DEPARTMENT OF TRANSPORTATION

Traffic Safety Evaluation of Pedestrians and Bicyclists at Roundabouts in Minnesota

Mark Wagner
Office of Traffic Engineering
Minnesota Department of Transportation

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Final Report 2023-36

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By the end of 2022, nearly 450 roundabouts were installed on Minnesota roadways. An evaluation of traffic safety at roundabouts published by MnDOT in 2017 showed substantial decreases in fatal and serious injury crashes for all users at intersections after installation of a roundabout. The safety effects of roundabouts are largely due to geometric design practices that reduce the speed of motorized vehicles as they approach and travel through the intersection. The purpose of this evaluation is to determine if the safety effects seen in the 2017 evaluation still apply to roundabouts with higher levels of use by pedestrians and bicyclists. This evaluation conducts a before-after analysis of 95 roundabouts in Minnesota and an analysis comparing roundabouts to untreated intersections. With the installation of a roundabout, this study finds that the before-after analysis results in a 40% decrease in all severity injury crashes for all roadway users, a 70% decrease in fatal and serious injury crashes for bikes and pedestrians, and a 15% decrease in total pedestrian bike and pedestrian crashes. The results of the comparison analyses suggest roundabouts have better safety performance than through-stop and traffic signal-controlled intersections and similar safety performance to locations with all-way stop control. The results of this evaluation thus indicate that roundabouts can be an effective safety treatment for pedestrian and bicycle crashes.

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Traffic Safety Evaluation at Roundabouts in Minnesota

Final Report

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List of Abbreviations & Definitions of Terms

Acronym	Meaning
FARS	Fatality Analysis Reporting System
KA	Fatal and/or Serious Injury Crash
MEV	Million Entering Vehicles
MnDOT	Minnesota Department of Transportation
NHTSA	National Highway Traffic Safety Administration

Crash Severities

- K Crash: Fatal crash. At least one person involved in the crash died because of injuries sustained in the crash.
- A Crash: Suspected serious injury crash. The crash resulted in a suspected serious injury for at least one person involved in the crash.
- B Crash: Suspected minor injury crash. The crash resulted in a suspected minor injury for at least one person involved in the crash.
- C Crash: Possible injury crash. The crash resulted in a possible injury for at least one person involved in the crash.
- N Crash: Property damage only crash. The crash resulted in property damage with no injuries for anyone involved in the crash.

Other Definitions:

- Site-Year: One year of data at a site.
- Urban: For the purposes of this evaluation, urban includes the area within incorporated city limits or and area that is sufficiently developed so as to be similar

Executive Summary

By the end of 2022, nearly 450 roundabouts were constructed on Minnesota roadways. Roundabouts are a type of circular intersection defined by the presence of a central island, counterclockwise circulation of traffic, and yield control of entering vehicles. Roundabouts provide safety benefits by using geometric design to reduce vehicle speeds and splitter islands to separate entering and exiting traffic, by providing refuge areas for pedestrians, and by reducing the number of points within an intersection in which vehicle paths might intersect (aka conflict points). Modern roundabouts have been shown to be safer than other methods of control for at-grade intersections. An evaluation of traffic safety at roundabouts published by MnDOT in 2017 shows substantial decreases in fatal and serious injury crashes at intersections after installation of a roundabout. While the safety benefits of roundabouts for vehicular traffic are well-established, the purpose of this evaluation is to determine whether the same benefits extend to non-motorized users such as pedestrians and bicyclists at roundabouts in Minnesota. This report includes the results of a before-after analysis at urbanized roundabouts in Minnesota and a cross-sectional analysis comparing roundabouts to untreated intersections.

With the construction of a roundabout at an intersection, the before-after analysis yielded the following results:

- 40% decrease in all severity injury crashes for all roadway users*
- 70% decrease in fatal and serious injury crashes for pedestrians**
- 15% decrease in total pedestrian bike and pedestrian crashes

* = significant at p=0.01; ** = nearly significant at p=0.10 (p value = 0.11)

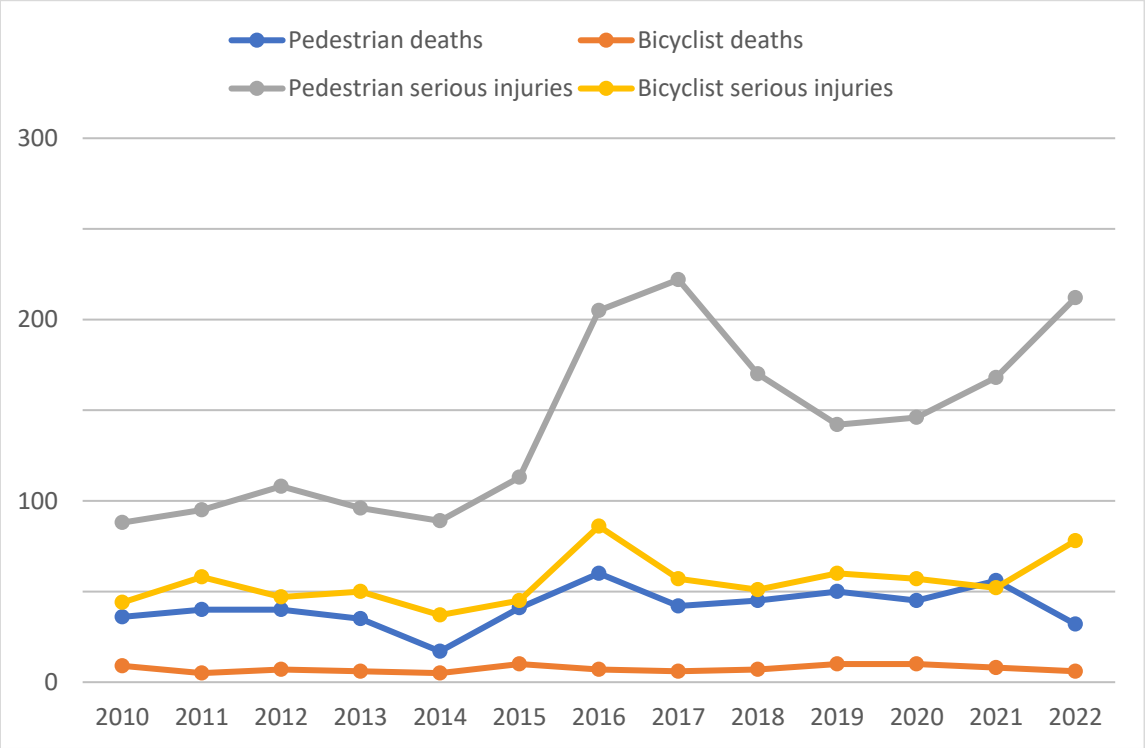
The comparison analyses showed that roundabouts have lower fatal, suspected serious injury, and suspected minor injury crashes than urban traffic signals with similar safety performance between roundabouts, all-way stop, and thru-stop intersections in urbanized areas.

The results of this evaluation indicate that conversion of an intersection to roundabout control confers significant safety benefits and that roundabouts continue to be one of the safest forms of intersection control for pedestrians and bikes, especially when compared to other forms of control such as a traffic signal. These results are consistent with the safety goals of roundabouts as well as with the previous evaluation of roundabouts in Minnesota. Though roundabouts are not causing significant changes in total bicycle and pedestrian crashes, there is a severity shift that is resulting in a decrease in high-severity crashes.

Chapter 1: Introduction

Nationwide, the number of people killed walking and biking has steadily increased since 2009. That year, 4,109 pedestrians and 628 bicyclists died in traffic crashes. The most recent data available in Fatality Analysis Reporting System (FARS) for the year 2020 counts 6,516 pedestrians and 938 bicyclist deaths, increases of 59% and 49%, respectively, in just over a decade. Preliminary data for 2021 indicate that this upward trend is likely to continue. According to early estimates from the Governors Highway Safety Association (GHSA) released in May 2022, 7,485 people walking were struck and killed in 2021, the highest number in 40 years.

Over the same period, Minnesota experienced a similar trend in pedestrian and bicycle fatalities and serious injuries. According to the Minnesota Motor Vehicle Crash Facts for 2020, published by the Minnesota Department of Public Safety (DPS), the annual totals for the number of pedestrian-involved vehicle crashes in Minnesota exceeded 1,000 incidents multiple times in recent years.[1][1] Figure 1.1 shows how the number of deaths and serious injuries involving pedestrians and bicyclists have steadily increased from 174 in 2010 to 322 in 2022.



Note: Changes in crash severity criteria and transition to a new database caused a spike in reported serious injury crashes in 2016.

Figure 1.1 – Pedestrian and Bicyclist Fatalities and Serious Injuries, 2010-2022

[1]Source: https://dps.mn.gov/divisions/ots/reports-statistics/Documents/CFmod_2021_Doc.pdf

To support the safety of all those traveling on Minnesota roads, the Strategic Highway Safety Plan (SHSP) lists pedestrian and bicyclist crashes as two of its identified focus areas for transportation safety improvements. One of the improvements available to engineers and transportation practitioners in Minnesota is the roundabout.

Roundabouts are a type of circular intersection defined by the presence of a central island, counterclockwise flow of traffic, and yield control of entering vehicles. Other types of circular intersections commonly seen in the United States include rotaries, signalized traffic circles, and neighborhood traffic circles. A brief description of each type, and how they differ from roundabouts, is below:

- Rotaries are an older style of circular intersection popular until the 1960s. They feature large diameters, weaving sections between legs, and typically require lane changes within the rotary for some movements. Some operate with circulating traffic yielding to entering traffic as well, in direct contrast to the roundabout.
- Signalized traffic circles are another older style of circular intersection in which traffic signals control some or all the points of entry to the circulatory roadway. As a result, traffic regularly queues in the circulatory roadway and approach legs.
- Neighborhood traffic circles are usually constructed at the intersection of two or more local streets for traffic calming or aesthetic reasons. The approaches may be uncontrolled or yield- or stop-controlled, and they do not include the channelization features of modern roundabouts.

The first roundabout in Minnesota was installed in 1995 at the intersection of Setzler Parkway, Neddersen Parkway, and Founders Parkway in Brooklyn Park. Since then, nearly 450 more have been constructed in the state[2]. They have become increasingly accepted as an intersection type by traffic engineers, elected officials, and the public. Roundabouts are considered an appropriate alternative in a variety of contexts including urban, suburban, and rural locations; at low- and high-volume locations; as gateway treatments for school zones; and at interchange ramp terminals. Figure 1.2 shows a sample layout of a roundabout intersection.

[2] Source: Roundabouts Database Home (kittelson.com)

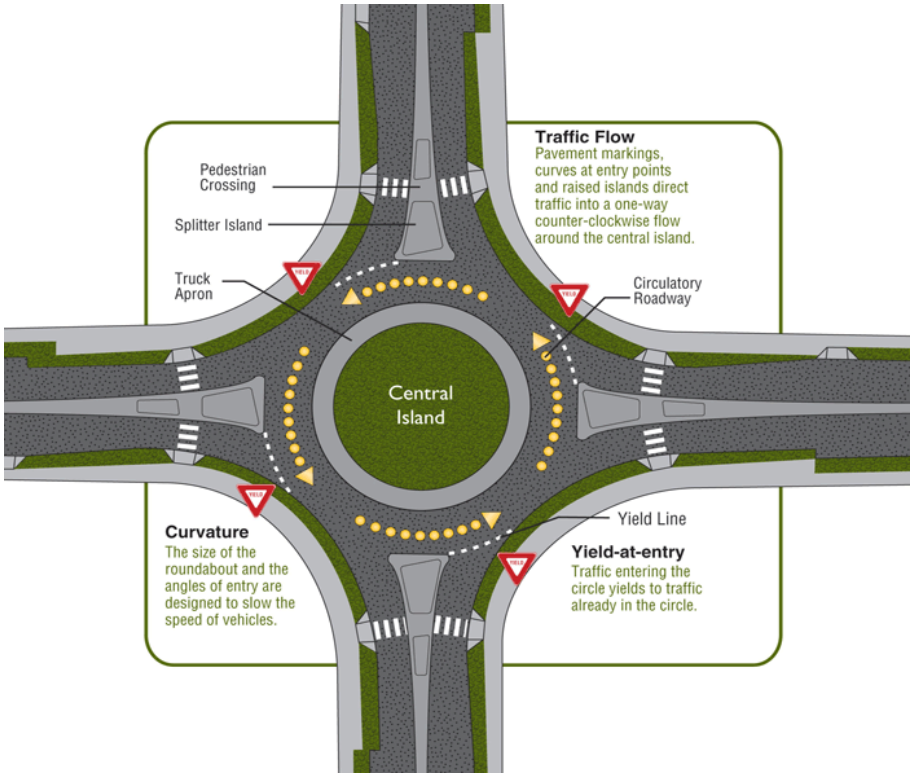


Figure 1.2 – Sample Roundabout Intersection

Modern roundabouts have been shown to be safer than other methods of control for at-grade intersections.[3] Roundabouts provide safety benefits by using geometric design to reduce vehicle speeds and splitter islands to separate entering and entering traffic, by providing refuge areas for pedestrians, and by reducing the number of points within an intersection in which vehicle paths might intersect. By eliminating the option for vehicles approaching the intersection to travel straight through the middle of the intersection, the overall likelihood of right-angle crashes at a roundabout is greatly reduced. Right-angle crashes, commonly referred to as T-bone crashes, often have severe outcomes.

An evaluation of traffic safety at roundabouts published by MnDOT in 2017[4] showed an 86% decrease in the fatal crash rate and an 83% reduction in the serious injury crash rate at intersections after installation of a roundabout. The report also noted that, as of its publishing, there had not been a multi-vehicle fatality at a roundabout in Minnesota. Through September 2023, this statement remained true.

While the safety benefits of roundabouts for vehicular traffic have been well-established, concerns regarding the safety of pedestrians and bicyclists have been raised by citizens, MnDOT staff, and other external agencies. A 2018 addendum[5] to the 2017 MnDOT evaluation reviewed crashes involving

[3] NCHRP 672
[4] A Study of the Traffic Safety at Roundabouts in Minnesota 2017
[5] Addendum to A Study of the Traffic Safety at Roundabouts in Minnesota 2017

pedestrians and bicycles at 126 roundabouts from 2006 to 2017 and found that they do not present a greater overall risk to pedestrians and bicyclists. Crash analysis in the addendum showed 58% and 4% reductions in pedestrian and bicycle crash rates, respectively, as well as 64% and 16% reductions in pedestrian and bicycle crash density, respectively.

The purpose of this evaluation is to further evaluate the safety of non-motorized users at roundabouts in urbanized areas, where pedestrian and bicycle activity is likely to be higher, to determine whether the benefits identified in previous research are still applicable at roundabouts in Minnesota. This report includes the results of a before-after analysis at urbanized roundabouts in Minnesota and a series of analyses comparing roundabouts to urban signalized, all-way stop control, and thru-stop control intersections.

Chapter 2: Methodology

2.1 Locations

An inventory of roundabouts to be used for site selection was obtained from Kittelson & Associates in April 2022. Neighborhood traffic circles and rotaries were excluded from the inventory. The data provided by Kittelson contained attributes for nearly 450 roundabouts constructed between 1995 and 2021. From this inventory, locations for this evaluation were chosen based on the following criteria:

1. The year of completed construction was 2018 or prior.
2. The location was within incorporated city limits.
3. The density of adjacent land uses, based on the Florida DOT Context Classification Guide.
    a. The Context Classification Guide contains six land use contexts, sorted below from most to least preferred for the purposes of this evaluation:
        i. C6-Urban Core
        ii. C5-Urban Center
        iii. C4-Urban General
        iv. C2T-Rural Town
        v. C3R-Suburban Residential
        vi. C3C-Suburban Commercial (only included nearby roundabouts in special cases)
    b. Roundabouts in denser, more urbanized areas were preferred as this is where one would expect to see the highest volumes of people biking and walking.
4. Proximity to a school site with pedestrian and bike path connections.
5. Proximity to popular walking and biking routes such as the Gateway State Trail, Paul Bunyan State Trail, etc.

To be included in the evaluation, roundabout sites had to meet criteria #1 plus any of #2-5. From the original group of about 400 roundabouts, 95 roundabouts were selected for this evaluation. Appendix A lists traits and locations for each of the roundabouts in Minnesota selected for this evaluation. A map of these locations is shown in Figure 2.1.

