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To: James Merten, P.E., City of Neenah

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From: Kenneth H. Voigt, P.E., Transportation Engineer

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Date: February 12, 2021 Project No.: 49-0123.00

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Re: Final Report on Intersection Control Evaluation (ICE): Main Street and Torrey Street

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## Study Background

The City of Neenah has retained Ayres Associates to analyze the feasibility of constructing a roundabout at the intersection of Main Street and Torrey Street as part of a downtown transportation network improvement study. For this study, Ayres Associates evaluated the existing Main Street intersection with Torrey Street under: 1) existing Stop sign control; 2) traffic signal control; and 3) roundabout control. The analysis studied morning and evening peak hour traffic operation for the years 2020 and 2040 under normal background traffic growth and with Main Street traffic taming traffic projections recommended in the downtown transportation improvement study. For study purposes Main Street is referenced as a north/south street with Torrey Street referenced as an east/west street.

## Existing Intersection Geometrics

Main Street is a four-lane undivided roadway in the north and south directions with a posted speed limit of 30 mph. The intersection of Main Street and Torrey Street has three legs with Stop sign control on the westbound approach of Torrey Street. South of its intersection with Torrey Street, Main Street's vertical profile includes a curved railroad crossing bridge which minimizes driver sight distance for westbound motorists at the Torrey Street intersection. The northbound Main Street approach to Torrey Street is constructed with a separate 'free flow' right turn lane which minimizes northbound right turn movements at the westbound Stop sign controlled approach of Torrey Street. The intersection design is shown in Figure 1. Existing intersection lane geometrics include:

- Main Street Northbound Approach
  - Through lane
  - Shared through/right-turn lane
- Main Street Southbound Approach
  - Through lane
  - Shared through/left turn lane
- Torrey Street Westbound Approach
  - Single, 20-foot wide shared through/left turn lane

**Figure 1: Existing Main Street Intersection with Torrey Street**



### Intersection Safety

A 5-year history of crashes at the study intersection was obtained from the University of Wisconsin Traffic Operation Lab. Table 1 summarizes the number of crashes reported at the intersection between 2015 and 2019.

**Table 1: Crash History at Main Street/Torrey Street Intersection (2015-2019)**

Location	Crashes/Year					Crash Severity			Total	Annual Average
	2015	2016	2017	2018	2019	Property Damage Only	Injury	Fatal		
Torrey Street & Main Street	1	1	0	0	0	1	1	0	2	0.4
<b>Total</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>2</b>	<b>0.4</b>

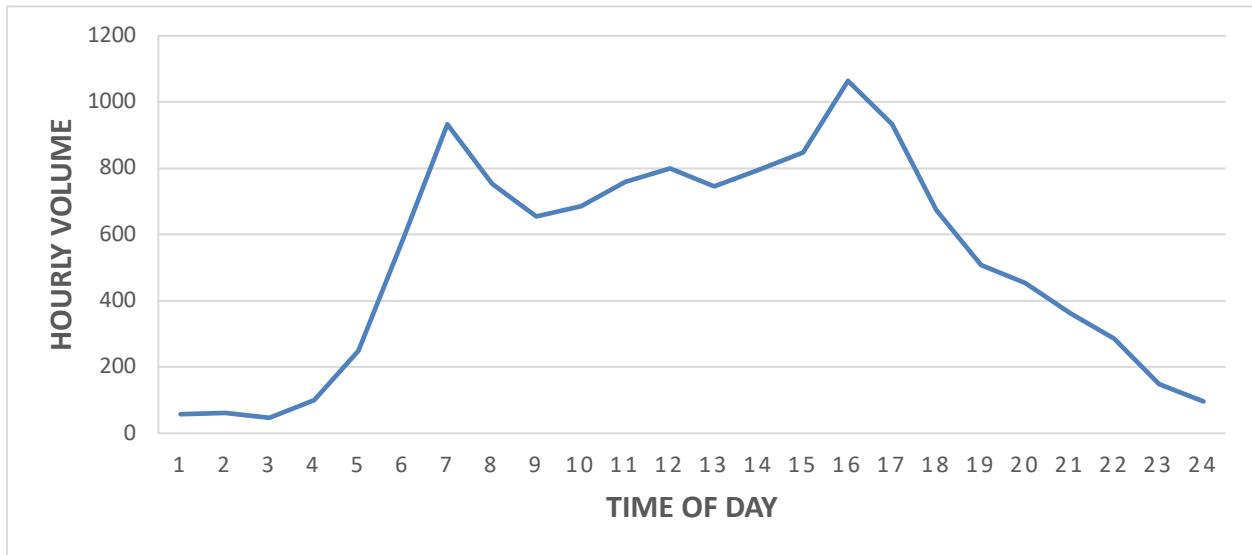
As shown on Table 1, there were only two motor vehicles crashes reported at the study intersection with no crashes reported during the 2015-2019 time period. One crash involved a sideswipe collision with the other crash involving an angle collision. One crash resulted in personal injury with the other crash reported as property damage only.

### Existing and Future Traffic Volumes

Based on 2019 traffic counts collected by the Wisconsin Department of Transportation (WisDOT), Main Street carries 13,400 vehicles per day (vpd) south of Torrey Street and 9,600

vpd north of Torrey Street. Torrey Street traffic west of Church Street was reported at 2,500 vpd. Figure 2 shows the hourly traffic flow distribution pattern on Main Street.

