Appendix C

Running Time Methodology

1. Overview

Running time estimates in the Nicollet-Central corridor were developed for the following three Build alternatives:

- Enhanced bus between 41st Avenue NE and 46th Street S (9.2 miles long)
- Modern streetcar between 41st Avenue NE and 46th Street S (9.2 miles long)
- Preliminary modern streetcar starter line between E Hennepin and Lake Street S (3.4 miles long)

The No-Build alternative does not assume any modifications to the runningway, stop locations, transit signal priority (TSP) or other elements that would impact running time. Therefore, the No Build alternative assumes existing scheduled running times for each route within the corridor.

Because the Build alternatives will operate in mixed traffic (as the existing transit routes do), the primary basis for developing running time estimates for the Build alternatives was the existing bus running times in the corridor. This foundation is further supported by the fact that Metro Transit closely manages running times on the primary routes in the corridor (Routes 10 and 18) and regularly adjusts running times based on actual experience. Thus, current transit travel times closely reflect existing conditions.

However, there are a number of service and vehicle characteristics that would make the running time estimates for each Build alternative faster than existing bus. The three characteristics assumed to improve running times for the Build alternatives include:

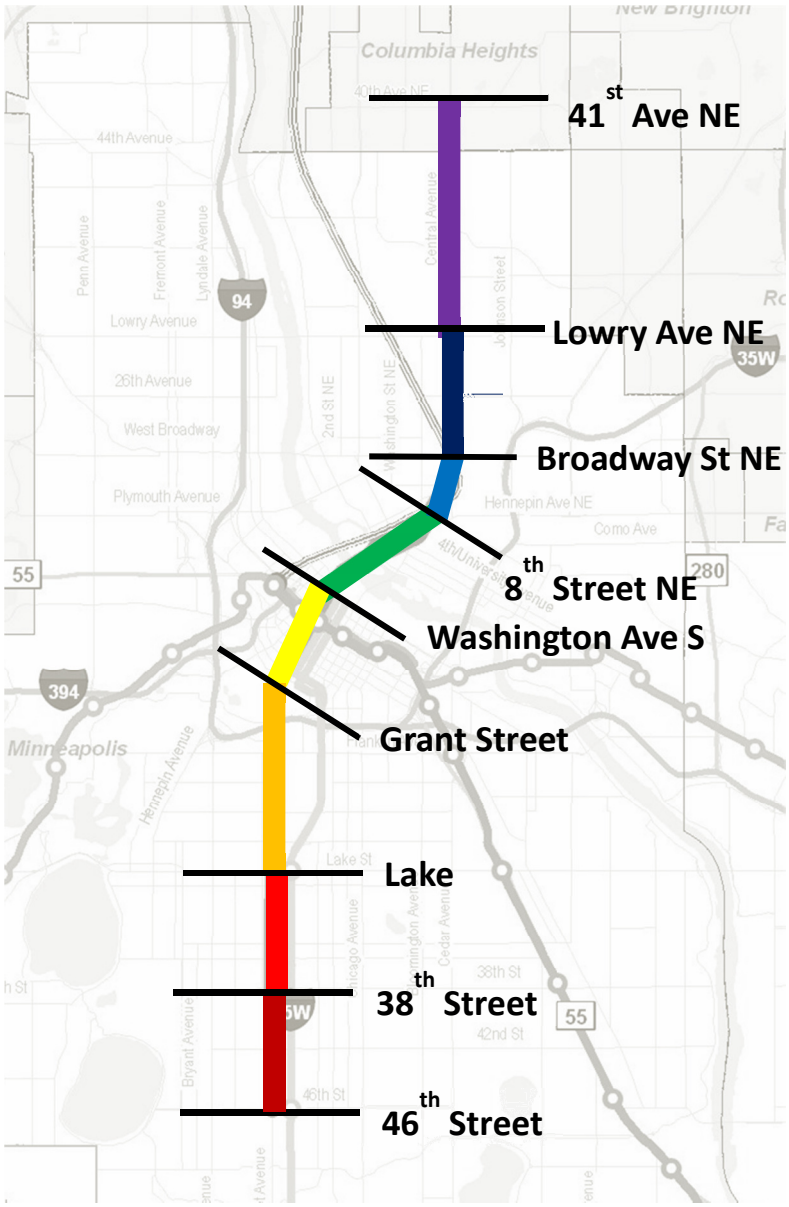
- **Wider stop spacing.** Based on the operating plans, all Build alternatives assume wider stop spacing than existing bus routes in the corridor, resulting in shorter running times.
- **Off-board fare payment and all-door boarding/deboarding.** All Build alternatives assume that fare payment would occur off-board and passengers would board/deboard using any of the enhanced bus or streetcar vehicle doors.
- **Transit Signal Priority (TSP).** With the exception of Nicollet Mall in downtown, the Build alternatives assume TSP and signal coordination to facilitate transit movements in the corridor. Therefore, there would be travel time savings due to TSP associated with the Build alternatives.
- **Differences between enhanced bus and modern streetcar.** Additionally, the estimated run times for enhanced bus and modern streetcar alternatives assume a difference in vehicle operating and runningway characteristics. Specifically, because of the fixed nature of rail tracks, streetcar vehicles will achieve greater consistency in approaching and departing from stops and the gap between the vehicle floor and platform. The ability of the enhanced bus with regards to these elements would rely primarily on the enhanced bus operator's experience.