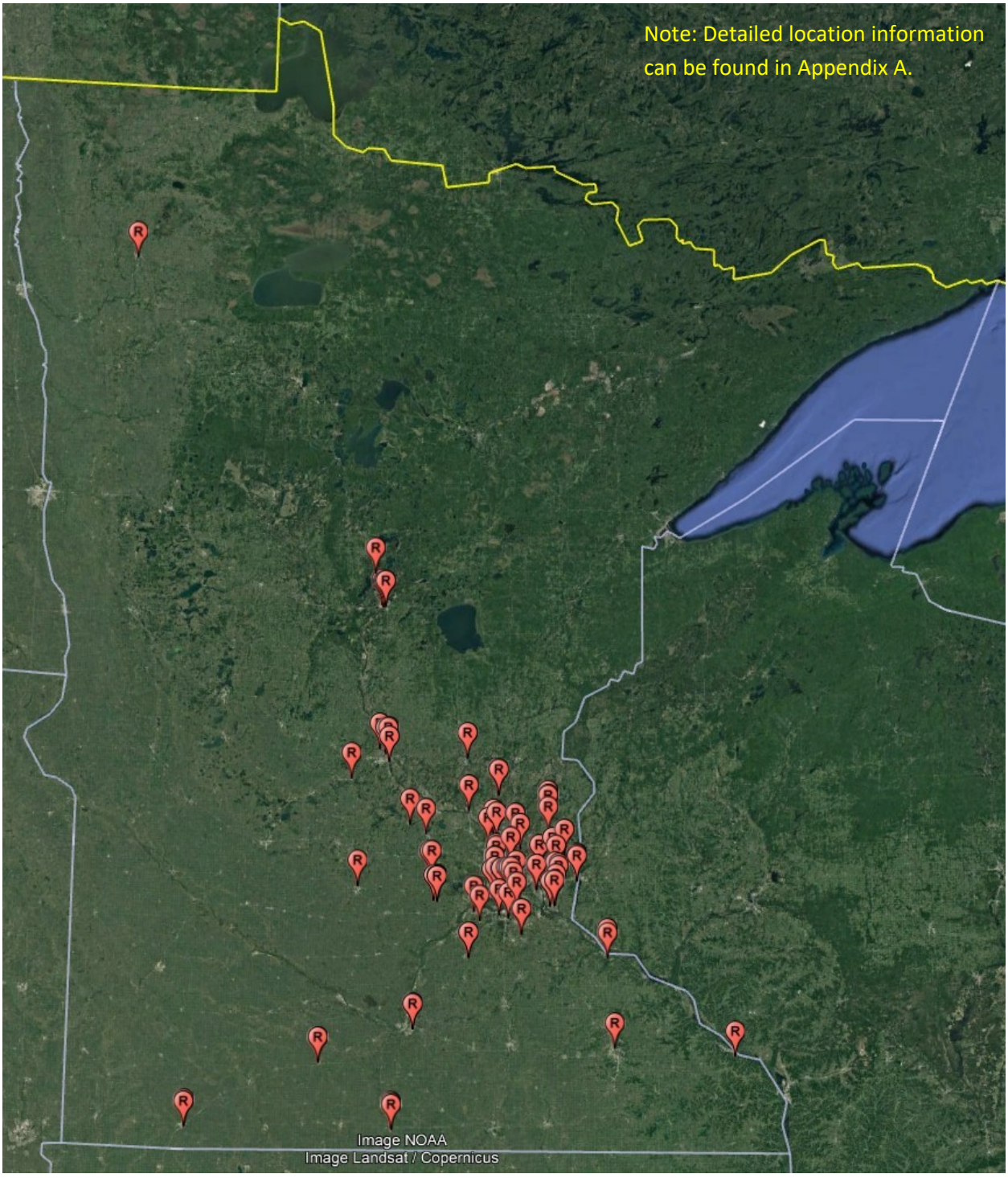


Figure 2.1 - Roundabout Locations

2.2 Crash Data

For this evaluation, crash data for the years 1998 through 2021 was collected for the roundabout sites and for the years 2016 through 2021 for the urban traffic signal and stop controlled intersection control sites. The analysis in this evaluation was conducted in 2022, so the most recent year of data analyzed is 2021 as there was not a full year of data for 2022 at the time of analysis. For the roundabout sites, the period of construction at each location is not included in the analysis.

Consideration was given to excluding the years 2020 and 2021 from the analysis due to the changes in travel patterns brought about by the COVID-19 pandemic but eventually the decision was made to include these years. We would not expect changes in travel patterns and safety to impact roundabouts differently than other intersections, so the transition from 2019 to 2020 and the ensuing spike in crashes provided a natural experiment to evaluate if any form of intersection control in this analysis had better safety performance than others during a time when fatal and serious injury crashes spiked.

Crash data for the applicable years was collected spatially at each location. At locations where there is an existing roundabout, and at the urban stop-controlled intersection control sites, the crashes located within 300 feet of the intersection associated with the approach legs were included. At urban traffic signal control sites crashes located within 500 feet of the intersection on all approaches were included. Crashes in this evaluation were analyzed by density (crashes per site-year) and rate (crashes per million entering vehicles).

Detailed crash counts by year and severity at each roundabout location can be seen in Appendix B. Detailed crash numbers by year and severity at control site intersections can be seen in Appendix C. Appendix D highlights all fatal and suspected serious injury crashes that have occurred at roundabouts in Minnesota since the first on was built in 1995.

2.3 Analysis Types Overview

Three different analysis types are conducted in this evaluation. Those types are:

A longitudinal analysis of locations with a roundabout.

This analysis focuses on 95 of the existing roundabout locations comparing the crashes in a period before roundabout construction to a period after roundabout construction. The before and after periods for each site include the same number of years.

A comparison to locations with urban traffic signals.

This analysis compares crash data for the years 2016-2021 at the 95 existing roundabouts described in Section 2.1 to 93 similar urban locations with traffic signals.

A comparison to urban thru-stop and all-way stop intersections.

This analysis compares the crash data for the years 2016-2021 at the 95 existing roundabouts described in Section 2.1 to a cohort of 276 urban thru-stop and all-way stop intersections. Sites for the cohort were selected from all thru-stop and all-way stop intersections statewide within the incorporated limits of a city.

Chapter 3: Results

3.1 Before-After Analysis

The before-after analysis compares crash data at existing roundabout locations before the roundabout was installed and after the roundabout was installed. Crashes that occurred during the year of construction were removed from the analysis.

3.1.1 Question Addressed

How do crashes change after a roundabout is installed at a location?

3.1.2 Locations

The analysis for this evaluation was conducted in the year 2022. The intent of the analysis was to use a minimum of three years each of before and after data. Therefore, there is not sufficient "after" data for roundabouts constructed from 2019 through 2022. Those locations are therefore not utilized in the analysis as treatment sites.

As described in the Analysis Types Overview portion of this report, 95 roundabout locations were identified that met the selection criteria and have at least three site-years of before and three site-years of after data. The number of before and after years varied by site. The set of 95 roundabouts has a total of 1,383 site-years of before data and 779 site-years of after data. Figure 3.1 shows the locations of the included sites.

Table 3.1 – Treatment Site Information Summary

Feature	Value	Location (If Applicable)
Average Entering Volume	10,332 vehicles per day	
Highest Entering Volume	28,220 vehicles per day	TH 22 / CSAH 17 / Madison Avenue Mankato, Blue Earth County
Lowest Entering Volume	785 vehicles per day	Community Drive & Wildcat Way Waconia, Carver County
Previous Traffic Control Device	25 signal, 13 AWS, 53 TWS, 4 None or Unknown	
Number of Approach Legs	3 5-legs, 69 4-legs, 23 3-legs	

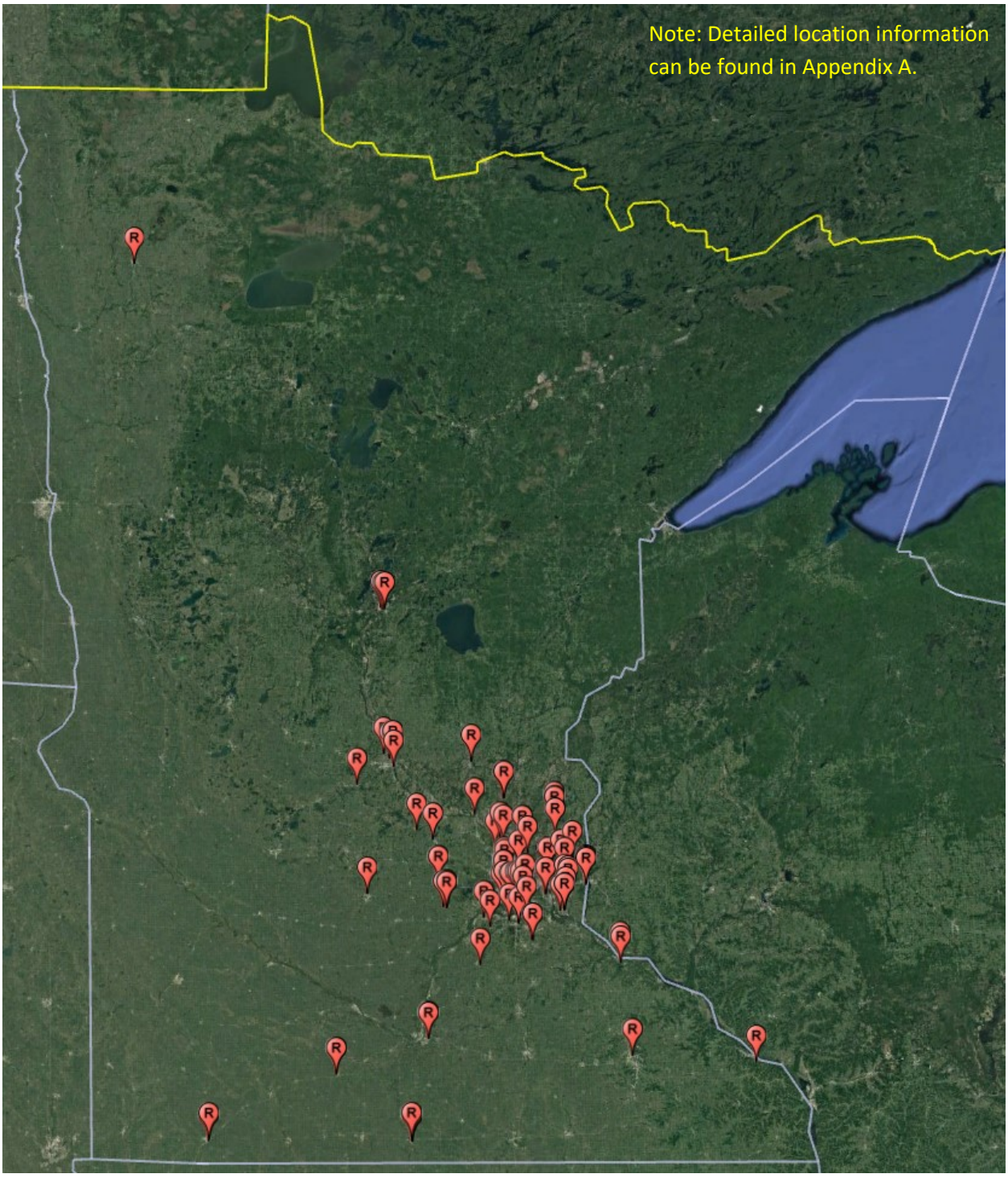


Figure 3.1 – Locations for Before-After Analysis

3.1.3 Crash Data

The before-after crash data at the 95 roundabout locations was collected and compiled. Tables 3.1 through 3.4 show that compiled crash data. Before-after crash data was analyzed at each roundabout site using all Before and After years and by matching the number of Before and After years. Taking site #1 as an example, the 'all years' scenario would include 1998-2017 data in the before period and 2019-2021 data in the after period whereas the 'matched years' scenario would include 2015-2017 data in the before period and 2019-2021 data in the after period. It's worth noting that, in this example, the long before period introduces some uncertainty due to shifting crash collection tools over the years.

Crash data for both Before-After scenarios was analyzed by crash density and crash rate. As mentioned above, the roundabout locations had a total of 1,383 site-years in the before period and 779 site-years in the after period. The total entering volumes (sum of daily volumes at each site) were calculated to be 5.79 billion vehicles in the before period and 3.20 billion vehicles in the after period. Crash density, in units of crashes per site-year, for the before-after scenarios are included in Tables 3.2 and 3.3. Crash rates, in units of crashes per million entering vehicles (MEV), for the before-after scenarios are included in Table 3.4 and 3.5.

Table 3.2 - Before-After Crash Density – All Years

Before-After Bike & Pedestrian Crash Density - All Years									
Time Period	Metric	K	A	KA	B	C	PDO	Total	Site Years
Before	# of Crashes	1	13	14	41	49	3	107	1383
Before	Crashes/Site-Year	0.001	0.009	0.010	0.030	0.035	0.002	0.077	
After	# of Crashes	1	2	3	26	19	7	55	779
After	Crashes/Site-Year	0.001	0.003	0.004	0.033	0.024	0.009	0.071	
% Change in Crash Density		0%	-73%	-62%	13%	-31%	314%	-9%	

* All Years includes all crash data before and after year of installation from 1998-2021.
* Example: Roundabout built in 2018 would have Before period from 1998-2017 and After period from 2019-2021.

Table 3.3 - Before-After Crash Density – Matched Years

Before-After Bike & Pedestrian Crash Density - Matched Years									
Time Period	Metric	K	A	KA	B	C	PDO	Total	Site Years
Before	# of Crashes	0	5	5	22	23	2	52	681
Before	Crashes/Site-Year	0.000	0.007	0.007	0.032	0.034	0.003	0.076	
After	# of Crashes	1	2	3	21	17	6	47	681
After	Crashes/Site-Year	0.001	0.003	0.004	0.031	0.025	0.009	0.069	
% Change in Crash Density		N/A	-60%	-40%	-4%	-26%	200%	-10%	

* Matched Years includes crash data for the same number of years before and after installation.
* Example: Roundabout built in 2018 would have Before period from 2015-2017 and After period from 2019-2021.

Table 3.4 - Before-After Crash Rates – All Years

Before-After Bike & Pedestrian Crash Rates - All Years									
Time Period	Metric	K	A	KA	B	C	PDO	Total	Entering Volume
Before	# of Crashes	1	13	14	41	49	3	107	5.99 billion
Before	Crashes / MEV	0.0002	0.002	0.002	0.007	0.008	0.001	0.0179	
After	# of Crashes	1	2	3	26	19	7	55	3.00 billion
After	Crashes / MEV	0.0003	0.001	0.001	0.009	0.006	0.002	0.0183	
% Change in Crash Rate		N/A	-69%	-57%	27%	-23%	366%	3%	

* All Years includes all crash data before and after year of installation from 1998-2021.
* Example: Roundabout built in 2018 would have Before period from 1998-2017 and After period from 2019-2021.

Table 3.5 - Before-After Crash Rates – Matched Years

Before-After Bike & Pedestrian Crash Rates - Matched Years									
Time Period	Metric	K	A	KA	B	C	PDO	Total	Entering Volume
Before	# of Crashes	0	5	5	22	23	2	52	2.90 billion
Before	Crashes / MEV	0.000	0.002	0.002	0.008	0.008	0.0007	0.0179	
After	# of Crashes	1	2	3	21	17	6	47	2.69 billion
After	Crashes / MEV	0.0004	0.001	0.001	0.008	0.006	0.0022	0.0175	
% Change in Crash Rate		N/A	-57%	-35%	3%	-20%	225%	-2%	

* Matched Years includes crash data for the same number of years before and after installation.
* Example: Roundabout built in 2018 would have Before period from 2015-2017 and After period from 2019-2021.

3.1.4 Crash Analysis

Using the before-after crash data, a Wilcoxon Signed Rank Test was used. This test assumes two dependent samples with independent observations but does not require normality in the data. The Wilcoxon Signed Rank Test tests the assumptions of a null hypothesis. For this analysis, the null hypothesis is that the median differences between the distribution of before-after crash rates is equal to zero (the two distributions are the same). The alternative hypothesis is that the median differences between the distribution of before-after crash rates is not equal to zero (the two distributions are different).

The analysis and testing were focused on five crash severities/types. These are based on both the expected benefits of roundabouts as well as commonly heard concerns about roundabouts. These focus types are listed below.

- Bike and pedestrian fatal (K) and suspected serious injury (A) crashes. Roundabouts are an alternative intersection that are intended to improve safety by reducing crashes with these serious outcomes.
- Bike and pedestrian suspected minor injury (B) crashes. The severity of pedestrian and bike crashes at an intersection is expected to decrease following the installation of a roundabout.

- Total crashes. Roundabouts are intended to reduce the most severe types of crashes at the intersections they are installed at, but not necessarily intended to reduce overall crashes.

The Wilcoxon Signed Rank Test results in a p-value which is compared to a predetermined threshold significance level of 0.05 in this case. When the p-value is below the significance level, the null hypothesis is rejected in favor of the alternative hypothesis suggesting there is a significant difference in the before-after results. The results are shown in Table 3.6 and 3.7.

