Memorandum

SRF No. 13195.00

To: Steve Lillehaug, PE, PTOE, Public Works Director/City Engineer
City of Shakopee

From: Brent Clark, PE, Senior Engineer
Matt Pacyna, PE, Principal

Date: June 24, 2020

Subject: Marystown Road Corridor Study

Introduction

The City of Shakopee, in partnership with Scott County and the Minnesota Department of Transportation (MnDOT), developed the future vision for County Road (CR) 15/Marystown Road/ Adams Street from Vierling Drive to CR 16 (17th Avenue W) in Shakopee, Minnesota. The development and operations along the corridor have been discussed and evaluated in the following studies that were completed in 2019:

- *Shakopee AUAR Transportation Analysis*, SRF Consulting (September 2019)
- *Trident Development Transportation Study*, SRF Consulting (December 2019)

These previous studies identified that the current traffic control along the corridor is not expected to sufficiently accommodate future growth and planned development in the area by the year 2025. In addition, there are safety concerns at the intersections, as CR 15/Marystown Road is a high-speed corridor (45 to 55 mph) and there has been a recent increase in crashes since construction of the Hy-Vee and Windermere developments (along with the addition of the west approaches at the US 169 South Ramp and CR 16 intersections to accommodate the Windermere development). The City also has a desire to repurpose the US 169 Bridge to provide a multi-use trail on both sides, thus connecting a gap in the City's trail system. Therefore, this study was completed to determine the current and future traffic control/corridor needs of CR 15/Marystown Road that will inform the anticipated reconstruction project from Vierling Drive to CR 16 planned for the year 2022. This study summarizes the technical evaluation completed for the project.

Agency Coordination

Throughout the study process, SRF worked closely with the City of Shakopee, Scott County, and the Minnesota Department of Transportation (MnDOT) to determine the preferred corridor vision and layout. Several coordination meetings occurred to provide each agency the opportunity to provide feedback on the study process, findings, and corridor recommendations.

The following provides a summary of the agency meetings, purpose, and timeline.:

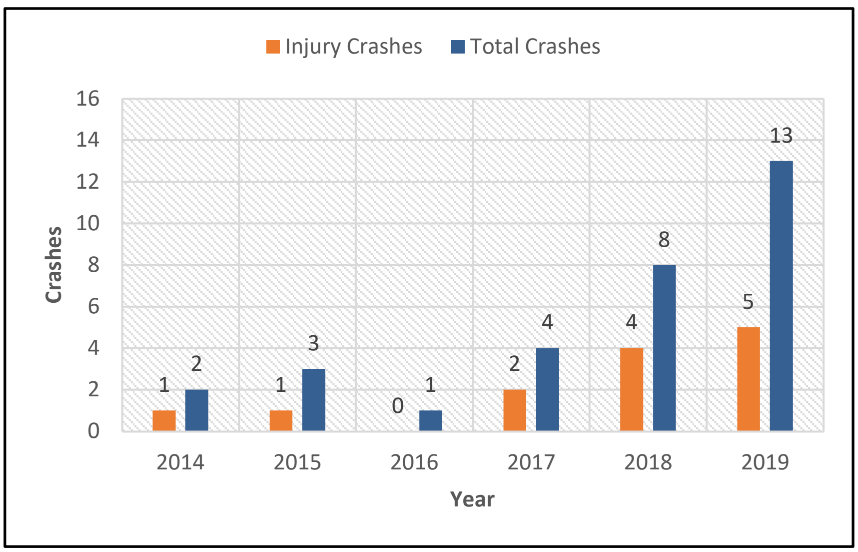
- Agency Meeting 1 – Project Kick-Off Meeting (January 10, 2020)
- Agency Meeting 2 – Project Timeline/Initial Comments (February 26, 2020)
- Agency Meeting 3 – Roundabout Design Meeting #1 (March 18, 2020)
- Agency Meeting 4 – Roundabout Design Meeting #2 (March 27, 2020)

Existing Pedestrian/Bicycle Facilities (Appendix A)

The *Shakopee Comprehensive Plan* was used to identify current local and regional bicycle facilities within the area. A summary of the existing pedestrian and bicycle facilities is illustrated in Appendix A. The comprehensive plan acknowledges that the City of Shakopee has a high quality, yet disconnected trail system. Note that there is a significant north-south pedestrian/bicycle facility gap along Marystown Road. On the west side of Marystown Road, the multi-use trail ends at Tahpah Park and continues back at Windermere Way. On the east side of Marystown Road, the multi-use trail ends at the Hy-Vee right-in/right-out access and does not continue. It is important to address these pedestrian/ bicycle facility gaps, especially when development occurs and roadway/traffic control changes are being proposed.

Existing Safety Analysis (Appendix B)

Crash data was obtained from the City of Shakopee from 2014 through 2019 to identify any crash trends at the study intersections. Average crashes per year along the corridor have increased from two (2) crashes between 2014 and 2016 to approximately eight (8) between 2017 and 2019. It should be noted that the Hy-Vee Development opened in late 2017, and the west legs of the Marystown Road/US 169 South Ramp and the CR 15/CR 16 intersections were constructed in 2018. These additions have not only increased traffic volumes at the study intersections, but also added conflict points to the two southernmost intersections. As development in the area continues, the crash trends identified are expected to continue unless traffic control improvements occur.



The latest three-year period (2017-2019) was used for the crash analysis per MnDOT ICE report guidance and is summarized below:

- 25 intersection crashes were reported at the study intersections; Approximately 70 percent of the crashes were right-angle crashes.
- No fatal or incapacitating injury crashes occurred along the corridor; there were six (6) non-incapacitating injury crashes, five (5) possible injury crashes, and 14 property damage only (PDO) crashes.
  - There was a right-angle crash that resulted in two fatalities at the Marystown Road/ US 169 North Ramp intersection in 2010.
- All four study intersections have crash rates higher than the average rate; the CR 15/CR 16 intersection has a crash rate higher than the critical crash rate.
  - All eight (8) CR 15/CR 16 intersection crashes occurred after the west leg of the intersection was constructed in 2018.
  - Six (6) of the eight (8) crashes were right-angle crashes; five (5) of which resulted in injury.

Existing Intersection Operations Analysis (Appendix C)

Existing hourly approach volumes at the study intersections were collected in October 2019 by SRF. Adjustments were made to the existing turning movement counts to account for ongoing construction in the region, which is outlined further in the *Trident Development Transportation Study*. An intersection capacity analysis was completed to quantify how traffic operates at the study intersections under existing conditions. All study intersections currently operate at an overall acceptable LOS B or better during the a.m. and p.m. peak hours with existing intersection geometry and traffic control. However, existing operational concerns identified include:

- Improper vehicular movements occur at the Hy-Vee right-in/right-out access; vehicles exiting the access that are destined southbound perform a U-turn at the end of the raised median or turn around in the adjacent neighborhood to the west.
- Sight distance can be difficult at the westbound approaches on the US 169 ramps when multiple vehicles are making turning movements at the same time.

Traffic Volume Forecasts (Appendix D)

The year 2025 volumes were developed as part of the *Trident Development Transportation Study* and account for the three on-going developments along the study corridor (Windermere, Bruggeman, Trident), as well as an annual background growth rate of one and a half (1.5) percent. As previously mentioned, the three on-going developments are expected to be developed before 2025. Therefore, the year 2025 represents one-year post-construction of the full-build out of these proposed developments.

The year 2040 turning movements were developed as part of the *Shakopee AUAR Transportation Study*, utilizing the Scott County Regional Travel Demand Model and the 2040 Scott County Comprehensive Plan. These 2040 turning movement counts were updated as part of the *Trident Development Transportation Study*.

As discussed later in this document, a 10-year forecast from the anticipated year of opening of the construction project (i.e. year 2034) was developed to inform geometric design decisions. These forecasts were developed by determining a linear growth rate between 2025 and 2040 and applying the annual growth rate to develop year 2034 traffic forecasts.

Future Operations Analysis (Appendix E)

A year 2025 and year 2040 intersection capacity analysis was completed to evaluate how the study intersections are expected to operate in the future if no geometric or traffic control changes are made. The intersections were evaluated with the existing geometry and traffic control, with forecasted turning movements. Results of the analysis identified the following:

- Under year 2025 conditions, the CR 15/CR 16 and Marystown Road/US 169 ramp intersections are expected to have failing side-street operations during the peak hours. The US 169 ramps are expected to have queues that extend over 50 percent of the off-ramp, which may cause safety issues as vehicles coming from US 169 may not expect these queues. Furthermore, as side-street operations begin to fail, drivers will begin to accept smaller gaps, which could present additional safety risks.
- Under year 2040 conditions, the CR 15/CR 16 and Marystown Road/US 169 ramp intersections are expected to operate at an overall LOS F during the peak hours, with delays greater than three (3) minutes. These intersections had model failure, meaning the full demand at these intersections was not able to enter the network.
  - The Adams Street/Vierling Drive intersection is expected to operate at a LOS D during the p.m. peak hour, with the westbound approach operating at LOS E; the improper movements at the Hy-Vee right-in/right-out access identified under existing conditions are expected to continue.

To address operational and safety issues, the CR 15/CR 16 and Marystown Road/US 169 ramp intersections traffic controls were evaluated to be converted to a traffic signal or roundabout. A roundabout, traffic signal, and reconfigured all-way stop control was evaluated at the Adams Street/Vierling Drive intersection to eliminate the existing multi-lane all-way stop condition and reduce improper movements along the corridor.

Note that Intersection Control Evaluations (ICE) reports were completed for the four study intersections along the corridor to determine the recommended traffic control at the intersections. These are documented and discussed in the next section.

Intersection Control Evaluations (Appendix F)

As part of the Intersection Control Evaluations, the following analyses/factors were considered to determine the long-term preferred intersection control:

- **Capacity Analysis:** The future operations of the traffic control alternatives were evaluated using a combination of Synchro/SimTraffic, HCS 7, and Rodel.
- **Safety Analysis:** The *Highway Safety Manual (HSM) Predictive Method* was used to predict crash frequency and severity at the study intersections based on traffic volumes and traffic controls.
- **Pedestrian Considerations:** Pedestrian connectivity and safety were discussed for the traffic control alternatives; this was particularly important due to the corridor's close proximity to area schools and regional parks.
- **Transportation System Considerations:** Traffic control continuity was discussed along with other alternative considerations.
- **Site Access:** Traffic control alternatives and their impacts to the Hy-Vee and Trident development access were discussed.
- **Cost Analysis:** An incremental benefit-cost analysis was performed to determine the economic benefit of an alternative; construction cost estimates for recent construction improvements were also discussed.
- **Right-of-Way:** Potential impacts to right-of-way were evaluated and discussed.

Based on the results of the ICE, a roundabout control is recommended at the four study intersections along the corridor. This alternative performed better in all categories measured.

Corridor Layout Design (Appendix G)

Intersection control evaluations determined that roundabouts were the recommended traffic control at the four study intersections. Therefore, a corridor layout was developed based on the roundabout design at each of the study intersections. The roundabout design was based on a combination of safety and near-/long-term traffic forecasts. Roundabouts have proven to be safer for vehicles and pedestrians with single-lane, single-approach geometrics. Because of these safety benefits, additional turn lanes/circulating lanes were not desired by area agencies unless they were essential from a traffic operations perspective, regardless of the existing roadway configurations or excess bridge space. Therefore, ten-year forecasts were developed to determine the near-term traffic operational needs. The proposed roundabout design was developed based on the near-term traffic volumes; however, this design is not expected to accommodate long-term traffic forecasts and will likely need additional capacity improvements/expansions by year 2040 or before. The City preferred constructing the ultimate roundabout layout, capable of accommodating long-term forecasts without intermediate reconstruction, however, area agencies required a near-term design approach. Therefore, the roundabouts were designed to have the ability to be easily expanded in the future if/when warranted.

A summary of the proposed roundabout design and potential future expansions are shown in Table 1.

Table 1. Proposed Roundabout Design

Intersection	Proposed Roundabout	Potential Future Expansion
Vierling Drive	• Single-Lane • Single-Approach	• N/A [(1)]
US 169 North Ramp	• Single-Lane • Westbound Right-Turn Lane	• Hybrid (Two Southbound Circulating Lanes)
US 169 South Ramp	• Single-Lane • Northbound/Southbound Right-Turn Lanes	• Hybrid (Two Southbound Circulating Lanes)
CR 16	• Single-Lane • Single-Approach	• Northbound/Southbound/Westbound Right-Turn Lanes

(1) A single-lane, single-approach roundabout is expected to accommodate long-term traffic forecasts, therefore, no future expansion is expected.

Preliminary cost estimates were developed for the proposed layout, which include construction costs, design engineering, construction administration, and contingencies. The conceptual layouts for the proposed construction and future expansions, along with the corresponding sensitivity traffic operations and detailed cost estimates are shown in the Appendix.

Next Steps

The City has begun the process to identify project funding. This includes applying for the Regional Solicitation, Highway Safety Improvement Program (HSIP), and the Local Partnership Program (LPP) funding applications, as well as incorporating the project into the City's Capital Improvement Plan. The City should continue to discuss project funding with the County and MnDOT, as well as leverage potential public/private partnerships where possible.

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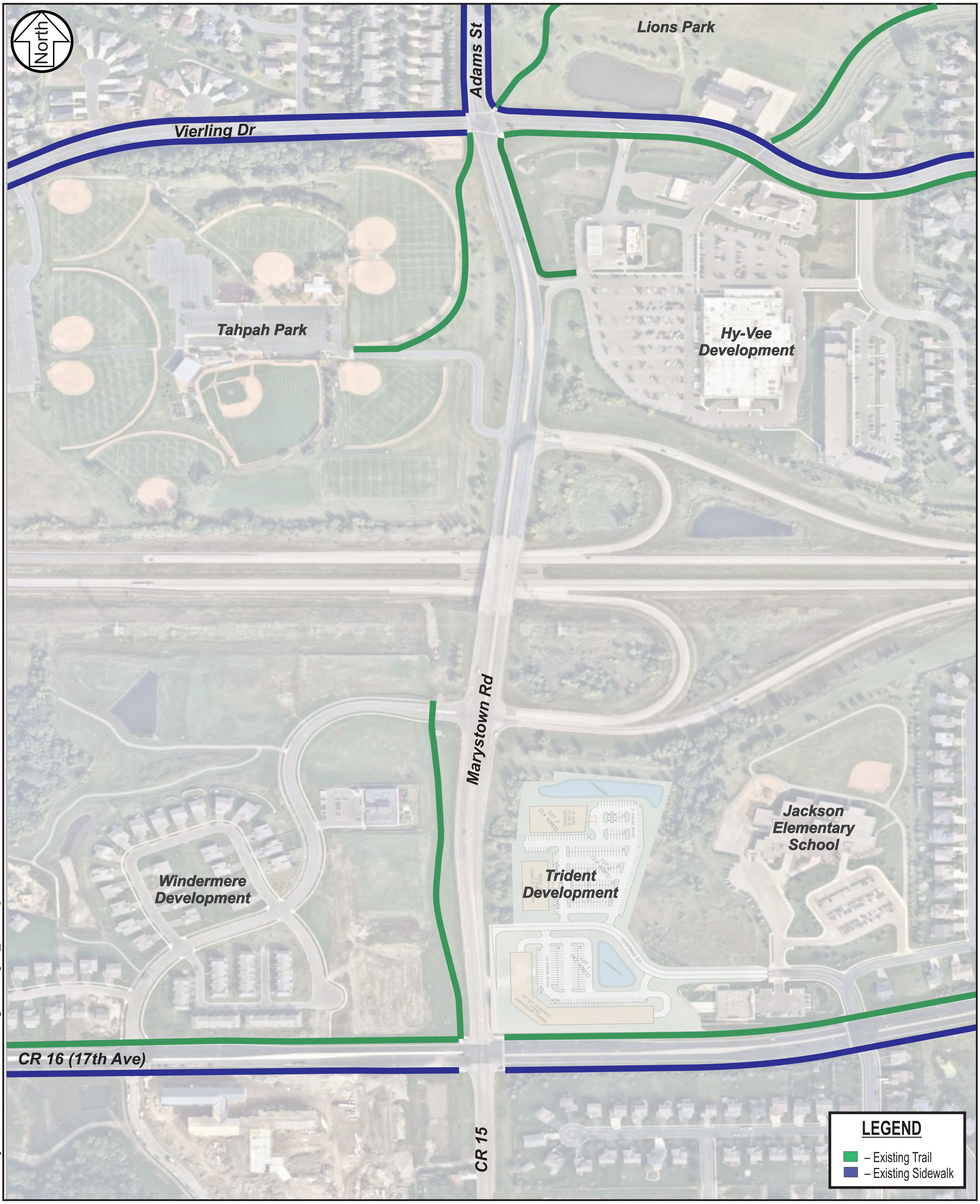
Appendix A

Existing Pedestrian/Bicycle Facilities



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Existing Pedestrian/Bicycle Facilities

Marystown Road Corridor Study

City of Shakopee

Figure 1

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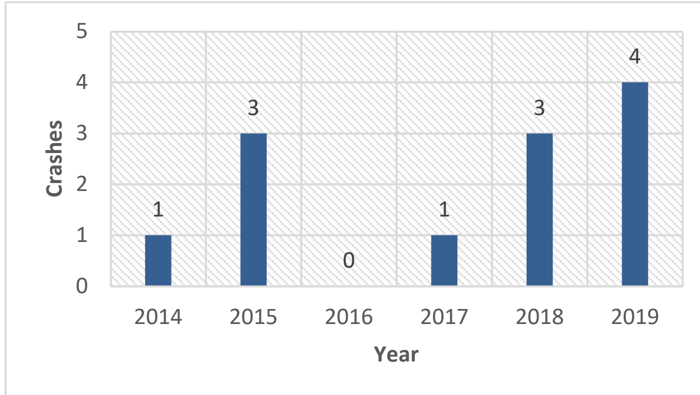
June 2020

Appendix B

Crash Data and Analysis

Crash History – Adams Street/Vierling Drive

Crash data was obtained from the City of Shakopee from 2014 through 2019 to identify any crash trends at the intersection and a summary of the historical crash data is shown below. The latest three-year period (2017-2019) was used for the crash analysis per MnDOT ICE report guidance and is summarized below and in Table 2. There was a total of eight (8) crashes at the Adams Street/Vierling Drive intersection, with one (1) non-incapacitating injury crash, three (3) possible injury crashes, and four (4) property damage only (PDO) crashes. Six (6) of the eight (8) crashes at this intersection were right-angle crashes. The intersection is below the critical crash rate, which indicates that there is not a statistically significant crash problem at the intersection, however, the intersection is above the average crash rate.