The methodology for estimating running times for the Build alternatives is discussed in detail in the following section.

2. Methodology

Because of the variation in existing bus running times in the corridor today, running time estimates for the Build alternatives were estimated during the AM peak (6:00-9:00 am), midday (9:00 am – 3:00 pm) and PM peak (3:00-6:30 pm). Running times were also estimated separately for the following eight segments in the corridor, illustrated in Figure 1 on the next page.

Figure 1 – Major Analysis Segments



Between Seventh Street NE and Third 3 Street South/Washington across the Mississippi River, there are two alignment options under consideration: the Hennepin/First Avenue bridge or the Central/Third Avenue bridge). Based on an analysis of bus running times along these two alignments, it was estimated that it was between 22 percent and 24 percent faster to travel via the Hennepin Avenue bridge compared to the Central/Third Avenue bridge (between 1.5 and 2.0 minutes depending on the mode).

Total running times for the Build alternatives were estimated by following the steps discussed below.

2.1. Step 1: Estimation of Bus versus Auto Travel Times by Segment

For each segment in the corridor, auto and bus travel times were collected using Google maps. This was done for the three time periods. Google maps offers real-time auto travel times (using actual input from users of Android

phones) as well as scheduled bus running times. As noted above, bus running times are regularly monitored in the corridor and thus scheduled times accurately reflect actual bus running times.

By comparing the auto travel time to the bus running time (by segment), it was possible to isolate time spent boarding and alighting passengers. By dividing the total time spent at stops by the total number of bus stops, it was possible to calculate the average time spent per stop.

Based on the actual auto travel times in the corridor, travel speeds are relatively slow (around 20 miles per hour) compared to the speed limit (30 mph in most of the corridor except downtown). Thus, it was assumed that the in-motion time on transit (which includes acceleration and deceleration) would be about the same as auto traffic in the corridor.[1]

2.2. Step 2: Estimation of Running Time Savings with Fewer Stops

Using the average time per stop (by segment), the total stop time was calculated for the Build alternatives assuming fewer stops in each segment. For example, if the difference in auto versus bus travel time in a segment was 2 minutes, and there were 11 existing bus stops in that segment, the average time spent per stop was about 11 seconds. For the Build alternatives, there were only six stops in this segment. Thus, the estimated total delay would be 66 seconds (six stops at 11 seconds per stop). The running time savings for the Build alternatives compared to existing bus associated with this sample segment was 54 seconds.