Table 3.6 - Results of Wilcoxon Signed Rank Test for Before-After Analysis – All Years

Category	Change in Crash Density	p-value	Significant?	Change in Crash Rate	p-value	Significant?
K+A Crashes	-61.3%	0.003	Yes	-61.0%	0.002	Yes
Injury Crashes	-50.2%	0.000	Yes	-49.8%	0.000	Yes
Total Crashes	+14.1%	0.388	No	+14.9%	0.008	Yes
Ped+Bike K+A Crashes	-76.3%	0.080	No	-76.2%	0.011	Yes
Ped+Bike Injury Crashes	-17.3%	0.389	No	-16.7%	0.017	Yes
Ped+Bike Total Crashes	-7.9%	0.558	No	-7.2%	0.024	Yes

Table 3.7 - Results of Wilcoxon Signed Rank Test for Before-After Analysis – Matched Years

Category	Change in Crash Density	p-value	Significant?	Change in Crash Rate	p-value	Significant?
K+A Crashes	-48.4%	0.023	Yes	-46.4%	0.299	No
Injury Crashes	-42.1%	0.000	Yes	-39.9%	0.000	Yes
Total Crashes	+32.9%	0.740	No	+38.0%	0.755	No
Ped+Bike K+A Crashes	-71.4%	0.122	No	-70.3%	0.110	No
Ped+Bike Injury Crashes	-20.9%	0.487	No	-17.9%	0.446	No
Ped+Bike Total Crashes	-18.2%	0.591	No	-15.1%	0.607	No

In tables 3.6 and 3.7, the conversion of an intersection to roundabout control resulted in statistically significant decreases in fatal and serious injury crashes and all-severity injury crashes for all users. Though there was an increase in total crashes, this change was not found to be statistically significant. Looking at pedestrian and bike crashes specifically, the conversion of an intersection to roundabout control resulted in decreases in fatal and serious injury crashes, all-severity injury crashes, and total crashes but these changes were generally not statistically significant except when considering the reductions in crash rate under the 'All Years' scenario in Table 3.6. This may indicate that roundabouts remain a safe form of intersection control for bikes and pedestrians even as traffic volumes have increased over the past two decades, but further analysis accounting for the number of possible interactions between motorized and non-motorized users at any given site would provide greater certainty.

It is noted that the crash reporting system behind the crash data in Minnesota underwent changes in the beginning of 2016. While this upgrade improved the crash data system in many ways, a change in the percentage of injury severity crashes was found. Two injury severity definitions were changed to

align with national standard definitions, though the underlying scale used to rank crash severity remained unchanged.

- “A – Incapacitating injury” became “A – Suspected serious injury”
- “B – Non-incapacitating injury” became “B – Suspected minor injury”

As the result of these label changes, Minnesota experienced a dramatic increase in A and B severity crashes from 2015 to 2016 (increasing by 83% and 51% for A and B crashes, respectively). Based on this change, some of the locations in the before-after analyses may have been impacted. However, tables 3.6 and 3.7 show that fatal crashes and injury crashes of all severities experienced large decreases at the roundabout locations. This emphasizes the severity shift seen with the installation of a roundabout.

3.2 Comparative urban traffic signal Analysis

One of the typical alternatives to installation of a roundabout at urban locations is installation of a traffic signal. This analysis compares the crash data at signalized intersections with volumes and characteristics similar to what would be found at the roundabouts selected for this evaluation.

3.2.1 Question Addressed

How do crash rates and densities at roundabouts in urbanized areas compare with traffic signal control at similar locations?

3.2.2 Locations

For this comparison, all 95 roundabout treatment sites were included that had an existing roundabout during the 2019 through 2021 period allowing for at least three years of analysis data at each roundabout.

When determining control sites to be used in a comparison group against treatment sites, locations are typically chosen that have similar characteristics to the treatment sites. Signalized intersections were selected for this comparison group using the same criteria that were used to select roundabout locations for this evaluation, which can be found in section 2.1 of this report.

Efforts were made to find an appropriate "match" for each of the 95 roundabout sites but because traffic signals are usually installed at higher-volume intersections, appropriate comparisons were difficult to find for some of the lower volume roundabouts in the treatment group. The affected treatment sites are:

50. W 70th St / Galleria Central Entrance;

51. W 70th St / Galleria East Entrance;

52. W 70th St / Galleria West Entrance in Hennepin County

The lower traffic volumes and nearby land use made identification of suitable control sites difficult for this set of roundabout sites. Using Google Maps to browse for other retail-heavy corridors in the Twin Cities and other large cities across the state, two control sites were identified in southern Ramsey County: CSAH 42 / Finn Ave and CSAH 42 / Kenneth St in the Highland Park neighborhood of Saint Paul. Traffic volume on CSAH 42 (Ford Pkwy) at Finn Ave was higher than any of the individual treatment sites, but when the major road volumes were added together for treatment sites 50 and 51, the number was like the volume for the Finn Ave control site. Traffic volume for treatment site 52 and the CSAH 42 (Ford Pkwy) / Kenneth St control site more closely matched, so they were considered an appropriate pair for comparison. The treatment sites on W 70th St are in the Galleria retail area of Edina and the control sites were located on a retail-heavy corridor in Saint Paul. Considering the total traffic volume and similar adjacent land uses, the selection of two control sites for comparison with three treatment sites is considered appropriate.

81. Hadley Ave S / 95th St S in Washington County

This roundabout intersection was included as a treatment site due to its location in a multi-use trail network connecting local parks, housing, and an elementary school. Pedestrians were also viewed traveling through the roundabout in Google Streetview. This site currently has low traffic volumes, with about 5,300 entering vehicles per day. No matching control site was selected for this treatment site.

Using the criteria described above for selection of control sites and considering the affected sites, 93 signalized intersections were selected as control sites and crash data from 2017 through 2021 was used. Figure 3.2 shows the locations of the included sites.

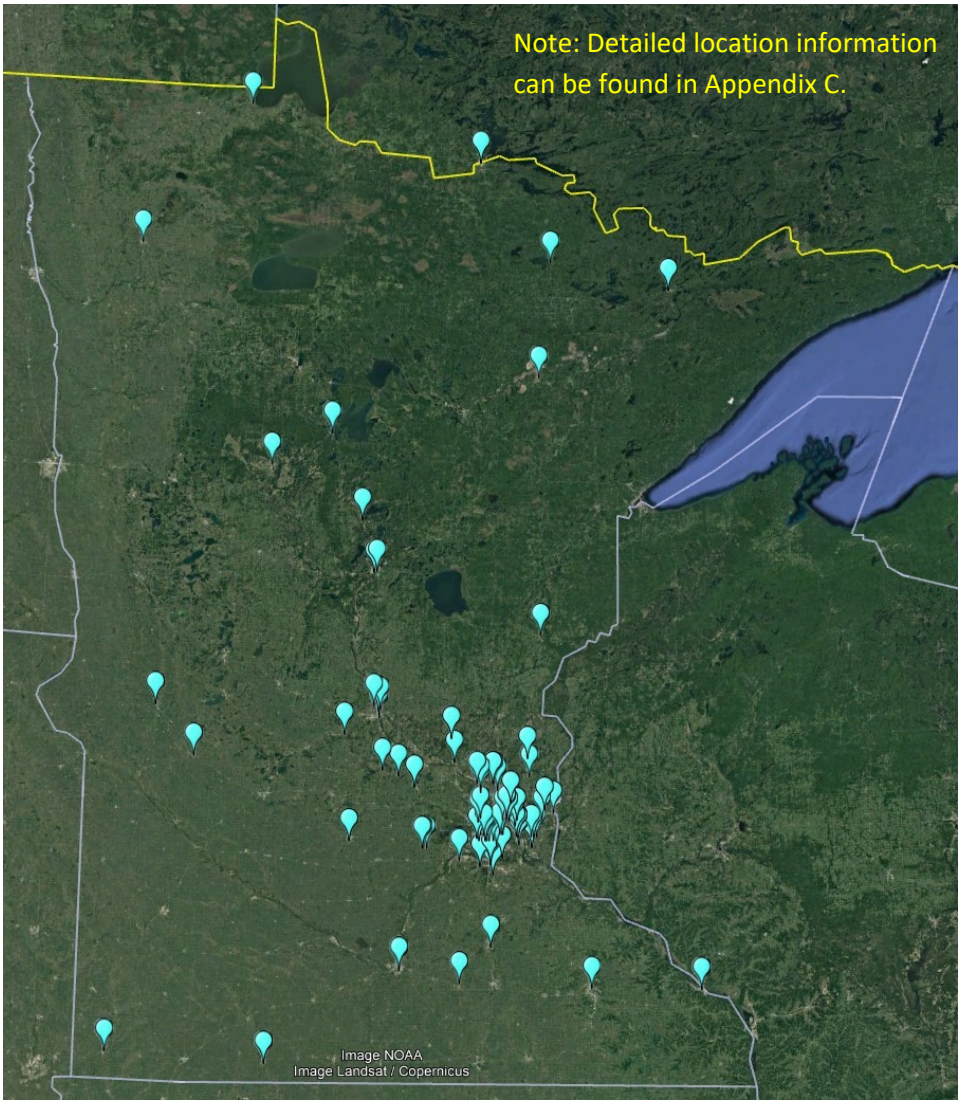


Figure 3.2 – Locations for Comparative Urban Traffic Signal Analysis

3.2.3 Crash Data

The area included when gathering crash data at roundabouts was previously discussed in Section 2.2. For urban signalized intersections, all crashes within 500 feet of the intersection on all approaches were included.

Crash data from 2017 through 2021 was used for the roundabout treatment sites and the traffic signal control sites. The following tables show the total entering volumes, the number of crashes, crash densities, and crash rates (crashes per MEV) for the After period at the roundabout treatment locations and from 2017 through 2021 at the traffic signal control sites.

Table 3.8 - Comparative Analysis Site-Years and Entering Volumes

	Roundabout (95 sites)	Urban Signals (93 sites)
Total Site-Years	447	465
Total Crashes	34	55
Total Entering Volume	1.75 billion	2.40 billion

Table 3.9 – Comparative Analysis Crash Densities – Roundabouts by Type with Urban Signal Comparison

Location	*Metric*	*K*	*A*	*KA*	*B*	*C*	*PDO*	*Total*	*Site Years*
Single Lane	# of Crashes	0	1	1	3	6	2	12	*256*
(53 sites)	**Crashes/Site-Year**	**0.000**	**0.004**	**0.004**	**0.012**	**0.023**	**0.008**	**0.047**	
Multi-Lane	# of Crashes	1	0	1	12	5	4	22	*191*
(41 sites)	**Crashes/Site-Year**	**0.005**	**0.000**	**0.005**	**0.063**	**0.026**	**0.021**	**0.115**	
Roundabout	# of Crashes	1	1	2	15	11	6	34	*447*
Total (94 sites)	**Crashes/Site-Year**	**0.002**	**0.002**	**0.004**	**0.034**	**0.025**	**0.013**	**0.076**	
Urban Signals	# of Crashes	2	8	10	25	13	7	55	*465*
(93 sites)	**Crashes/Site-Year**	**0.004**	**0.017**	**0.022**	**0.054**	**0.028**	**0.015**	**0.118**	

Table 3.10 – Comparative Analysis Crash Rates – Roundabouts by Type with Urban Signal Comparison

Location	*Metric*	*K*	*A*	*KA*	*B*	*C*	*PDO*	*Total*	Entering Volume
Single Lane	# of Crashes	0	1	1	3	6	2	12	633 million
(53 sites)	**Crashes / MEV**	**0.0000**	**0.0016**	**0.0016**	**0.0047**	**0.0095**	**0.0032**	**0.0189**	
Multi-Lane	# of Crashes	1	0	1	12	5	4	22	505 million
(41 sites)	**Crashes / MEV**	**0.0020**	**0.0000**	**0.0020**	**0.0237**	**0.0099**	**0.0079**	**0.0435**	
Roundabout	# of Crashes	1	1	2	15	11	6	34	1.14 billion
Total (94 sites)	**Crashes / MEV**	**0.0009**	**0.0009**	**0.0018**	**0.0132**	**0.0097**	**0.0053**	**0.0299**	
Urban Signals	# of Crashes	2	8	10	25	13	7	55	2.40 billion
(93 sites)	**Crashes / MEV**	**0.0008**	**0.0033**	**0.0042**	**0.0104**	**0.0054**	**0.0029**	**0.0229**	

Figures 3.3 through 3.6 illustrate the crash densities and rates from Tables 3.9 and 3.10.

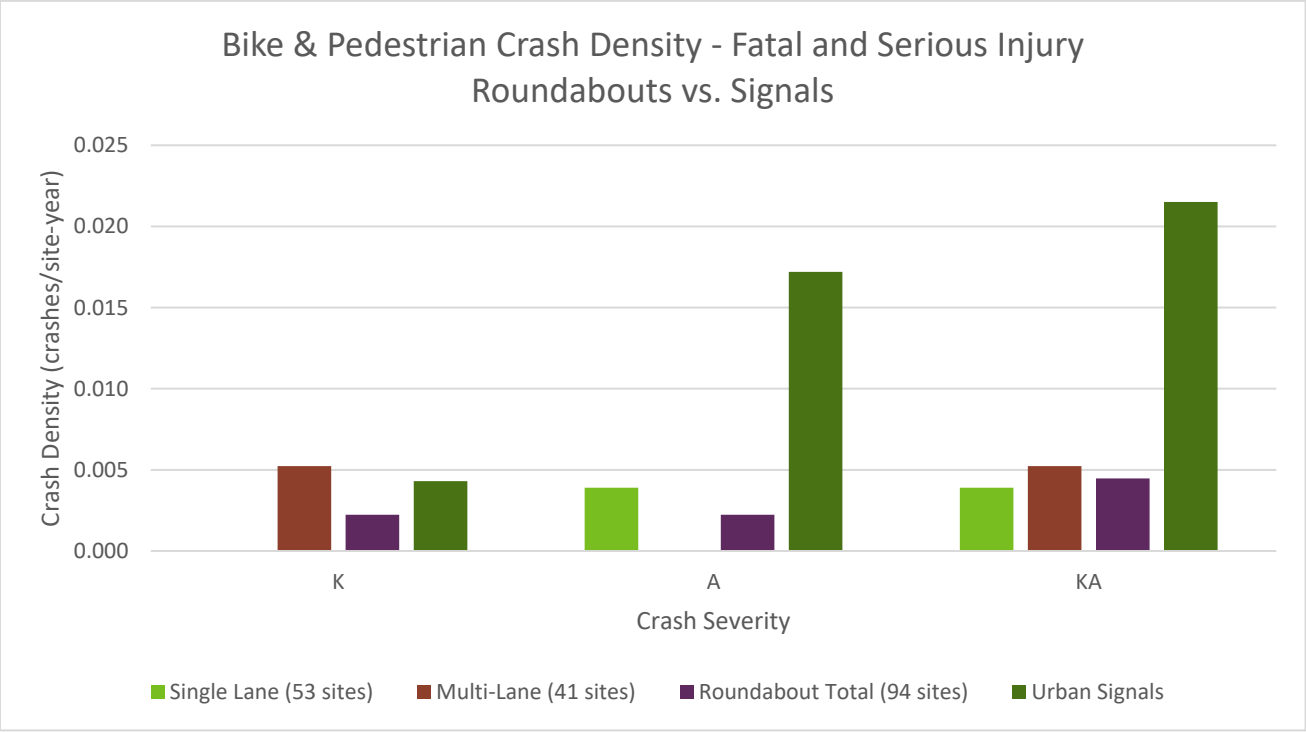


Figure 3.3 – Comparative Analysis K+A Crash Density – Roundabouts by Type with Urban Signal Comparison

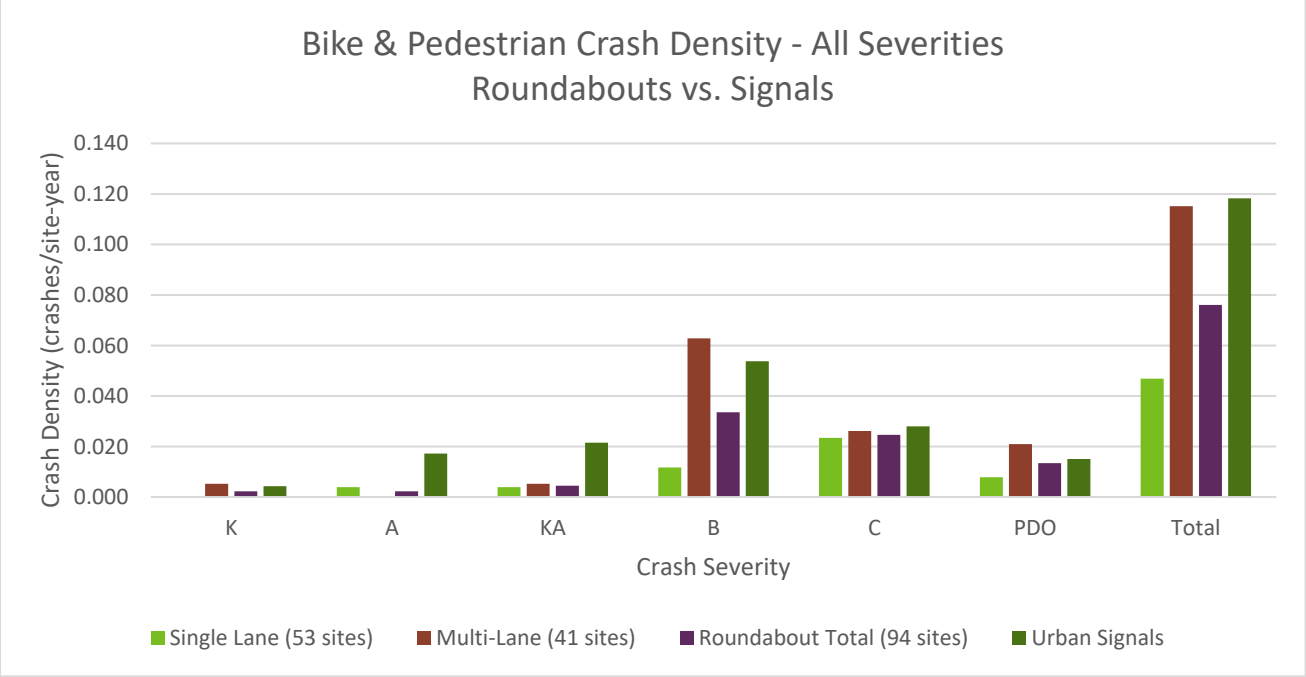


Figure 3.4 – Comparative Analysis All Crash Density – Roundabouts by Type with Urban Signal Comparison