- Crash Severity:
  - 4 – Property Damage Only Crashes
  - 3 – Possible Injury (Type C) Crashes
  - 1 – Non-incapacitating Injury (Type B) Crashes
- Crash Type:
  - 6 – Right Angle (1- 2017, 2 - 2018, 3 -2019)
  - 1 – Sideswipe (2018)
  - 1 – Pedestrian Collision (2019)

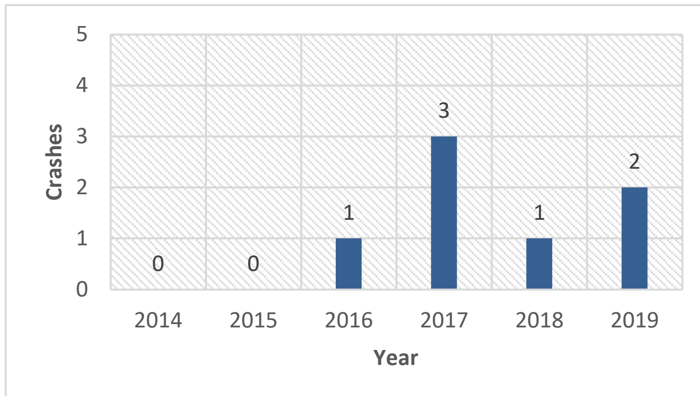
Table 2. Crash History Summary

Location	Number of Crashes	Daily Entering Volume	Total Crash Rate (1)		
			Calculated	Average	Critical
Adams Street/ Vierling Drive	8	10,500 (3)	0.70	0.34	0.83

(1) Intersection crash rates are expressed in crashes per million entering vehicles.
(2) Intersection crash rates are expressed in crashes per 100 million entering vehicles.
(3) Intersection Daily Entering Volume calculated based on combination of 13-hour counts collected as part of the *Trident Development Transportation Study* (SRF, 2019) and the latest available MnDOT AADT volumes.

Crash History – Marystown Road/US 169 North Ramp

Crash data was obtained from the City of Shakopee from 2014 through 2019 to identify any crash trends at the intersection and a summary of the historical crash data is shown below. It should be noted that, while outside of the crash trends and analysis period, a fatal accident (right-angle crash) occurred at the intersection in 2010. The latest three-year period (2017-2019) was used for the crash analysis per MnDOT ICE report guidance and is summarized below and in Table 2. There was a total of six (6) crashes at the Marystown Road/US 169 North Ramp/Tahpah Park Access intersection, with one (1) possible injury crash and five (5) property damage only (PDO) crashes. The crashes at this location were split evenly between right-angle and rear end crashes. A high number of right-angle crashes can indicate that there may be limited available gaps in traffic and drivers are having a difficult time determining gaps or are accepting smaller gaps. A high number of rear end crashes can indicate that drivers are not anticipating vehicles. The intersection is below the critical crash rate, which indicates that there is not a statistically significant crash problem at the intersection, however, the intersection is above the average crash rate.



- Crash Severity:
  - 5 – Property Damage Only Crashes
  - 1 – Possible Injury (Type C) Crashes
- Crash Type:
  - 3 – Rear End (2017, 2019, 2019)
  - 3 – Right-Angle Crashes (2017, 2017, 2018)

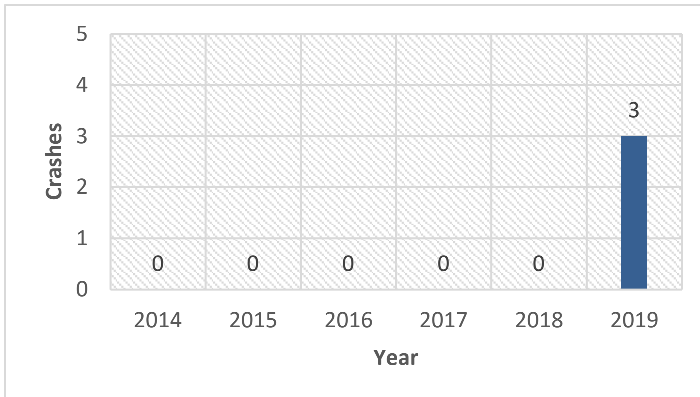
Table 2. Crash History Summary

Location	Number of Crashes	Daily Entering Volume	Total Crash Rate (1)		
			Calculated	Average	Critical
Marystown Rd at US 169 North Ramp/ Tahpah Park Access	6	11,000 (3)	0.50	0.19	0.55

(1) Intersection crash rates are expressed in crashes per million entering vehicles.
(2) Intersection crash rates are expressed in crashes per 100 million entering vehicles.
(3) Intersection Daily Entering Volume calculated based on combination of 13-hour counts collected as part of the *Trident Development Transportation Study* (SRF, 2019) and the latest available MnDOT AADT volumes.

Crash History – Marystown Road/US 169 South Ramp

Crash data was obtained from the City of Shakopee from 2014 through 2019 to identify any crash trends at the intersection and a summary of the crash data is shown below. The latest three-year period (2017-2019) was used for the crash analysis per MnDOT ICE report guidance and is summarized below and in Table 2. There was a total of three (3) crashes at the Marystown Road/US 169 South Ramp/Windermere Way intersection, with one (1) non-incapacitating injury crash and two (2) property damage only (PDO) crashes. All intersection crashes occurred in 2019 after the west approach of the intersection was constructed. Two of the three crashes at this intersection were right-angle crashes. A high number of right-angle crashes can indicate that there may be limited available gaps in traffic and drivers are having a difficult time determining gaps or are accepting smaller gaps. The intersection is below the critical crash rate, which indicates that there is not a statistically significant crash problem at the intersection. However, the recent increase in crashes in 2019 could indicate a trend due to a combination of the addition of the west approach and the increase in traffic volumes.



- Crash Severity:
  - 2 – Property Damage Only Crashes
  - 1 – Non-incapacitating Injury (Type B) Crashes
- Crash Type:
  - 1 – Rear End (2019)
  - 2 – Right-Angle Crashes (Both 2019)

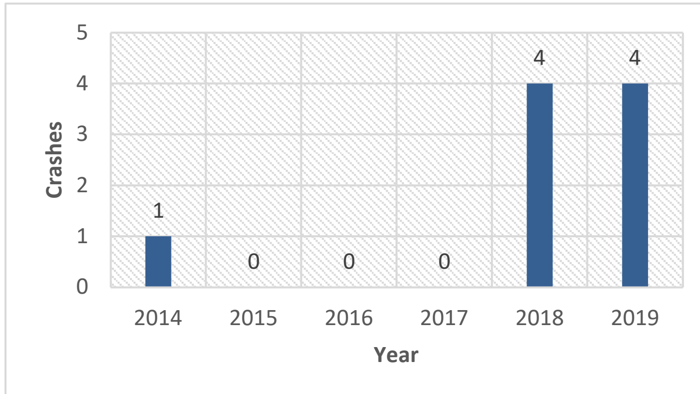
Table 2. Crash History Summary

Location	Number of Crashes	Daily Entering Volume	Total Crash Rate (1)		
			Calculated	Average	Critical
Marystown Rd at US 169 South Ramp/ Windermere Way	3	9,500 (3)	0.29	0.19	0.58

(1) Intersection crash rates are expressed in crashes per million entering vehicles.
(2) Intersection crash rates are expressed in crashes per 100 million entering vehicles.
(3) Intersection Daily Entering Volume calculated based on combination of 13-hour counts collected as part of the *Trident Development Transportation Study* (SRF, 2019) and the latest available MnDOT AADT volumes.

Crash History – CR 15/CR 16

Crash data was obtained from the City of Shakopee from 2014 through 2019 to identify any crash trends at the intersection and a summary of the historical crash data is shown below. The latest three-year period (2017-2019) was used for the crash analysis per MnDOT ICE report guidance and is summarized below and in Table 2. There was a total of eight (8) crashes at the CR 15/CR 16 (17th Avenue W) intersection, with four (4) non-incapacitating injury crashes, one (1) possible injury crash, and three (3) property damage only (PDO) crashes. All intersection crashes occurred in 2018 and 2019 after the west approach of the intersection was constructed. Six of the eight crashes at this intersection were right-angle crashes. A high number of right-angle crashes can indicate that there may be limited available gaps in traffic and drivers are having a difficult time determining gaps or are accepting smaller gaps. This intersection is also above the critical crash rate, which indicates that more crashes have occurred at this intersection than intersections with similar characteristics around the state.



- Crash Severity:
  - 3 – Property Damage Only Crashes
  - 1 – Possible Injury (Type C) Crash
  - 4 – Non-incapacitating Injury (Type B) Crashes
- Crash Type:
  - 1 – Lost Control Crash (2019)
  - 1 – Overtaking Sideswipe Crash (2019)
  - 6 – Right-Angle Crashes (All 2018 and 2019)

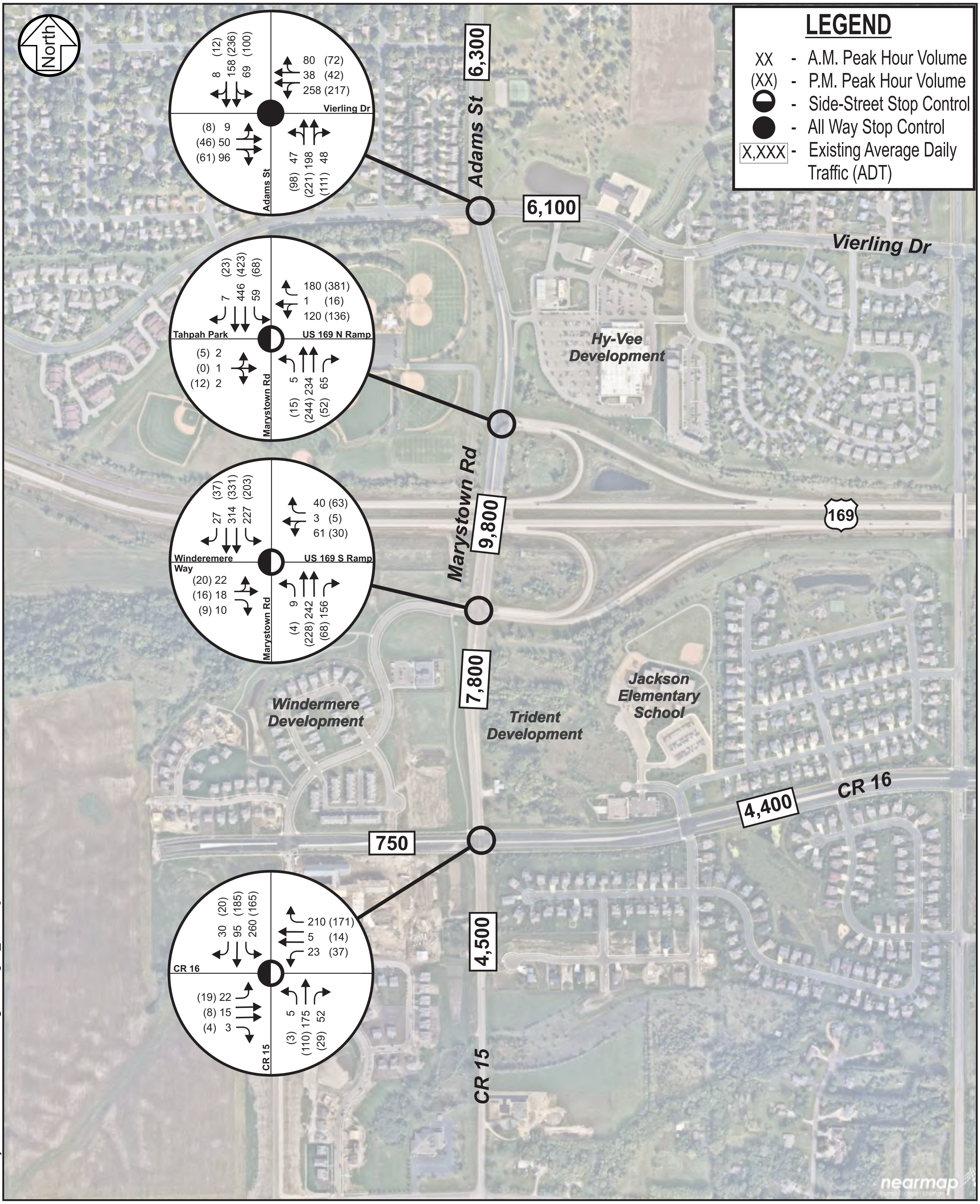
Table 2. Crash History Summary

Location	Number of Crashes	Daily Entering Volume	Total Crash Rate (1)		
			Calculated	Average	Critical
CR 15 at CR 16 (17th Avenue W)	8	7,400 (3)	0.99	0.19	0.64

(1) Intersection crash rates are expressed in crashes per million entering vehicles.
(2) Intersection crash rates are expressed in crashes per 100 million entering vehicles.
(3) Intersection Daily Entering Volume calculated based on combination of 13-hour counts collected as part of the *Trident Development Transportation Study* (SRF, 2019) and the latest available MnDOT AADT volumes.

Appendix C

Existing Intersection Operations Analysis



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Existing Conditions

Marystown Road Corridor Study

City of Shakopee

Figure 2

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June 2020

Table 1. Existing Intersection Capacity Analysis

Intersection	A.M. Peak Hour		P.M. Peak Hour	
	LOS	Delay	LOS	Delay
Adams Street/Vierling Drive (2)	B	13 sec.	B	14 sec.
Marystown Road/US 169 North Ramp (1)	A/A	9 sec.	A/B	12 sec.
Marystown Road/US 169 South Ramp (1)	A/C	20 sec.	A/B	13 sec.
CR 15/CR 16 (1)	A/B	12 sec.	A/A	8 sec.

(1) Indicates an unsignalized intersection with side-street stop control, where the overall LOS is shown followed by the worst side-street approach LOS. The delay shown represents the worst side-street approach delay.

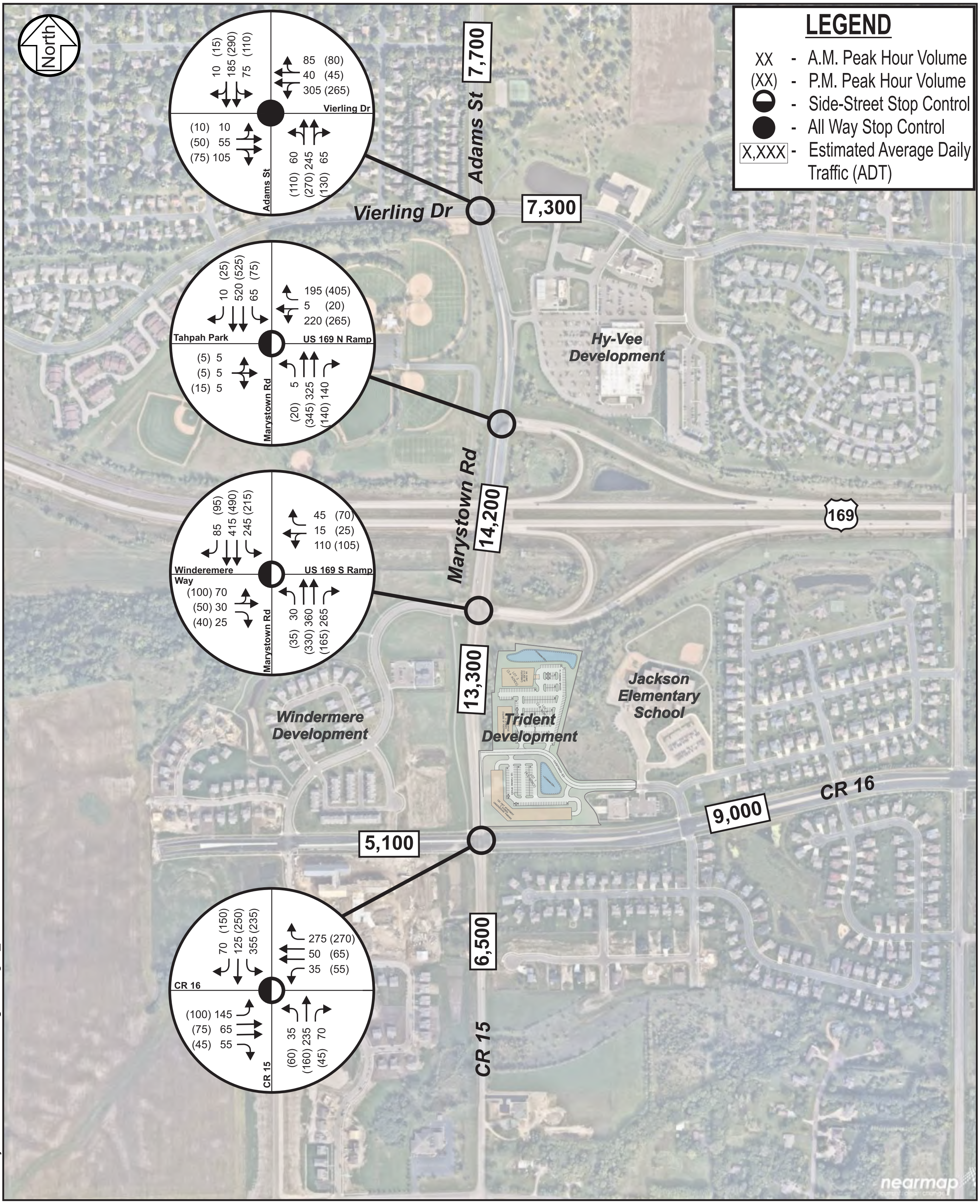
(2) Indicates an intersection with all-way stop control and was analyzed using HCS 7.

The following information summarizes the operational and/or queuing issues identified as part of the existing capacity analysis:

- **Hy-Vee right-in/right-out on Marystown Road:** Based on discussions with City staff, there have been numerous complaints of improper vehicular movements in the study area. These movements result from vehicles exiting the Hy-Vee development at the right-in/right-out access along Marystown Road that are destined southbound. In order to reroute their trip southbound, vehicles perform one of two improper movements. The first movement is a northbound U-turn north of the Hy-Vee right-in/right-out access at the end of the raised median. This movement typically occurs during non-peak hours, as this is a difficult maneuver during peak hours. The other improper movement typically occurs only during peak hours. In this situation, vehicles will take a northbound left-turn at the Adams Street/Vierling Drive all-way stop intersection and turn around in the Quincy Circle neighborhood to head back to the south along Marystown Road.
- **Marystown Road/US 169 Ramps:** Sight distance issues occur on the westbound approaches when multiple vehicles are making turning movements at the same time. For example, when a westbound left- and right-turn movement are occurring at the same time, the vehicles can obstruct the sight distance for the adjacent vehicle.