2.3. Step 3: Estimation of Running Time Savings with Off-Board Fare Collection

For the purpose of the running time estimates, it was assumed that the time spent for boarding and alighting would be about 20 percent faster for streetcar and enhanced bus than existing bus service.[2]

2.4. Step 4: Estimation of Running Time Savings with Transit Signal Priority

With the exception of Nicollet Mall, the Build alternatives assume TSP and signal coordination to help improve transit running times along the Nicollet-Central corridor. Based on an analysis of delay at traffic signals in the corridor with and without TSP (see Appendix A), existing bus run times were reduced by approximately 1.5 minutes in each direction (or 3 minutes round trip) to account for TSP.

2.5. Step 5: Estimation of Running Time Savings between Enhanced Bus and Modern Streetcar

Additionally, the estimated run times for enhanced bus and modern streetcar alternatives assume a difference in vehicle operating and runningway characteristics. Specifically, because of the fixed nature of rail tracks, streetcar vehicles will achieve greater consistency in approaching and departing from stops and the gap between the vehicle floor and platform. The ability of the enhanced bus with regards to these elements would rely primarily on

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1 Existing auto run times in the corridor between Central Avenue at 41st Avenue NE and Nicollet Avenue at 46th Street South is approximately 28 minutes today. Source: Nicollet-Central Transit Alternatives, *Draft Traffic & Parking Technical Memorandum*, June 2013, Table 3.

2 The 20 percent additional boarding and alighting time for existing bus service and also assumed in the No-Build alternative is based on dwell time research presented in the Transit Cooperative Research Program's (TCRP) Transit Capacity and Quality of Service Manual (TCRP Report 100). Boarding times for bus systems with off-board fare payment systems are in the range of 2.25 to 2.75 seconds per passenger (Exhibit 4-2, pages 4-5), whereas boarding times for rail systems assuming off-board fare payment are in the range of 1.75 to 2.0 seconds per passenger (Exhibit 5-16, pages 5-22).

the enhanced bus operator's experience. The estimated difference in run time between the two Build alternatives associated with transit mode is approximately 1 minute in each direction.

2.6. Exception – Nicollet Mall

The one segment where running times are assumed to be the same as the No-Build is the Nicollet Mall (between Washington/Nicollet and 13th/Nicollet). There are several reasons why this assumption was made:

- The Nicollet Mall is primarily used by transit vehicles today, and this would remain the same in all Build alternatives
- There is no change in the number of transit stops between the No-Build and Build alternatives
- The time savings associated with off-board fare collection would be negated by the inability to pass transit vehicles (there will only be one travel lane in each direction in all alternatives)
- There would be no Transit Signal Priority (as noted above)

Based on these assumptions, the estimated run time for the Build alternatives along Nicollet Mall is 11 minutes, which is identical to the No-Build (based on the 2010 Metropolitan Council Travel Behavior Inventory and validated by 2012 actual Metro Transit bus running times).

3. Results

Based on the methodology discussed above, Table 1 presents the results of the running time estimates for the Build alternatives compared to existing 2012 Metro Transit running times in the corridor. Because running time estimates were only developed for the AM peak, midday and PM peak time periods – but running times were also needed for the early evening (6:30 pm – midnight) and late evening time periods (midnight-6:00 am) for the purposes of developing accurate operating cost estimates – it was assumed that the early evening running times were the same as the midday and the late evening running times were the same as the AM peak.