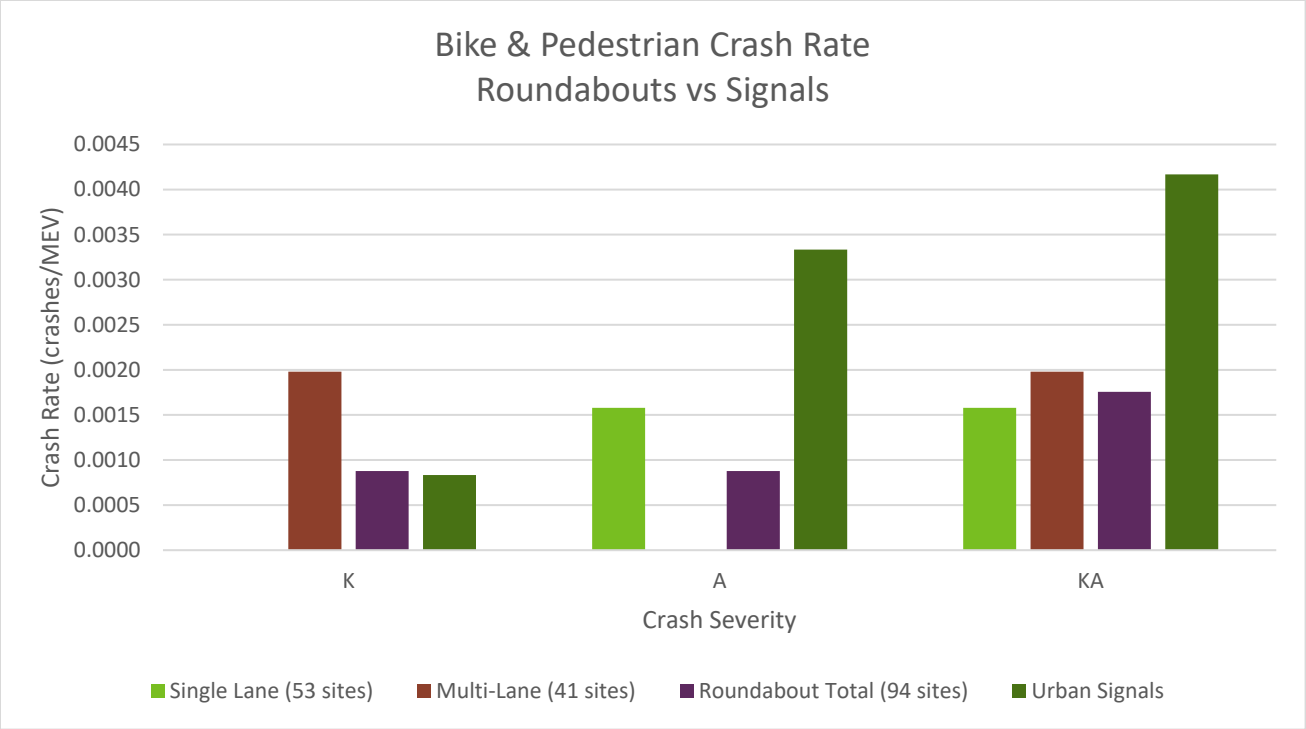


Figure 3.5 – Comparative Analysis K+A Crash Rates – Roundabouts by Type with Urban Signal Comparison

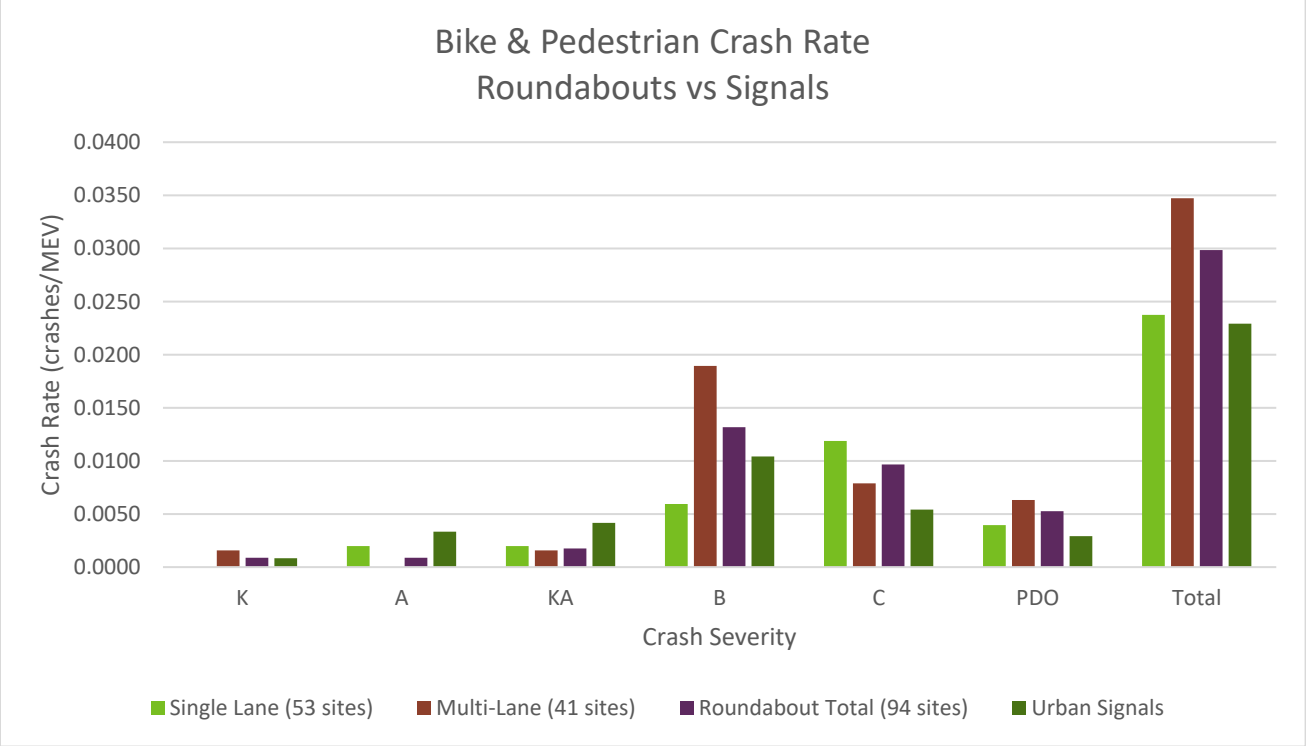


Figure 3.6 – Comparative Analysis All Crash Rates – Roundabouts by Type with Urban Signal Comparison

3.2.4 Crash Analysis

This analysis looked at the safety performance of single-lane and multi-lane roundabouts compared to urban traffic signals in the context of intersection crash density and crash rate. Crash density is a useful metric for looking at the number of crashes over a certain span of time while crash rate is a way to provide an equal comparison among sites with different traffic characteristics. For example, the figures above show multi-lane roundabouts have a higher crash rate than urban traffic signals, but it's possible this is a function of vehicle volumes/conflict potential as the two comparison groups have similar crash densities, or crashes per year at a site.

Previous studies and crash records have indicated roundabouts tend to have higher crash rates compared to signalized intersection when it comes to overall crashes and considerably lower crash rates compared to signalized intersections when it comes to fatal (K) and suspected serious injury (A) crashes. These findings are consistent with the results from this study.

Table 3.9 and 3.10 and associated Figures 3.3 through 3.6 show that roundabouts have a lower density of fatal and serious injury as well as total crashes when compared signalized intersections in urban areas. The results are similar for crash rates, where roundabouts have lower fatal and serious injury rates, but a higher rate of total crashes compared to urban traffic signals.

3.3 Comparative thru-stop and all-way stop Analysis

Roundabouts frequently replace side-street, stop-controlled (thru-stop) and all-way, stop controlled (all-way stop) intersections when they are installed. This analysis compares the crash data at side-street, stop-controlled and all-way, stop-controlled intersections in urbanized areas to the roundabouts that were selected as treatment sites for this evaluation.

3.3.1 Question Addressed

How do roundabouts in urbanized areas compare with side-street, stop-controlled and all-way, stop controlled intersections in similar contexts?

3.3.2 Locations

For this comparison, all 94 roundabout treatment sites were included that had an existing roundabout during the 2019 through 2021 period allowing for at least three years of analysis at each roundabout.

When determining control sites to be used in a comparison group against treatment sites, locations are typically chosen that have similar characteristics to the treatment sites. For this comparative analysis, however, the amount of time and labor necessary to identify singular thru-stop and all-way stop intersections for comparison was considered too great for the benefits to the analysis.

Instead, the decision was made to include thru-stop and all-way stop sites from the MnDOT 2017-2021 Pedestrian and Bike Crash Data Toolkit. Filtering the Comparison Groups by thru-stop and all-way stop and Environment by urban, 76 all-way stop and 200 thru-stop intersections were selected and crash data from 2017 through 2021 was used.

3.3.3 Crash Data

The area included when gathering crash data at roundabouts was previously discussed in Section 2.2. For the urban stop-controlled intersections in this analysis, all crashes linked to the Linear Referencing System (LRS) linework at the intersection on all approaches were included.

The following tables show the total site years, number of crashes, and entering volumes, as well as crash densities (crashes per site-year) and crash rates (crashes per MEV) from 2017 through 2021 for each comparison group.

Table 3.11 - Comparative Analysis Total Site-Years & Entering Volumes

	Roundabouts (94 sites)	All-Way Stop (76 sites)	Thru-Stop (200 sites)
Total Site Years	447	380	1000
Total Crashes	34	6	9
Total Entering Volume	1.75 billion	1.15 billion	656 million

Table 3.12 - Comparative Analysis Crash Densities – Roundabouts by Type with Urban Stop Control Comparison

Location	*Metric*	*K*	*A*	*KA*	*B*	*C*	*PDO*	*Total*	*Site Years*
Single Lane	# of Crashes	0	1	1	3	6	2	12	*256*
(53 sites)	**Crashes/Site-Year**	**0.000**	**0.004**	**0.004**	**0.012**	**0.023**	**0.008**	**0.047**	
Multi-Lane	# of Crashes	1	0	1	12	5	4	22	*191*
(41 sites)	**Crashes/Site-Year**	**0.005**	**0.000**	**0.005**	**0.063**	**0.026**	**0.021**	**0.115**	
Roundabout	# of Crashes	1	1	2	15	11	6	34	*447*
Total (94 sites)	**Crashes/Site-Year**	**0.002**	**0.002**	**0.004**	**0.034**	**0.025**	**0.013**	**0.076**	
Urban All-Way	# of Crashes	0	0	0	3	2	1	6	*380*
Stop (76 sites)	**Crashes/Site-Year**	**0.000**	**0.000**	**0.000**	**0.008**	**0.005**	**0.003**	**0.0158**	
Urban Thru	# of Crashes	0	2	2	2	1	4	9	*1000*
Stop (200 sites)	**Crashes/Site-Year**	**0.0000**	**0.002**	**0.002**	**0.002**	**0.001**	**0.004**	**0.009**	

Table 3.13 - Comparative Analysis Crash Rates – Roundabouts by Type with Urban Stop Control Comparison

Location	*Metric*	*K*	*A*	*KA*	*B*	*C*	*PDO*	*Total*	Entering Volume
Single Lane	# of Crashes	0	1	1	3	6	2	12	680 million
(53 sites)	**Crashes / MEV**	**0.0000**	**0.0015**	**0.0015**	**0.0044**	**0.0088**	**0.0029**	**0.0176**	
Multi-Lane	# of Crashes	1	0	1	12	5	4	22	1.07 billion
(41 sites)	**Crashes / MEV**	**0.0009**	**0.0000**	**0.0009**	**0.0112**	**0.0047**	**0.0037**	**0.0205**	
Roundabout	# of Crashes	1	1	2	15	11	6	34	1.75 billion
Total (94 sites)	**Crashes / MEV**	**0.0006**	**0.0006**	**0.0011**	**0.0085**	**0.0063**	**0.0034**	**0.0194**	
Urban All-Way	# of Crashes	0	0	0	3	2	1	6	1.15 billion
Stop (76 sites)	**Crashes / MEV**	**0.0000**	**0.0000**	**0.0000**	**0.0026**	**0.0017**	**0.0009**	**0.0052**	
Urban Thru	# of Crashes	0	2	2	2	1	4	9	656 million
Stop (200 sites)	**Crashes / MEV**	**0.0000**	**0.0031**	**0.0031**	**0.0031**	**0.0015**	**0.0061**	**0.0137**	

Figures 3.7 through 3.10 illustrate the crash densities and rates from Tables 3.12 and 3.13.

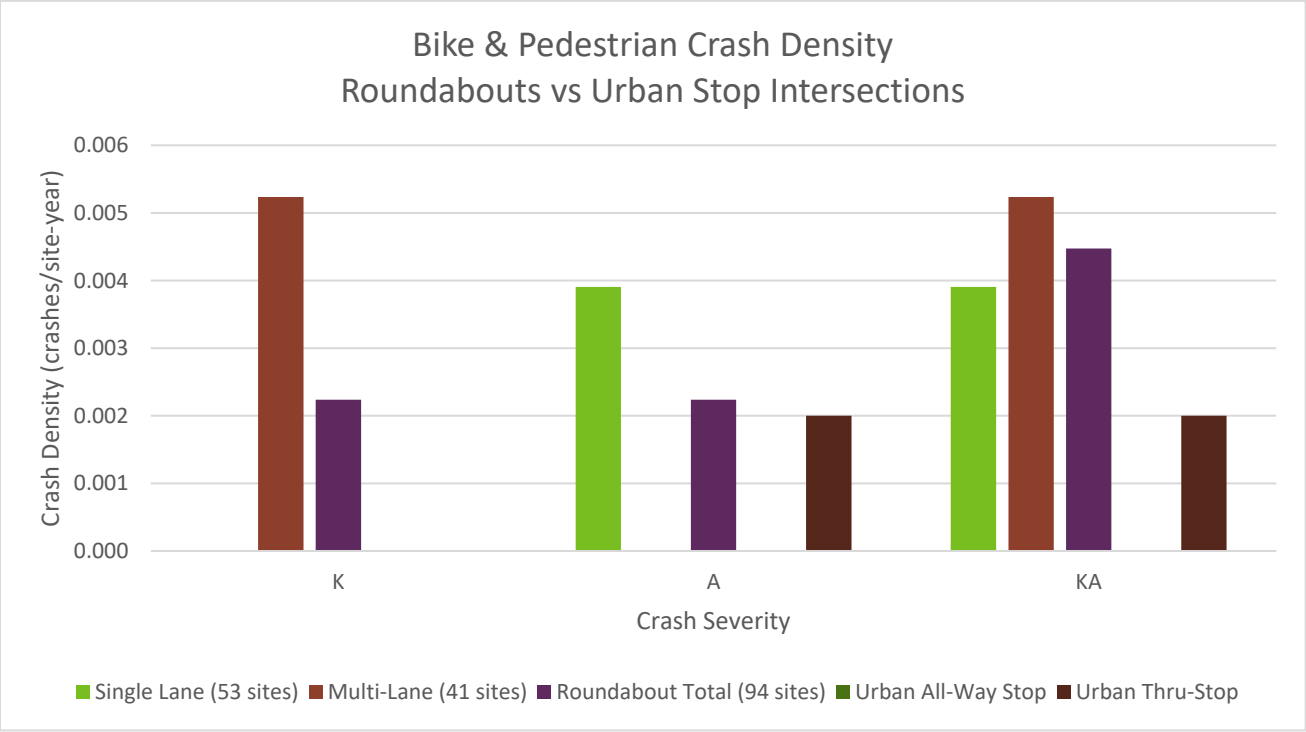


Figure 3.7 – Comparative Analysis K+A Crash Density – Roundabouts by Type w/ Urban Stop Control Comparison