Appendix D

Traffic Volume Forecasts



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Year 2025 Conditions

Marystown Road Corridor Study

City of Shakopee

Figure 3

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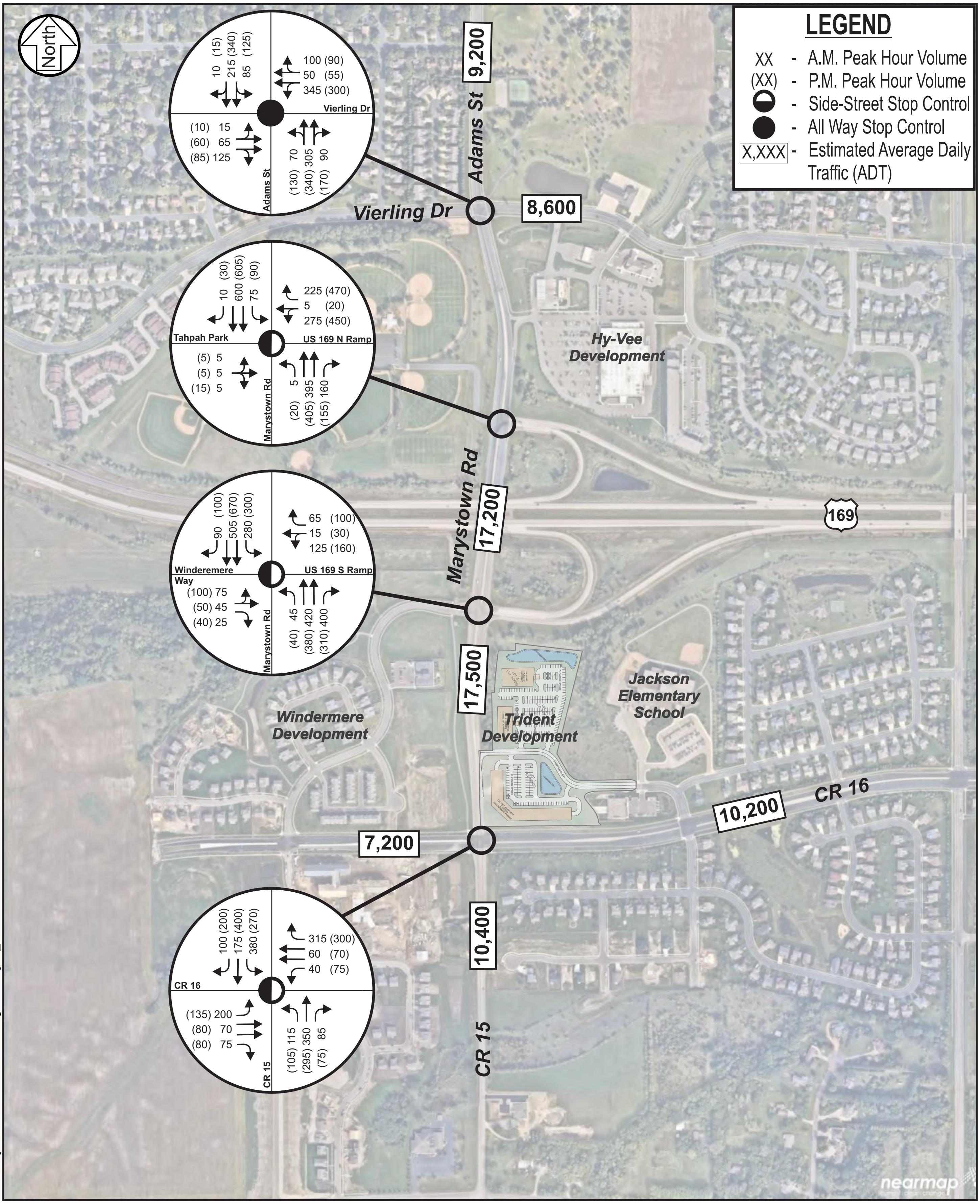
June 2020



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Year 2040 Conditions

Marystown Road Corridor Study

City of Shakopee

Figure 4

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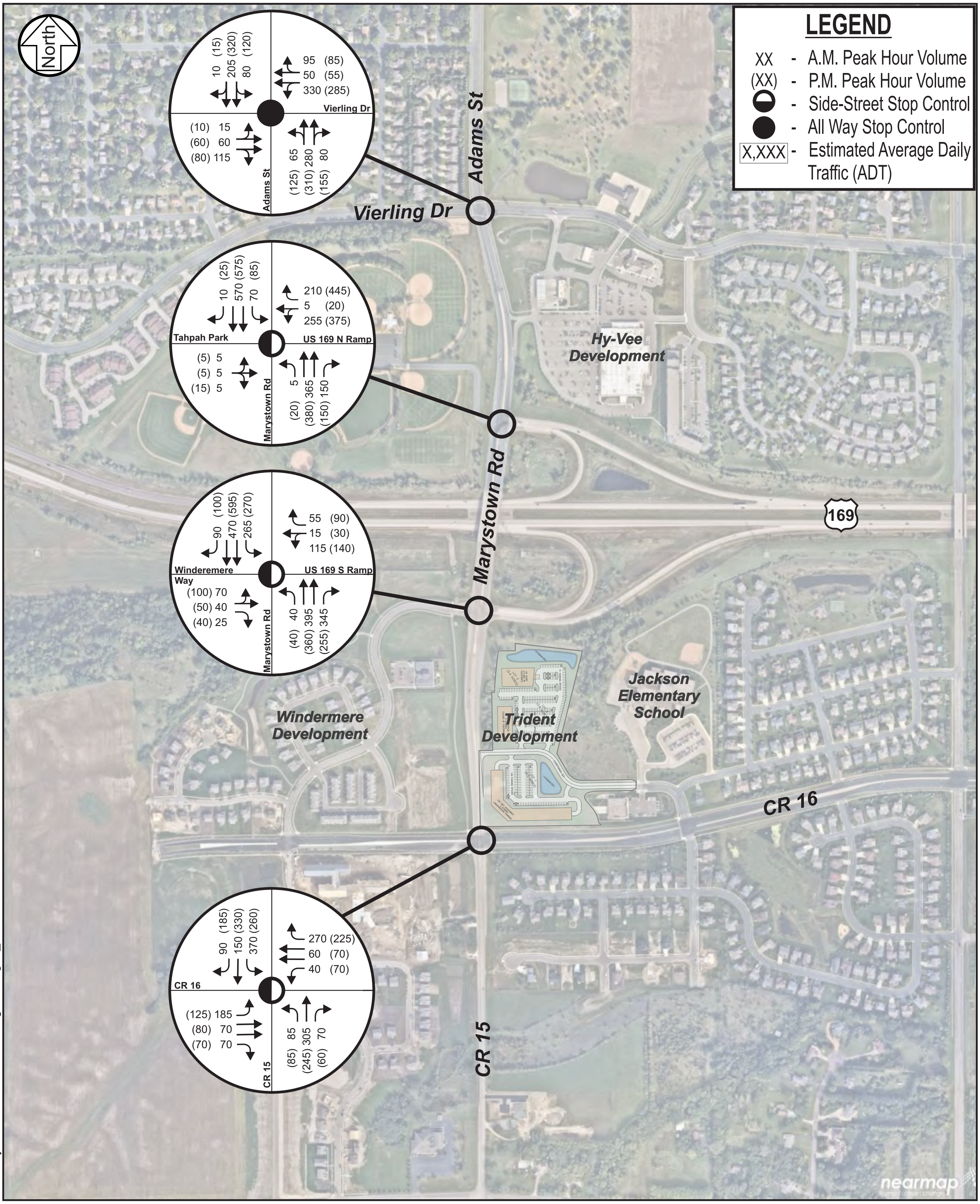
June 2020



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Year 2034 Conditions

Marystown Road Corridor Study

City of Shakopee

Figure 5

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June 2020

Appendix E

Future Operations Analysis

Table 2. Year 2025 Intersection Capacity Analysis

Intersection	A.M. Peak Hour		P.M. Peak Hour	
	LOS	Delay	LOS	Delay
Adams Street/Vierling Drive (2)	C	17 sec.	C	19 sec.
Marystown Road/US 169 North Ramp (1)	A/C	24 sec.	D/F	75 sec.
Marystown Road/US 169 South Ramp (1)	E/F	~3 min	E/F	>3 min
CR 15/CR 16 (1)	C/F	73 sec.	A/C	19 sec.

(1) Indicates an unsignalized intersection with side-street stop control, where the overall LOS is shown followed by the worst side-street approach LOS. The delay shown represents the worst side-street approach delay.

(2) Indicates an intersection with all-way stop control and was analyzed using HCS 7.

In addition to the operational and safety issues previously noted, the following information summarizes other operational and/or queuing issues that warrant consideration as development occurs.

- **Marystown Road/US 169 North Ramp**: The westbound 95th percentile queues during the p.m. peak hour are expected to extend approximately 925 feet, and the westbound left-turn queue is expected to block the westbound right-turn lane approximately 50 percent of the p.m. peak hour. This queue would extend over half of the off-ramp, which may cause safety issues as vehicles coming from US 169 may not expect these queues.
- **Marystown Road/US 169 South Ramp:** Westbound left-turn queues are expected to extend approximately 515 feet and block the westbound right-turn lane approximately 25 percent of the a.m. peak hour. Eastbound 95th percentile queues are expected to extend 350 feet and 650 feet during the a.m. and p.m. peak hours, respectively. These queues are expected to block the eastbound right-turn lane approximately 40 to 70 percent of peak hours.
- The westbound queue is expected to extend over half of the off-ramp, which may cause safety issues as vehicles coming from US 169 may not expect these queues.
- Due to the poor operations and queueing, it is expected that eastbound vehicles on Windermere Way are expected to reroute their trips and utilize CR 16 (17th Avenue) and other routes to avoid the US 169 South Ramp intersection.
- **CR 15/CR 16:** Eastbound left-turn queues are expected to extend beyond the turn-lane storage approximately 15 percent of the a.m. peak hour. Westbound queues are not expected to impact the proposed right-in/right-out access as part of Access Alternative 2.

Table 3. Year 2040 Intersection Capacity Analysis

Intersection	A.M. Peak Hour		P.M. Peak Hour	
	LOS	Delay	LOS	Delay
Adams Street/Vierling Drive (2)	C	24 sec.	D	29 sec.
Marystown Road/US 169 North Ramp (1)	D/F	109 sec.	F/F	> 3 min
Marystown Road/US 169 South Ramp (1)	F/F	>3 min	F/F	> 3 min
CR 15/CR 16 (1)	F/F	>3 min	C/F	77 sec.

(1) Indicates an unsignalized intersection with side-street stop control, where the overall LOS is shown followed by the worst side-street approach LOS. The delay shown represents the worst side-street approach delay.

(2) Indicates an intersection with all-way stop control and was analyzed using HCS 7.

In addition to the operational and safety issues previously noted, the following information summarizes other operational and/or queuing issues that warrant consideration as development occurs.

- **Marystown Road/US 169 Ramps and CR 15/CR 16**: All intersection side-streets are expected to operate as an overall LOS F during the a.m. and/or p.m. peak hours, with delays greater than three (3) minutes.
- **Adams Street/Vierling Drive:** The westbound approach is expected to operate with a LOS E during both the a.m. and p.m. peak hours. In addition, the improper movements identified at the Hy-Vee right-in/right-out intersection under existing conditions are expected to continue

Appendix F

Intersection Control Evaluations (ICE) Reports

Table 4. ICE Report Summary - Traffic Signal vs. Roundabout Analysis/Factors (1)

Analysis/Factor	Summary
Capacity Analysis	• Both the traffic signal and roundabout alternatives are expected to perform with acceptable levels of service with the proposed lane configurations and future volumes. In general, the roundabout alternatives are expected to have less peak hour and non-peak hour vehicular delay.
Safety Analysis	• The roundabout alternatives are expected to have similar property damage only crashes to the signal alternatives, but fewer fatal and injury crashes.
Pedestrian Considerations	• Both alternatives are expected to provide safety benefits for pedestrians compared to existing conditions. • The roundabout alternatives would provide the opportunity to repurpose the US 169 Bridge to provide a multi-use trail on both sides. The existing roadway configuration does not have adequate space to provide safe pedestrian facilities, therefore, the signal alternatives would likely result in a trail/sidewalk being terminated before the bridge.
Transportation System Considerations	• If roundabouts were constructed at the other study intersections, it would provide consistent traffic control along the corridor. • The roundabout alternatives would provide flexibility to handle potential traffic surges before or after sporting events at Tahpah Park. • A roundabout at the CR 15/CR 16 intersection would provide a transition to alert drivers coming from the south that they are entering a more suburban area and pedestrian activity could be higher.
Site Access	• The roundabout alternative would eliminate the improper maneuvers that are occurring along the corridor at the Hy-Vee access. An all-way stop control or traffic signal alternative at Adams Street/Vierling Drive would not fully address the issue. • A roundabout at the CR 15/CR 16 intersection would provide drivers the ability to utilize a U-turn to enter the Trident Development. This would result in less vehicles passing Jackson Elementary School/Ladybug Child Care Center.
Cost Analysis	• In general, the roundabout is considered cost effective compared to the traffic signal due to the positive impacts on intersection operations and safety. • The roundabout alternative would result in a loss in recent construction costs at the CR 15/CR 16 and Marystown Road/US 169 South Ramp intersections.
Right-of-Way	• Additional right-of-way is not required at the three southern study intersections. • The roundabout alternative at the Adams Street/Vierling Drive intersection is expected to have minor impacts.

(1) An all-way stop control alternative was also evaluated at the Adams Street/Vierling Drive intersection. However, the neither the all-way stop or traffic signal alternatives were expected to fully address the improper maneuvers along the corridor, therefore, the roundabout control was recommended.

Intersection Control Evaluation

Adams Street at Vierling Drive W

City of Shakopee, Scott County, Minnesota

May 2020

SRF No. 020 13195

Intersection Control Evaluation

Adams Street at
Vierling Drive W

Proposed Letting Date: TBD

Report Certification:

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Brent Clark	57198
Print Name	Reg. No.
	5/14/2020
Signature	Date

Approved:

	5/18/2020
City of Shakopee City Engineer	Date
	5/21/2020
For MnDOT Metro District State-Aid Engineer	Date

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Introduction

The City of Shakopee, in partnership with Scott County and the Minnesota Department of Transportation (MnDOT), is developing an ultimate vision for County Road (CR) 15/Marystown Road/Adams Street from Vierling Drive to CR 16 (17th Avenue W) in Shakopee, Minnesota. The development and operations along the corridor have been discussed and evaluated in the following studies that were completed in 2019:

1) *Shakopee AUAR Transportation Analysis*, SRF Consulting (Draft - September 2019)

2) *Trident Development Transportation Study*, SRF Consulting (December 2019)

The previous studies identified various operational and safety issues at the major corridor intersections south of the Adams Street/Vierling Drive intersection by the year 2025. Therefore, roundabout alternatives were recommended to address the operational and safety issues, along with repurposing the US 169 Bridge to provide pedestrian/bicycle facilities, thus connecting a City trail.

With the roundabout alternative, the travel lanes along Marystown Road/Adams Street will no longer align with the existing Adams Street/Vierling Drive intersection. In addition, based on discussions with City staff, there have been numerous complaints of improper vehicular movements in the study area. These movements result from vehicles exiting the Hy-Vee development at the right-in/right-out access along Marystown Road that are destined southbound. The improper vehicular movements consist of either performing a U-turn along the corridor, north of the raised median, or using the Quincy Circle neighborhood to redirect southbound. Therefore, this intersection control evaluation was completed to support the *Marystown Road Corridor Study* that is being completed to determine the current and future needs of CR 15/Marystown Road that will inform the anticipated reconstruction project from Vierling Drive to CR 16 planned for the year 2022. The main objectives are to provide a form of traffic control that will align with the proposed roundabout alternatives while addressing improper movements along the corridor.

This report documents the intersection control evaluation results for the Adams Street and Vierling Drive intersection in the City of Shakopee, Scott County, Minnesota (see Figure 1). The purpose of this evaluation was to analyze various intersection control alternatives under near-term and long-term conditions to identify a preferred intersection control alternative. The following intersection control alternatives were considered applicable:

- All-way Stop Control (existing)
- Traffic Signal Control
- Roundabout Control

Side-street stop control was determined not applicable to this intersection because it is currently under all-way stop control due to heavy mainline and side street turning volumes. Detailed warrants, operations, safety, and benefit-cost analyses were performed to determine a preferred intersection control alternative. In addition to the above analyses, other factors considered applicable to determining the long-term preferred intersection control included: Right of Way Considerations, Pedestrian Considerations, Transportation System Considerations, and Improper Movements.

Existing Conditions

Intersection Control Evaluation
Adams Street S at Vierling Drive W
Shakopee, Minnesota

Figure 2

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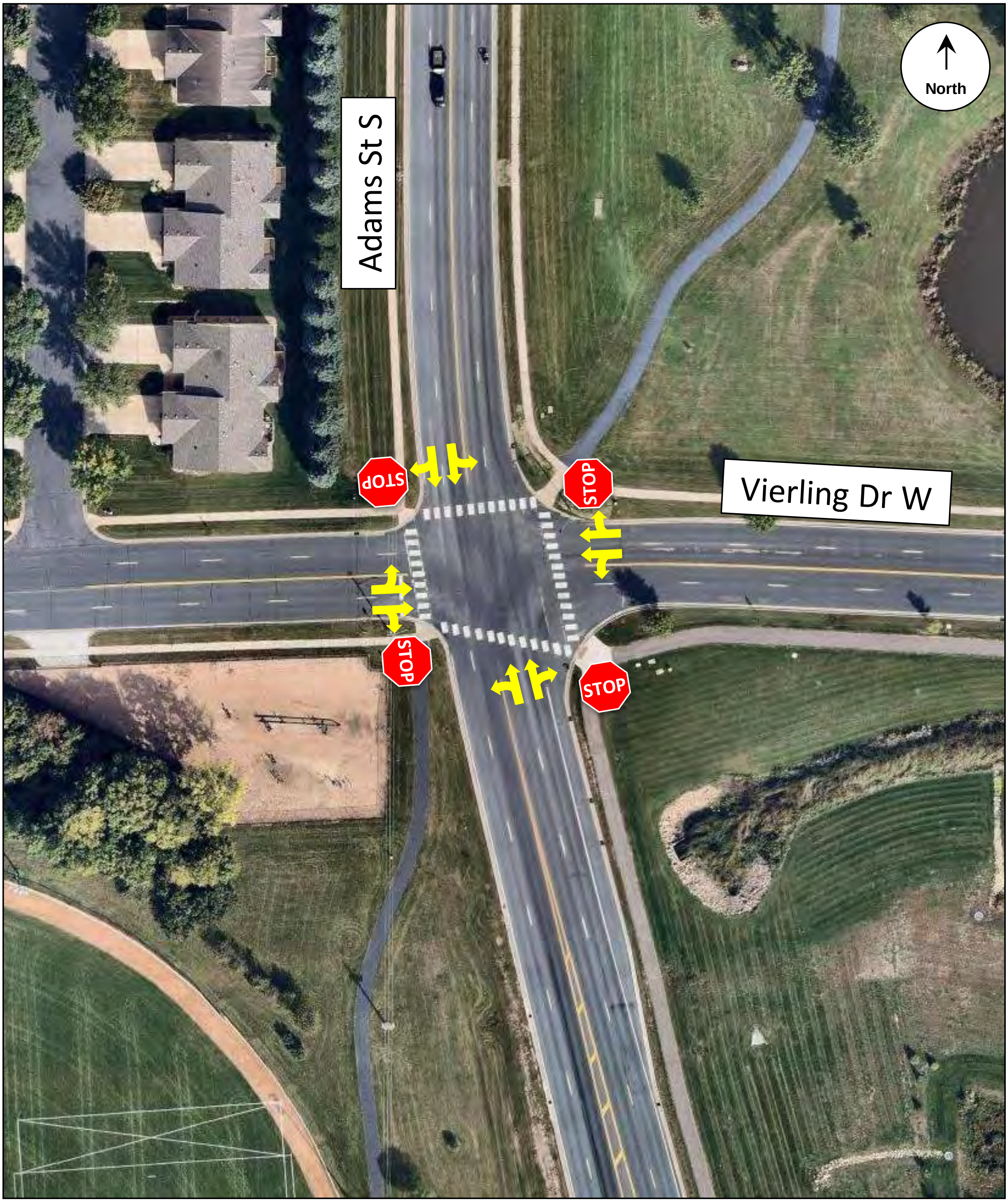
Intersection Characteristics

Existing Conditions

The Adams Street at Vierling Drive intersection is currently under all-way stop control (AWSC). Adams Street is a four-lane undivided roadway at the study intersection and is functionally classified as a collector with a posted speed limit of 45 miles per hour (mph). Vierling Drive is a four-lane undivided roadway that is functionally classified as a collector with a posted speed limit of 30 mph. The Hy-Vee development is in the southeast quadrant and residential land uses are in the northwest quadrant. City parks are in the northeast and southwest quadrants of the intersection. It should be noted that the Shakopee Fire Station 2 is located approximately 1/8 mile east of the intersection. Current intersection geometrics are listed below in Table 1 and shown in Figure 2.