Table 1 – Running Time Summary

SEGMENT	EXISTING BUS (via Central)	EXISTING BUS (via Hennepin)	ENHANCED BUS (via Central)	ENHANCED BUS (via Hennepin)	STREETCAR (via Central)	STREETCAR (via Hennepin)	STREETCAR STARTER (via Central)	STREETCAR STARTER (via Hennepin)
41st - Lowry	*8.2*	*8.2*	*7.0*	*7.0*	*6.8*	*6.8*		
Lowry - Broadway	*5.0*	*5.0*	*3.8*	*3.8*	*3.6*	*3.6*		
Broadway - 7th St NE	*2.7*	*2.7*	*2.5*	*2.5*	*2.5*	*2.5*		
7th St NE - 3rd St/Washington	*7.3*	*5.7*	*6.9*	*5.4*	*6.8*	*5.2*	*6.8*	*5.2*
3rd St/Washington - 13th St	*11.0*	*11.0*	*11.0*	*11.0*	*11.0*	*11.0*	*11.0*	*11.0*
13th St - Lake	*11.2*	*11.2*	*9.3*	*9.3*	*9.0*	*9.0*	*9.0*	*9.0*
Lake - 38th	*5.0*	*5.0*	*4.4*	*4.4*	*4.3*	*4.3*		
38th - 46th	*4.7*	*4.7*	*3.6*	*3.6*	*3.5*	*3.5*		
Total End-to-End	*55.0*	*53.4*	*48.5*	*47.0*	*47.5*	*45.9*	*26.8*	*25.2*
Minutes Saved over Existing Bus			***6.5***	***6.4***	***7.5***	***7.4***	***2.7***	***2.6***
% faster			*12%*	*12%*	*14%*	*14%*	*9%*	*10%*

Attachment A: Transit Signal Priority Analysis

Mean Stop Time & Stop Probability Estimation - AM Peak Hour

Evaluation based on 5 seconds of TSP

Intersection		Input Stop Probability	Input Mean Stop Time	Cycle Length	Coordinated Phase
Mainline	Sidestreet				
Nicollet	Franklin	65%	29	90	Nicollet
Nicollet	24th	30%	14	90	24th
Nicollet	26th	50%	22	90	26th
Nicollet	28th	55%	24	90	Nicollet
Nicollet	Lake St	75%	33	90	Nicollet
Nicollet	31st	60%	27	90	Nicollet
Nicollet	34th	30%	14	90	Nicollet
Nicollet	35th	65%	28	90	35th
Nicollet	36th	70%	32	90	Nicollet
Nicollet	38th	45%	19	90	Nicollet
Nicollet	40th	50%	22	90	Nicollet
Nicollet	42nd	40%	17	90	Nicollet
Nicollet	46th	55%	25	90	Nicollet

Evaluation based on 5 seconds of TSP

Intersection		Input Stop Probability	Input Mean Stop Time	Cycle Length	Coordinated Phase
Mainline	Sidestreet				
Central	Hennepin/5th	55%	21	80	Central
Central	Spring	40%	17	90	Central
Central	Broadway	65%	30	90	Broadway
Central	14th Ave NE	40%	16	80	Central
Central	18th Ave NE	45%	18	80	Central
Central	18 1/2 Ave NE	40%	16	80	Central
Central	19th Av NE	40%	16	80	Central
Central	20th Ave NE	40%	16	80	Central
Central	22nd Ave NE	40%	16	80	Central
Central	24th Ave NE	40%	16	80	Central
Central	Lowry Ave	60%	24	80	Lowry Ave
Central	26th Ave NE	40%	16	80	Central
Central	27th Ave NE	55%	23	80	Central
Central	29th Ave NE	55%	23	80	Central
Central	St Anthony Pkwy	55%	22	80	Central
Central	35th Ave NE	55%	23	80	Central
Central	37th Ave NE	75%	41	110	Central

