Figure 6. PM Peak Hour Percentage of ADT

Based on this comparison, 106th Street is experiencing a higher than typical PM peak hour factor than many other streets. The conversion to a three-lane roadway does not appear to have changed the streets function or peak hour traffic capacity. 84th Street was found to have a higher than typical peak hour factor as well; similar to 106th Street traffic being affected by the flow on 35W, 84th Street does carry some level of diversion traffic depending upon congestion levels on 494.

9. Summary

Based on a comparison of the before and after traffic data, the roadway safety and traffic operations of 106th Street are acceptable. Overall, the function of 106th Street does not appear to have changed, the capacity of the corridor has not been impacted and the overall quality of access and observed travel speeds are reasonable. Key findings include:

- A before (year 2010) and after (year 2015) comparison of the daily traffic volumes along 106th Street found an increase in motor vehicle volume of 15%. 106th Street carries approximately 10,800 vehicles per day, which is much less than the typical observed capacity of a three lane roadway (17,000 vehicles per day).

- The data shows a decrease in bicycle volumes; however, the "after" data was collected immediately upon completion of construction, which likely influenced demand. Continuation of the City of Bloomington biennial bicycle and pedestrian counts in 2016 will document a better reflection of the existing users of the facility.
- Since the completion of construction, 1 crash has been reported. This is a decrease over the previous reporting period. Since crashes are largely random in nature, and a function of exposure, it is recommended the City of Bloomington continue to monitor crashes and reevaluate the crash records once the three-lane facility has been in operation for a longer period of time.
- The speed data shows that the 85th percentile speed is below the posted limit and a very small percentage of motorists are traveling at an "excessive" speed (less than 1% traveling greater than 35 mph).
- The gap study data indicates there is a considerable number of opportunities for a motorist to access 106th Street. The morning study period shows a decrease in acceptable gaps since the conversion and the afternoon period shows an increase in acceptable gaps.
- As the number of traffic gaps relates to the average time a motorist is waiting to access 106th Street, the field collected data during the highest traveled time periods of the day found the average wait time to be between 15 and 25 seconds depending upon location.
- The study found that the PM peak hour volume as a percentage of the daily traffic volume has remained at 13%. 106th Street is experiencing a higher than typical PM peak hour factor than other streets. The conversion to a three-lane roadway does not appear to have changed 106th Streets function or peak hour traffic capacity.