Table 1. Existing Conditions

Approach	Lane Configurations
Northbound Adams Street	One shared thru-left and one shared thru-right lane
Southbound Adams Street	One shared thru-left and one shared thru-right lane
Eastbound Vierling Drive	One shared thru-left and one shared thru-right lane
Westbound Vierling Drive	One shared thru-left and one shared thru-right lane



Existing Conditions

Figure 2

Intersection Control Evaluation
Adams Street S at Vierling Drive W
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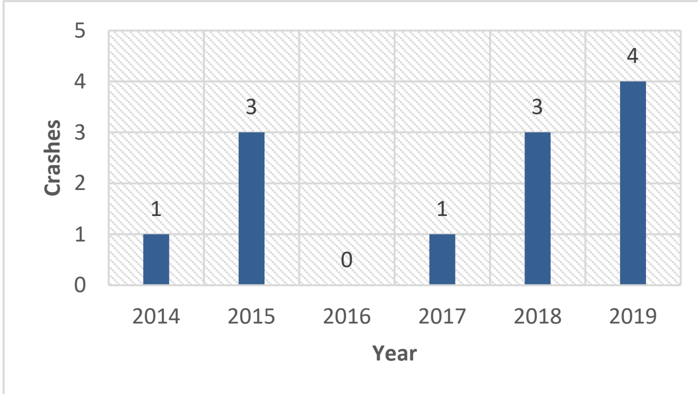
Crash History

Crash data was obtained from the City of Shakopee from 2014 through 2019 to identify any crash trends at the intersection and a summary of the historical crash data is shown below. The latest three-year period (2017-2019) was used for the crash analysis per MnDOT ICE report guidance and is summarized below and in Table 2. There was a total of eight (8) crashes at the Adams Street/Vierling Drive intersection, with one (1) non-incapacitating injury crash, three (3) possible injury crashes, and four (4) property damage only (PDO) crashes. Six (6) of the eight (8) crashes at this intersection were right-angle crashes. The intersection is below the critical crash rate, which indicates that there is not a statistically significant crash problem at the intersection, however, the intersection is above the average crash rate.



- Crash Severity:
  - 4 – Property Damage Only Crashes
  - 3 – Possible Injury (Type C) Crashes
  - 1 – Non-incapacitating Injury (Type B) Crashes
- Crash Type:
  - 6 – Right Angle (1- 2017, 2 - 2018, 3 -2019)
  - 1 – Sideswipe (2018)
  - 1 – Pedestrian Collision (2019)

Table 2. Crash History Summary

Location	Number of Crashes	Daily Entering Volume	Total Crash Rate (1)		
			Calculated	Average	Critical
Adams Street/ Vierling Drive	8	10,500 (3)	0.70	0.34	0.83

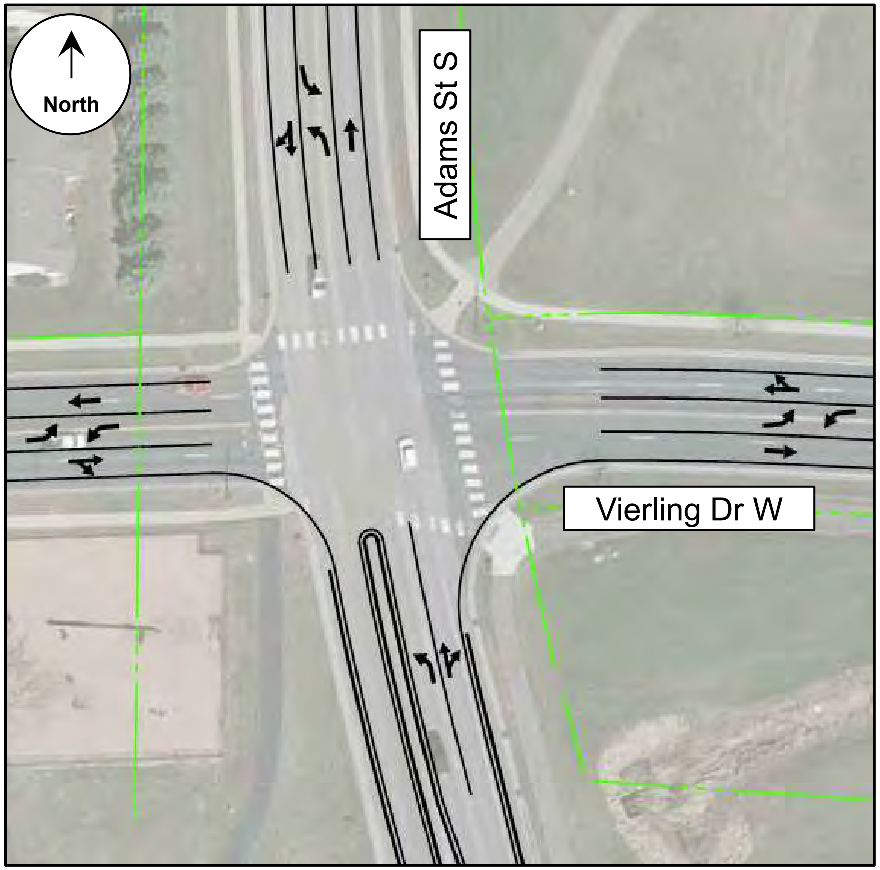
(1) Intersection crash rates are expressed in crashes per million entering vehicles.
(2) Intersection crash rates are expressed in crashes per 100 million entering vehicles.
(3) Intersection Daily Entering Volume calculated based on combination of 13-hour counts collected as part of the *Trident Development Transportation Study* (SRF, 2019) and the latest available MnDOT AADT volumes.

Future Conditions

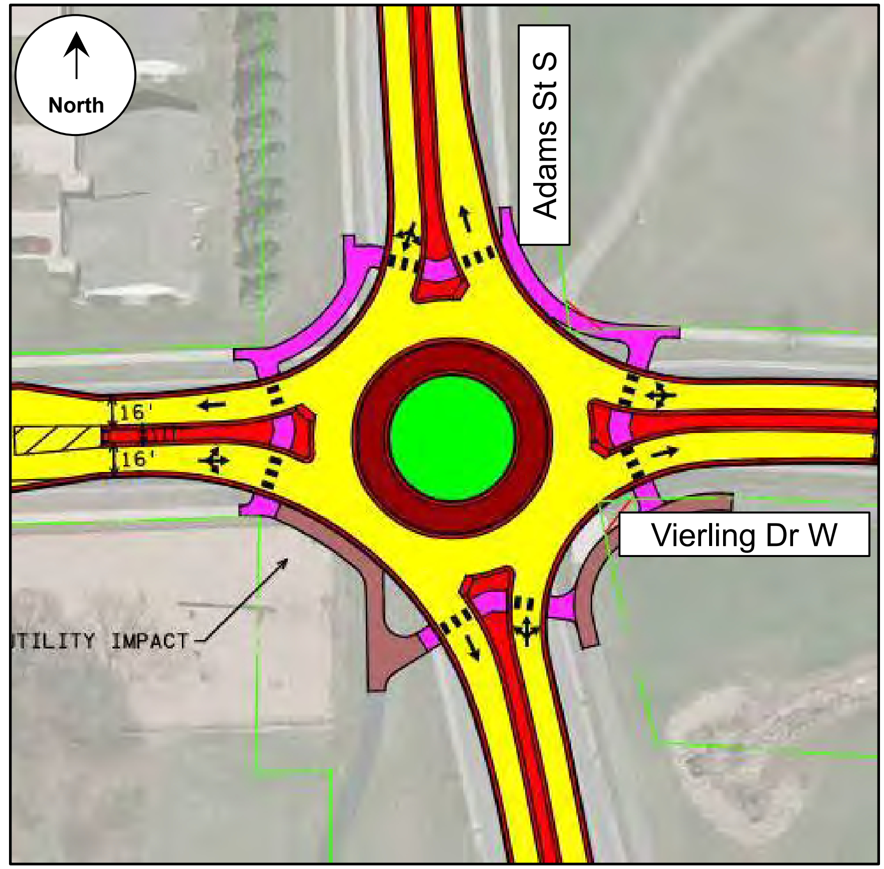
Future lane configurations were developed to accommodate projected traffic volumes and the corridor vision for CR 15/Marystown Road/Adams Street. A roundabout intersection control was recommended for the Marystown Road/US 169 North Ramp intersection; therefore, the south leg of the study intersection was assumed to tie into the proposed layout. This results in a reconfiguration of the existing all-way stop control and traffic signal alternatives, with the north/east/west legs being converted to three-lane facilities before the intersection. This layout would help assign right-of-way for the all-way stop control and provide left-turn lanes for the traffic signal alternative. For the roundabout control alternative, it was determined – through analysis described later in this report – that a single lane roundabout would be adequate at the study intersection through the forecast year 2040. The assumed lane configurations for these alternatives are shown in Table 3 and can be seen in Figure 3.

Table 3. Future Intersection Lane Configurations

Approach	All-Way Stop and Traffic Signal Control	Roundabout Control
Northbound Adams Street	• One left-turn lane • One shared thru/right-turn lane	• One shared left-turn/thru lane/right-turn lane
Southbound Adams Street	• One left-turn lane • One shared thru/right-turn lane	• One shared left-turn/thru lane/right-turn lane
Eastbound Vierling Drive	• One left-turn lane • One shared thru/right-turn lane	• One shared left-turn/thru lane/right-turn lane
Westbound Vierling Drive	• One left-turn lane • One shared thru/right-turn lane	• One shared left-turn/thru lane/right-turn lane



All-Way Stop and Traffic
Signal Alternatives



Roundabout
Alternative

Proposed Lane Configurations

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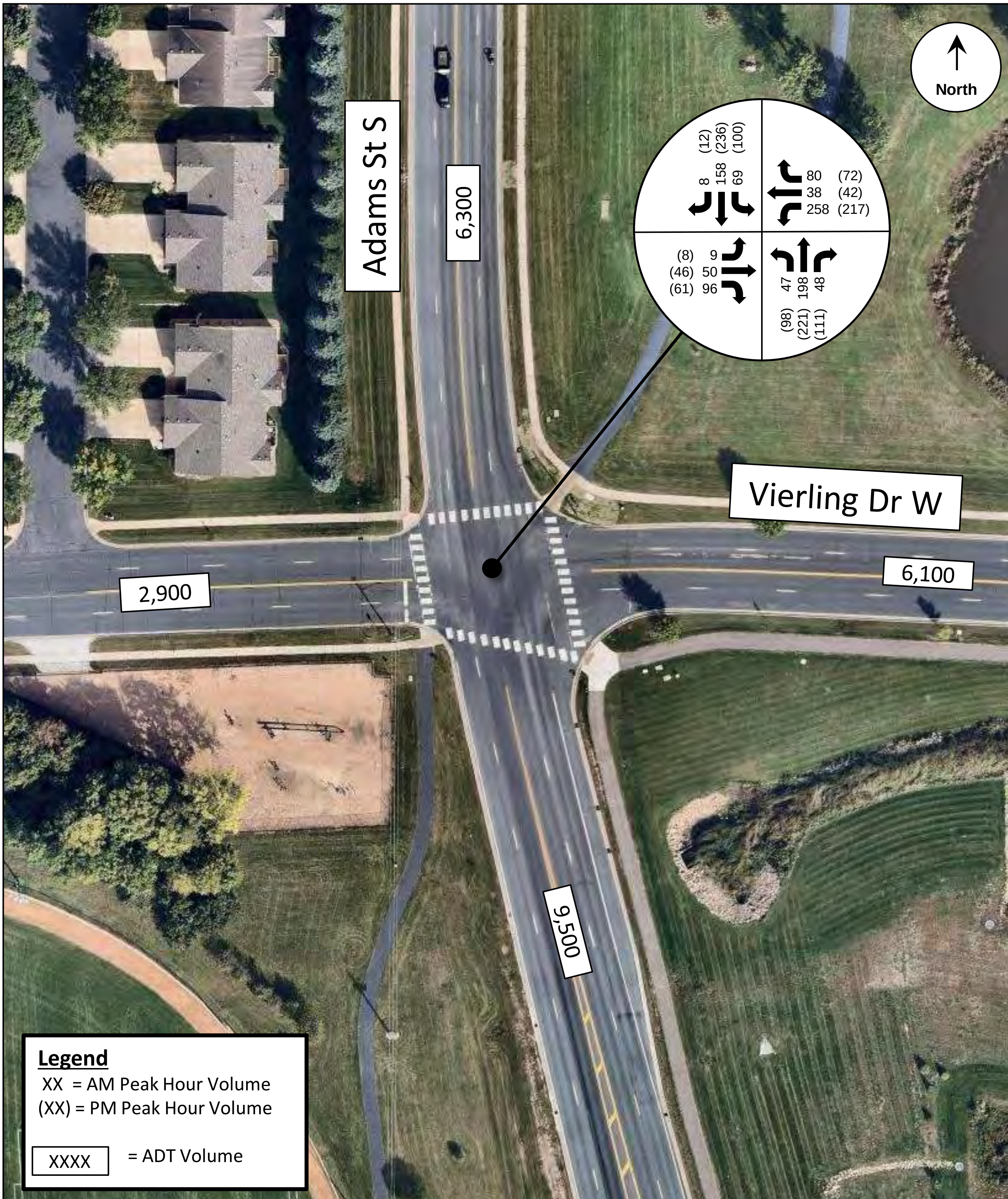
Figure 3

Traffic Volumes

Existing hourly approach volumes at the study intersection were collected in October 2019 by SRF and are summarized in Figure 4 and included in the Appendix. It should be noted that adjustments were made to the existing turning movement counts to account for ongoing construction in the region, which is outlined further in the *Trident Development Transportation Study*.

The year 2025 volumes were developed as part of the *Trident Development Transportation Study* and account for the three on-going developments along the study corridor (Windermere, Bruggeman, Trident), and a general background growth rate of one and a half (1.5) percent. As previously mentioned, the three on-going developments are expected to be developed before 2025, therefore, the year 2025 represents one-year post-construction of the full build-out of the proposed development. Construction of a traffic control alternative is anticipated for the year 2022, with a year of opening anticipated for 2023. Therefore, due to the similar timeframes of the year of opening of the roadway construction and the development full-build out, the year 2025 is considered the year of opening.

The year 2040 turning movements were developed along the Marystown Road corridor as part of the *Shakopee AUAR Transportation Study*, utilizing the Scott County Regional Travel Demand Model and the 2040 Scott County Comprehensive Plan. The Adams Street/Vierling Drive intersection, however, was not included as a study intersection in the *Shakopee AUAR Transportation Study*. Therefore, these 2040 turning movement counts were updated to include the Adams Street/Vierling Drive intersection as part of the *Trident Development Transportation Study*. The projected peak hour year 2025 and year 2040 turning movement volumes are shown in Figure 5 and Figure 6, respectively.



Existing Volumes

Figure 4

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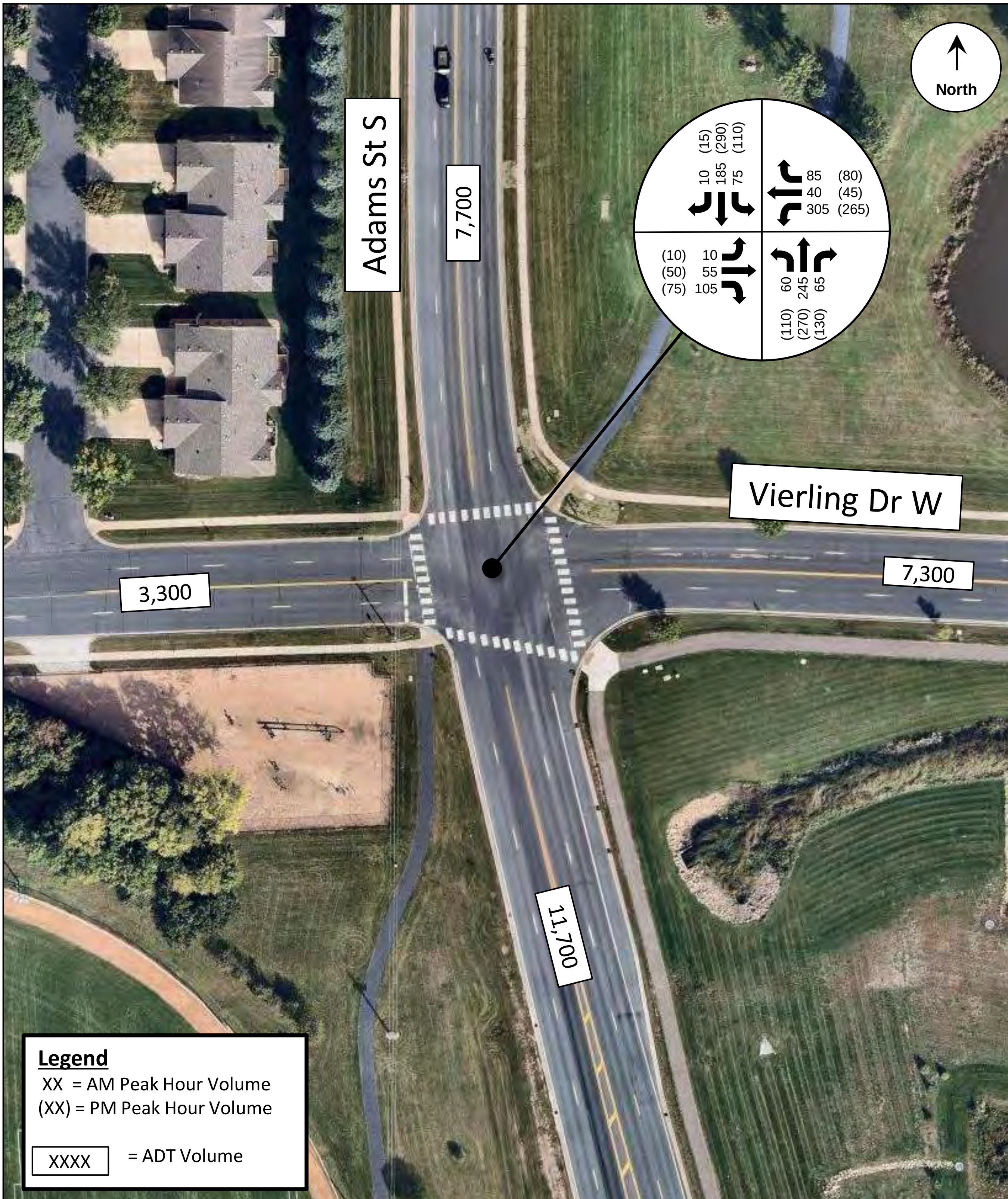

Forecast Year 2025 Volumes

Intersection Control Evaluation
Adams Street S at Vierling Drive W
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Figure 5