Source: Developed by AECOM for the Nicollet-Central Transit Alternatives

Mean Stop Time & Stop Probability Estimation - AM Peak Hour

Evaluation based on 0 seconds of TSP

Intersection		***Input Stop***	***Input Mean***	*Cycle*	*Coordinated*
Mainline	*Sidestreet*	***Probability***	***Stop Time***	*Length*	*Phase*
Nicollet	Franklin	**70%**	**31**	90	Nicollet
Nicollet	24th	**35%**	**17**	90	24th
Nicollet	26th	**55%**	**25**	90	26th
Nicollet	28th	**60%**	**27**	90	Nicollet
Nicollet	Lake St	**80%**	**36**	90	Nicollet
Nicollet	31st	**65%**	**30**	90	Nicollet
Nicollet	34th	**35%**	**17**	90	Nicollet
Nicollet	35th	**70%**	**31**	90	35th
Nicollet	36th	**75%**	**34**	90	Nicollet
Nicollet	38th	**50%**	**22**	90	Nicollet
Nicollet	40th	**55%**	**25**	90	Nicollet
Nicollet	42nd	**45%**	**20**	90	Nicollet
Nicollet	46th	**60%**	**27**	90	Nicollet

Evaluation based on 0 seconds of TSP

Intersection		***Input Stop***	***Input Mean***	*Cycle*	*Coordinated*
Mainline	*Sidestreet*	***Probability***	***Stop Time***	*Length*	*Phase*
Central	Hennepin/5th	**60%**	**24**	80	Central
Central	Spring	**45%**	**20**	90	Central
Central	Broadway	**70%**	**32**	90	Broadway
Central	14th Ave NE	**45%**	**18**	80	Central
Central	18th Ave NE	**50%**	**20**	80	Central
Central	18 1/2 Ave NE	**45%**	**19**	80	Central
Central	19th Av NE	**45%**	**19**	80	Central
Central	20th Ave NE	**45%**	**19**	80	Central
Central	22nd Ave NE	**45%**	**18**	80	Central
Central	24th Ave NE	**45%**	**18**	80	Central
Central	Lowry Ave	**65%**	**27**	80	Lowry Ave
Central	26th Ave NE	**45%**	**19**	80	Central
Central	27th Ave NE	**65%**	**25**	80	Central
Central	29th Ave NE	**65%**	**25**	80	Central
Central	St Anthony Pkwy	**60%**	**24**	80	Central
Central	35th Ave NE	**65%**	**25**	80	Central
Central	37th Ave NE	**80%**	**43**	110	Central

Mean Stop Time & Stop Probability Estimation- Off Peak

Evaluation based on 5 seconds of TSP

Intersection		***Input Stop***	***Input Mean***	*Cycle*	*Coordinated*
Mainline	*Sidestreet*	***Probability***	***Stop Time***	*Length*	*Phase*
Nicollet	Franklin	**50%**	**18**	70	Nicollet
Nicollet	24th	**40%**	**14**	70	24th
Nicollet	26th	**50%**	**17**	70	26th
Nicollet	28th	**60%**	**20**	70	Nicollet
Nicollet	Lake St	**60%**	**21**	70	Nicollet
Nicollet	31st	**60%**	**21**	70	Nicollet
Nicollet	34th	**40%**	**14**	70	Nicollet
Nicollet	35th	**50%**	**17**	70	35th
Nicollet	36th	**60%**	**21**	70	Nicollet
Nicollet	38th	**40%**	**14**	70	Nicollet
Nicollet	40th	**50%**	**17**	70	Nicollet
Nicollet	42nd	**45%**	**16**	70	Nicollet
Nicollet	46th	**75%**	**27**	70	Nicollet

Evaluation based on 5 seconds of TSP

Intersection		***Input Stop***	***Input Mean***	*Cycle*	*Coordinated*
Mainline	*Sidestreet*	***Probability***	***Stop Time***	*Length*	*Phase*
Central	Hennepin/5th	**60%**	**21**	70	Central
Central	Spring	**50%**	**17**	70	Central
Central	Broadway	**65%**	**30**	90	Broadway
Central	14th Ave NE	**45%**	**16**	70	Central
Central	18th Ave NE	**60%**	**21**	70	Central
Central	18 1/2 Ave NE	**50%**	**17**	70	Central
Central	19th Av NE	**50%**	**17**	70	Central
Central	20th Ave NE	**50%**	**17**	70	Central
Central	22nd Ave NE	**45%**	**16**	70	Central
Central	24th Ave NE	**45%**	**16**	70	Central
Central	Lowry Ave	**55%**	**20**	70	Lowry Ave
Central	26th Ave NE	**50%**	**17**	70	Central
Central	27th Ave NE	**65%**	**22**	70	Central
Central	29th Ave NE	**65%**	**23**	70	Central
Central	St Anthony Pkwy	**60%**	**21**	70	Central
Central	35th Ave NE	**65%**	**23**	70	Central
Central	37th Ave NE	**75%**	**41**	110	Central