**Figure 2: Main Street Weekday Hourly Traffic Distribution West of Torrey Street (2019)**

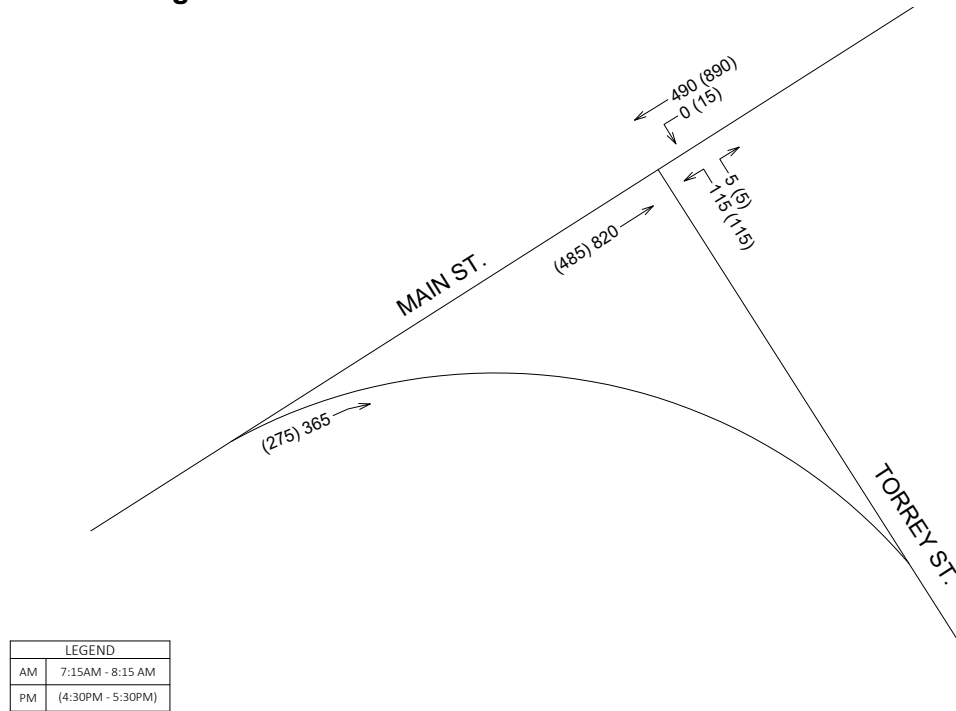


**2020 and 2040 Peak Hour Intersection Traffic Movements**

Based on historic traffic volume growth data obtained from the WisDOT it is concluded that year 2020 intersection traffic movement counts are similar to volumes counted in 2018. For report reference purposes, the 2018 count data will be referred to as Year 2020. Year 2040 traffic projections are based on an annual traffic growth rate of 0.5% per year.

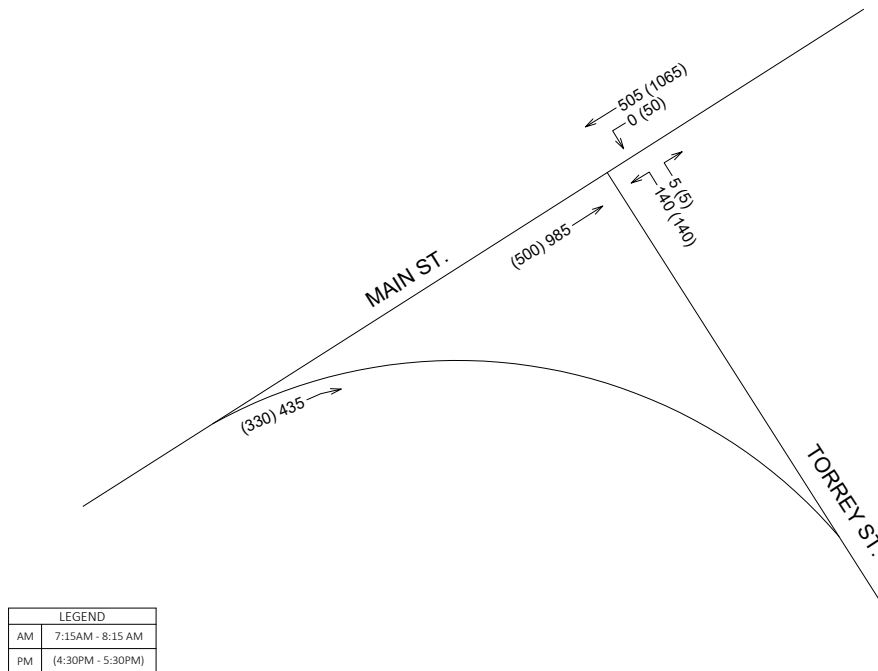
**Year 2020 Traffic:** Figure 3 identifies Year 2020 morning (7:15 A.M. to 8:15 A.M.) and evening (4:30 P.M. to 5:30 P.M.) peak hour intersection traffic movement volumes. These peak hour time periods represent the two peak volumes shown on Figure 2.

**Figure 3: Year 2020 Peak Hour Traffic Movements**



**Year 2040 Traffic:** Figure 4 shows year 2040 peak hour intersection traffic movements based on an annual traffic growth rate of 0.5% per year over the 20 year time period between 2020 and 2040.

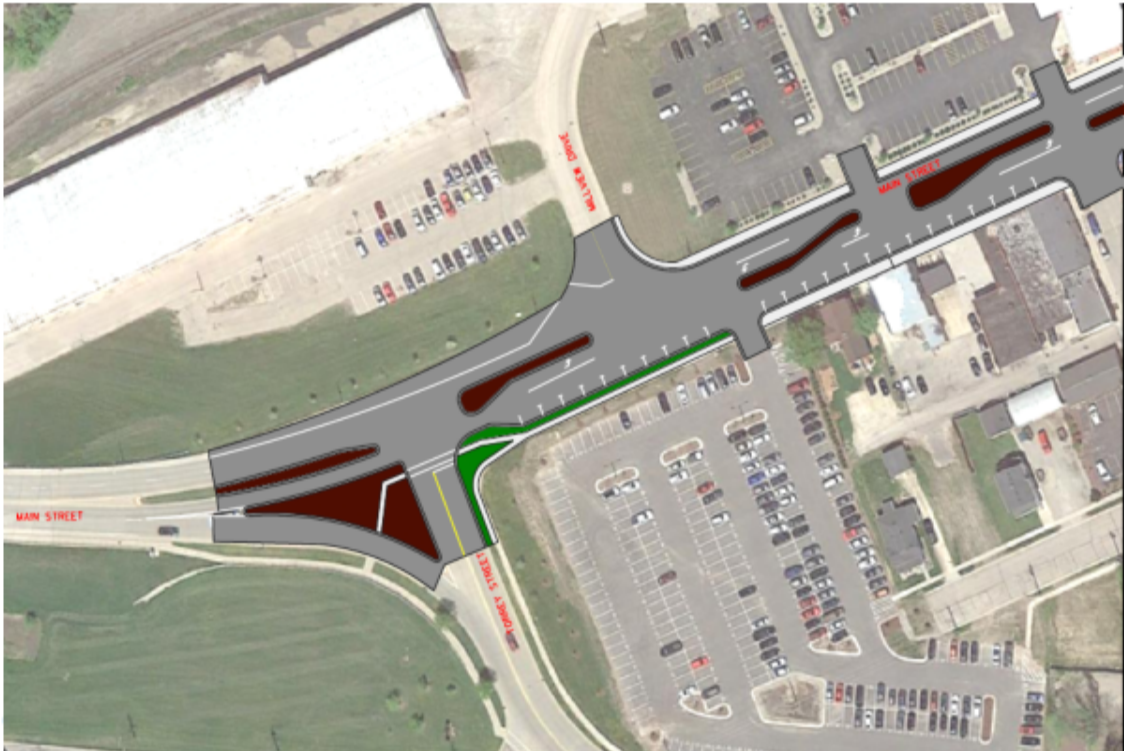
**Figure 4: Year 2040 Peak Hour Traffic Movements**