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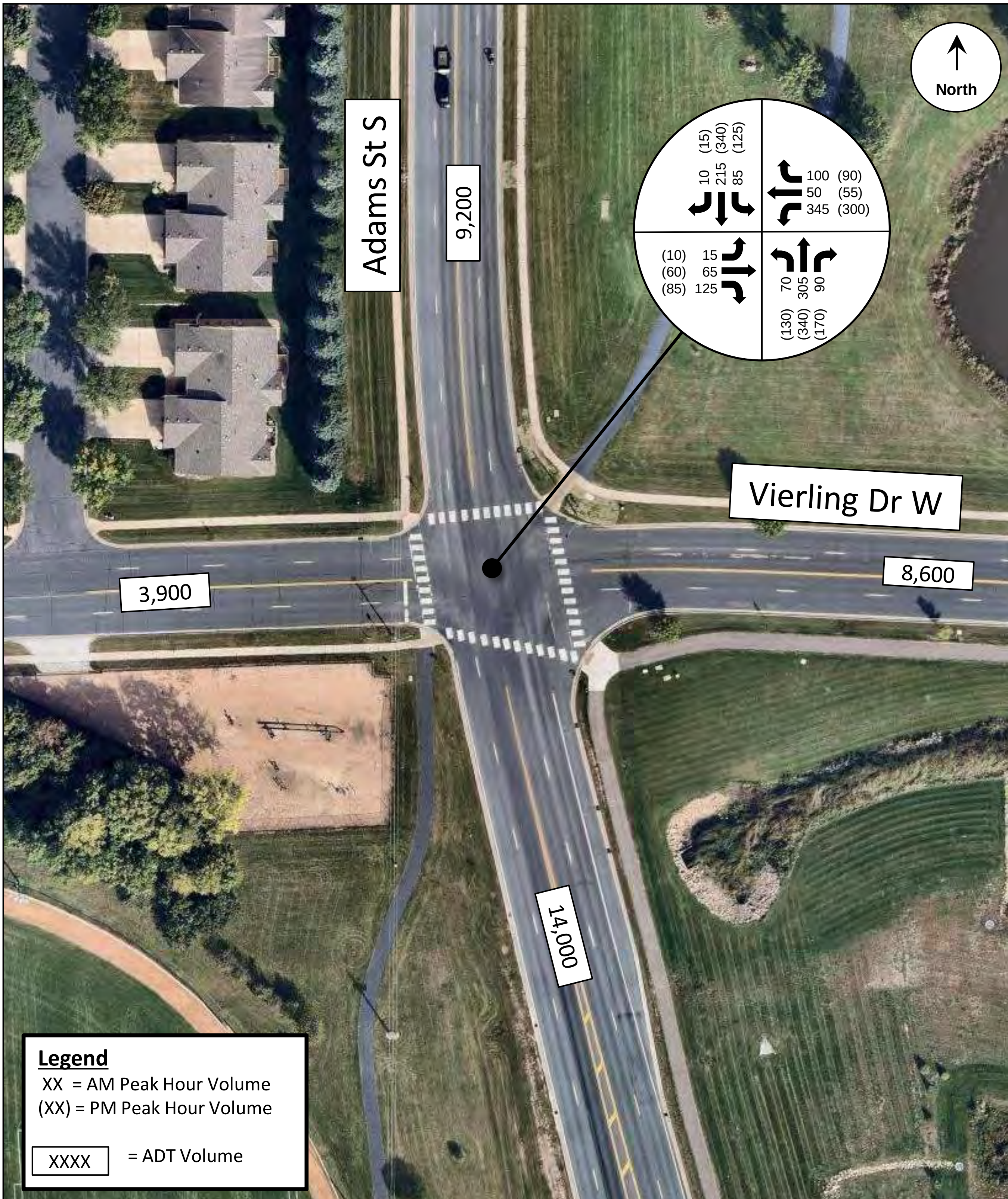

Forecast Year 2040 Volumes

Intersection Control Evaluation
Adams Street S at Vierling Drive W
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Figure 6

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Analysis of Alternatives

Warrants Analysis

A warrants analysis was performed for the traffic signal control alternative as outlined in the December 2019 *Minnesota Manual on Uniform Traffic Control Devices* (MN MUTCD). Analysis of signal warrants 1-3 was performed for the Year 2025 and Year 2040 forecasted traffic volumes. Signal warrants 4-9 were investigated and were determined to be not applicable to the study intersection. It should be noted that under the MnDOT ICE process, roundabouts are typically considered to be warranted if traffic volumes meet the criteria for either all-way stop or traffic signal control. The lane geometry and approach speeds assumed for the warrant analysis are shown in Table 4.

Table 4. Warrants Analysis Assumptions

Approach	Geometry	Speed Limit
Northbound Adams Street	Two or more approach lanes	45 mph
Southbound Adams Street	Two or more approach lanes	45 mph
Eastbound Vierling Drive	Two or more approach lanes	30 mph
Westbound Vierling Drive	Two or more approach lanes	30 mph

For the analysis, right-turning vehicles on the minor approaches were included as these turns are not given a dedicated lane and may impact the thru-movement on both minor approaches.

The 70 percent traffic volume factor was used for the warrants analysis, as proposed conditions met the necessary criteria of the speed limit exceeding 45 mph on at least one of the approaches. Table 5 provides a summary of the warrants analysis results, while the detailed volume-based warrants analysis is included in the Appendix.

Although the intersection is currently an all-way stop control, the Multiway Stop Applications Warrant Condition C (MWSA C) was also evaluated as outlined in the MN MUTCD. The results of the MWSA warrants analysis are also shown in Table 5.

Table 5. Warrants Analysis Summary

MN MUTCD Warrant	Hours Required	Existing Volumes		2025 Volumes (Year of Opening)		2040 Volumes	
		Hours Met	Warrant Met?	Hours Met	Warrant Met?	Hours Met	Warrant Met?
MWSA C: Minimum Volumes	8	14	Yes	14	Yes	14	Yes
Warrant 1A: Minimum Vehicular Volume	8	7	No	9	Yes	13	Yes
Warrant 1B: Interruption of Continuous Traffic	8	3	No	5	No	6	No
Warrant 1C: Combination of Warrants	8	5	No	6	No	11	Yes
Warrant 2: Four-Hour Volume	4	5	Yes	9	Yes	13	Yes
Warrant 3B: Peak Hour Volume	1	2	Yes	5	Yes	7	Yes
Warrants 4-9	Not Applicable						

The results of the warrants analysis indicate the intersection satisfies Signal Warrants 2 and 3B with existing volumes, Signal Warrants 1A, 2, and 3B with 2025 volumes, and Signal Warrants 1A, 1C, 2, and 3B with 2040 volumes. The analysis also indicates that the current all-way stop control is justified, as the existing volumes satisfy the MWSA warrant.

Operations Analysis

An initial planning-level analysis was performed for the roundabout control alternative based on Highway Capacity Manual (HCM) 6th Edition methods. Planning-level analysis results for Forecast Year 2040 volumes are shown in Figure 8. As can be seen, the Forecast Year 2040 volumes are below the theoretical capacity of a single-lane roundabout. In addition to the planning-level analysis, capacity analysis tests were performed at the intersection using the Highway Capacity Software (HCS) 7. Results of the analysis indicate that a single approach, single-lane roundabout would be under capacity at the intersection during both peak hours. Therefore, a single approach, single-lane roundabout would be the minimum geometry recommended for the intersection. The following geometry assumed for analysis is shown in Table 6.

As mentioned previously, under all alternatives, Vierling Drive and the north leg of Adams Street are proposed to be converted to a three-lane facility near the intersection. Therefore, a high-level review of the forecasted 2040 ADT's was performed. The results of the review indicate that the study roadways are anticipated to operate acceptably as three-lane facilities.

Figure 8. Adams Street at Vierling Drive Roundabout Entry Lane Capacity (Forecast Year 2040 Volumes)

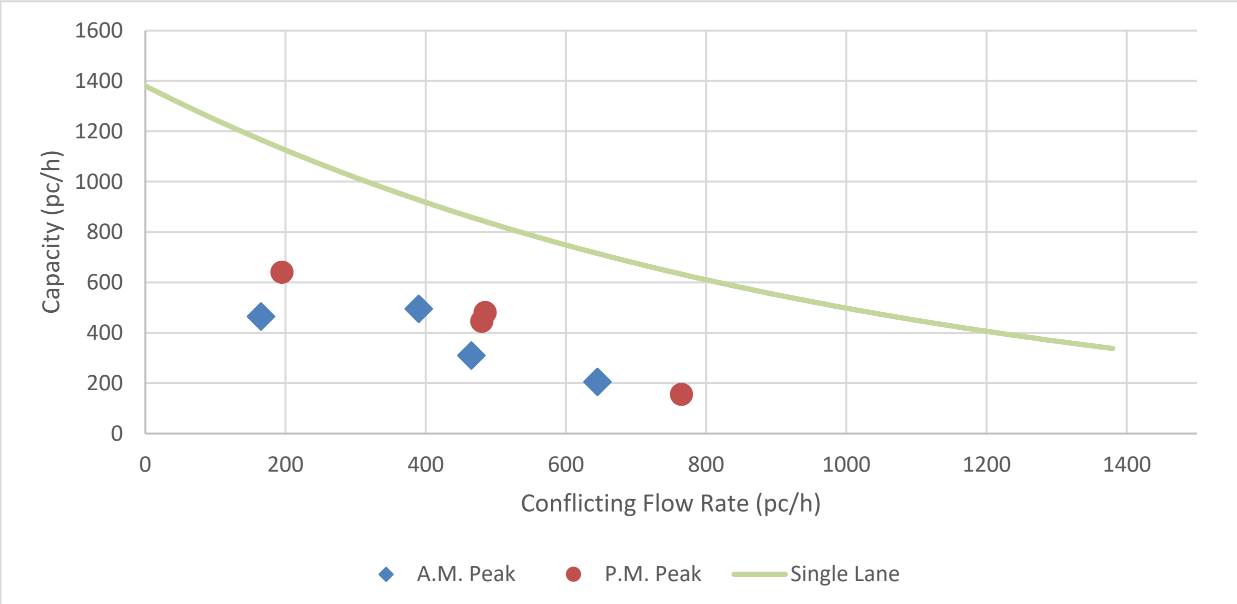

Table 6. Roundabout Lane Configuration

Approach	Geometry
Northbound Adams Street	• One-lane entry, One circulating lane
Southbound Adams Street	• One-lane entry, One circulating lane
Eastbound Vierling Drive	• One-lane entry, One circulating lane
Westbound Vierling Drive	• One-lane entry, One circulating lane

The traffic operations analysis identifies a Level of Service (LOS) which indicates how well an intersection is operating based on average delay per vehicle. Intersections are given a ranking from LOS A to LOS F. LOS A indicates the best traffic operation and LOS F indicates an intersection where demand exceeds capacity. LOS A through LOS D are considered acceptable because the intersection would be operating under capacity.

Operational analysis of the all-way stop was performed using HCS 7 and operations analysis of the traffic signal control alternative was performed using Synchro/SimTraffic. Traffic operations analysis of the roundabout alternative was conducted using RODEL software. RODEL is a software program that is based on existing roundabout operational research and uses an empirical formula method to determine roundabout delay based on geometric features and traffic flows.

Results of the Year 2025 traffic operations analysis indicate that all alternatives would perform at acceptable levels of service under the proposed lane configurations, with the roundabout alternative having less overall delay. Table 7 provides a summary of the Year 2025 operations analysis. The Year 2025 detailed analysis results are included in the Appendix.

Table 7. Operations Analysis Results – 2025 Conditions (Year of Opening)

Alternative	Analysis Tool	AM Peak Hour		PM Peak Hour	
		Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
All-Way Stop Control (existing)	HCS 7	18	C	24	C
Traffic Signal Control	SimTraffic	14	B	14	B
Roundabout Control	RODEL	11	B	14	B

Table 8 provides a summary of the Forecast Year 2040 operations analysis. Results of the traffic operations analysis indicate that the all-way stop control alternative would operate as a LOS F during the PM peak hour. Two northbound thru lanes would need to be provided for the all-way stop alternative to provide acceptable operations. Both the traffic signal and roundabout alternatives would continue to operate at acceptable levels of service under the proposed lane configurations, with the roundabout alternative overall having less delay. The detailed analysis can be found in the Appendix.

Table 8. Operations Analysis Results – 2040 Conditions

Alternative	Analysis Tool	AM Peak Hour		PM Peak Hour	
		Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
All-Way Stop Control (existing)	HCS 7	32	D	57	F
Traffic Signal Control	SimTraffic	20	B	22	C
Roundabout Control	RODEL	14	B	20	C

Safety Analysis

The *Highway Safety Manual (HSM) Predictive Method* (referred to as the "predictive method") was used to predict the crash frequency and severity at the study intersection based on future traffic volumes and roadway characteristics. The predictive method was evaluated for the all-way stop, traffic signal, and roundabout control at the study intersection. The analysis was performed using the Interactive Highway Safety Design Model (IHSDM) site-based interface provided by the Federal Highway Administration (FWHA). The predictive method was analyzed for 20 years, with the first full year of benefits estimated to be in year 2024. It should be noted that crash prediction for all-way stop control is a limitation of the predictive method, therefore, the existing crashes (fatal/injury and PDO) per year was assumed over the analysis period. It should be noted that the existing intersection crashes were above the average crash rate for intersections with similar characteristics. If the intersection was reconfigured to eliminate two thru lanes, crashes per year at the intersection are anticipated to be reduced. Table 9 is a summary of the total predicted fatal/injury and property damage only crashes expected over the 20 years, along with the average crash frequency per year.

Table 9. Predicted Crash Frequency per Intersection Alternative

Alternative	Total Predicted Crashes for Evaluation Period (2024-2043)			Average Predicted Crashes/Year		
	FI	PDO	Total	FI	PDO	Total
All-Way Stop Control (1)	26.6	26.6	53.2	1.3	1.3	2.7
Traffic Signal Control	14.3	29.0	43.3	0.7	1.5	2.2
Roundabout Control	9.7	32.6	42.3	0.5	1.6	2.1

(1) Due to Predictive Method limitations, the existing FI, PDO, and total crashes per year was assumed throughout the analysis period. It should be noted that the existing crashes were above the average crash rate for an all-way stop control with similar characteristics. If the intersection was reconfigured to eliminate two thru lanes, crashes per year at the intersection are anticipated to be reduced.

Results indicate that a single-lane roundabout is expected to have the highest amount of property damage only crashes, however, it is also expected to have the lowest amount of total crashes and fatal and injury crashes at the intersection.

Benefit-Cost Comparison

A benefit-cost analysis provides an indication of the economic desirability of an alternative. Results must be weighed by decision-makers along with the assessment of other effects and impacts. Projects are considered cost-effective if the benefit-cost ratio is greater than 1.00, which reflects that project benefits exceed the expected life-cycle costs. The larger the ratio number, the greater the benefits per unit cost.

Both build alternatives were compared to the existing all-way stop alternative. In this case, if the benefit-cost ratio of either the signal or roundabout alternatives are greater than 1.00, then that alternative is considered cost-effective compared to the all-way stop alternative. The following methodology and assumptions were used for the benefit-cost analysis:

Main Components Analyzed Include:

- a. Crashes by severity.
- b. Travel time/delay (Vehicle Hours Traveled – VHT).
- c. Initial capital costs: These costs were divided into different categories in accordance with service life (consistent with the recommendations of MnDOT Office of Planning and Programming, July 2019).
- d. Remaining Capital Value: The remaining capital value (value of the improvement beyond the analysis period) was not considered a reduction in cost.
- e. Maintenance costs.

2. **Analysis Years:** The analysis assumed that each of the alternatives would be constructed in year 2022 and 2023. Therefore, year 2024 is the first full year that benefits would be realized from the project. The analysis focused on the twenty-year period from 2024 to 2043.
3. **Economic Assumptions:** The present value of all benefits and costs were calculated considering 2020 as the year of current dollars. The assumed discount rate of 1.2 percent was used per guidelines from the "*Recommended standard values for use in cost-effectiveness and benefit-cost analysis in SFY 2020*", Minnesota Department of Transportation, Office of Transportation System Management, July 2019. Value of time, crash costs, and remaining capital value assumptions were consistent with values also published by MnDOT.
4. **Development of Vehicle Hours Traveled (VHT)**: Vehicle Hours Traveled (VHT) were derived from the expected intersection vehicle delay over the analysis period. Peak hour intersection vehicle delay was obtained using Synchro/SimTraffic software for the traffic signal alternative. RODEL software was used to determine the peak hour delay for the roundabout control alternative. Analysis was performed for both year 2025 and forecast year 2040 conditions. Delay for years between 2025 and 2040 was interpolated based on a linear growth rate. Delay for years outside 2025 and 2040 were extrapolated using the same growth rate. VHT benefits were summarized by the difference in delay costs between the no build alternative and the build alternative. Savings due to reduction of VHT were calculated using costs per hour that account for vehicle occupancy and different vehicle types.
5. **Safety Analysis:** Safety benefits were estimated based on annual crashes by severity. The Highway Safety Manual (HSM) Predictive Method (referred to as the "predictive method")

was used to predict crash frequency and severity at the study intersection based on future traffic volumes and roadway characteristics for each alternative. Crash predictions were produced for each year in the benefit-cost analysis period. Crash costs from each severity type were valued in accordance with "*Recommended standard values for use in B/C analysis in SFY 2020*", MnDOT Office of Transportation System Management, July 2019.

6. **Maintenance Costs**: Annual maintenance costs between the alternatives were monetized based on typical values observed in the state of Minnesota for similar traffic control types. Under the traffic signal alternative, costs typically include electricity and routine maintenance required to keep the signal in operation. The roundabout alternative was assumed to require lighting and routine landscaping. Annual maintenance costs for the traffic signal and roundabout, in terms of 2012 dollars, were $5,000 and $1,000, respectively. These dollar amounts were inflated to year 2020 dollars using an inflation rate of 1.1337, which was provided by the Consumer Price Index Inflation Calculator, Bureau of Labor Statistics. No maintenance costs were assumed for the all-way stop alternative.
7. **Calculation of Remaining Capital Value:** Because many components of the initial capital costs have service lives well beyond the 20-year benefit-cost analysis period, the remaining capital value was calculated for each alternative. The remaining capital value was subtracted from the initial capital cost to determine the net capital cost. In determining remaining capital value, the initial costs of the alternatives were separated into the following categories:
    a. Right-of-Way
    b. Major Structures
    c. Grading and Drainage
    d. Sub-Base and Base
    e. Surface
    f. Miscellaneous Costs – Includes mobilization, removal of temporary pavement and drainage, traffic control, and design and engineering costs. These were assumed to be sunk costs and assigned zero remaining capital value.
8. **Factors Not Quantified**: Several factors were not quantified as part of the analysis because review of initial data indicates low potential to yield substantial benefit. These factors included the following:
    a. All alternatives are not expected to cause traffic diversion; therefore, benefits derived from Vehicle Miles Traveled (VMT) were assumed to be negligible and have been excluded from the analysis for these alternatives.
    b. A factor that was not quantified in the benefit-cost analysis was delay savings outside of the AM and PM peak hours. It is expected that the roundabout alternative would provide travel time benefits during non-peak hours of the day. This should be considered a conservative estimate for the roundabout alternative.

A planning level estimate of $250,000 was assumed for the all-way stop control alternative, which includes geometric changes to the subject intersection to reduce the number of lanes. A planning level estimate of $570,000 was assumed for the traffic signal alternative, which includes the construction of a new signal system and geometric improvements to the existing lane configuration. The roundabout control alternative was estimated at $1,000,000 which includes the construction of a single-lane roundabout as shown in the proposed conditions figure. Results of the benefit-cost analysis are included in Table 10.

The benefit-cost analysis workbook summaries are included in the Appendix. Detailed cost breakdowns for the traffic signal and roundabout alternatives are also included in the Appendix.

Table 10. Benefit-Cost Analysis Summary

Intersection Alternative	User Costs Savings (millions)	Project Costs (millions)	Benefit-Cost Ratio
Traffic Signal	$3.46	$0.32	10.72
Roundabout	$4.97	$0.58	8.55

User Costs Savings = the monetized user costs savings benefit of the roundabout versus the signal based on vehicular travel time and crash reduction savings.

Project Costs = the differential between the construction, maintenance, and capital value costs between the roundabout and the traffic signal alternatives. Capital value costs account for the difference in the value of the alternative investment beyond the analysis years.