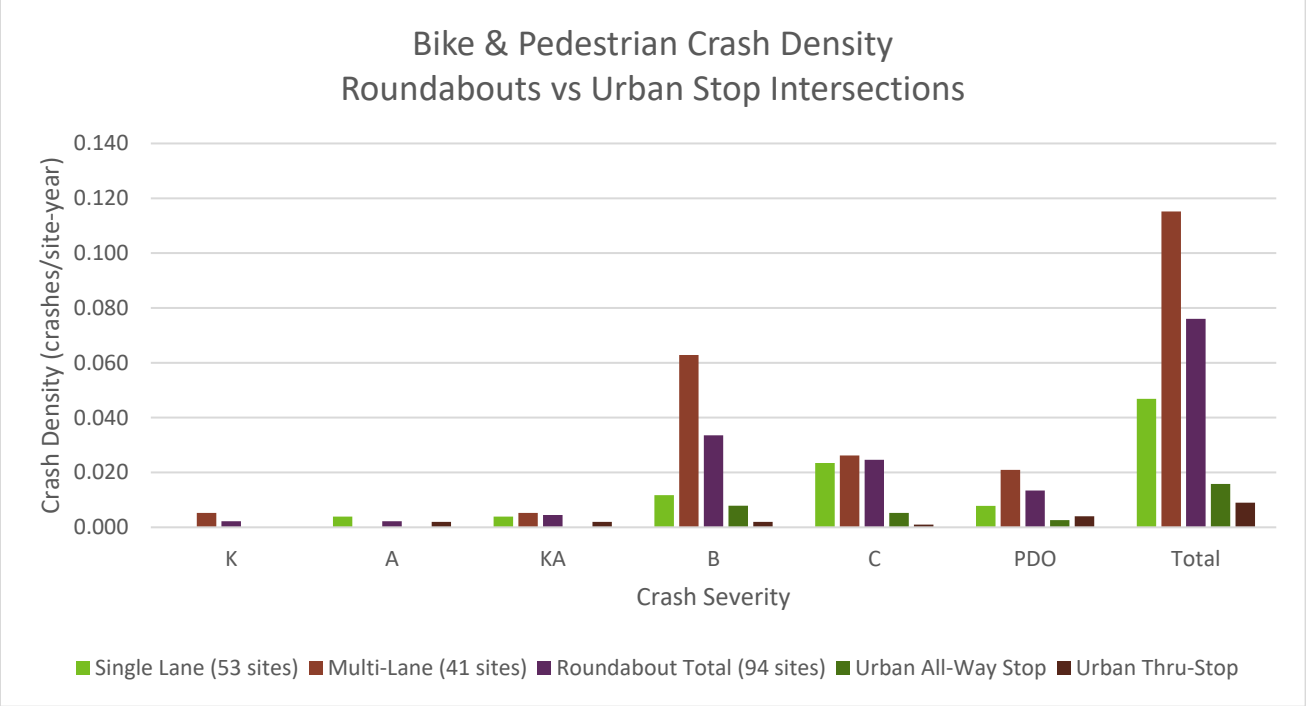


Figure 3.8 – Comparative Analysis All Crash Density – Roundabouts by Type with Urban Stop Control Comparison

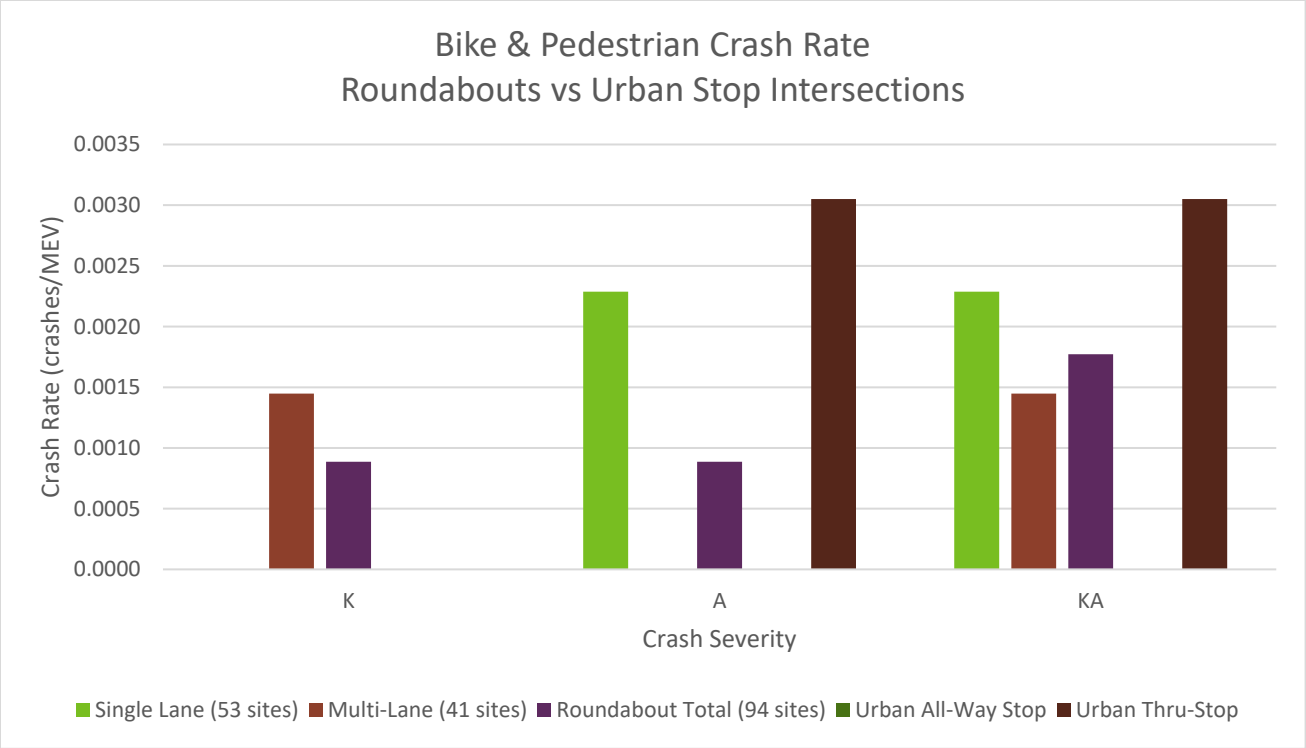


Figure 3.9 – Comparative Analysis K+A Crash Rates – Roundabouts by Type with Urban Stop Control Comparison

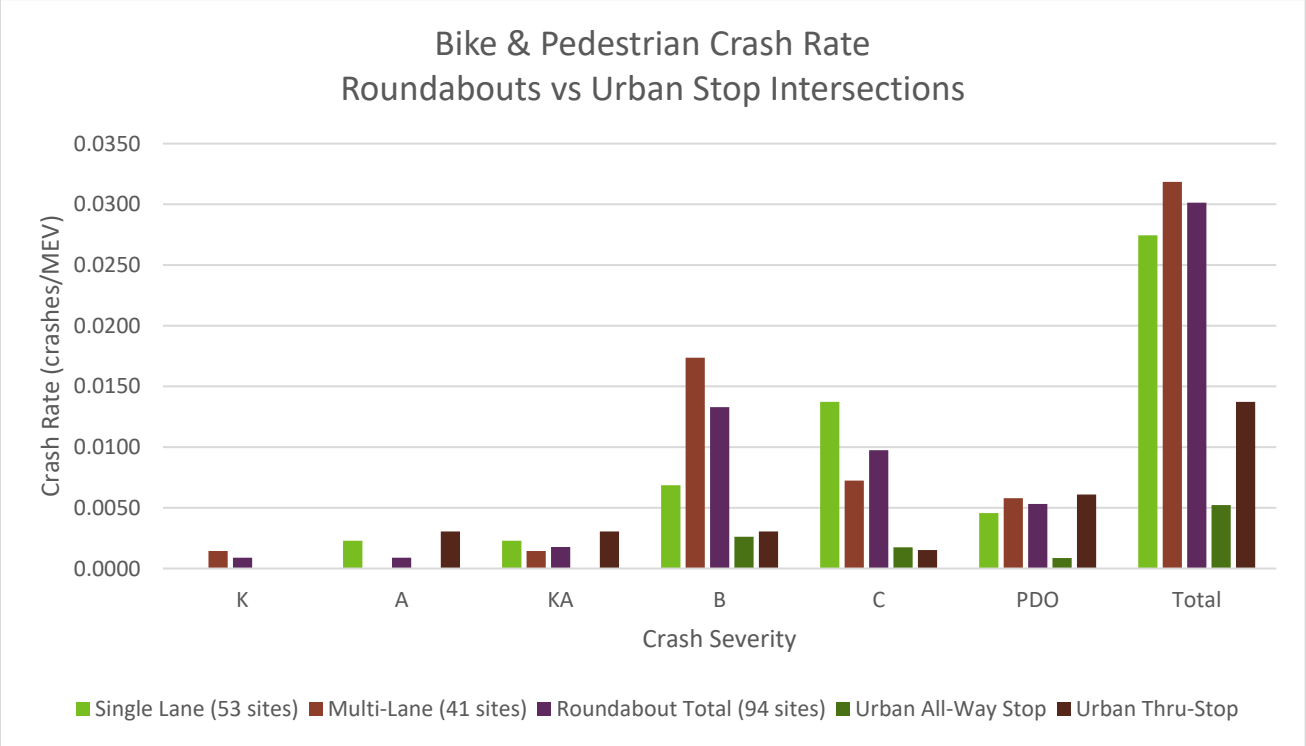


Figure 3.10 – Comparative Analysis All Crash Rates – Roundabouts by Type with Urban Stop Control Comparison

3.3.4 Crash Analysis

This analysis looked at the safety performance of single-lane and multi-lane roundabouts compared to urban all-way and thru-stop intersections in the context of intersection crash density and crash rate. Crash density is a useful metric for looking at the number of crashes over a certain span of time while crash rate is a way to provide an equal comparison among sites with different traffic characteristics.

Previous national research[6] has shown that converting a thru-stop controlled intersection to a roundabout lead to reductions in all crashes and injury crashes but did not directly compare the safety performance over a similar period. A MnDOT evaluation[7] of traffic safety at roundabouts looked at the overall crash rate and fatal and serious injury crash rate for roundabouts, thru-stop controlled intersections, and all-way stop controlled intersections. In terms of total crashes, roundabouts had a higher overall crash rate than thru- and all-way stop controlled intersections but a lower rate of fatal and serious injury crashes.

These findings are mostly consistent with the results from this comparison analysis. Tables 3.12 and 3.13 and associated Figures 3.7 through 3.10 show that roundabouts have a similar density of fatal and serious injury crashes but a higher density of total crashes when compared with stop-controlled intersections in urban areas. The results are similar for crash rates, where roundabouts have similar fatal and serious injury rates, but a higher rate of total crashes compared to urban traffic signals.

In this comparison, all-way stop control had the best safety performance overall. There were zero fatal or serious injury crashes at the locations in the comparison group and the crash densities and rates were lower than the other intersection types for all severities.

[6] Roundabouts: An Informational Guide – Second Edition |The National Academies Press
[7] A Study of the Traffic Safety at Roundabouts in Minnesota 2017

Chapter 4: Summary

The results of the before-after and comparative analyses conducted show that roundabouts in Minnesota are exhibiting their intended safety benefits. The analyses showed the following impacts of roundabouts:

- Reductions in fatal and serious injury crashes for all users after installation of a roundabout.
- Reductions in fatal and serious injury crashes for pedestrians and bicycles after installation of a roundabout.
- Improved safety performance when compared to traffic signal-controlled intersections in urbanized areas.
- Similar safety performance among roundabouts, all-way stop, and thru-stop intersections in urbanized areas.

These results are consistent with the safety goals of roundabouts as well as with the previous evaluation of roundabouts in Minnesota. Though roundabouts are not causing significant changes in total bicycle and pedestrian crashes, a severity shift resulting in a decrease in high-severity crashes is occurring.

The comparison between roundabouts, urban traffic signal-controlled intersections, and urban stop-controlled intersections shows that roundabouts have:

- Lower densities and rates of fatal, suspected serious injury, and suspected minor injury crashes than signalized intersections in urban areas.
- Similar incidence of fatal and serious injury crashes compared to urban stop-controlled intersections.
- Higher densities and rates of total crashes than urban stop-controlled intersections.

The relatively small number of roundabouts in this analysis can affect how crash densities and rates for fatal crashes appear compared to other intersection types. Experience with roundabouts across the state as well as the longitudinal analysis in this report continue to demonstrate the safety benefits of installation of a roundabout.

To that point, it is worth noting that, as of the publishing of this report, one pedestrian fatality has occurred at a roundabout in Minnesota since the installation of the first one in 1995. Since 2013, 112 pedestrian and bicycle fatalities have occurred at traffic signals.

APPENDIX A
Roundabout Locations

Table A.1 – Roundabout Locations

Site Number and Intersection Name	Configuration	Built Year	County	City
01. Anoka - 105th Ave NE / Irvin Pkwy	Unbalanced	2018	Anoka	Blaine
02. Anoka - 105th Ave NE / NSC Access	Unbalanced	2018	Anoka	Blaine
03. Anoka - 39th Ave NE / Jefferson St NE	Single Lane	2006	Anoka	Columbia Heights
04. Anoka - CSAH 24 / CSAH 9	Single Lane	2016	Anoka	Saint Francis
05. Anoka - CSAH 24 / CR 72 / Poppy St NW	Single Lane	2016	Anoka	Saint Francis
06. Benton - CSAH 3 / 6th Ave N	Unbalanced	2017	Benton	Sauk Rapids
07. Benton - CSAH 3 / Summit Ave	Unbalanced	2017	Benton	Sauk Rapids
08. Blue Earth - TH 22 / Adams St	Multi-Lane	2015	Blue Earth	Mankato
09. Blue Earth - TH 22 / CSAH 17 / Madison Ave	Multi-Lane	2015	Blue Earth	Mankato
10. Carver - Community Dr / Wildcat Way	Single Lane	2007	Carver	Waconia
11. Carver - CSAH 10 / CSAH 20	Single Lane	2011	Carver	Watertown
12. Carver - CSAH 10 / CSAH 27 / Lewis Ave	Single Lane	2011	Carver	Watertown
13. Carver - CSAH 20 / Paul Ave	Single Lane	2011	Carver	Watertown Twp
14. Carver - TH 284 / 10th St	Single Lane	2013	Carver	Waconia
15. Carver - TH 284 / CSAH 10	Single Lane	2009	Carver	Waconia
16. Carver - TH 284 / Sparrow Rd	Single Lane	2009	Carver	Waconia Twp
17. Crow Wing - CSAH 18 / S Main St	Single Lane	2012	Crow Wing	Nisswa
18. Crow Wing - E College Dr / S 4th St	Multi-Lane	2013	Crow Wing	Brainerd
19. Crow Wing - Excelsior Blvd / Cypress Dr	Unbalanced	2018	Crow Wing	Baxter
20. Crow Wing - W College Dr. / Mississippi Pkwy.	Unbalanced	2013	Crow Wing	Brainerd
21. Crow Wing - W College Dr. / SW 4th St. / Mississippi Pkwy.	Unbalanced	2013	Crow Wing	Brainerd
22. Dakota - CSAH 64 / Akin Rd	Unbalanced	2015	Dakota	Farmington
23. Dakota - CSAH 64 / CR 64 / CSAH 31	Unbalanced	2015	Dakota	Farmington
24. Dakota - CR 8 / US 52 NB Offramp / Lafayette Ave	Single Lane	2009	Dakota	West Saint Paul
25. Dakota - CSAH 30 / Rahn Rd	Unbalanced	2010	Dakota	Eagan
26. Dakota - CSAH 8 / CSAH 73	Single Lane	2017	Dakota	West Saint Paul
27. Dakota - CSAH 8 / Waterloo Ave / US 52 SB Onramp	Single Lane	2009	Dakota	South Saint Paul
28. Dakota - Portland Ave / E Nicollet Blvd	Single Lane	2005	Dakota	Burnsville
29. Faribault - US 169 / CSAH 16 / E 1st St	Single Lane	2015	Faribault	Blue Earth
30. Faribault - US 169 / CSAH 16 / CSAH 53	Single Lane	2015	Faribault	Blue Earth