## Traffic Taming Peak Hour Intersection Movements

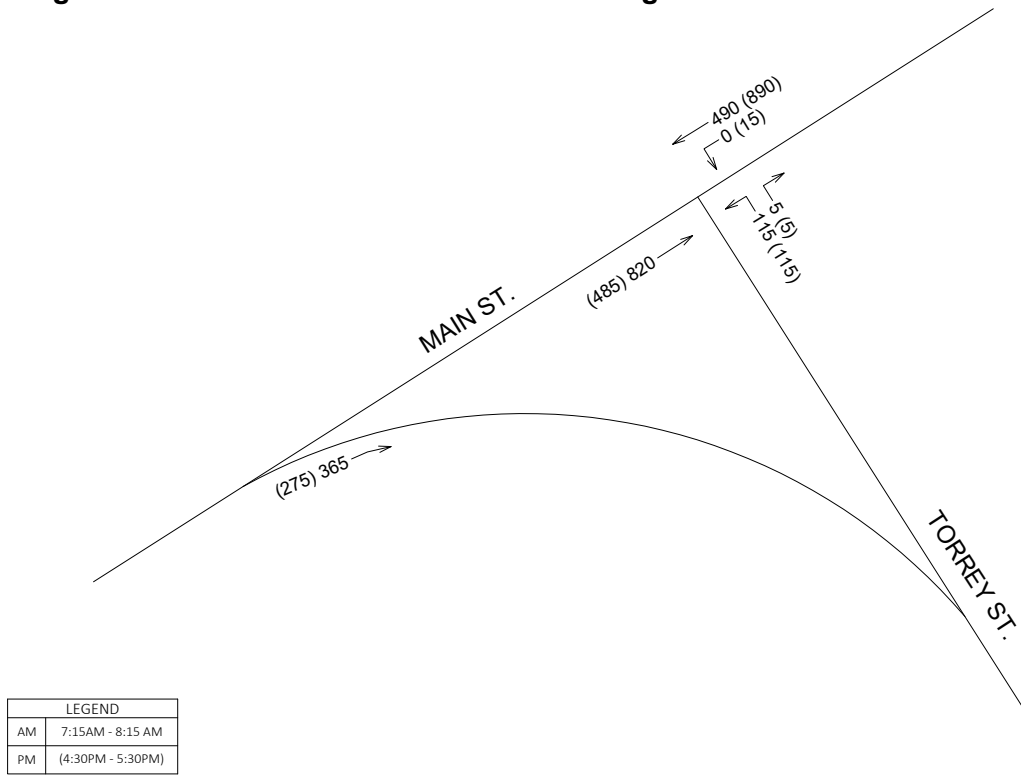
As reported in the Downtown Neenah Transportation Network Study, it is expected that the implementation of the traffic taming improvements shown on Figure 5 for the segment of Main Street between Torrey Street and Wisconsin Avenue have the potential to modify 'through' traffic patterns currently on Wisconsin Avenue. The traffic taming is expected to encourage 'through' traffic on Main Street to utilize the Torrey Street connection to the Columbian Avenue route for access to Commercial Street. Implementation of the traffic taming actions is projected to reduce daily traffic on the segment of Main Street north of Torrey Street by approximately 20 percent.

**Figure 5: Main Street Traffic Taming Improvements**

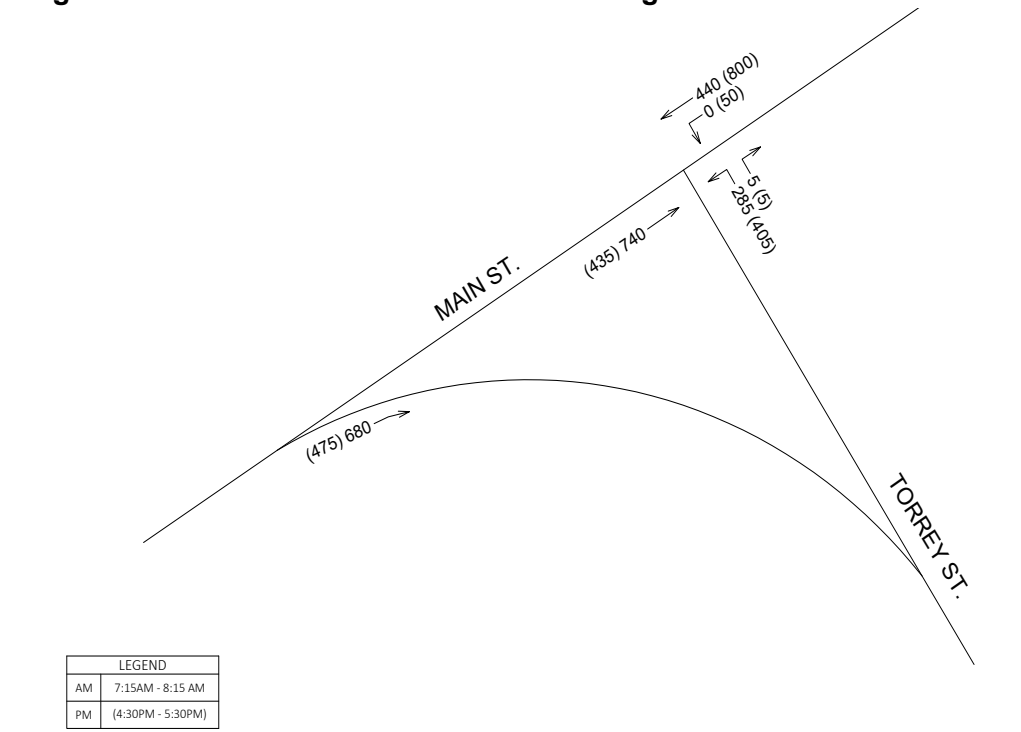


Figures 6 and 7 show the adjusted year 2020 and 2040 traffic taming peak hour volumes at the Main Street/Torrey Street intersection.