Benefit-Cost Ratio = The user costs savings of the roundabout versus the traffic signal divided by the project costs differential.

Right-of-Way Considerations

The reconfigured all-way stop and traffic signal control alternatives are not expected to require additional right-of-way. The roundabout control alternative is expected to have minor impacts to right-of-way in the northeast and southeast quadrants. These quadrants, which are City owned property, may require a permanent easement revision for roundabout construction. In addition, the roundabout construction may result in impacts to the existing gas facility in the southwest quadrant.

Pedestrian Considerations

The reconfigured all-way stop control intersection would result in fewer lanes for pedestrians to cross, thus improving pedestrian safety. If a signal system were to be installed, a more robust pedestrian system would be incorporated into the design to better match current pedestrian facility standards. The dedicated walk phase would reduce the pedestrian/vehicle interaction; however, the traffic signal would result in increased travel speeds at the intersection. In addition, the design of a roundabout would allow pedestrians to cross only one lane and one direction of traffic at a time on each leg of the roundabout. Furthermore, pedestrians typically experience less delay at an all-way stop and roundabout compared to a traffic signal because they do not have to wait for the pedestrian walk phase to be served.

Transportation System Considerations

Currently, all intersections along the Marystown Rd/CR 15 corridor are stop-controlled. However, the three major intersections along the corridor, Marystown Road/US 169 North Ramp, Marystown Road/US 169 South Ramp, and CR 15/CR 16, are all proposed roundabouts as part of the *Marystown Road Corridor Study*. If a roundabout was constructed at this intersection it would provide consistent traffic control at the major intersections along Marystown Road/CR 15.

Improper Movements

Constructing a roundabout at the Adams Street/Vierling Drive intersection would provide the capability to make a northbound to southbound U-turn at the intersection, which would eliminate any potential improper maneuvers that are occurring along the corridor from the Hy-Vee Access. The reconfigured all-way stop and traffic signal control alternatives would extend the existing median along the corridor, which would help reduce improper maneuvers along the Marystown Road corridor. However, there is not expected to be enough space at the intersection to perform the desired U-turn maneuver. Therefore, vehicles will likely continue to use the Quincy Circle neighborhood to reroute their trip southbound.

Alternatives Summary

The following intersection control evaluation (ICE) conclusions are provided for the Adams Street at Vierling Drive intersection in Shakopee, Scott County, Minnesota:

- *Warrants Analysis*
  The results of the warrant analyses indicate that the intersection satisfies Signal Warrants 2 and 3B with existing volumes, Signal Warrants 1A, 2, and 3B with 2025 volumes and Signal Warrants 1A, 1C, 2, and 3B with 2040 volumes. The analysis also indicates that the current all-way stop control is justified, as the existing volumes satisfy the MWSA warrant.

- *Operations Analysis*
  Operational analysis results of the year 2025 and 2040 volumes indicate that both the traffic signal and roundabout alternatives are expected to perform with acceptable levels of service with proposed lane configurations and forecasted volumes. Long-term, the all-way stop control is expected to operate as a LOS F during the PM peak hour. Two northbound lanes would need to be provided to achieve acceptable operations.

- *Safety Analysis*
  The HSM crash prediction methodologies were utilized to compare the all-way stop, traffic signal, and roundabout controls. From a safety perspective, the roundabout is expected to have the highest property damage crashes, but the lowest amount of total crashes and fatal/injury crashes.

- *Benefit-Cost Comparison*
  Both of the benefit-cost ratios for the build alternatives are greater than one compared to the all-way stop alternative due to the build alternatives' expected positive impacts on intersection operations and safety compared to the all-way stop alternative. However, the benefit-cost ratio of the traffic signal alternative is higher than the benefit-cost ratio of the roundabout alternative. Therefore, the traffic signal is considered the most cost-effective.

- *Right-of-Way Considerations*
  The reconfigured all-way stop and traffic signal control alternatives are not expected to require additional right-of-way. The roundabout control alternative is expected to have minor impacts to the right-of-way in the northeast and southeast quadrants. In addition, the roundabout construction may cause impacts to the existing gas facility in the southwest quadrant.

- *Pedestrian Considerations*
  The reconfigured all-way stop control would result in fewer lanes for pedestrians to cross. The traffic signal alternative would provide a dedicated walk phase, reducing vehicle/pedestrian interaction, however, vehicle speeds are expected to be increased at the intersection. The roundabout alternative would allow pedestrians to only cross one lane and direction of travel at a time.

- *Transportation System Considerations*
  If a roundabout was constructed at this intersection it would provide consistent traffic control at the major intersections along Marystown Road/CR 15, assuming the proposed roundabouts are constructed at the other three major intersections.

- *Improper Movements*
  The roundabout alternative would provide the capability to make a northbound to southbound U-turn at the intersection, which would eliminate any potential improper maneuvers that are occurring along the corridor from the Hy-Vee Access. The other alternatives would help reduce improper movements, however, vehicles are expected to continue to utilize the Quincy Circle neighborhood to reroute their trip southbound.

Recommended Intersection Control

As previously noted, traffic signal and roundabout control are currently warranted with existing volumes. Long-term, the traffic signal and roundabout alternatives would provide acceptable overall traffic operations. The all-way stop control alternative would likely need to add two northbound thru lanes to provide acceptable operations. This would be inconsistent with the other legs of the intersection and could cause driver confusion.

One of the main objectives that supports the roundabout alternative at the Adams Street/Vierling Drive intersection is the ability to provide a safe U-turn maneuver for vehicles exiting the Hy-Vee development at the right-in/right-out access that are destined southbound. Neither the all-way stop control or traffic signal control alternatives are expected to fully address this issue.

The roundabout alternative would also provide less peak hour and non-peak hour vehicular delay, is expected to have less total and fatal/injury crashes and is considered cost-effective compared to the all-way stop alternative.

Based on the results of this Intersection Control Evaluation, a roundabout control is recommended for the intersection of Adams Street at Vierling Drive intersection.

Intersection Control Evaluation

Marystown Road at US 169 North Ramp

City of Shakopee, Scott County, Minnesota

May 2020

SRF No. 020 13195

Intersection Control Evaluation

Marystown Road at
US 169 North Ramp

Proposed Letting Date: TBD

Report Certification:

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Brent Clark	57198
Print Name	Reg. No.
	5/14/2020
Signature	Date

Approved:

	5/18/2020
City of Shakopee City Engineer	Date
Lars Impola Digitally signed by Lars Impola Date: 2020.05.20 13:13:55 -05'00'	
MnDOT Metro District Traffic Engineer	Date
Julie Dresel Digitally signed by Julie Dresel Date: 2020.05.21 12:53:41 -05'00'	
MnDOT Metro District State-Aid Engineer	Date

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Introduction

The City of Shakopee, in partnership with Scott County and the Minnesota Department of Transportation (MnDOT), is developing an ultimate vision for County Road (CR) 15/Marystown Road/Adams Street from Vierling Drive to CR 16 (17th Avenue W) in Shakopee, Minnesota. The development and operations along the corridor have been discussed and evaluated in the following studies that were completed in 2019:

1) *Shakopee AUAR Transportation Analysis*, SRF Consulting (Draft - September 2019)

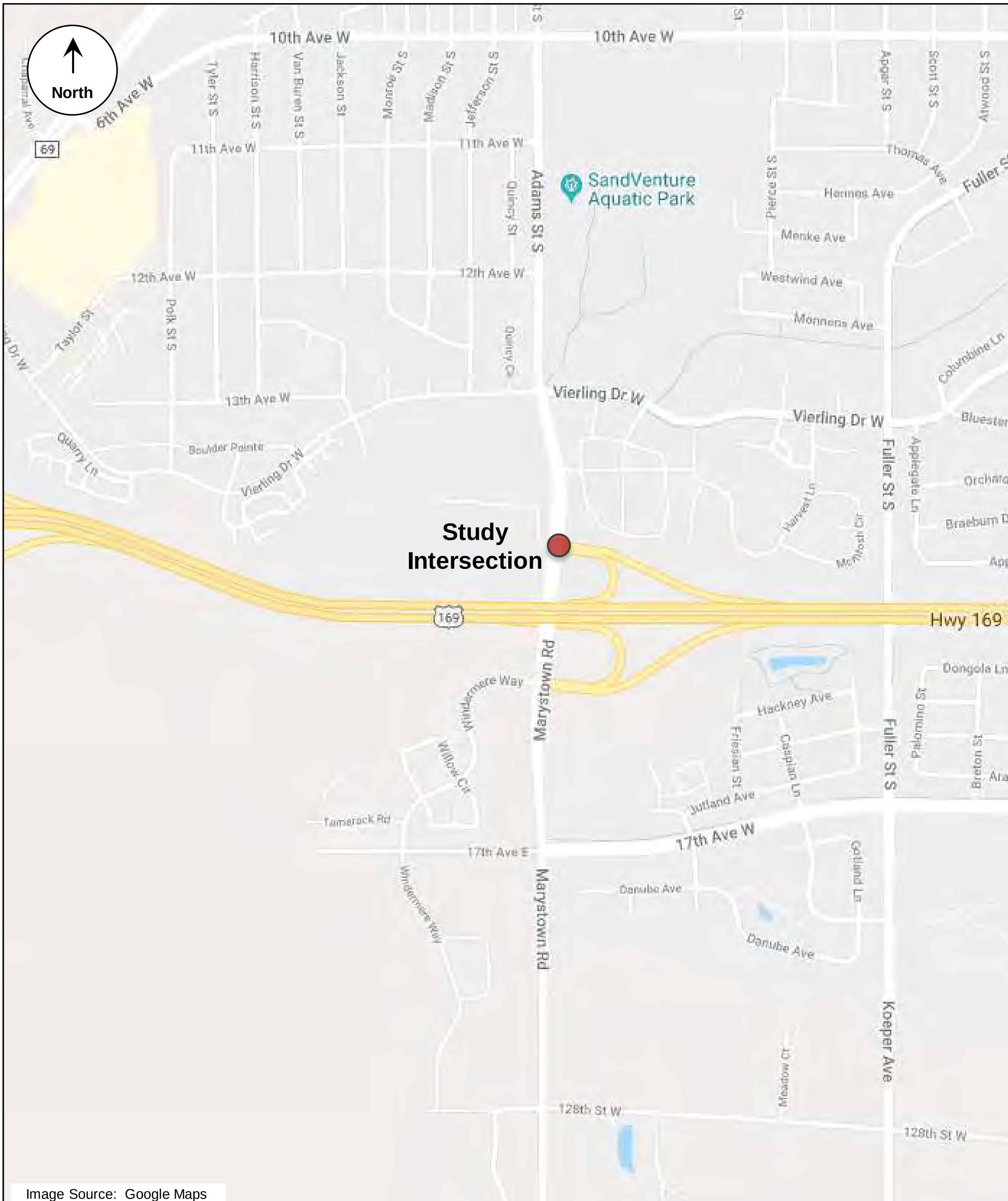
2) *Trident Development Transportation Study*, SRF Consulting (December 2019)

The previous studies identified that the current traffic control along the corridor is not expected to sufficiently accommodate future growth and planned development in the area by the year 2025. In addition, there are also safety concerns at the intersections, as CR 15/Marystown Road is a high-speed corridor (45/55 mph) and there has been a recent increase in crashes since construction of the Hy-Vee and Windermere developments (along with the addition of west approaches at the US 169 South Ramp and CR 16 intersections to accommodate the Windermere development). In addition to operations and safety, the City has a desire to repurpose the US 169 Bridge to provide a multi-use trail on both sides, thus connecting a gap in the City's trail system. Therefore, this intersection control evaluation was completed to support the *Marystown Road Corridor Study* that is being completed to determine the current and future needs of CR 15/Marystown Road that will inform the anticipated reconstruction project from Vierling Drive to CR 16 planned for the year 2022.

This report documents the intersection control evaluation results for the Marystown Road and US 169 North Ramp intersection in the City of Shakopee, Scott County, Minnesota (see Figure 1). The purpose of this evaluation was to analyze various intersection control alternatives under near-term and long-term conditions to identify a preferred intersection control alternative. The following intersection control alternatives were considered applicable:

- Side-Street Stop Control (existing)
- Traffic Signal Control
- Roundabout Control

The *Trident Development Transportation Study* identified all-way stop control as a potential short-term interim improvement if safety issues become a significant concern, however, an all-way stop control is not considered an applicable long-term intersection control. This is based on a cursory review of traffic volumes beyond 2025, that indicate an all-way stop-controlled intersection would be well overcapacity. All-way stop control would also require every vehicle on Marystown Road to come to a stop, which is undesirable due to the high volume on this corridor, and the existing number of lanes at the intersection (four northbound/southbound) would create driver confusion. Detailed warrants, operations, safety, and benefit-cost analyses were performed to determine a preferred intersection control alternative. In addition to the above analyses, other factors considered applicable to determining the long-term preferred intersection control included: Right of Way Considerations, Pedestrian Considerations, and Transportation System Considerations.



Intersection Location

Intersection Control Evaluation
Marystown Road at North TH 169 Ramp
Shakopee, Minnesota

Figure 1

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Intersection Characteristics

Existing Conditions

The Marystown Road at US 169 North Ramp/Tahpah Park Access intersection is currently under two-way stop control (TWSC) with US 169 North Ramp/Tahpah Park Access being controlled by stop signs. Marystown Road is a four-lane divided roadway at the study intersection and is functionally classified as an A-Minor Arterial with a posted speed limit of 55 mph south of the intersection. North of the intersection, Marystown Road is classified as a collector with a posted speed limit of 45 mph. US 169 is a four-lane divided roadway that is functionally classified as a principal arterial with a posted speed limit of 65 mph. Tahpah Park Access is a two-lane undivided local roadway with a statutory speed limit of 30 mph. Current intersection geometrics are listed below in Table 1 and shown in Figure 2.

Table 1. Existing Conditions

Approach	Lane Configurations
Northbound Marystown Road	One left-turn lane, two thru-lanes, and one right-turn lane
Southbound Marystown Road	One left-turn lane, two thru-lanes, and one right-turn lane
Eastbound Tahpah Park Access	One shared left-thru-right lane
Westbound US 169 Ramp	One shared left-thru lane and one right-turn lane

Existing Conditions

Figure 2

Intersection Control Evaluation
Marystown Road at North TH 169 Ramp
Shakopee, Minnesota

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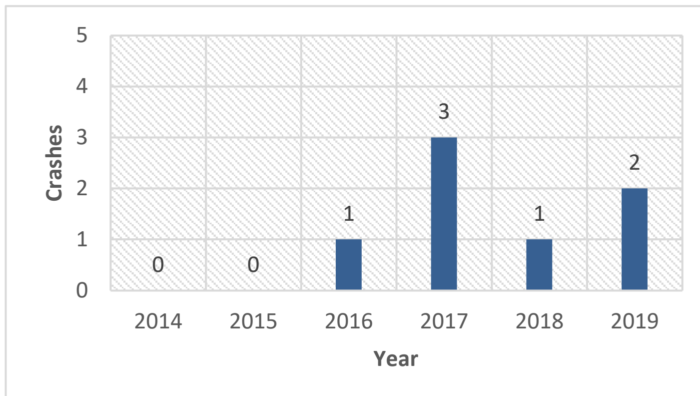
Crash History

Crash data was obtained from the City of Shakopee from 2014 through 2019 to identify any crash trends at the intersection and a summary of the historical crash data is shown below. It should be noted that, while outside of the crash trends and analysis period, a fatal accident (right-angle crash) occurred at the intersection in 2010. The latest three-year period (2017-2019) was used for the crash analysis per MnDOT ICE report guidance and is summarized below and in Table 2. There was a total of six (6) crashes at the Marystown Road/US 169 North Ramp/Tahpah Park Access intersection, with one (1) possible injury crash and five (5) property damage only (PDO) crashes. The crashes at this location were split evenly between right-angle and rear end crashes. A high number of right-angle crashes can indicate that there may be limited available gaps in traffic and drivers are having a difficult time determining gaps or are accepting smaller gaps. A high number of rear end crashes can indicate that drivers are not anticipating vehicles. The intersection is below the critical crash rate, which indicates that there is not a statistically significant crash problem at the intersection, however, the intersection is above the average crash rate.



- Crash Severity:
  - 5 – Property Damage Only Crashes
  - 1 – Possible Injury (Type C) Crashes
- Crash Type:
  - 3 – Rear End (2017, 2019, 2019)
  - 3 – Right-Angle Crashes (2017, 2017, 2018)

Table 2. Crash History Summary

Location	Number of Crashes	Daily Entering Volume	Total Crash Rate (1)		
			Calculated	Average	Critical
Marystown Rd at US 169 North Ramp/ Tahpah Park Access	6	11,000 (3)	0.50	0.19	0.55

(1) Intersection crash rates are expressed in crashes per million entering vehicles.
(2) Intersection crash rates are expressed in crashes per 100 million entering vehicles.
(3) Intersection Daily Entering Volume calculated based on combination of 13-hour counts collected as part of the *Trident Development Transportation Study* (SRF, 2019) and the latest available MnDOT AADT volumes.

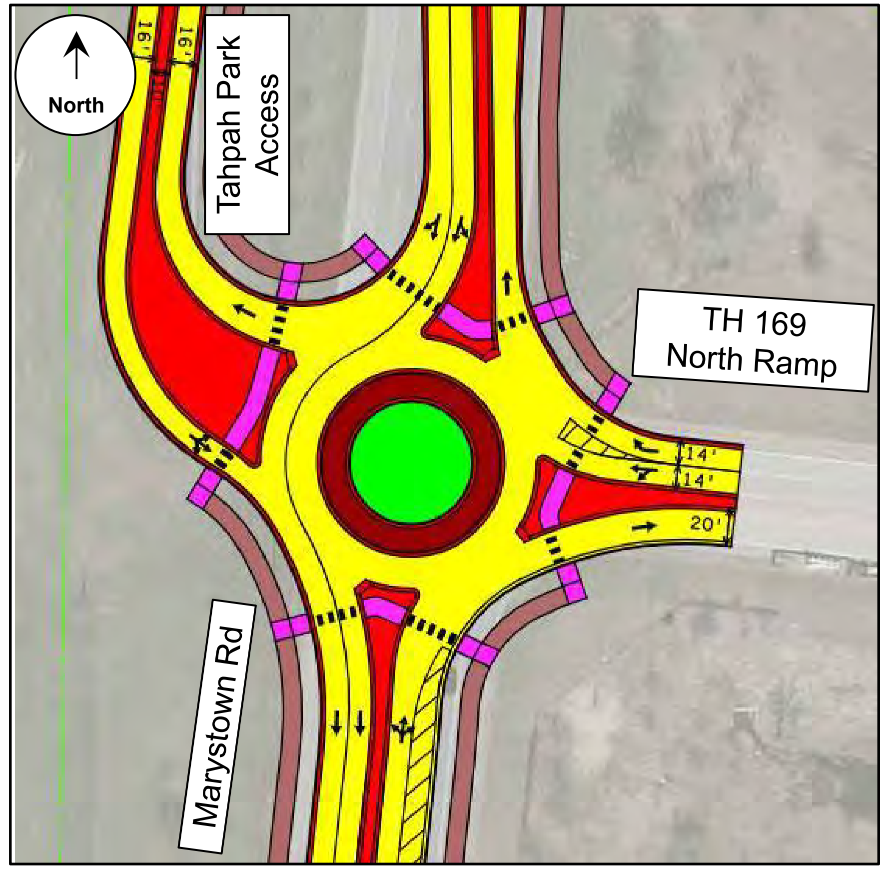
Future Conditions

Future lane configurations were developed to accommodate projected traffic volumes and the corridor vision for CR 15/Marystown Road. For the side-street stop and traffic signal control alternatives, the existing lane configuration was assumed. For the roundabout control alternative, a hybrid roundabout was assumed for the purpose of this ICE report to accommodate 20-year forecast volumes and beyond. However, the City is planning to construct a single-lane roundabout with the ability to be expanded in the future if/when needed. The assumed lane configurations for these alternatives are shown in Table 3 and can be seen in Figure 3.