Mean Stop Time & Stop Probability Estimation - Off Peak

Evaluation based on 0 seconds of TSP

Intersection		***Input Stop***	***Input Mean***	*Cycle*	*Coordinated*
Mainline	*Sidestreet*	***Probability***	***Stop Time***	*Length*	*Phase*
Nicollet	Franklin	**60%**	**21**	70	Nicollet
Nicollet	24th	**45%**	**16**	70	24th
Nicollet	26th	**55%**	**19**	70	26th
Nicollet	28th	**65%**	**23**	70	Nicollet
Nicollet	Lake St	**65%**	**23**	70	Nicollet
Nicollet	31st	**65%**	**23**	70	Nicollet
Nicollet	34th	**45%**	**16**	70	Nicollet
Nicollet	35th	**55%**	**20**	70	35th
Nicollet	36th	**70%**	**24**	70	Nicollet
Nicollet	38th	**50%**	**17**	70	Nicollet
Nicollet	40th	**55%**	**20**	70	Nicollet
Nicollet	42nd	**50%**	**18**	70	Nicollet
Nicollet	46th	**85%**	**29**	70	Nicollet

Evaluation based on 0 seconds of TSP

Intersection		***Input Stop***	***Input Mean***	*Cycle*	*Coordinated*
Mainline	*Sidestreet*	***Probability***	***Stop Time***	*Length*	*Phase*
Central	Hennepin/5th	**70%**	**24**	70	Central
Central	Spring	**55%**	**19**	70	Central
Central	Broadway	**70%**	**32**	90	Broadway
Central	14th Ave NE	**50%**	**18**	70	Central
Central	18th Ave NE	**65%**	**23**	70	Central
Central	18 1/2 Ave NE	**55%**	**19**	70	Central
Central	19th Av NE	**55%**	**19**	70	Central
Central	20th Ave NE	**55%**	**19**	70	Central
Central	22nd Ave NE	**50%**	**18**	70	Central
Central	24th Ave NE	**50%**	**18**	70	Central
Central	Lowry Ave	**65%**	**22**	70	Lowry Ave
Central	26th Ave NE	**55%**	**19**	70	Central
Central	27th Ave NE	**70%**	**25**	70	Central
Central	29th Ave NE	**70%**	**25**	70	Central
Central	St Anthony Pkwy	**70%**	**24**	70	Central
Central	35th Ave NE	**70%**	**25**	70	Central
Central	37th Ave NE	**80%**	**43**	110	Central

Mean Stop Time & Stop Probability Estimation - PM Peak Hour

Evaluation based on 5 seconds of TSP

Intersection		***Input Stop***	***Input Mean***	*Cycle*	*Coordinated*
Mainline	*Sidestreet*	***Probability***	***Stop Time***	*Length*	*Phase*
Nicollet	Franklin	**70%**	**32**	90	Nicollet
Nicollet	24th	**40%**	**18**	90	24th
Nicollet	26th	**55%**	**25**	90	26th
Nicollet	28th	**55%**	**25**	90	Nicollet
Nicollet	Lake St	**70%**	**32**	90	Nicollet
Nicollet	31st	**65%**	**30**	90	Nicollet
Nicollet	34th	**35%**	**15**	90	Nicollet
Nicollet	35th	**50%**	**22**	90	35th
Nicollet	36th	**55%**	**22**	90	Nicollet
Nicollet	38th	**40%**	**18**	90	Nicollet
Nicollet	40th	**50%**	**22**	90	Nicollet
Nicollet	42nd	**40%**	**17**	90	Nicollet
Nicollet	46th	**70%**	**31**	90	Nicollet