**Figure 6: Year 2020 Peak Hour Traffic Taming Intersection Movements**



**Figure 7: Year 2040 Peak Hour Traffic Taming Intersection Movements**



## Intersection Control Operation Analysis

Intersection operation is nationally defined by Level of Service (LOS) categories. These LOS categories have been defined by the National Academy of Sciences Transportation Research Board and have been adopted by Federal, state and local municipalities to analyze intersection operation. Level of Service (LOS) 'D', as defined in the Highway Capacity Manual 6<sup>th</sup> Edition (HCM), is normally used as the threshold for acceptable peak hour intersection operation in built out urban areas. The LOS is determined based on the average amount of delay experienced by each vehicle entering an intersection during the study period and is categorized by grades of 'A' through 'F'. Table 3 summarizes the different intersection LOS descriptions.

**Table 3: Intersection Level of Service Description**

Alpha LOS	Signalized (sec/veh)	Unsignalized Delay (sec/veh)	Description
A	≤ 10	≤ 10	No Congestion: Very few vehicles experience delay.
B	> 10 - 20	> 10 – 15	Minimal Congestion: Some vehicles experience delay but many travel through intersection without stopping.
C	> 20 – 35	> 15 – 25	Minor Congestion: Many vehicles experience delay but some travel through intersection without stopping.
D	> 35 – 55	> 25 – 35	Moderate Congestion: Most vehicles experience delay.
E	> 55 – 80	> 35 – 50	Severe Congestion: Most vehicles experience significant delay. Volumes nearing capacity.
F	> 80 Or V/C >1.0	> 50 Or V/C >1.0	Extreme Congestion: Nearly all vehicles experience significant delay. Volume may be higher than capacity. Potential gridlock.

The 95<sup>th</sup> percentile queue is also included in the operations summary as an additional performance measure. The 95<sup>th</sup> percentile queue (sometimes referred to as the “maximum probable queue”) represents the distance away from the stop bar of an intersection at which 95% of all queues for a given traffic movement are expected to extend. In other words, there is only a 5% probability that the 95<sup>th</sup> percentile queue length will be exceeded during the analysis period.

Intersection operation for the traffic signal and stop sign controls at the study intersections were analyzed using Synchro 10 software. The results presented in this report are based on HCM 2000 format.

### Existing Stop Sign Operation

Table 4 summarizes expected morning and evening peak hour study intersection operation with its existing Stop sign control through the year 2040 without implementation of any Main Street traffic taming improvements.



**Table 4: 2020 and 2040 Peak Hour Intersection Stop Sign Operation Without Main Street Traffic Taming**

• **Year 2020 Without Main Street Traffic Taming**

2020 Existing AM Peak Hour Traffic Operations - Main St. TWSC										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL	WBT	NBL	NBR		
Torrey Street	Stop	LOS	A	A	A	A	F	B	A	
		Delay (sec)	0.0	0.0	0.0	0.0	100.5	12.0	6.5	
		Queue (ft)	25'	25'	25'	25'	175'	25'	--	
* EB movement has an EBR bypass lane										
2020 Existing PM Peak Hour Traffic Operations - Main St. TWSC										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL	WBT	NBL	NBR		
Torrey Street	Stop	LOS	A	A	A	A	F	B	A	
		Delay (sec)	0.0	0.0	8.8	8.8	70.3	10.2	4.7	
		Queue (ft)	25'	25'	25'	25'	125'	25'	--	

• **Year 2040 Without Main Street Traffic Taming**

2040 Existing AM Peak Hour Traffic Operations - Main St. TWSC										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL	WBT	NBL	NBR		
Torrey Street	Stop	LOS	A	A	A	A	F	B	B	
		Delay (sec)	0.0	0.0	0.0	0.0	201.2	12.6	12.7	
		Queue (ft)	25'	25'	25'	25'	250'	25'	--	
* EB movement has an EBR bypass lane										
2040 Existing PM Peak Hour Traffic Operations - Main St. TWSC										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL	WBT	NBL	NBR		
Torrey Street	Stop	LOS	A	A	A	A	F	B	A	
		Delay (sec)	0.0	0.0	9.0	9.0	134.0	10.4	8.7	
		Queue (ft)	25'	25'	25'	25'	200'	25'	--	

As shown on Table 4, all traffic movements are expected to operate at LOS 'A' and 'B' except for the Stop sign controlled westbound approach of Torrey Street at its intersection with Main Street which operates at LOS 'F' with average delays of 100.5 seconds per vehicle and a maximum queue of 175 feet in 2020. By the Year 2040, average vehicle delays can reach 201.2 seconds per vehicle with a maximum queue of 250 feet.

Table 5 summarizes Stop sign controlled intersection operation expected with traffic pattern changes attributed to implementing Main Street traffic taming improvements.



**Table 5: 2020 and 2040 Peak Hour Intersection Stop Sign Operation With Main Street Traffic Taming**

• **Year 2020 With Main Street Traffic Taming**

2020 Proposed Traffic Taming AM Peak Hour Traffic Operations - Main St. TWSC										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL	WBT	NBL	NBR		
Torrey Street	Stop	LOS	A	A	A	A	F	B	C	
		Delay (sec)	0.0	0.0	0.0	0.0	134.8	10.8	17.7	
		Queue (ft)	25'	25'	25'	25'	325'	25'	--	
* EB movement has an EBR bypass lane										
2020 Proposed Traffic Taming PM Peak Hour Traffic Operations - Main St. TWSC										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL	WBT	NBL	NBR		
Torrey Street	Stop	LOS	A	A	A	A	F	A	E	
		Delay (sec)	0.0	0.0	8.3	8.3	256.7	9.6	48.3	
		Queue (ft)	25'	25'	25'	25'	575'	25'	--	

• **Year 2040 With Main Street Traffic Taming**

2040 Proposed Traffic Taming AM Peak Hour Traffic Operations - Main St. TWSC										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL	WBT	NBL	NBR		
Torrey Street	Stop	LOS	A	A	A	A	F	B	F	
		Delay (sec)	0.0	0.0	0.0	0.0	425.6	11.5	56.4	
		Queue (ft)	25'	25'	25'	25'	625'	25'	--	
* EB movement has an EBR bypass lane										
2040 Proposed Traffic Taming PM Peak Hour Traffic Operations - Main St. TWSC										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL	WBT	NBL	NBR		
Torrey Street	Stop	LOS	A	A	A	A	F	A	F	
		Delay (sec)	0.0	0.0	8.7	8.7	868.6	9.9	162.5	
		Queue (ft)	25'	25'	25'	25'	>1000	25'	--	

As shown on Table 5, the westbound Torrey Street approach to Main Street under existing Stop sign control and the implementation of Main Street traffic taming improvements can be expected to experience LOS 'F' operation with average traffic delays reaching 868 seconds by the year 2040 and queues exceeding 1,000 feet.