Site Number and Intersection Name	Configuration	Built Year	County	City
31. Faribault - US 169 / CSAH 44	Single Lane	2015	Faribault	Blue Earth
32. Goodhue - CSAH 66 / Pioneer Rd / Twin Bluff Rd	Single Lane	2017	Goodhue	Red Wing
33. Goodhue - Levee Rd / Jackson St	Single Lane	2016	Goodhue	Red Wing
34. Hennepin - 28th Ave S / Lindau Ln	Unbalanced	2015	Hennepin	Bloomington
35. Hennepin - CSAH 102 / Golden Valley Rd	Unbalanced	2017	Hennepin	Golden Valley
36. Hennepin - CSAH 102 / Sandburg Rd	Unbalanced	2017	Hennepin	Golden Valley
37. Hennepin - CSAH 12 / W River Rd	Single Lane	2014	Hennepin	Champlin
38. Hennepin - CSAH 14 / 117th Ave	Single Lane	2011	Hennepin	Champlin
39. Hennepin - CSAH 53 (66th St) / CSAH 52 (Nicollet Ave)	Unbalanced	2018	Hennepin	Richfield
40. Hennepin - CSAH 53 (66th St) / Lyndale Ave S	Unbalanced	2018	Hennepin	Richfield
41. Hennepin - CSAH 53 (66th St) / Portland Ave	Unbalanced	2009	Hennepin	Richfield
42. Hennepin - CSAH 53 (66th St) / Richfield Pkwy	Unbalanced	2007	Hennepin	Richfield
43. Hennepin - Hazelton Rd / Rue de France entr / 71 France entr	Single Lane	2014	Hennepin	Edina
44. Hennepin - Louisiana Ave S / TH 7 WB Ramps	Unbalanced	2014	Hennepin	Saint Louis Park
45. Hennepin - Louisiana Ave S / TH 7 EB Ramps / W Lake St	Unbalanced	2014	Hennepin	Saint Louis Park
46. Hennepin - Louisiana Ave S / Walker St	Unbalanced	2014	Hennepin	Saint Louis Park
47. Hennepin - Minnehaha Ave / Godfrey Pkwy	Single Lane	2001	Hennepin	Minneapolis
48. Hennepin - Valley View Rd / Braemar Blvd	Single Lane	2015	Hennepin	Edina
49. Hennepin - Valley View Rd / Tracy Ave / Valley Ln	Single Lane	2016	Hennepin	Edina
50. Hennepin - W 70th St / Galleria central entr	Single Lane	2007	Hennepin	Edina
51. Hennepin - W 70th St / Galleria east entr	Single Lane	2007	Hennepin	Edina
52. Hennepin - W 70th St / Galleria west entr	Single Lane	2007	Hennepin	Edina
53. Hennepin - W 70th St / Valley View Rd	Single Lane	2011	Hennepin	Edina
54. Hennepin - CR 202 / 101st Ave N	Single Lane	2013	Hennepin	Maple Grove
55. Le Sueur - TH 19 / Alton Ave	Single Lane	2008	Le Sueur	Lanesburgh Twp
56. Le Sueur - TH 19 / Chalupsky Ave SE	Single Lane	2008	Le Sueur	New Prague
57. McLeod - TH 15 / CSAH 12	Single Lane	2009	McLeod	Hutchinson
58. Mille Lacs - TH 95 / CSAH 29	Unbalanced	2010	Mille Lacs	Princeton
59. Nobles - US 59-TH 60 / CSAH 35	Unbalanced	2012	Nobles	Worthington
60. Nobles - US 59-TH 60 / Oxford St	Unbalanced	2013	Nobles	Worthington

Site Number and Intersection Name	Configuration	Built Year	County	City
61. Olmsted - 18th Ave NW / 48th St NW	Single Lane	2018	Olmsted	Rochester
62. Pennington - Greenwood St E / Pennington Ave	Single Lane	2013	Pennington	Thief River Falls
63. Ramsey - CR I / Old Hwy 8 / I-35W NB Offramp / Rice Creek Pkwy	Single Lane	2017	Ramsey	Mounds View
64. Ramsey - Frost Ave / Parkway Dr / E Shore Dr	Single Lane	2011	Ramsey	Maplewood
65. Ramsey - Frost Ave / English St	Single Lane	2002	Ramsey	Maplewood
66. Scott - CR 79 / Vierling Dr	Single Lane	2014	Scott	Shakopee
67. Scott - Dakotah Pkwy / Mystic Lake-Little Six Access	Single Lane	2017	Scott	Prior Lake
68. Scott - CSAH 16 / Glendale Rd / Lynn Ave	Unbalanced	2010	Scott	Savage
69. Sherburne - Railroad Dr / 3rd St NW / Irving Ave NW	Single Lane	2013	Sherburne	Elk River
70. Stearns - 2nd St S / Pinecone Rd N	Multi-Lane	2015	Stearns	Le Sauk Twp
71. Stearns - CSAH 120 / CSAH 1	Unbalanced	2010	Stearns	Sartell
72. Stearns - CSAH 2 / CSAH 50	Single Lane	2016	Stearns	Cold Spring
73. Stearns - University Dr S / 5th Ave S	Multi-Lane	2011	Stearns	Saint Cloud
74. Washington - CSAH 14 / CSAH 6 / Jamaca Ave	Unbalanced	2011	Washington	Lake Elmo
75. Washington - CSAH 18 / 4th St S	Single Lane	2009	Washington	Lakeland
76. Washington - CSAH 18 / 5th St N	Single Lane	2009	Washington	Lakeland
77. Washington - CSAH 18 / Division St	Single Lane	2009	Washington	Lakeland
78. Washington - CSAH 19 / CSAH 18	Unbalanced	2013	Washington	Woodbury
79. Washington - CSAH 19 / Lake Rd	Unbalanced	2013	Washington	Woodbury
80. Washington - CSAH 22 / CSAH 20 / Jamaica Ave	Unbalanced	2016	Washington	Cottage Grove
81. Washington - Hadley Ave S / 95th St S	Single Lane	2016	Washington	Cottage Grove
82. Washington - CSAH 29 / TH 36 WB On-Ramp / 60th St N	Single Lane	2013	Washington	Pine Springs
83. Washington - Jamaica Ave / US 10-US 61 EB Ramps / W Point Douglas Rd	Unbalanced	2007	Washington	Cottage Grove
84. Washington - Jamaica Ave. / US 10-US 61 WB Ramps	Unbalanced	2007	Washington	Cottage Grove
85. Washington - Pioneer Dr / Interlachen Pkwy	Unbalanced	2016	Washington	Woodbury
86. Washington - TH 96 / CSAH 15	Single Lane	2016	Washington	Stillwater
87. Washington - US 61 / CSAH 4 / CR 4A	Single Lane	2013	Washington	Hugo
88. Washington - US 61 / CSAH 2 / Broadway Ave	Unbalanced	2010	Washington	Forest Lake
89. Washington - US 61 / TH 97 N jct / Forest Blvd N	Unbalanced	2016	Washington	Forest Lake
90. Washington - US 61 / TH 97 S jct / 210th St N	Unbalanced	2016	Washington	Forest Lake
91. Watonwan - TH 4-TH 30 / CSAH 56 E Jct	Single Lane	2017	Watonwan	Saint James
92. Watonwan - TH 4-TH 30 / CSAH 56 W Jct / Armstrong Blvd	Single Lane	2017	Watonwan	Saint James
93. Winona - CSAH 17 / CSAH 15	Single Lane	2012	Winona	Wilson Twp
94. Wright - CSAH 8 / CSAH 57 / Elm Ave	Single Lane	2018	Wright	Maple Lake
95. Wright - TH 25 / 8th St NW-NE	Unbalanced	2016	Wright	Buffalo

APPENDIX B
ROUNDABOUT crash data summary

Table B.1 – Before-After Crash Data – All

Crash Period	Before					After				
Site	K	A	B	C	PDO	K	A	B	C	PDO
01. Anoka - 105th Ave NE / Irvin Pkwy	0	0	11	36	65	0	0	1	0	9
02. Anoka - 105th Ave NE / NSC Access	1	2	7	7	44	0	0	1	0	0
03. Anoka - 39th Ave NE / Jefferson St NE	0	0	1	3	3	0	0	0	0	3
04. Anoka - CSAH 24 / CSAH 9	0	3	27	38	78	0	0	1	1	1
05. Anoka - CSAH 24 / CR 72 / Poppy St NW	0	1	7	41	135	0	0	0	0	1
06. Benton - CSAH 3 / 6th Ave N	0	0	3	6	24	0	0	1	0	10
07. Benton - CSAH 3 / Summit Ave	0	1	8	9	32	0	0	1	1	18
08. Blue Earth - TH 22 / Adams St	0	0	5	13	49	0	0	6	17	290
09. Blue Earth - TH 22 / CSAH 17 / Madison Ave	0	1	10	15	64	0	0	2	15	379
10. Carver - Community Dr / Wildcat Way	1	0	4	2	29	0	0	2	4	12
11. Carver - CSAH 10 / CSAH 20	0	0	1	2	2	0	1	0	1	1
12. Carver - CSAH 10 / CSAH 27 / Lewis Ave	0	0	0	0	0	0	0	0	0	4
13. Carver - CSAH 20 / Paul Ave	0	0	0	0	0	0	0	0	1	5
14. Carver - TH 284 / 10th St	0	0	8	19	88	0	0	1	0	10
15. Carver - TH 284 / CSAH 10	0	1	8	20	23	0	1	2	1	22
16. Carver - TH 284 / Sparrow Rd	0	0	8	7	21	0	0	1	1	18
17. Crow Wing - CSAH 18 / S Main St	0	0	0	0	0	0	0	0	0	1
18. Crow Wing - E College Dr / S 4th St	0	0	2	3	7	0	0	1	3	13
19. Crow Wing - Excelsior Blvd / Cypress Dr	0	0	2	3	19	0	0	3	3	13
20. Crow Wing - W College Dr. / Mississippi Pkwy.	0	0	0	4	33	0	0	0	0	11
21. Crow Wing - W College Dr. / SW 4th St. / Mississippi Pkwy.	0	0	7	14	38	0	0	1	2	26
22. Dakota - CSAH 64 / Akin Rd	0	0	1	4	18	0	0	0	0	12
23. Dakota - CSAH 64 / CR 64 / CSAH 31	0	0	0	0	0	0	0	1	0	3
24. Dakota - CR 8 / US 52 NB Offramp / Lafayette Ave	0	0	0	2	8	0	0	1	1	3
25. Dakota - CSAH 30 / Rahn Rd	0	0	0	0	4	0	0	3	8	114
26. Dakota - CSAH 8 / CSAH 73	0	1	12	17	64	0	0	1	2	14
27. Dakota - CSAH 8 / Waterloo Ave / US 52 SB Onramp	0	0	0	1	1	0	0	1	5	24
28. Dakota - Portland Ave / E Nicollet Blvd	0	0	1	0	2	0	0	1	2	14
29. Faribault - US 169 / CSAH 16 / E 1st St	0	0	3	3	8	0	0	0	0	6
30. Faribault - US 169 / CSAH 16 / CSAH 53	0	0	0	1	8	0	0	1	1	14

Crash Period	Before					After				
Site	K	A	B	C	PDO	K	A	B	C	PDO
31. Faribault - US 169 / CSAH 44	0	0	2	6	31	0	0	0	1	14
32. Goodhue - CSAH 66 / Pioneer Rd / Twin Bluff Rd	0	0	1	7	22	0	0	1	0	9
33. Goodhue - Levee Rd / Jackson St	0	1	6	15	34	0	0	0	1	2
34. Hennepin - 28th Ave S / Lindau Ln	0	0	0	2	11	0	0	0	0	0
35. Hennepin - CSAH 102 / Golden Valley Rd	0	2	6	24	53	0	0	0	0	3
36. Hennepin - CSAH 102 / Sandburg Rd	0	0	11	23	59	0	0	2	0	2
37. Hennepin - CSAH 12 / W River Rd	0	1	0	1	2	0	0	2	3	7
38. Hennepin - CSAH 14 / 117th Ave	0	4	3	27	90	0	1	1	3	14
39. Hennepin - CSAH 53 (66th St) / CSAH 52 (Nicollet Ave)	0	2	14	23	93	0	1	0	8	24
40. Hennepin - CSAH 53 (66th St) / Lyndale Ave S	1	0	9	26	46	0	0	2	4	27
41. Hennepin - CSAH 53 (66th St) / Portland Ave	0	0	4	2	13	1	0	7	22	175
42. Hennepin - CSAH 53 (66th St) / Richfield Pkwy	0	1	6	12	28	0	0	6	10	82
43. Hennepin - Hazelton Rd / Rue de France entr / 71 France entr	0	7	17	61	173	0	0	1	0	2
44. Hennepin - Louisiana Ave S / TH 7 WB Ramps	0	0	4	15	39	0	0	5	15	89
45. Hennepin - Louisiana Ave S / TH 7 EB Ramps / W Lake St	1	0	4	9	29	0	0	1	3	35
46. Hennepin - Louisiana Ave S / Walker St	0	2	14	20	25	0	0	0	1	8
47. Hennepin - Minnehaha Ave / Godfrey Pkwy	0	0	0	1	4	0	0	4	8	33
48. Hennepin - Valley View Rd / Braemar Blvd	0	2	5	11	45	0	0	0	0	0
49. Hennepin - Valley View Rd / Tracy Ave / Valley Ln	1	5	10	34	99	0	0	1	1	2
50. Hennepin - W 70th St / Galleria central entr	0	0	0	1	12	0	0	2	2	10
51. Hennepin - W 70th St / Galleria east entr	0	1	0	0	1	0	0	2	3	4
52. Hennepin - W 70th St / Galleria west entr	0	3	6	13	11	0	1	9	9	26
53. Hennepin - W 70th St / Valley View Rd	0	0	3	13	50	0	0	0	2	3
54. Hennepin - CR 202 / 101st Ave N	0	1	9	4	40	0	0	1	1	5
55. Le Sueur - TH 19 / Alton Ave	0	1	18	19	49	0	0	1	3	12
56. Le Sueur - TH 19 / Chalupsky Ave SE	0	0	2	3	11	0	1	1	7	26

Crash Period	Before					After				
Site	K	A	B	C	PDO	K	A	B	C	PDO
57. McLeod - TH 15 / CSAH 12	0	0	0	0	2	0	1	1	7	37
58. Mille Lacs - TH 95 / CSAH 29	0	2	4	9	40	0	0	3	3	38
59. Nobles - US 59-TH 60 / CSAH 35	0	0	3	7	27	0	0	1	3	29
60. Nobles - US 59-TH 60 / Oxford St	0	0	0	0	1	0	0	1	4	26
61. Olmsted - 18th Ave NW / 48th St NW	0	1	11	15	64	0	0	0	0	7
62. Pennington - Greenwood St E / Pennington Ave	0	2	5	6	22	0	0	1	1	3
63. Ramsey - CR I / Old Hwy 8 / I-35W NB Offramp / Rice Creek Pkwy	0	0	8	30	138	0	0	4	3	38
64. Ramsey - Frost Ave / Parkway Dr / E Shore Dr	0	0	1	0	2	0	0	0	2	9
65. Ramsey - Frost Ave / English St	0	0	2	0	0	0	0	2	7	30
66. Scott - CR 79 / Vierling Dr	0	2	9	10	56	0	1	3	3	59
68. Scott - CSAH 16 / Glendale Rd / Lynn Ave	0	0	0	0	8	0	1	1	10	70
69. Sherburne - Railroad Dr / 3rd St NW / Irving Ave NW	0	2	5	11	33	0	0	1	1	28
70. Stearns - 2nd St S / Pinecone Rd N	0	0	6	15	52	0	1	1	3	43
71. Stearns - CSAH 120 / CSAH 1	0	2	2	1	13	0	0	0	8	49
72. Stearns - CSAH 2 / CSAH 50	0	0	3	5	15	0	0	0	0	6
73. Stearns - University Dr S / 5th Ave S	1	7	30	51	241	1	0	9	18	187
74. Washington - CSAH 14 / CSAH 6 / Jamaca Ave	0	0	0	0	1	0	0	1	1	10
75. Washington - CSAH 18 / 4th St S	0	0	2	5	12	1	1	0	4	8
76. Washington - CSAH 18 / 5th St N	0	1	6	9	48	0	0	2	4	8
77. Washington - CSAH 18 / Division St	0	0	4	7	22	0	1	0	5	4
78. Washington - CSAH 19 / CSAH 18	0	1	4	8	29	0	0	1	3	31
79. Washington - CSAH 19 / Lake Rd	0	0	0	1	6	0	0	3	3	23
80. Washington - CSAH 22 / CSAH 20 / Jamaica Ave	0	0	0	6	4	0	0	1	0	10
81. Washington - Hadley Ave S / 95th St S	0	0	1	1	4	0	0	0	0	6
82. Washington - CSAH 29 / TH 36 WB On-Ramp / 60th St N	0	0	2	2	7	0	0	2	2	20
83. Washington - Jamaica Ave / US 10-US 61 EB Ramps / W Point Douglas Rd	0	0	0	0	3	0	0	2	1	66
84. Washington - Jamaica Ave. / US 10-US 61 WB Ramps	0	0	1	2	3	0	0	0	0	26
85. Washington - Pioneer Dr / Interlachen Pkwy	3	0	24	54	202	0	0	0	0	1
86. Washington - TH 96 / CSAH 15	0	0	1	3	21	0	0	0	2	8
87. Washington - US 61 / CSAH 4 / CR 4A	0	0	3	2	4	0	0	0	3	22

Crash Period	Before					After				
Site	K	A	B	C	PDO	K	A	B	C	PDO
88. Washington - US 61 / CSAH 2 / Broadway Ave	0	0	0	5	17	0	1	4	10	88
89. Washington - US 61 / TH 97 N jct / Forest Blvd N	1	0	18	34	172	0	0	5	4	44
90. Washington - US 61 / TH 97 S jct / 210th St N	2	2	13	41	120	0	0	0	6	50
91. Watonwan - TH 4-TH 30 / CSAH 56 E Jct	0	0	5	4	22	0	0	3	0	12
92. Watonwan - TH 4-TH 30 / CSAH 56 W Jct / Armstrong Blvd	0	0	0	0	9	0	0	0	0	8
93. Winona - CSAH 17 / CSAH 15	0	0	3	13	19	1	0	1	0	2
94. Wright - CSAH 8 / CSAH 57 / Elm Ave	0	1	15	29	64	0	0	0	0	3
95. Wright - TH 25 / 8th St NW-NE	0	0	4	13	17	0	0	0	1	29
Totals	12	66	485	1041	3457	4	13	135	298	2803