Table 3. Future Intersection Lane Configurations

Approach	Side-Street Stop and Traffic Signal Control	Roundabout Control
Northbound Marystown Rd	• One left-turn lane • Two thru lanes • One right-turn lane	• One shared left-turn/thru lane/ right-turn lane
Southbound Marystown Rd	• One left-turn lane • Two thru lanes • One right-turn lane	• One shared left-turn/thru lane • One shared thru/right-turn lane
Eastbound Tahpah Park Access	• One shared left-turn/thru/right-turn lane	• One shared left-turn/thru lane/right-turn lane
Westbound US 169 Ramp	• One shared left-turn/thru lane • One right-turn lane	• One shared left-turn/thru lane • One right-turn lane

Side-Street Stop and Traffic Signal Alternatives



Hybrid Roundabout Alternative

Proposed Lane Configurations

Intersection Control Evaluation
Marystown Road at North TH 169 Ramp
Shakopee, Minnesota

Figure 3

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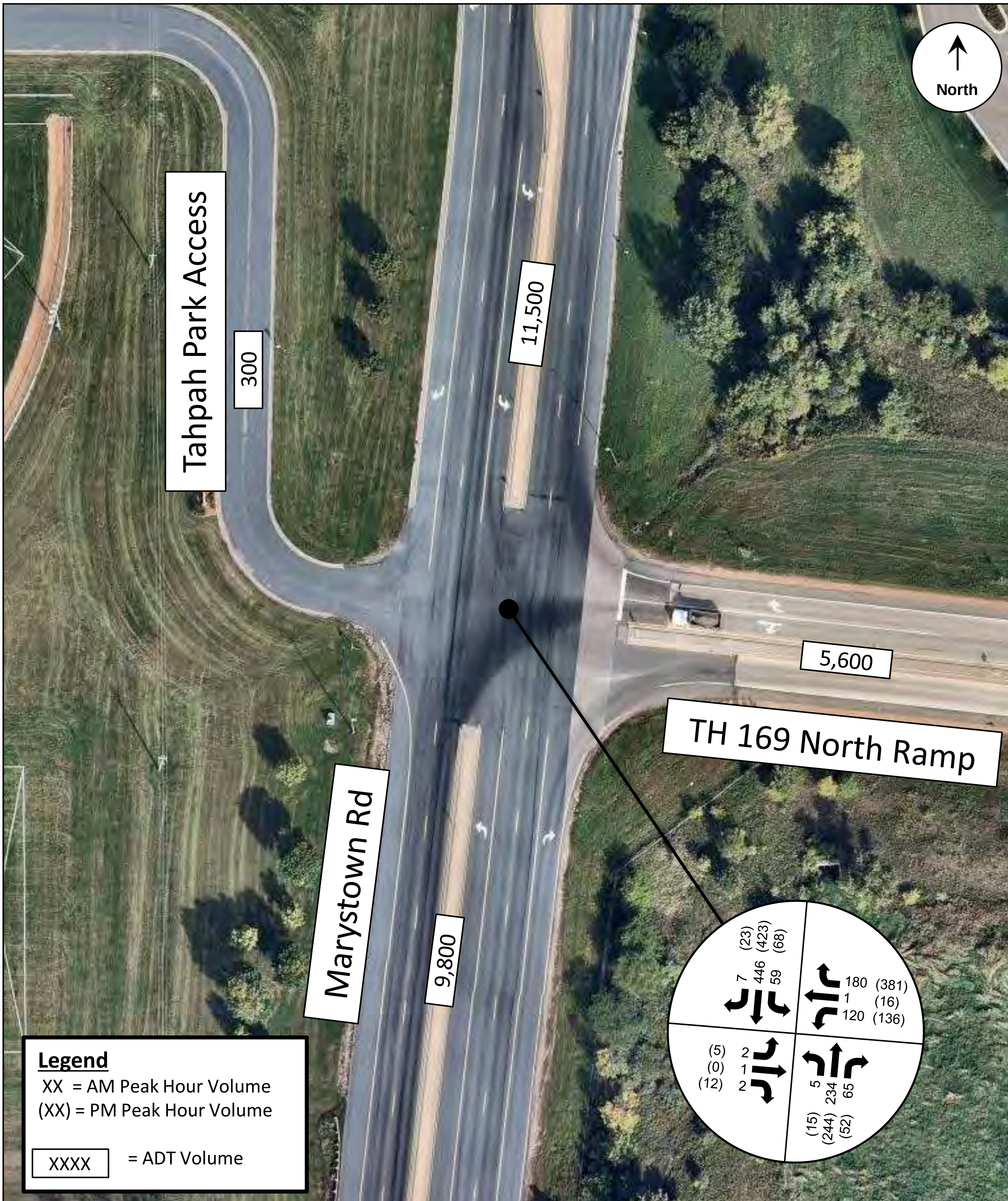
Traffic Volumes

Existing hourly approach volumes at the study intersection were collected in October 2019 by SRF and are summarized in Figure 4 and included in the Appendix. It should be noted that adjustments were made to the existing turning movement counts to account for ongoing construction in the region, which is outlined further in the *Trident Development Transportation Study*.

The year 2025 volumes were developed as part of the *Trident Development Transportation Study* and account for the three on-going developments along the study corridor (Windermere, Bruggeman, Trident), and a general background growth rate of one and a half (1.5) percent. As previously mentioned, the three on-going developments are expected to be developed before 2025, therefore, the year 2025 represents one-year post-construction of the full-build out of the proposed development. Construction of a traffic control alternative is anticipated for the year 2022, with a year of opening anticipated for 2023. Therefore, due to the similar timeframes of the year of opening of the roadway construction and the development full-build out, the year 2025 is considered the year of opening.

The year 2040 turning movements were developed as part of the *Shakopee AUAR Transportation Study*, utilizing the Scott County Regional Travel Demand Model and the 2040 Scott County Comprehensive Plan. These 2040 turning movement counts were updated as part of the *Trident Development Transportation Study*. The projected peak hour year 2025 and year 2040 turning movement volumes are shown in Figure 5 and Figure 6, respectively.



Existing Volumes

Intersection Control Evaluation
Marystown Road at North TH 169 Ramp
Shakopee, Minnesota

Figure 4

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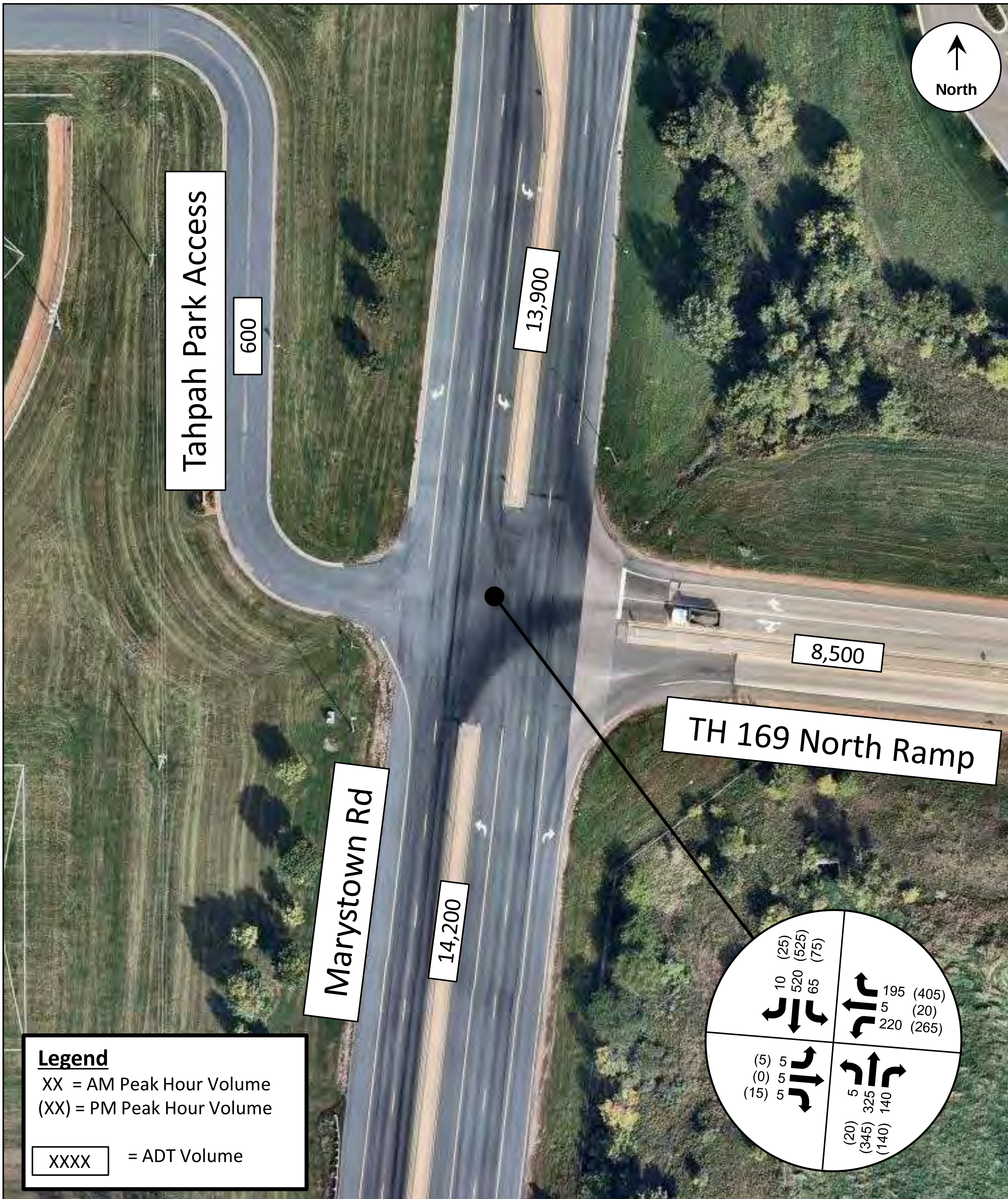

SRF

Forecast Year 2025 Volumes

Intersection Control Evaluation
Marystown Road at North TH 169 Ramp
Shakopee, Minnesota

Figure 5

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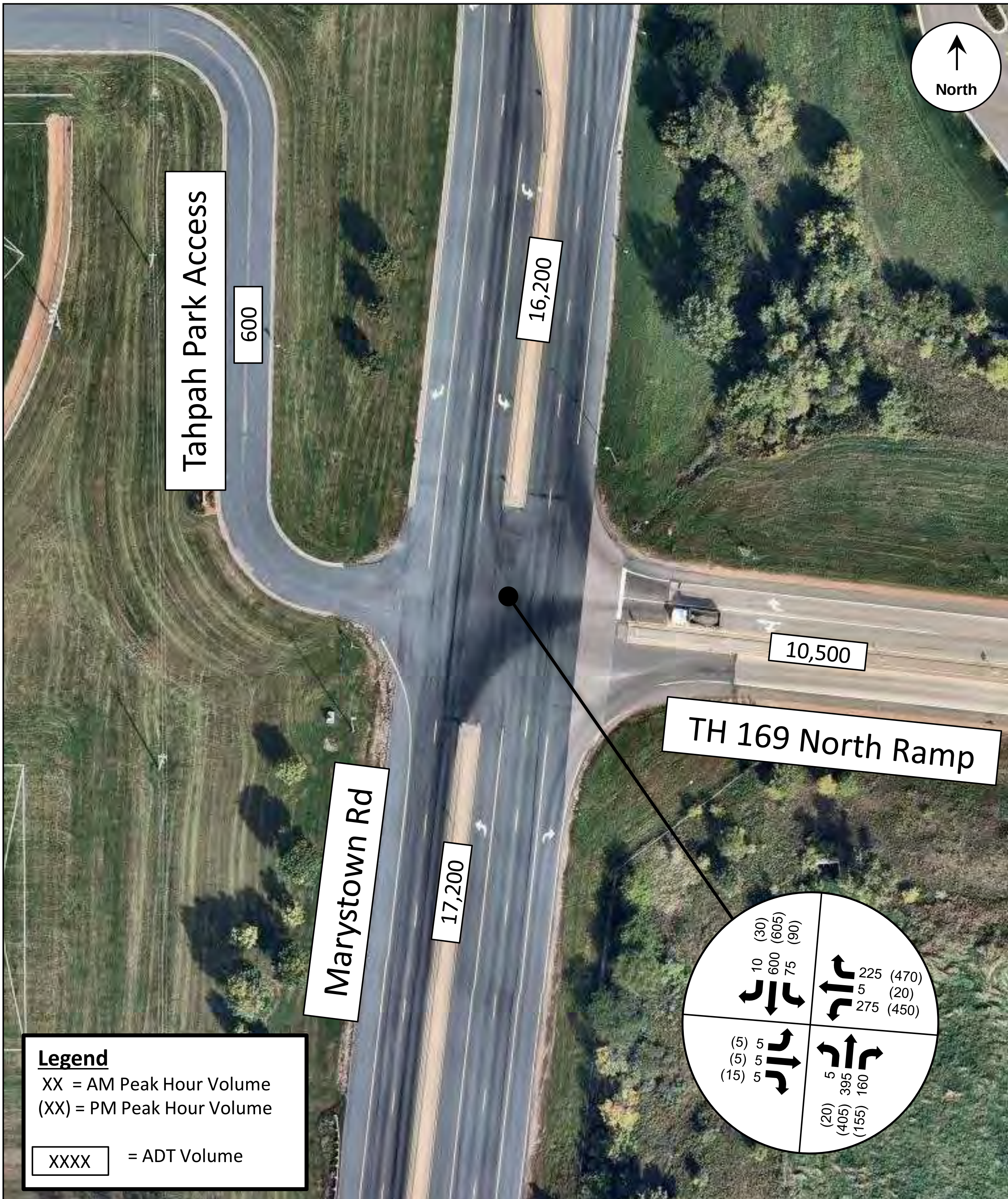

SRF

Forecast Year 2040 Volumes

Intersection Control Evaluation
Marystown Road at North TH 169 Ramp
Shakopee, Minnesota

Figure 6

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Analysis of Alternatives

Warrants Analysis

The Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD) provides guidance on when it may be appropriate to use all-way stop or signal control at an intersection. This guidance is provided in the form of "warrants", or criteria, and engineering analysis of the intersection's design factors to determine when all-way stop or signal control may be justified.

Meeting a warrant at an intersection does not in itself require the installation of a particular control type. The particular control type also requires an engineering analysis of the intersection's design for it to be justified. Under the MnDOT ICE process, roundabouts are typically considered to be warranted if traffic volumes meet the criteria for either all-way stop or traffic signal control.

A warrants analysis was performed for the traffic signal control alternative as outlined in the December 2019 MN MUTCD. Analysis of signal warrants 1-3 was performed utilizing existing volumes. Signal warrants 4-9 were investigated and were determined to not be applicable to the study.

The lane geometry and approach speeds assumed for the warrant analysis are shown in Table 4.

Table 4. Warrants Analysis Assumptions

Approach	Geometry	Speed Limit
Northbound Marystown Road	Two or more approach lanes	55 mph
Southbound Marystown Road	Two or more approach lanes	55 mph
Eastbound Tahpah Park Access	One approach lanes	30 mph
Westbound US 169 Ramp	Two or more approach lanes	45 mph

For the analysis, right-turning vehicles on the minor approaches were not included as these turns are given a dedicated lane and thus do not significantly impact the thru-movement on both minor approaches.

The 70 percent traffic volume factor was used for the warrants analysis, as proposed conditions met the necessary criteria of the speed limit exceeding 45 mph on at least one of the approaches. Table 5 provides a summary of the warrants analysis results, while the detailed volume-based warrants analysis is included in the Appendix.

In addition to the signal warrants, Multiway Stop Applications Warrant Condition C (MWSA C) was also evaluated as outlined in the MN MUTCD. The results of the MWSA warrants analysis are also shown in Table 5.

Table 5. Warrants Analysis Summary

MN MUTCD Warrant	Hours Required	Existing Volumes		2025 Volumes (Year of Opening)		2040 Volumes	
		Hours Met	Warrant Met?	Hours Met	Warrant Met?	Hours Met	Warrant Met?
MWSA C: Minimum Volumes	8	2	No	7	No	14	Yes
Warrant 1A: Minimum Vehicular Volume	8	1	No	7	No	14	Yes
Warrant 1B: Interruption of Continuous Traffic	8	6	No	9	Yes	13	Yes
Warrant 1C: Combination of Warrants	8	3	No	11	Yes	14	Yes
Warrant 2: Four-Hour Volume	4	3	No	7	Yes	12	Yes
Warrant 3B: Peak Hour Volume	1	0	No	5	Yes	7	Yes
Warrants 4-9	Not Applicable						

The results of the warrants analysis indicate the intersection does not satisfy any MN MUTCD Signal Warrants with existing volumes. However, the intersection does satisfy Signal Warrants 1B, 1C, 2, and 3B with 2025 volumes and Signal Warrants 1A, 1B, 1C, 2, and 3B with 2040 volumes. The analysis also indicates that the intersection satisfies MWSA warrants under 2040 volumes.

Operations Analysis

An initial planning-level analysis was performed for the roundabout control alternative based on Highway Capacity Manual (HCM) 6th Edition methods. Planning-level analysis results for Forecast Year 2040 volumes are shown in Figure 8. As can be seen, the Forecast Year 2040 volumes are generally below the theoretical capacity of a single-lane roundabout. However, one entry approach is at the theoretical capacity of a single-lane roundabout. In addition to the planning-level analysis, capacity analysis tests were performed at the intersection using the Highway Capacity Software (HCS) 7. Results of the analysis indicates that a single-lane roundabout would be near capacity at the intersection during the p.m. peak hour with Forecast Year 2040 volumes. Therefore, for the purposes of this ICE report, a partial multi-lane roundabout, with two southbound circulating lanes was assumed. The following geometry assumed for analysis is shown in Table 6. It should be noted that the City is planning to construct a single-lane roundabout with the ability to be expanded in the future if/when needed. A year 2034 operations analysis was completed to determine near-term needs and is shown in the Appendix.