**Signalized Intersection Operation**

In order to determine if the installation of traffic signals is a viable traffic control improvement option, it is necessary to conduct a traffic signal warrant analysis documented in the national Manual on Uniform Traffic Control Devices (MUTCD). There are nine warrants that may justify the safe installation of traffic signals at an intersection. Table 6 summarizes an evaluation of the MUTCD Warrants for the Installation of Traffic Signals.

**Table 6: Traffic Signal Warrant Evaluation Summary**

<b>Warrant</b>	<b>Background</b>		<b>Traffic Taming</b>	
	<b>2020</b>	<b>2040</b>	<b>2020</b>	<b>2040</b>
<b>Warrant 1: Eight-Hour Volume</b>				
Condition A: Minimum Vehicular Volume	No	No	Yes	Yes
Condition B: Interruption of Continuous Traffic	No	No	No	No
Condition C: Combination: 80% of A and B	No	No	No	Yes
<b>Warrant 2: Four-Hour Volume</b>	No	No	Yes	Yes
<b>Warrant 3: Peak Hour Volume</b>	No	No	Yes	Yes
<b>Warrant 4: Pedestrian Volume</b>				
Criterion A: Four-Hour	N/A	N/A	N/A	N/A
Criterion B: Peak Hour	N/A	N/A	N/A	N/A
<b>Warrant 5: School Crossing</b>	N/A	N/A	N/A	N/A
<b>Warrant 6: Coordinated Signal System</b>	N/A	N/A	N/A	N/A
<b>Warrant 7: Crash Experience</b>	N/A	N/A	N/A	N/A
<b>Warrant 8: Roadway Network</b>	N/A	N/A	N/A	N/A
<b>Warrant 9: Intersection Near a Grade Crossing</b>	N/A	N/A	N/A	N/A

As shown on Table 6, year 2020 and 2040 traffic volumes do not satisfy any of the Warrants under existing traffic patterns without implementation of any traffic taming improvements on Main Street. Therefore, without changes in existing traffic patterns it is not considered feasible to install traffic signals at the Main Street intersection with Torrey Street without creating traffic safety concerns. However, Table 6 also indicates that the 3 primary traffic signal warrants (1. Eight-Hour Volume; 2. Four-Hour Volume; and 3. Peak Hour Volume) are satisfied with traffic patterns changes attributed to the installation of traffic taming improvements on Main Street.

Table 7 summarizes Year 2020 and 2040 signalized intersection operation with the implementation of Main Street traffic taming improvement travel pattern changes.

**Table 7: Year 2020 and 2040 Peak Hour Intersection Traffic Signal Operation With Implementation of Main Street Traffic Taming Improvements**

- Year 2020 With Main Street Traffic Taming

2020 Proposed Traffic Taming AM Peak Hour Traffic Operations - Main St. Signalized Intersection										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL	WBT	NBL	NBR		
Torrey Street	Signal	LOS	A	A		A		D	C	B
		Delay (sec)	6.2	0.0		5.6		46.8	32.4	13.9
		Queue (ft)	150'	450'		200'		225'	25'	--
* EB movement has an EBR bypass lane which cannot be calculated for a signalized delay (yield sign)										
2020 Proposed Traffic Taming PM Peak Hour Traffic Operations - Main St. Signalized Intersection										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL	WBT	NBL	NBR		
Torrey Street	Signal	LOS	A	A		B		D	C	B
		Delay (sec)	8.4	0.0		11.3		48.3	26.7	19.4
		Queue (ft)	125'	300'		125'		300'	25'	--
* EB movement has an EBR bypass lane which cannot be calculated for a signalized delay (yield sign)										

- Year 2040 With Main Street Traffic Taming

2040 Proposed Traffic Taming AM Peak Hour Traffic Operations - Main St. Signalized Intersection										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL	WBT	NBL	NBR		
Torrey Street	Signal	LOS	A	A		A		D	C	B
		Delay (sec)	8.2	0.0		7.3		46.2	29.5	15.3
		Queue (ft)	225'	700'		200'		250'	25'	--
* EB movement has an EBR bypass lane which cannot be calculated for a signalized delay (yield sign)										
2040 Proposed Traffic Taming PM Peak Hour Traffic Operations - Main St. Signalized Intersection										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL	WBT	NBL	NBR		
Torrey Street	Signal	LOS	B	B		B		D	C	C
		Delay (sec)	11.1	0.0		17.0		50.7	23.2	23.3
		Queue (ft)	125'	400'		375'		350'	25'	--
* EB movement has an EBR bypass lane which cannot be calculated for a signalized delay (yield sign)										

As shown on Table 7, a signalized intersection is expected to operate at LOS 'C' or better except for the westbound left turn on Torrey Street which is expected to operate at acceptable LOS 'D' conditions through the year 2040. Even though average vehicle delays would be significantly less than experienced with Stop sign control, maximum queues reach a high of 350 feet on the Torrey Street approach to Main Street. Queuing can be reduced by shortening the cycle length, which for this initial analysis was set at 100 seconds to match the signal cycle at Wisconsin Avenue and Commercial Street.

## Roundabout Control Operation

This section provides a peak hour operation comparison for a single lane and a dual westbound lane roundabout.

- **Single Lane Roundabout**

An initial single lane roundabout conceptual design was developed to analyze 2020 and 2040 intersection operation. Figure 8 illustrates the conceptual design for a single lane roundabout at the Main Street intersection with Torrey Street. This concept is compatible with future traffic taming improvements on Main Street.