Table B.2 – Before-After Crash Data – Bike & Pedestrian

Bike-Ped Crash Period	Before					After				
Site	K	A	B	C	PDO	K	A	B	C	PDO
01. Anoka - 105th Ave NE / Irvin Pkwy	0	0	0	1	0	0	0	0	0	0
02. Anoka - 105th Ave NE / NSC Access	1	2	1	1	0	0	0	0	0	0
03. Anoka - 39th Ave NE / Jefferson St NE	0	0	1	0	0	0	0	0	0	0
04. Anoka - CSAH 24 / CSAH 9	0	0	6	2	0	0	0	0	0	0
05. Anoka - CSAH 24 / CR 72 / Poppy St NW	0	0	2	5	0	0	0	0	0	0
06. Benton - CSAH 3 / 6th Ave N	0	0	0	0	0	0	0	0	0	0
07. Benton - CSAH 3 / Summit Ave	0	0	1	0	0	0	0	0	0	0
08. Blue Earth - TH 22 / Adams St	0	0	0	0	0	0	0	2	0	0
09. Blue Earth - TH 22 / CSAH 17 / Madison Ave	0	0	1	0	1	0	0	0	0	0
10. Carver - Community Dr / Wildcat Way	0	0	0	0	0	0	0	0	0	0
11. Carver - CSAH 10 / CSAH 20	0	0	0	0	0	0	0	1	1	0
12. Carver - CSAH 10 / CSAH 27 / Lewis Ave	0	0	0	0	0	0	0	0	0	0
13. Carver - CSAH 20 / Paul Ave	0	0	0	0	0	0	0	0	0	0
14. Carver - TH 284 / 10th St	0	0	0	0	0	0	0	1	0	0
15. Carver - TH 284 / CSAH 10	0	1	0	0	0	0	0	0	0	0
16. Carver - TH 284 / Sparrow Rd	0	0	0	1	0	0	0	0	0	0
17. Crow Wing - CSAH 18 / S Main St	0	0	0	0	0	0	0	0	0	0
18. Crow Wing - E College Dr / S 4th St	0	0	0	0	0	0	0	0	0	0
19. Crow Wing - Excelsior Blvd / Cypress Dr	0	0	0	0	0	0	0	1	0	0
20. Crow Wing - W College Dr. / Mississippi Pkwy.	0	0	0	0	0	0	0	0	0	0
21. Crow Wing - W College Dr. / SW 4th St. / Mississippi Pkwy.	0	0	1	1	0	0	0	0	0	0
22. Dakota - CSAH 64 / Akin Rd	0	0	0	0	0	0	0	0	0	1
23. Dakota - CSAH 64 / CR 64 / CSAH 31	0	0	0	0	0	0	0	0	0	0
24. Dakota - CR 8 / US 52 NB Offramp / Lafayette Ave	0	0	0	1	0	0	0	1	0	0
25. Dakota - CSAH 30 / Rahn Rd	0	0	0	0	0	0	0	1	1	0
26. Dakota - CSAH 8 / CSAH 73	0	0	2	0	0	0	0	0	0	0
27. Dakota - CSAH 8 / Waterloo Ave / US 52 SB Onramp	0	0	0	0	0	0	0	0	0	0
28. Dakota - Portland Ave / E Nicollet Blvd	0	0	0	0	0	0	0	0	0	0
29. Faribault - US 169 / CSAH 16 / E 1st St	0	0	0	1	0	0	0	0	0	0
30. Faribault - US 169 / CSAH 16 / CSAH 53	0	0	0	0	0	0	0	0	0	0

Bike-Ped Crash Period	Before					After				
Site	K	A	B	C	PDO	K	A	B	C	PDO
31. Faribault - US 169 / CSAH 44	0	0	0	0	0	0	0	0	0	0
32. Goodhue - CSAH 66 / Pioneer Rd / Twin Bluff Rd	0	0	0	0	0	0	0	0	0	0
33. Goodhue - Levee Rd / Jackson St	0	0	0	0	0	0	0	0	1	0
34. Hennepin - 28th Ave S / Lindau Ln	0	0	0	0	0	0	0	0	0	0
35. Hennepin - CSAH 102 / Golden Valley Rd	0	0	0	1	0	0	0	0	0	0
36. Hennepin - CSAH 102 / Sandburg Rd	0	0	1	1	0	0	0	1	0	0
37. Hennepin - CSAH 12 / W River Rd	0	0	0	0	0	0	0	1	0	0
38. Hennepin - CSAH 14 / 117th Ave	0	1	0	1	0	0	0	0	0	0
39. Hennepin - CSAH 53 (66th St) / CSAH 52 (Nicollet Ave)	0	1	0	2	1	0	0	0	1	1
40. Hennepin - CSAH 53 (66th St) / Lyndale Ave S	0	0	1	3	0	0	0	0	0	0
41. Hennepin - CSAH 53 (66th St) / Portland Ave	0	0	1	0	0	0	0	2	0	1
42. Hennepin - CSAH 53 (66th St) / Richfield Pkwy	0	0	0	0	0	0	0	3	1	1
43. Hennepin - Hazelton Rd / Rue de France entr / 71 France entr	0	0	0	1	0	0	0	0	0	0
44. Hennepin - Louisiana Ave S / TH 7 WB Ramps	0	0	0	0	0	0	0	0	0	0
45. Hennepin - Louisiana Ave S / TH 7 EB Ramps / W Lake St	0	0	0	0	0	0	0	1	0	0
46. Hennepin - Louisiana Ave S / Walker St	0	0	2	0	0	0	0	0	0	0
47. Hennepin - Minnehaha Ave / Godfrey Pkwy	0	0	0	0	0	0	0	2	7	3
48. Hennepin - Valley View Rd / Braemar Blvd	0	1	0	1	0	0	0	0	0	0
49. Hennepin - Valley View Rd / Tracy Ave / Valley Ln	0	2	1	0	0	0	0	0	0	0
50. Hennepin - W 70th St / Galleria central entr	0	0	0	0	0	0	0	1	1	0
51. Hennepin - W 70th St / Galleria east entr	0	0	0	0	0	0	0	0	0	0
52. Hennepin - W 70th St / Galleria west entr	0	0	0	2	0	0	0	0	0	0
53. Hennepin - W 70th St / Valley View Rd	0	0	0	0	0	0	0	0	0	0
54. Hennepin - CR 202 / 101st Ave N	0	1	0	0	0	0	0	0	0	0
55. Le Sueur - TH 19 / Alton Ave	0	1	3	1	0	0	0	0	0	0
56. Le Sueur - TH 19 / Chalupsky Ave SE	0	0	0	1	0	0	0	1	0	0

Bike-Ped Crash Period	Before					After				
Site	K	A	B	C	PDO	K	A	B	C	PDO
57. McLeod - TH 15 / CSAH 12	0	0	0	0	0	0	0	0	0	0
58. Mille Lacs - TH 95 / CSAH 29	0	0	0	0	0	0	0	1	0	0
59. Nobles - US 59-TH 60 / CSAH 35	0	0	1	2	0	0	0	0	0	0
60. Nobles - US 59-TH 60 / Oxford St	0	0	0	0	0	0	0	0	0	0
61. Olmsted - 18th Ave NW / 48th St NW	0	0	1	2	0	0	0	0	0	0
62. Pennington - Greenwood St E / Pennington Ave	0	1	0	3	0	0	0	0	0	0
63. Ramsey - CR I / Old Hwy 8 / I-35W NB Offramp / Rice Creek Pkwy	0	0	0	0	0	0	0	0	0	0
64. Ramsey - Frost Ave / Parkway Dr / E Shore Dr	0	0	0	0	0	0	0	0	0	0
65. Ramsey - Frost Ave / English St	0	0	1	0	0	0	0	0	0	0
66. Scott - CR 79 / Vierling Dr	0	0	1	2	0	0	1	0	1	0
68. Scott - CSAH 16 / Glendale Rd / Lynn Ave	0	0	0	0	0	0	0	0	0	0
69. Sherburne - Railroad Dr / 3rd St NW / Irving Ave NW	0	2	0	0	0	0	0	0	0	0
70. Stearns - 2nd St S / Pinecone Rd N	0	0	0	0	0	0	0	0	0	0
71. Stearns - CSAH 120 / CSAH 1	0	0	0	0	0	0	0	0	0	0
72. Stearns - CSAH 2 / CSAH 50	0	0	0	1	0	0	0	0	0	0
73. Stearns - University Dr S / 5th Ave S	0	0	0	0	0	1	0	3	1	0
74. Washington - CSAH 14 / CSAH 6 / Jamaca Ave	0	0	0	0	0	0	0	0	0	0
75. Washington - CSAH 18 / 4th St S	0	0	0	1	0	0	0	0	0	0
76. Washington - CSAH 18 / 5th St N	0	0	0	0	0	0	0	1	0	0
77. Washington - CSAH 18 / Division St	0	0	0	0	0	0	0	0	0	0
78. Washington - CSAH 19 / CSAH 18	0	0	0	0	0	0	0	0	0	0
79. Washington - CSAH 19 / Lake Rd	0	0	0	0	0	0	0	1	0	0
80. Washington - CSAH 22 / CSAH 20 / Jamaica Ave	0	0	0	0	0	0	0	1	0	0
81. Washington - Hadley Ave S / 95th St S	0	0	0	0	0	0	0	0	0	0
82. Washington - CSAH 29 / TH 36 WB On-Ramp / 60th St N	0	0	0	0	0	0	0	0	0	0
83. Washington - Jamaica Ave / US 10-US 61 EB Ramps / W Point Douglas Rd	0	0	0	0	0	0	0	0	0	0
84. Washington - Jamaica Ave. / US 10-US 61 WB Ramps	0	0	0	0	0	0	0	0	0	0
85. Washington - Pioneer Dr / Interlachen Pkwy	0	0	0	0	1	0	0	0	0	0
86. Washington - TH 96 / CSAH 15	0	0	0	1	0	0	0	0	0	0
87. Washington - US 61 / CSAH 4 / CR 4A	0	0	0	1	0	0	0	0	0	0

Bike-Ped Crash Period	Before					After				
Site	K	A	B	C	PDO	K	A	B	C	PDO
88. Washington - US 61 / CSAH 2 / Broadway Ave	0	0	0	1	0	0	0	1	4	0
89. Washington - US 61 / TH 97 N jct / Forest Blvd N	0	0	0	1	0	0	0	0	0	0
90. Washington - US 61 / TH 97 S jct / 210th St N	0	0	0	2	0	0	0	0	0	0
91. Watonwan - TH 4-TH 30 / CSAH 56 E Jct	0	0	5	1	0	0	0	0	0	0
92. Watonwan - TH 4-TH 30 / CSAH 56 W Jct / Armstrong Blvd	0	0	0	0	0	0	0	0	0	0
93. Winona - CSAH 17 / CSAH 15	0	0	0	0	0	0	0	0	0	0
94. Wright - CSAH 8 / CSAH 57 / Elm Ave	0	1	5	3	0	0	0	0	0	0
95. Wright - TH 25 / 8th St NW-NE	0	0	2	0	0	0	0	0	0	0
Totals	1	14	40	48	3	1	1	27	19	7

APPENDIX C
TRAFFIC SIGNAL CONTROL SITE CRASH DATA

Table C.1 – Traffic Signal Control Site Crashes – 2017-2021 – All

Site	Severity Type				
	K	A	B	C	PDO
1. Anoka - Davenport St NE / 105th Ave NE	0	0	5	6	53
2. Anoka - CSAH 12 / Davenport St NE / Club West Pkwy NE	1	0	5	13	74
3. Saint Louis - MN 1 / 3rd Ave E	0	0	0	1	19
4. Sherburne - CSAH 4 / CR 45	1	0	2	7	25
5. Sherburne - School St NW / Jackson Ave NW	0	1	4	6	21
6. Benton - CSAH 3 / 2nd Ave N	0	1	7	8	53
7. Benton - CSAH 3 / Stearns Dr	0	0	0	0	6
8. Blue Earth - CSAH 82 / Madison Ave	0	0	8	15	42
9. Blue Earth - CSAH 82 / Main St	0	0	5	8	17
10. Carver - Community Dr / Oak Ave	0	0	0	0	5
11. Cass - TH 371 / 5th St S	0	0	1	0	6
12. Stevens - TH 9-28 / 7th St	0	0	2	2	29
13. Ramsey - CSAH 49 / Hodgson Connection	0	0	0	1	4
14. Carver - CSAH 59 / E 10th St / Airport Rd	0	0	0	0	2
15. Carver - CSAH 59 / CSAH 10	0	1	2	1	4
16. Carver - CSAH 10 / Marketplace Dr / W 10th St	0	0	5	8	42
17. Crow Wing - TH 371 / CSAH 16 / Myers Rd	0	0	3	0	2
18. Crow Wing - TH 371B / Quince St	0	1	3	1	12
19. Cass - TH 371-210 / TH 34 / 8th St N	0	0	0	3	7
20. Crow Wing - CSAH 48 / W College Dr / College Rd S	0	0	2	1	10
21. Saint Louis - US 169-TH 73 / E 25th St	0	0	6	7	34
22. Dakota - 175th St W / Ipava Ave	0	0	2	4	18
23. Dakota - Nicollet Ave / E 134th St / Woodcrest Dr	0	0	1	2	17
24. Dakota - CR 6 / US 52 NB On-Ramp / Lafeyette Ave	0	0	3	5	28
25. Dakota - CSAH 32 / Johnny Cake Ridge Rd	0	3	7	5	15
26. Dakota - TH 3 / Moreland Ave E	0	3	3	9	34
27. Dakota - CR 6 / US 52 SB Off-Ramp / Waterloo Ave	0	0	5	7	36
28. Dakota - Nicollet Ave / Nicollet Blvd	0	1	4	6	15
29. Jackson - US 71 / North Hwy	0	0	0	1	8
30. Jackson - US 71 / Sherman St	0	0	1	1	10
31. Pennington - TH 32 / 2nd St	0	1	1	0	10
32. US 71-TH 11 / 6th Ave	0	0	0	0	4
33. Saint Louis - US 53 / CSAH 23	0	0	1	0	3
34. Hennepin - 28th Ave S / American Blvd E	0	0	0	1	0
35. Hennepin - Rhode Island Ave / Golden Valley Rd	0	0	1	3	4
36. Hennepin - CSAH 70 / CSAH 102 / Medicine Lake Rd	0	0	1	3	22
37. Hennepin - CSAH 12 / CSAH 14	0	0	1	2	1
38. Hennepin - CSAH 14 & Oxbow Creek Dr N	0	0	1	0	8

Site	Severity Type				
	K	A	B	C	PDO
39. Hennepin - CSAH 53 / Lake Shore Dr S / Rae Dr	0	0	2	7	21
40. Hennepin - CSAH 53 / CSAH 31	0	1	2	3	13
41. Hennepin - CSAH 53 / CSAH 32	0	1	5	9	36
42. Hennepin - CSAH 53 / 12th Ave S	0	0	1	2	14
43. Ramsey - County Road B / Har Mar Service Rd	0	0	2	6	9
44. Ramsey - CSAH 51 (Hamline Ave) / TH 36 WB Ramps	0	0	0	2	3
45. Ramsey - CSAH 51 (Hamline Ave) / TH 36 EB Ramps / Commerce St	0	0	3	2	7
46. Ramsey - CSAH 51 (Hamline Ave) / CSAH 78 (County Rd B)	0	1	1	6	12
47. Hennepin - CSAH 46 / 46th Ave S	0	0	3	3	8
48. Hennepin - CSAH 158 / Vernon Ave	0	0	1	0	5
49. Hennepin - CSAH 158 / Tracy Ave	0	0	1	1	2
50. Ramsey - CSAH 42 / Finn St	0	0	0	4	26
51. Ramsey - CSAH 42 / Kenneth St	1	0	0	3	15
52. Hennepin - W 50th St / Market St / Halifax Ave	0	0	2	3	11
53. Rice - TH 60 / Central Ave N	0	0	3	8	56
54. Wright - TH 55 / CSAH 5	0	0	1	1	9
55. Hubbard - TH 34 / Main Ave	0	3	3	2	27
56. Waseca - TH 13 / 13th Ave NW	0	1	2	1	5
57. Chisago - US 61 / CR 22 / CSAH 30 / E Viking Blvd	0	0	2	4	12
58. Swift - US 12 / TH 9 / TH 29	0	0	1	3	23
59. McLeod - TH 15 / Denver Ave	0	1	3	6	47
60. Olmsted - 18th Ave NW / 41st St NW	0	1	1	3	18
61. Ramsey - CSAH 30 / Victoria St N	0	0	1	1	7
62. Ramsey - E Cayuga St / I-35E SB Off-Ramp / L'Orient St	0	0	6	6	46
63. Ramsey - CSAH 46 / Roselawn Ave W	0	0	1	4	3
64. Ramsey - CSAH 58 / Roselawn Ave	0	0	2	3	3
65. Scott - CSAH 16 / CR 79	0	1	1	3	16
66. Pine - TH 48 / Lady Luck Dr	0	0	1	1	8
67. Scott - CSAH 27 / S Park Dr	0	0	0	1	7
68. Stearns - W St Germain St / 8th Ave S	0	0	1	1	23
69. Stearns - CSAH 78 / CSAH 133	0	0	5	4	29
70. Benton - Benton Dr / 1st St S	1	1	2	7	41
71. Stearns - CSAH 2 / Main St	0	0	0	8	18
72. Stearns - University Dr S / 9th Ave S	0	3	11	34	196
73. Washington - CSAH 14 / CSAH 17 W Jct	0	0	1	0	6
74. Winona - TH 43 / Main St / W 4th St	0	0	2	0	1
75. Winona - TH 43 / Winona St / W 4th St	0	0	1	3	2
76. Winona - Huff St / W 4th St	0	0	3	0	2