Evaluation based on 5 seconds of TSP

Intersection		***Input Stop***	***Input Mean***	*Cycle*	*Coordinated*
Mainline	*Sidestreet*	***Probability***	***Stop Time***	*Length*	*Phase*
Central	Hennepin/5th	**65%**	**26**	80	Central
Central	Spring	**55%**	**25**	90	Central
Central	Broadway	**65%**	**30**	90	Broadway
Central	14th Ave NE	**40%**	**16**	80	Central
Central	18th Ave NE	**45%**	**18**	80	Central
Central	18 1/2 Ave NE	**50%**	**20**	80	Central
Central	19th Av NE	**40%**	**16**	80	Central
Central	20th Ave NE	**40%**	**16**	80	Central
Central	22nd Ave NE	**40%**	**16**	80	Central
Central	24th Ave NE	**40%**	**16**	80	Central
Central	Lowry Ave	**60%**	**23**	80	Lowry Ave
Central	26th Ave NE	**40%**	**16**	80	Central
Central	27th Ave NE	**55%**	**23**	80	Central
Central	29th Ave NE	**60%**	**23**	80	Central
Central	St Anthony Pkwy	**55%**	**22**	80	Central
Central	35th Ave NE	**60%**	**23**	80	Central
Central	37th Ave NE	**70%**	**44**	130	Central

Mean Stop Time & Stop Probability Estimation - PM Peak Hour

Evaluation based on 0 seconds of TSP

Intersection		***Input Stop***	***Input Mean***	*Cycle*	*Coordinated*
Mainline	*Sidestreet*	***Probability***	***Stop Time***	*Length*	*Phase*
Nicollet	Franklin	**75%**	**34**	90	Nicollet
Nicollet	24th	**45%**	**20**	90	24th
Nicollet	26th	**60%**	**28**	90	26th
Nicollet	28th	**60%**	**28**	90	Nicollet
Nicollet	Lake St	**75%**	**34**	90	Nicollet
Nicollet	31st	**70%**	**32**	90	Nicollet
Nicollet	34th	**40%**	**17**	90	Nicollet
Nicollet	35th	**55%**	**25**	90	35th
Nicollet	36th	**60%**	**28**	90	Nicollet
Nicollet	38th	**45%**	**21**	90	Nicollet
Nicollet	40th	**55%**	**25**	90	Nicollet
Nicollet	42nd	**45%**	**20**	90	Nicollet
Nicollet	46th	**75%**	**34**	90	Nicollet

Evaluation based on 0 seconds of TSP

Intersection		***Input Stop***	***Input Mean***	*Cycle*	*Coordinated*
Mainline	*Sidestreet*	***Probability***	***Stop Time***	*Length*	*Phase*
Central	Hennepin/5th	**70%**	**28**	80	Central
Central	Spring	**60%**	**28**	90	Central
Central	Broadway	**70%**	**32**	90	Broadway
Central	14th Ave NE	**45%**	**18**	80	Central
Central	18th Ave NE	**50%**	**20**	80	Central
Central	18 1/2 Ave NE	**55%**	**22**	80	Central
Central	19th Av NE	**45%**	**19**	80	Central
Central	20th Ave NE	**45%**	**19**	80	Central
Central	22nd Ave NE	**45%**	**18**	80	Central
Central	24th Ave NE	**45%**	**18**	80	Central
Central	Lowry Ave	**65%**	**26**	80	Lowry Ave
Central	26th Ave NE	**45%**	**19**	80	Central
Central	27th Ave NE	**65%**	**25**	80	Central
Central	29th Ave NE	**65%**	**26**	80	Central
Central	St Anthony Pkwy	**60%**	**24**	80	Central
Central	35th Ave NE	**65%**	**26**	80	Central
Central	37th Ave NE	**70%**	**47**	130	Central