**Figure 8: Single Lane Roundabout Conceptual Design**

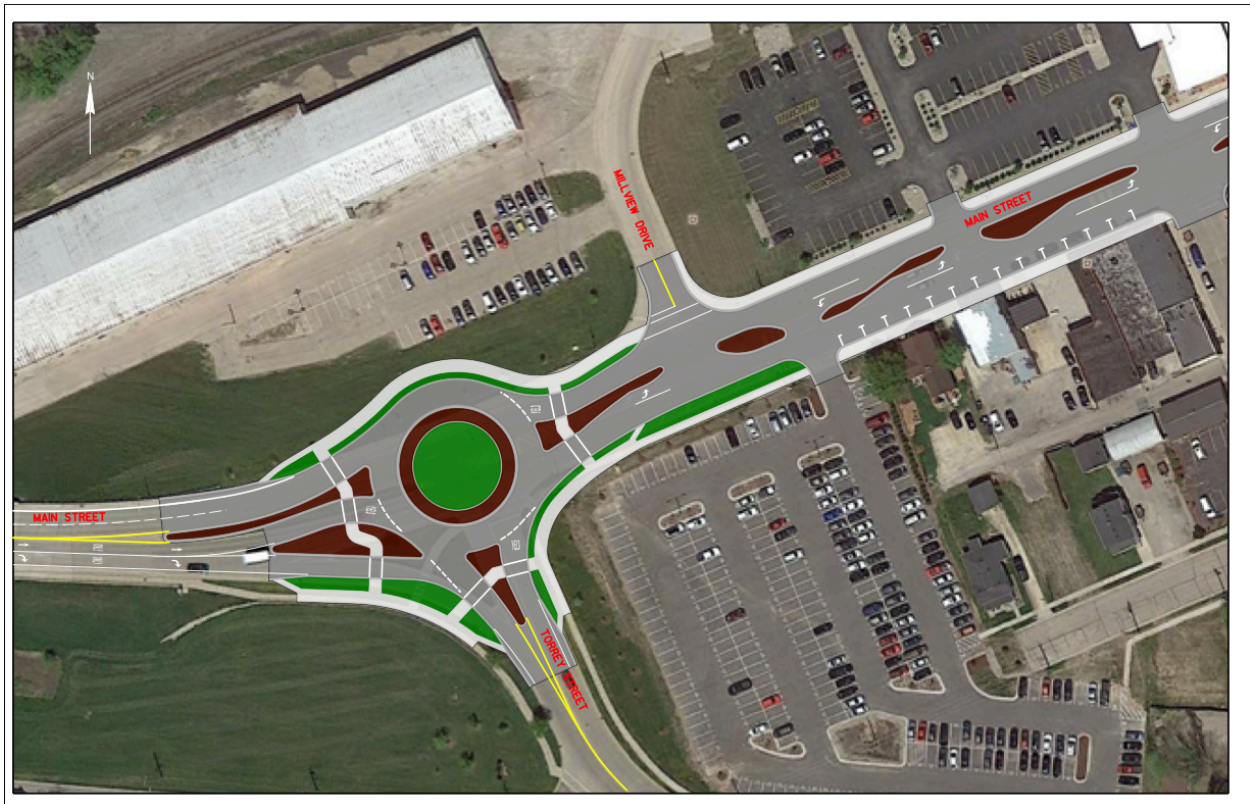


Table 8 summarizes year 2020 operation of a single lane roundabout at the Main Street intersection with Torrey Street with and without implementation of any Main Street traffic taming improvements.

**Table 8: Year 2020 Single Lane Roundabout Operation Without and With Main Street Traffic Taming**

• **Year 2020 Without Main Street Traffic Taming**

2020 Existing AM Peak Hour Traffic Operations - Main St. Roundabout 1 WB Lane										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL	WBT	NBL	NBR		
Torrey Street	Rdbt	LOS	B	A	A	A	A	B		
		Delay (sec)	13.3	5.8	8.4	8.6	10.1			
		Queue (ft)	175'	60'	75'	25'	--			
* EB movement has an EBR bypass lane										
2020 Existing PM Peak Hour Traffic Operations - Main St. Roundabout 1 WB Lane										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL	WBT	NBL	NBR		
Torrey Street	Rdbt	LOS	A	A	C	A	C			
		Delay (sec)	7.2	5.1	24.3	6.0	15.4			
		Queue (ft)	75'	25'	325'	25'	--			
* EB movement has an EBR bypass lane										

• **Year 2020 With Main Street Traffic Calming**

2020 Proposed Traffic Taming AM Peak Hour Traffic Operations - Main St. Roundabout 1 WB Lane										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL	WBT	NBL	NBR		
Torrey Street	Rdbt	LOS	A	A	A	A	A			
		Delay (sec)	8.8	8.2	7.8	9.4	8.5			
		Queue (ft)	100'	75'	50'	50'	--			
* EB movement has an EBR bypass lane										
2020 Proposed Traffic Taming PM Peak Hour Traffic Operations - Main St. Roundabout 1 WB Lane										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL	WBT	NBL	NBR		
Torrey Street	Rdbt	LOS	A	A	C	A	B			
		Delay (sec)	5.9	6.2	21.2	8.7	12.4			
		Queue (ft)	50'	50'	225'	50'	--			
* EB movement has an EBR bypass lane										

As shown on Table 8, it can be expected that a single lane roundabout will operate satisfactorily in the Year 2020 with all approaches at LOS 'C' or better with and without traffic taming induced travel pattern changes.

Table 9 summarizes year 2040 intersection operation with and without implementation of Main Street traffic taming improvements.

**Table 9: Year 2040 Single Lane Roundabout Operation Without and With Main Street Traffic Taming**

- Year 2040 Without Traffic Taming**

2040 Existing AM Peak Hour Traffic Operations - Main St. Roundabout 1 WB Lane									
Scenario	Control	MOE	Movement						OVERALL
			EBT	EBR	WBL	WBT	NBL	NBR	
Torrey Street	Rdbt	LOS	C	A	A	A	A	B	
		Delay (sec)	16.5	6.2	9.3	9.7	12.0		
		Queue (ft)	225'	50'	100'	25'	--		

\* EB movement has an EBR bypass lane

2040 Existing PM Peak Hour Traffic Operations - Main St. Roundabout 1 WB Lane									
Scenario	Control	MOE	Movement						OVERALL
			EBT	EBR	WBL	WBT	NBL	NBR	
Torrey Street	Rdbt	LOS	A	A	E	A	C		
		Delay (sec)	7.9	5.3	39.7	6.5	23.5		
		Queue (ft)	75'	50'	475'	25'	--		

\* EB movement has an EBR bypass lane

- Year 2040 With Main Street Traffic Calming**

2040 Proposed Traffic Taming AM Peak Hour Traffic Operations - Main St. Roundabout 1 WB Lane									
Scenario	Control	MOE	Movement						OVERALL
			EBT	EBR	WBL	WBT	NBL	NBR	
Torrey Street	Rdbt	LOS	B	A	A	B	B		
		Delay (sec)	11.2	9.9	9.7	12.9	10.7		
		Queue (ft)	125'	125'	75'	75'	--		

\* EB movement has an EBR bypass lane

2040 Proposed Traffic Taming PM Peak Hour Traffic Operations - Main St. Roundabout 1 WB Lane									
Scenario	Control	MOE	Movement						OVERALL
			EBT	EBR	WBL	WBT	NBL	NBR	
Torrey Street	Rdbt	LOS	A	A	F	B	D		
		Delay (sec)	6.9	7.4	66.8	11.3	31.3		
		Queue (ft)	50'	75'	550'	100'	--		

\* EB movement has an EBR bypass lane

As shown on Table 9, by the Year 2040, the southbound Main Street roundabout approach can be expected to operate at LOS 'E' without Main Street traffic taming and at LOS 'F' with traffic taming during the evening peak hour. All other peak hour traffic movements are at LOS 'C' or better in the year 2040.