Site	Severity Type				
	K	A	B	C	PDO
77. Washington - CSAH 13 / Lake Road	0	0	1	3	5
78. Washington - Lake Rd / Woodlane Dr	0	0	4	4	12
79. Washington - CSAH 22 / Hardwood Ave S	0	1	0	1	12
80. Washington - TH 95 / TH 36 WB Off-Ramp	0	0	4	2	17
81. Dakota - Upper 55th St / US 52 SB Ramps	0	0	1	2	21
82. Dakota - Upper 55th St / US 52 NB Ramps	0	3	2	6	35
83. Washington - Lake Road / Wimbledon Dr	0	0	0	0	3
84. Washington - CSAH 12 / CSAH 15	0	0	2	3	9
85. Washington - US 61 / Headwaters Pkwy	0	0	1	1	4
86. Anoka - E Main St / 2nd Ave	0	0	1	3	55
87. Anoka - CSAH 14 / CSAH 51 / University Ave	0	2	2	5	44
88. Anoka - CSAH 14 / Jefferson St NE	0	0	2	2	25
89. Rock - US 75 / CSAH 4	0	1	0	1	20
90. Rock - CSAH 4 / Cedar St	0	0	1	2	13
91. Roseau - TH 11 / CSAH 74	0	0	0	0	2
92. Wright - TH 55 / CSAH 8 / CSAH 37	0	0	1	5	11
93. Wright - TH 25 / CSAH 35 / 1st St NE	0	0	2	2	7
Totals	4	33	193	334	1782

Table C.2 – Traffic Signal Control Site Crashes – 2017-2021 – Bike & Pedestrian Crashes

Site	Severity Type				
	K	A	B	C	PDO
1. Anoka - Davenport St NE / 105th Ave NE	0	0	0	0	0
2. Anoka - CSAH 12 / Davenport St NE / Club West Pkwy NE	0	0	0	0	0
3. Saint Louis - MN 1 / 3rd Ave E	0	0	0	0	0
4. Sherburne - CSAH 4 / CR 45	1	0	1	0	0
5. Sherburne - School St NW / Jackson Ave NW	0	0	0	1	0
6. Benton - CSAH 3 / 2nd Ave N	0	1	2	0	0
7. Benton - CSAH 3 / Stearns Dr	0	0	0	0	0
8. Blue Earth - CSAH 82 / Madison Ave	0	0	1	0	0
9. Blue Earth - CSAH 82 / Main St	0	0	0	1	0
10. Carver - Community Dr / Oak Ave	0	0	0	0	0
11. Cass - TH 371 / 5th St S	0	0	0	0	0
12. Stevens - TH 9-28 / 7th St	0	0	0	0	0
13. Ramsey - CSAH 49 / Hodgson Connection	0	0	0	0	0
14. Carver - CSAH 59 / E 10th St / Airport Rd	0	0	0	0	0
15. Carver - CSAH 59 / CSAH 10	0	0	0	0	0
16. Carver - CSAH 10 / Marketplace Dr / W 10th St	0	0	0	0	0
17. Crow Wing - TH 371 / CSAH 16 / Myers Rd	0	0	0	0	0
18. Crow Wing - TH 371B / Quince St	0	0	3	0	0
19. Cass - TH 371-210 / TH 34 / 8th St N	0	0	0	0	0
20. Crow Wing - CSAH 48 / W College Dr / College Rd S	0	0	0	0	0
21. Saint Louis - US 169-TH 73 / E 25th St	0	0	0	0	0
22. Dakota - 175th St W / Ipava Ave	0	0	0	0	0
23. Dakota - Nicollet Ave / E 134th St / Woodcrest Dr	0	0	0	0	0
24. Dakota - CR 6 / US 52 NB On-Ramp / Lafeyette Ave	0	0	0	0	0
25. Dakota - CSAH 32 / Johnny Cake Ridge Rd	0	0	0	0	0
26. Dakota - TH 3 / Moreland Ave E	0	1	0	3	0
27. Dakota - CR 6 / US 52 SB Off-Ramp / Waterloo Ave	0	0	0	0	0
28. Dakota - Nicollet Ave / Nicollet Blvd	0	0	0	0	0
29. Jackson - US 71 / North Hwy	0	0	0	0	0
30. Jackson - US 71 / Sherman St	0	0	1	0	0
31. Pennington - TH 32 / 2nd St	0	1	0	0	0
32. US 71-TH 11 / 6th Ave	0	0	0	0	0
33. Saint Louis - US 53 / CSAH 23	0	0	1	0	0
34. Hennepin - 28th Ave S / American Blvd E	0	0	0	0	0
35. Hennepin - Rhode Island Ave / Golden Valley Rd	0	0	0	0	0
36. Hennepin - CSAH 70 / CSAH 102 / Medicine Lake Rd	0	0	0	0	0
37. Hennepin - CSAH 12 / CSAH 14	0	0	0	0	0
38. Hennepin - CSAH 14 & Oxbow Creek Dr N	0	0	0	0	0

Site	Severity Type				
	K	A	B	C	PDO
39. Hennepin - CSAH 53 / Lake Shore Dr S / Rae Dr	0	0	0	1	1
40. Hennepin - CSAH 53 / CSAH 31	0	1	1	0	1
41. Hennepin - CSAH 53 / CSAH 32	0	0	0	0	2
42. Hennepin - CSAH 53 / 12th Ave S	0	0	0	0	0
43. Ramsey - County Road B / Har Mar Service Rd	0	0	0	0	0
44. Ramsey - CSAH 51 (Hamline Ave) / TH 36 WB Ramps	0	0	0	0	0
45. Ramsey - CSAH 51 (Hamline Ave) / TH 36 EB Ramps / Commerce St	0	0	0	0	0
46. Ramsey - CSAH 51 (Hamline Ave) / CSAH 78 (County Rd B)	0	0	0	0	0
47. Hennepin - CSAH 46 / 46th Ave S	0	0	1	1	0
48. Hennepin - CSAH 158 / Vernon Ave	0	0	0	0	0
49. Hennepin - CSAH 158 / Tracy Ave	0	0	1	0	0
50. Ramsey - CSAH 42 / Finn St	0	0	0	1	0
51. Ramsey - CSAH 42 / Kenneth St	0	0	0	0	0
52. Hennepin - W 50th St / Market St / Halifax Ave	0	0	2	1	0
53. Rice - TH 60 / Central Ave N	0	0	1	0	0
54. Wright - TH 55 / CSAH 5	0	0	0	0	0
55. Hubbard - TH 34 / Main Ave	0	1	3	0	0
56. Waseca - TH 13 / 13th Ave NW	0	1	0	0	0
57. Chisago - US 61 / CR 22 / CSAH 30 / E Viking Blvd	0	0	1	0	0
58. Swift - US 12 / TH 9 / TH 29	0	0	1	0	0
59. McLeod - TH 15 / Denver Ave	0	0	0	0	0
60. Olmsted - 18th Ave NW / 41st St NW	0	0	0	0	0
61. Ramsey - CSAH 30 / Victoria St N	0	0	0	0	0
62. Ramsey - E Cayuga St / I-35E SB Off-Ramp / L'Orient St	0	0	0	0	1
63. Ramsey - CSAH 46 / Roselawn Ave W	0	0	0	0	0
64. Ramsey - CSAH 58 / Roselawn Ave	0	0	0	0	0
65. Scott - CSAH 16 / CR 79	0	0	0	0	0
66. Pine - TH 48 / Lady Luck Dr	0	0	0	0	0
67. Scott - CSAH 27 / S Park Dr	0	0	0	0	0
68. Stearns - W St Germain St / 8th Ave S	0	0	1	0	0
69. Stearns - CSAH 78 / CSAH 133	0	0	1	0	0
70. Benton - Benton Dr / 1st St S	0	0	0	0	0
71. Stearns - CSAH 2 / Main St	0	0	0	0	0
72. Stearns - University Dr S / 9th Ave S	1	1	0	2	1
73. Washington - CSAH 14 / CSAH 17 W Jct	0	0	0	0	0
74. Winona - TH 43 / Main St / W 4th St	0	0	0	0	0
75. Winona - TH 43 / Winona St / W 4th St	0	0	0	0	0
76. Winona - Huff St / W 4th St	0	0	1	0	0

Site	Severity Type				
	K	A	B	C	PDO
77. Washington - CSAH 13 / Lake Road	0	0	0	0	0
78. Washington - Lake Rd / Woodlane Dr	0	0	0	0	0
79. Washington - CSAH 22 / Hardwood Ave S	0	0	0	0	0
80. Washington - TH 95 / TH 36 WB Off-Ramp	0	0	0	0	0
81. Dakota - Upper 55th St / US 52 SB Ramps	0	0	0	0	0
82. Dakota - Upper 55th St / US 52 NB Ramps	0	0	0	0	0
83. Washington - Lake Road / Wimbledon Dr	0	0	0	0	0
84. Washington - CSAH 12 / CSAH 15	0	0	0	0	0
85. Washington - US 61 / Headwaters Pkwy	0	0	0	0	0
86. Anoka - E Main St / 2nd Ave	0	0	0	1	0
87. Anoka - CSAH 14 / CSAH 51 / University Ave	0	0	0	1	0
88. Anoka - CSAH 14 / Jefferson St NE	0	0	0	0	1
89. Rock - US 75 / CSAH 4	0	1	0	0	0
90. Rock - CSAH 4 / Cedar St	0	0	0	0	0
91. Roseau - TH 11 / CSAH 74	0	0	0	0	0
92. Wright - TH 55 / CSAH 8 / CSAH 37	0	0	0	0	0
93. Wright - TH 25 / CSAH 35 / 1st St NE	0	0	2	0	0
Totals	2	8	25	13	7

APPENDIX D – SEVERE CRASHES AT ROUNDABOUTS

Few enough fatal and serious injury crashes occurred at roundabouts included in this evaluation that we can review each narrative to see if the roundabout was a contributing factor. Table D.1 lists each severe crash that occurred during or after the construction of a roundabout.

Table D.1 – K & A Severity Crashes at Roundabouts

Location	City	Crash Year	Crash Severity	Incident ID	Related to Roundabout?
CSAH 17 / CSAH 15	Winona	2016	K	328614	No
CSAH 53 (66th St) / Portland Ave	Richfield	2016	K	375803	No
CSAH 18 / 4th St S	Lakeland	2017	K	456132	No
University Dr / 5th Ave S	Saint Cloud	2017	K	511243	Yes
W 70th St / Galleria West Ent.	Edina	2008	A	10490451	Unknown
CSAH 18 / Division St	Lakeland	2010	A	10622794	Unknown
University Dr / 5th Ave S	Saint Cloud	2011[1]	A	10741488	Unknown
US 61 / CSAH 2 / Broadway Ave	Forest Lake	2015	A	11076816	No
CSAH 18 / 4th St S	Lakeland	2015	A	11088239	No
2nd St S / Pinecone Rd	Sartell	2016	A	355229	No
CSAH 16 / Glendale Rd / Lynn Ave	Savage	2016	A	357390	Yes
TH 15 / CSAH 12	Hutchinson	2016	A	357729	Yes
CSAH 14 / 117th Ave	Champlin	2017	A	498413	Yes
105th Ave NE / Irvin Pkwy	Blaine	2018[1]	A	538606	Yes
Jamaica Ave / US 10-61 WB Ramps	Cottage Grove	2018	A	565825	No
CSAH 53 (66th St) / Lyndale Ave	Richfield	2018[1]	A	607768	No
CR 79 / Vierling Dr	Shakopee	2019	A	723056	Yes
University Dr / 5th Ave S	Saint Cloud	2019	A	734179	No
CSAH 53 (66th St) / Nicollet Ave	Richfield	2020	A	777277	Yes
CSAH 10 / CSAH 20	Watertown	2020	A	861238	Yes
TH 284 / CSAH 10	Waconia	2021	A	916076	Yes
CSAH 53 (66th St) / Portland Ave	Richfield	2022	A	1002834	No
Excelsior Rd / Cypress Dr	Baxter	2022	A	1012958	No
CSAH 64 / Akin Rd	Farmington	2022	A	1016962	Yes
CSAH 2 / CSAH 50	Cold Spring	2022	A	1017566	Yes
TH 15 / CSAH 12	Hutchinson	2022	A	1027080	No
Minnehaha Ave / Godfrey Pkwy	Minneapolis	2022	A	1030137	Yes
CSAH 18 / 4th St S	Lakeland	2022	A	1053291	Yes

Note: 1 = Crash occurred in construction year

The table above indicates that 1 fatal crash and 12 serious injury crashes have occurred at roundabouts that were part of this evaluation. Further details of each crash are provided below:

- Incident ID 511243 – A person walking suffered a head injury after being struck by a vehicle near the crosswalk on the west side of the roundabout. The individual later died because of their injuries.

- Incident ID 357390 – A driver failed to yield the right of way to a motorcycle already in the roundabout. The operator of the motorcycle was forced to lay down his vehicle to avoid collision and suffered a suspected serious injury as a result.
- Incident ID 357729 – A driver failed to yield the right of way to a motorcycle already in the roundabout and struck the rear tire. The operator of the motorcycle was thrown from their vehicle suffered serious injuries as a result.
- Incident ID 498413 – A motorcycle operator lost control of their vehicle entering the roundabout and tipped. There were no witnesses to the crash.
- Incident ID 538606 – A motorist traveling through a work zone was distracted by their passenger and did not see the roundabout under construction. They ran off road, entered the construction zone, and hit a pole as well as other construction equipment. The crash diagram shows two-way traffic operating on one side of the proposed roundabout through the work zone.
- Incident ID 723056 – A driver struck a pedestrian crossing in the crosswalk at the roundabout. The crash occurred during sunrise so visual impairment because of glare from the rising sun may have affected the motorist as well.
- Incident ID 777277 – A driver traveling through the roundabout ran off the road and impacted a curb and cement block. Their vehicle then rolled and landed on its roof. Alcohol use is suspected.
- Incident ID 861238 – A motorcycle operator lost control of their vehicle entering the roundabout, tipped, and was thrown from the motorcycle. Alcohol use is suspected.
- Incident ID 916076 – A driver entering the roundabout failed to yield the right of way to a motorcycle already in the roundabout. The operator of the motorcycle suffered a suspected serious injury as a result.
- Incident ID 1016962 – A driver entering the roundabout hit a patch of ice on the road and was unable to stop before sliding into the intersection where their vehicle collided with another vehicle already in the roundabout. A minor was transported to the hospital because of the crash, but the crash report gives no specifics on their injuries.
- Incident ID 1017566 – A vehicle crashed into a light pole at the south end of the roundabout. The crash report notes the driver was asleep or fatigued but neither vehicle occupant could come up with an idea of what had caused the collision or vehicle to go off the road.
- Incident ID 1030137 – A driver struck a bicyclist in the roundabout. The bike rider was thrown off the bike and suffered injuries to both their legs as well as a possible head injury but declined medical attention at the scene. The crash report notes that both vehicles thought the other was going to yield.
- Incident ID 1053291 – A motorcycle operator lost control of their vehicle navigating the roundabout and crashed over the curb and onto the sidewalk. The operator suffered possible serious injuries to their torso and were transported to the hospital via ambulance. The crash report notes the operator was inexperienced and had their motorcycle permit for less than 6 months.

In reviewing the thirteen fatal or serious injury crashes that were indicated as roundabout related, certain SHSP Focus Areas emerge. The most common were Motorcyclist and Lane Departure SVROR, with six instances each, as well as Older Drivers and Impairment, with four each. The most concerning of these are Motorcyclist and Older Driver, as this indicates some potential navigational issues for motorcycles and the possibility that older drivers who could have slower reaction times or more life experience with typical traffic control at intersections have more difficulty with determining user right-of-way or selection of appropriate gaps to enter. Overall, however, the review of these crashes supports the safety benefits that roundabouts provide. In many instances above, such as when a motorcycle, pedestrian, or bicycle is hit by a vehicle, a suspected serious injury crash could have been a fatal event if it had occurred at a standard intersection. The higher speeds potentially involved could increase injury severity for vulnerable road users.