- Dual Southbound Lane Roundabout**

A dual southbound lane roundabout design was evaluated to resolve the expected poor year 2040 evening peak hour operation of the single lane roundabout design. Figure 9 shows the conceptual design for a dual southbound lane roundabout.



**Figure 9: Dual Southbound Lane Roundabout Conceptual Design**



It is noted that the dual southbound lane roundabout encroaches on potential future development right-of-way along the west side of Main Street. An option to the design shown in Figure 9 would be to realign a portion of Main Street resulting in the roundabout being located in the parking lot area adjacent to the east side of Torrey Street as shown in Figure 10. This design is shown to provide an option for roundabout location to minimize right-of-way impacts along the westside of Main Street. It is expected the impact on Main Street alignment continuity could significantly reduce traffic exposure to businesses located along Wisconsin Avenue.



**Figure 10: Main Street Alignment Reconstruction Option for a Dual Southbound Lane Roundabout**

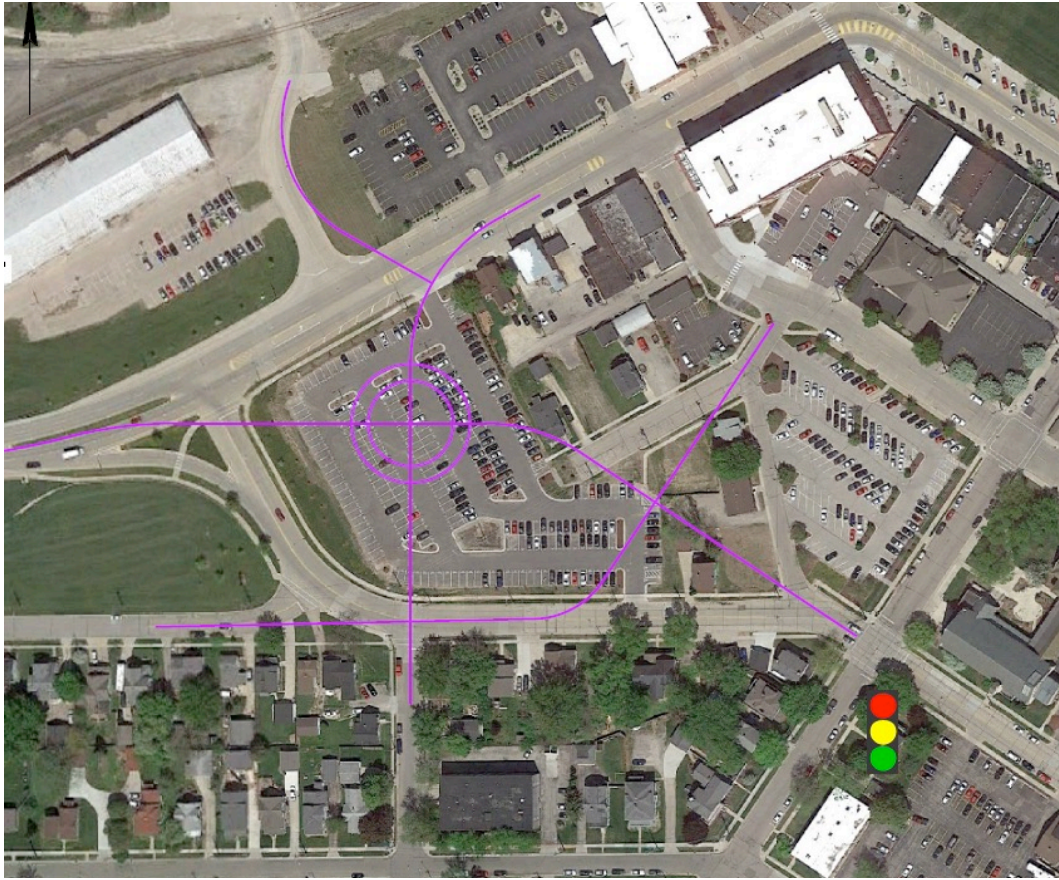


Table 11 summarizes year 2020 peak hour traffic operation of a dual southbound lane roundabout with and without implementation of Main Street traffic taming improvements.

**Table 11: Year 2020 Peak Hour Operation of a Dual Southbound Lane Roundabout Without and With Main Street Traffic Taming Improvements**

- Year 2020 Without Main Street Traffic Taming**

2020 Existing AM Peak Hour Traffic Operations - Main St. Roundabout 2 WB Lane										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL/WBT	WBT	NBL	NBR		
Torrey Street	Rdbt	LOS	B	A	A	A	A	A	A	A
		Delay (sec)	13.3	5.8	8.5	5.5	8.6	8.6	9.7	
		Queue (ft)	175'	50'	50'	25'	25'	25'	--	
* EB movement has an EBR bypass lane										
2020 Existing PM Peak Hour Traffic Operations - Main St. Roundabout 2 WB Lane										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL/WBT	WBT	NBL	NBR		
Torrey Street	Rdbt	LOS	A	A	A	A	A	A	A	A
		Delay (sec)	7.2	5.1	7.4	8.2	6.0	6.0	7.1	
		Queue (ft)	75'	25'	50'	75'	25'	25'	--	
* EB movement has an EBR bypass lane										

- Year 2020 With Main Street Traffic Taming**

2020 Proposed Traffic Taming AM Peak Hour Traffic Operations - Main St. Roundabout 2 WB Lane										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL/WBT	WBT	NBL	NBR		
Torrey Street	Rdbt	LOS	A	A	A	A	A	A	A	A
		Delay (sec)	8.8	8.2	8.2	5.5	9.4	9.4	8.3	
		Queue (ft)	100'	75'	50'	25'	50'	50'	--	
* EB movement has an EBR bypass lane										
2020 Proposed Traffic Taming PM Peak Hour Traffic Operations - Main St. Roundabout 2 WB Lane										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL/WBT	WBT	NBL	NBR		
Torrey Street	Rdbt	LOS	A	A	A	A	A	A	A	A
		Delay (sec)	5.9	6.2	8.0	8.8	8.7	8.7	7.5	
		Queue (ft)	50'	50'	50'	75'	50'	50'	--	
* EB movement has an EBR bypass lane										

As shown on Table 11, all Year 2020 peak hour traffic movements are expected to operate at LOS 'B or better' with and without the implementation of Main Street traffic calming improvements.

Table 12, summarizes year 2040 peak hour traffic operation of a dual westbound lane roundabout with and without implementation of Main Street traffic taming improvements.

**Table 12: Year 2040 Peak Hour Operation of a Dual Westbound Lane Roundabout Without and With Main Street Traffic Taming Improvements**

• **Year 2040 Without Main Street Traffic Taming**

2040 Existing AM Peak Hour Traffic Operations - Main St. Roundabout 2 WB Lane										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL/WBT	WBT	NBL	NBR		
Torrey Street	Rdbt	LOS	C	A	A	A	A			B
		Delay (sec)	16.5	6.2	9.1	5.8	9.7			11.5
		Queue (ft)	225'	50'	50'	50'	25'			--
* EB movement has an EBR bypass lane										
2040 Existing PM Peak Hour Traffic Operations - Main St. Roundabout 2 WB Lane										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL/WBT	WBT	NBL	NBR		
Torrey Street	Rdbt	LOS	A	A	A	A	A			A
		Delay (sec)	7.9	5.3	8.2	9.2	6.5			7.8
		Queue (ft)	75'	50'	75'	75'	25'			--
* EB movement has an EBR bypass lane										

• **Year 2040 With Main Street Traffic Calming**

2040 Proposed Traffic Taming AM Peak Hour Traffic Operations - Main St. Roundabout 2 WB Lane										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL/WBT	WBT	NBL	NBR		
Torrey Street	Rdbt	LOS	B	A	A	A	B			B
		Delay (sec)	11.2	9.9	9.3	6.3	12.9			10.3
		Queue (ft)	125'	125'	50'	25'	75'			--
* EB movement has an EBR bypass lane										
2040 Proposed Traffic Taming PM Peak Hour Traffic Operations - Main St. Roundabout 2 WB Lane										
Scenario	Control	MOE	Movement						OVERALL	
			EBT	EBR	WBL/WBT	WBT	NBL	NBR		
Torrey Street	Rdbt	LOS	A	A	B	B	B			A
		Delay (sec)	6.9	7.4	10.5	11.9	11.3			9.6
		Queue (ft)	50'	75'	75'	100'	100'			--
* EB movement has an EBR bypass lane										

As shown on Table 12, without implementation of Main Street traffic taming improvements, all approaches of a dual southbound lane roundabout are expected to operate LOS 'A' except for the northbound through movement which operates at LOS 'C' during the morning peak hour in the Year 2040. In comparison, implementation of Main Street traffic calming induced traffic pattern redirection will result in all dual southbound lane roundabout movements operating at LOS 'B' or better through the Year 2040.

## Summary of Findings

1. In 2019 Main Street carried 13,400 vpd south of Torrey Street and 9,600 vpd north of Torrey Street. Torrey Street carried 2,500 vpd west of Church Street. It is projected that traffic levels on the downtown Neenah street network may increase at an annual rate of 0.5% per year.
2. It is projected that traffic levels on the Main Street segment north of Torrey Street and on Wisconsin Avenue can be expected to distribute 20% of its volume to the Torrey Street/Columbian Avenue route with the implementation of Main Street traffic taming improvements.
3. During the 5-year time period between 2015 and 2019 there were only 2 motor vehicle crashes reported at the Main Street intersection with Torrey Street indicating the intersection is relatively safe compared to many other urban arterial street intersections.

## Intersection Control Evaluation Options

- **Stop Sign Control:** The existing Stop sign control of the Main Street intersection with Torrey Street currently operates with the northbound approach of Torrey Street at LOS 'F'. This LOS through the year 2040 will result in a maximum queuing of 250 feet with average peak hour vehicle delays exceeding 200 seconds. With traffic pattern changes attributed to Main Street traffic taming it is projected that the Torrey Street intersection approach will also operate at LOS 'F' with average vehicle delays exceeding 800 seconds and queues exceeding 1,000 feet. Therefore, this intersection control option is not considered a viable option for continued intersection operation.
- **Traffic Signal Control:** Without implementation of Main Street traffic taming improvements, the Main Street intersection with Torrey Street does not satisfy the MUTCD Warrants for the Installation of Traffic Signals through the Year 2040.

With potential traffic redistribution to Torrey Street/Columbian Avenue attributed to the implementation of Main Street traffic taming improvements, the Main Street intersection with Torrey Street can be expected to satisfy the traffic signal installation Warrants during the Years 2020 through 2040.

Operation of a traffic signalized intersection results in all peak hour traffic movements operating at LOS 'D' or better. Even though average vehicle delays are not expected to exceed 50 seconds, maximum westbound queues on Torrey Street may approach 350 feet by the year 2040.

- **Roundabout Control:** With and without the implementation of Main Street traffic taming improvements, construction of a single lane roundabout can be expected to result in the southbound approach of Main Street operating at LOS 'C' in the year 2020. However, by the year 2040 operation of the southbound approach of Main Street without Main Street traffic taming is expected to worsen to LOS 'E' and with traffic taming is expected to operate at LOS 'F'. Therefore, a single lane roundabout is not considered a viable option.

In comparison, construction of a dual southbound lane roundabout without implementation of Main Street traffic taming improvements in the year 2020 is expected to operate with all approaches at LOS 'A' except for the northbound approach which would operate at LOS 'B'. With traffic taming in 2020, all roundabout approaches are expected to operate at LOS 'A'. In the Year 2040, without traffic taming improvements all roundabout movements are

expected to operate at LOS 'A' except for the northbound through movement which would operate at LOS 'C'. With traffic taming implementation, all roundabout traffic movements are expected to operate at LOS 'A' except for the northbound through movement which would operate at LOS 'B'. or better in the Year 2040.

## **Recommendation**

Based on the detailed analysis of intersection control device findings, it is recommended to construct a dual southbound lane roundabout at the Main Street intersection with Torrey Street. Construction of a roundabout is compatible with future Main Street traffic taming improvements and has the added ability to create a 'gateway' entrance to downtown Neenah. It is recognized that this roundabout design will impact existing Main Street right-of-way and potential future development sites adjacent to the Torrey Street intersection.

Detailed roundabout design will be required to identify right-of-way impacts, safe Main Street driver sight distance requirements, utility impacts and implementation cost estimates.