Figure 8. Marystown Rd at US 169 North Ramp Roundabout Entry Lane Capacity (Forecast Year 2040 volumes)

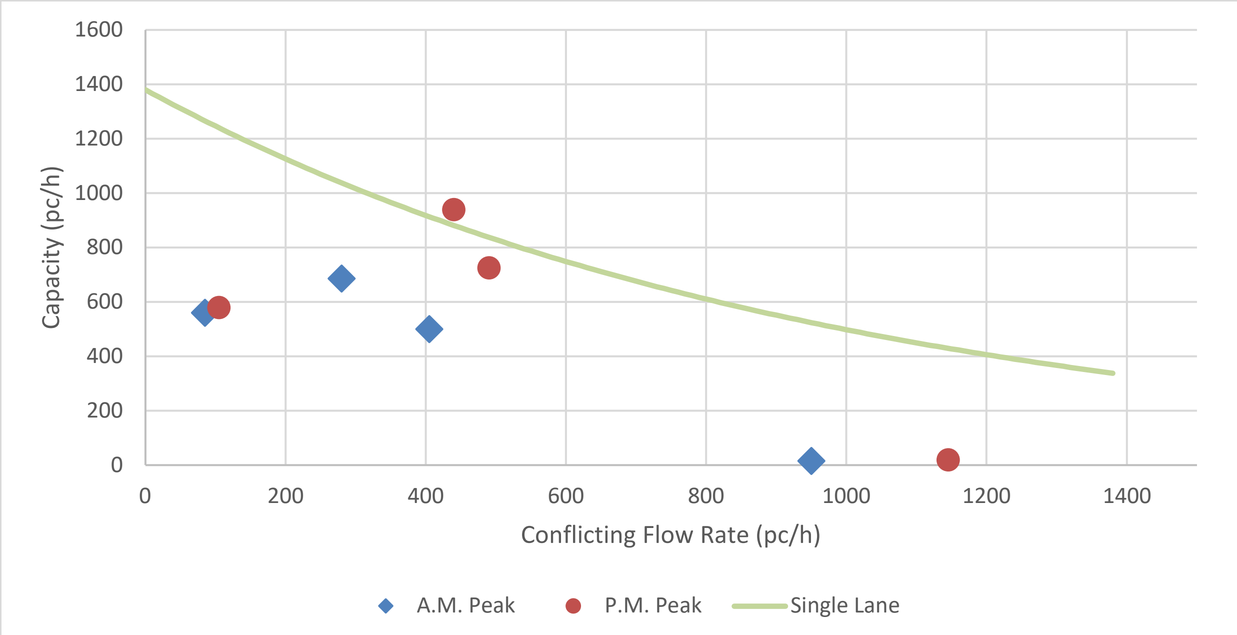


Table 6. Roundabout Lane Configuration

Approach	Geometry
Northbound Marystown Road	• One-lane entry, One circulating lane
Southbound Marystown Road	• Two-lane entry, Two circulating lanes
Eastbound Tahpah Park Access	• One-lane entry, One circulating lane
Westbound US 169 North Ramp	• Two-lane entry, One circulating lane

The traffic operations analysis identifies a Level of Service (LOS) which indicates how well an intersection is operating based on average delay per vehicle. Intersections are given a ranking from LOS A to LOS F. LOS A indicates the best traffic operation and LOS F indicates an intersection where demand exceeds capacity. LOS A through LOS D are considered acceptable because the intersection would be operating under capacity.

Operational analysis of the side-street stop and traffic signal control alternatives was performed using Synchro/SimTraffic. Traffic operations analysis of the roundabout alternative was conducted using RODEL software. RODEL is a software program that is based on existing roundabout operational research and uses an empirical formula method to determine roundabout delay based on geometric features and traffic flows.

Results of the Year 2025 traffic operations analysis indicate that both alternatives would perform at acceptable levels of service under the proposed lane configurations, with the roundabout alternative having less overall delay. The side-street stop alternative is expected to be overcapacity during the PM peak hour, with side-street stop approach delays of 75 seconds per vehicle. Table 7 provides a summary of the Year 2025 operations analysis. The Year 2025 detailed analysis results are included in the Appendix.

Table 7. Operations Analysis Results – 2025 Conditions (Year of Opening)

Alternative	Analysis Tool	AM Peak Hour		PM Peak Hour	
		Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Side-Street Stop Control (existing) (1)	SimTraffic	8 / 25	A / C	30 / 75	D / F
Traffic Signal Control	SimTraffic	9	A	11	B
Roundabout Control	RODEL	9	A	12	B

(1) Overall results are followed by the worst approach results.

Table 8 provides a summary of the Forecast Year 2040 operations analysis. Results of the traffic operations analysis indicate that both the traffic signal and roundabout alternatives would continue to operate at acceptable levels of service under proposed lane configurations, with the roundabout alternative overall having less delay. The analysis indicated the side-street stop control alternative would operate well overcapacity during both peak hours. The detailed analysis can be found in the Appendix.

Table 8. Operations Analysis Results – 2040 Conditions

Alternative	Analysis Tool	AM Peak Hour		PM Peak Hour	
		Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Side-Street Stop Control (existing) (1)	SimTraffic	34 / 109	D / F	124 / >3 min	F / F
Traffic Signal Control	SimTraffic	10	B	16	B
Roundabout Control	RODEL	11	B	13	B

(1) Overall results are followed by the worst approach results.

Safety Analysis

The *Highway Safety Manual (HSM) Predictive Method* (referred to as the "predictive method") was used to predict crash frequency and severity at the study intersection based on future traffic volumes and roadway characteristics. The predictive method was evaluated for the traffic signal and roundabout control at the study intersection. It should be noted that based on the year 2040 operations, the side-street stop control is not considered a feasible option, therefore is not considered in the safety analysis comparison. Analysis was performed using the Interactive Highway Safety Design Model (IHSDM) site-based interface provided by the Federal Highway Administration (FWHA). The predictive method was analyzed for a 20-year time period, with the first full year of benefits estimated to be in year 2024. Table 9 is a summary of the total predicted fatal/injury and property damage only crashes expected over the 20-year period, along with the average crash frequency per year.

Table 9. Predicted Crash Frequency per Intersection Alternative

Alternative	Total Predicted Crashes for Evaluation Period (2024-2043)			Average Predicted Crashes/Year		
	FI	PDO	Total	FI	PDO	Total
Traffic Signal Control	18.0	36.0	54.0	0.9	1.8	2.7
Roundabout Control	10.4	32.1	42.5	0.5	1.6	2.1

Results indicate that property damage only crashes are expected to be similar between the traffic signal and roundabout, while fatal and injury crashes are expected to be approximately 0.4 less per year, with a total of 7.6 less fatal and injury crashes throughout the evaluation period. Furthermore, roundabouts typically have fewer conflict points than conventional intersections, and the geometry of a roundabout induces lower speeds for vehicles approaching and traversing an intersection. With lower speeds, the severity of injury crashes is anticipated to decrease. Also, half of the crashes that have occurred at the intersection in the past three years were right-angle crashes, which are converted to low-speed, shallow-angle crashes with a roundabout.

Incremental Benefit-Cost Comparison

A benefit-cost analysis provides an indication of the economic desirability of an alternative. Results must be weighed by decision-makers along with the assessment of other effects and impacts. Projects are considered cost-effective if the benefit-cost ratio is greater than 1.00, which reflects that project benefits exceed the expected life-cycle costs. The larger the ratio number, the greater the benefits per unit cost.

Incremental benefit-costs are a type of benefit-cost that compares two alternatives in a project, rather than comparing them both to a no-build condition that is considered unfeasible. The existing side-street stop intersection was not considered as a feasible alternative due to the expected decline in safety and operational performance, as mentioned above. Thus, the incremental benefit-cost analysis compares project life-cycle costs and benefits between the roundabout alternative and the traffic signal alternative. In this case, if the incremental benefit-cost is greater than 1.00, the roundabout alternative is considered cost-effective compared to the traffic signal alternative. Vice versa, if the benefit-cost is less than 1.00, the roundabout alternative is not considered cost effective compared to the traffic signal alternative. While similar to a standard benefit-cost analysis, an incremental benefit-cost can give greater insights into the relationship of costs/benefits of two alternatives. The following methodology and assumptions were used for the benefit-cost analysis:

Main Components Analyzed Include:

a. Crashes by severity.
b. Travel time/delay (Vehicle Hours Traveled – VHT).
c. Initial capital costs: These costs were divided into different categories in accordance with service life (consistent with the recommendations of MnDOT Office of Planning and Programming, July 2019).
d. Remaining Capital Value: The remaining capital value (value of the improvement beyond the analysis period) was not considered a reduction in cost.
e. Maintenance costs.

2. **Analysis Years:** The analysis assumed that each of the alternatives would be constructed in year 2022 and 2023. Therefore, year 2024 is the first full year that benefits would be realized from the project. The analysis focused on the twenty-year period from 2024 to 2043.
3. **Economic Assumptions:** The present value of all benefits and costs were calculated considering 2020 as the year of current dollars. The assumed discount rate of 1.2 percent was used per guidelines from the "*Recommended standard values for use in cost-effectiveness and benefit-cost analysis in SFY 2020*", Minnesota Department of Transportation, Office of Transportation System Management, July 2019. Value of time, crash costs, and remaining capital value assumptions were consistent with values also published by MnDOT.
4. **Development of Vehicle Hours Traveled (VHT)**: Vehicle Hours Traveled (VHT) were derived from the expected intersection vehicle delay over the analysis period. Peak hour intersection vehicle delay was obtained using Synchro/SimTraffic software for the traffic signal alternative. RODEL software was used to determine the peak hour delay for the roundabout control alternative. Analysis was performed for both year 2025 and forecast year

2040 conditions. Delay for years between 2025 and 2040 was interpolated based on a linear growth rate. Delay for years outside 2025 and 2040 were extrapolated using the same growth rate. VHT benefits were summarized by the difference in delay costs between the no build alternative and the build alternative. Savings due to reduction of VHT were calculated using costs per hour that account for vehicle occupancy and different vehicle types.

5. **Safety Analysis:** Safety benefits were estimated based on annual crashes by severity. The Highway Safety Manual (HSM) Predictive Method (referred to as the "predictive method") was used to predict crash frequency and severity at the study intersection based on future traffic volumes and roadway characteristics for each alternative. Crash predictions were produced for each year in the benefit-cost analysis period. Crash costs from each severity type were valued in accordance with "*Recommended standard values for use in B/C analysis in SFY 2020*", MnDOT Office of Transportation System Management, July 2019.
6. **Maintenance Costs**: Annual maintenance costs between the traffic signal and roundabout alternatives were monetized based on typical values observed in the state of Minnesota for similar traffic control types. Under the traffic signal alternative, costs typically include electricity and routine maintenance required to keep the signal in operation. The roundabout alternative was assumed to require lighting and routine landscaping. Annual maintenance costs for the traffic signal and roundabout, in terms of 2012 dollars, were $5,000 and $1,000, respectively. These dollar amounts were inflated to year 2020 dollars using an inflation rate of 1.1337, which was provided by the Consumer Price Index Inflation Calculator, Bureau of Labor Statistics.
7. **Calculation of Remaining Capital Value:** Because many components of the initial capital costs have service lives well beyond the 20-year benefit-cost analysis period, the remaining capital value was calculated for each alternative. The remaining capital value was subtracted from the initial capital cost to determine the net capital cost. In determining remaining capital value, the initial costs of the alternatives were separated into the following categories:
    a. Right-of-Way
    b. Major Structures
    c. Grading and Drainage
    d. Sub-Base and Base
    e. Surface
    f. Miscellaneous Costs – Includes mobilization, removal of temporary pavement and drainage, traffic control, and design and engineering costs. These were assumed to be sunk costs and assigned zero remaining capital value.
8. **Factors Not Quantified**: Several factors were not quantified as part of the analysis because review of initial data indicates low potential to yield substantial benefit. These factors included the following:
    a. All alternatives are not expected to cause traffic diversion; therefore, benefits derived from Vehicle Miles Traveled (VMT) were assumed to be negligible and have been excluded from the analysis for these alternatives.

b. A factor that was not quantified in the benefit-cost analysis was delay savings outside of the AM and PM peak hours. It is expected that the roundabout alternative would provide travel time benefits during non-peak hours of the day. This should be considered a conservative estimate for the roundabout alternative.

A planning level estimate of $320,000 was assumed for the traffic signal control alternative, which includes the construction of a new signal system with no geometric improvements to the existing lane configuration. The roundabout control alternative was estimated at $1,910,000 which includes the construction of a partial multi-lane roundabout as shown in the proposed conditions figure. It should be noted that the cost estimate includes half of the bridge reconstruction costs. Results of the benefit-cost analysis are included in Table 10. The benefit-cost ratio greater than one for the roundabout alternative is due to the alternative's expected positive impacts on intersection operations and safety compared to the traffic signal alternative.

The benefit-cost analysis workbook summaries are included in the Appendix. Detailed cost breakdowns for the traffic signal and roundabout alternatives are also included in the Appendix.

Table 10. Benefit-Cost Analysis Summary

Intersection Alternative	User Costs Savings (millions)	Project Costs (millions)	Benefit-Cost Ratio
Roundabout vs. Traffic Signal	$1.78	$0.97	1.84

User Costs Savings = the monetized user costs savings benefit of the roundabout versus the signal based on vehicular travel time and crash reduction savings.

Project Costs = the differential between the construction, maintenance, and capital value costs between the roundabout and the traffic signal alternatives. Capital value costs account for the difference in the value of the alternative investment beyond the analysis years.

Benefit-Cost Ratio = The user costs savings of the roundabout versus the traffic signal divided by the project costs differential.

Right-of-Way Considerations

All alternatives are not expected to require additional right-of-way. The traffic signal control alternative is not expected to change the existing lane configuration and thus are not expected to require additional right-of-way. While the roundabout control alternative is expected to require additional space, there appears to be sufficient right-of-way surrounding the existing intersection.

Pedestrian Considerations

One of the main objectives that supports the roundabout alternatives at the Marytsown Rd/US 169 Ramp intersections is the ability to repurpose the US 169 Bridge to provide a multi-use trail on both sides, thus connecting a gap in the City of Shakopee's trail system. The existing roadway configuration along the US 169 Bridge does not have adequate space to provide safe pedestrian facilities. The signal alternative would likely result in a trail/sidewalk being terminated before the bridge, unless existing turn lanes and/or travel lanes were reduced.

The current side-street stop intersection is not equipped with pedestrian pushbuttons or indications. If a signal system were to be installed, a more robust pedestrian system would be incorporated into the design to better match current pedestrian facility standards. This would result in increased pedestrian safety. In addition, the design of a roundabout allows pedestrians to cross one direction of traffic at a time on each leg of the roundabout and the geometry of the roundabout induces lower speeds thereby greatly reducing the severity of crashes. Furthermore, the pedestrians typically experience less delay at a roundabout compared to a traffic signal because they do not have to wait for the pedestrian walk phase to be served.

It is still unclear at this point which of the two alternatives (traffic signal or roundabout) would provide a safer pedestrian crossing. In theory, the roundabout would suggest a safer crossing as the high speeds (45 mph or greater) are reduced (generally 20 mph through a roundabout) and there are fewer conflict points, however, the traffic signal has a dedicated phase for pedestrians to cross, rather than relying entirely on pedestrian/vehicle interaction. Therefore, more research is needed to determine which of the traffic control alternatives would provide a safer pedestrian environment, however, both are considered improvements from existing conditions.

Transportation System Considerations

Currently, all intersections along the Marystown Rd/CR 15 corridor are stop-controlled. However, the three major intersections along the corridor, Adams Street/Vierling Drive, Marystown Road/US 169 South Ramp, and CR 15/CR 16, are all proposed roundabouts as part of the *Marystown Road Corridor Study*. If a roundabout was constructed at this intersection it would provide consistent traffic control at the major intersections along Marystown Road/CR 15. With adjacent partial multi-lane roundabouts, lane changing/weaving is inevitable for vehicles that may turn into one lane that are destined for another lane at the adjacent roundabout. The roundabouts along the corridor are generally at ¼-mile spacing, which is expected to be enough distance for vehicles to make these maneuvers

In addition, the eastbound approach of this intersection provides access to/from Tahpah Park. Thus, this approach carries potential for traffic surges before or after sporting events. Roundabouts are more flexible in their ability to handle shifting traffic patterns.

Alternatives Summary

The following intersection control evaluation (ICE) conclusions are provided for the Marystown Road at US 169 North Ramp intersection in Shakopee, Scott County, Minnesota:

- *Warrants Analysis*
  The results of the warrant analyses indicate that the intersection satisfies Signal Warrants 1B, 1C, 2, and 3B with 2025 volumes and Signal Warrants 1A, 1B, 1C, 2, and 3B with 2040 volumes. The analysis also indicates that the intersection satisfies MWSA warrants under 2040 volumes.

- *Operations Analysis*
  Operational analysis results of the year 2025 and 2040 volumes indicate that both the traffic signal and roundabout alternatives are expected to perform with acceptable levels of service with proposed lane configurations and forecasted volumes. Long-term, side-street stop control will not be feasible from an intersection delay perspective

- *Safety Analysis*
  The HSM crash prediction methodologies were utilized to compare signal and roundabout control. From a safety perspective, the roundabout is anticipated to have similar property damage only crashes to the signal, but fewer fatal and injury crashes

- *Incremental Benefit-Cost Comparison*
  The benefit-cost ratio is greater than one for the roundabout alternative compared to the signal alternative due to the alternative's expected positive impacts on intersection operations and safety compared to the traffic signal alternative. Therefore, the roundabout is considered cost effective compared to the traffic signal.

- *Right-of-Way Considerations*
  None of the alternatives are expected to require additional right-of-way.

- *Pedestrian Considerations*
  The roundabout alternative would provide the opportunity to repurpose the US 169 Bridge to provide a multi-use trail on both sides, which would connect a gap in the City of Shakopee's trail system. The existing roadway configuration along the US 169 Bridge does not have adequate space to provide safe pedestrian facilities. The signal alternative would likely result in a trail/sidewalk being terminated before the bridge, unless existing turn lanes and/or travel lanes were reduced.

- *Transportation System Considerations*
  If a roundabout was constructed at this intersection it would provide consistent traffic control at the major intersections along Marystown Road/CR 15, assuming the proposed roundabouts are constructed at the other three major intersections. The roundabout alternative would also provide flexibility to handle potential traffic surges before or after sporting events at Tahpah Park.

Recommended Intersection Control

Long-term, side-street stop control will not be feasible from an intersection delay perspective. As previously noted, traffic signal and roundabout control would be warranted by year 2025, and likely sooner depending on the expected timing of nearby development.

The traffic signal alternative would provide acceptable traffic operations and would be consistent with the existing roadway configuration.

One of the main objectives that supports the roundabout alternatives at the Marytsown Rd/US 169 Ramp intersections is the ability to repurpose the US 169 Bridge to provide a multi-use trail on both sides. Providing these pedestrian/bicycle facilities would connect a gap in the City of Shakopee's trail system.

The roundabout alternative would also provide less peak hour and non-peak hour vehicular delay, would reduce speeds along the corridor, is expected to have less fatal and injury crashes, and is considered cost effective compared to the signal alternative.

Based on the results of this Intersection Control Evaluation, a roundabout control is recommended for the intersection of Marystown Road at US 169 North Ramp intersection.

Appendix

- 2017-2019 Crash Analysis
- 2019 Warrants Analysis
- 2025 Warrants Analysis
- 2040 Warrants Analysis
- Detailed 2025 Network Operations Analysis Results
- Detailed 2040 Network Operations Analysis Results
- Year 2034 Roundabout Analysis
- Roundabout Layout and Cost Estimates
- Incremental Benefit-Cost Analysis
- *Trident Development Transportation Study* (SRF, 2019)
- *Shakopee AUAR Transportation Study* (SRF, 2019)

Intersection Control Evaluation

Marystown Road at US 169 South Ramp

City of Shakopee, Scott County, Minnesota

May 2020

SRF No. 020 13195

Intersection Control Evaluation

Marystown Road at
US 169 South Ramp

Proposed Letting Date: TBD

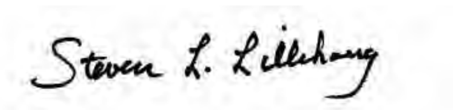
Report Certification:

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Brent Clark	57198
Print Name	Reg. No.

	5/14/2020
Signature	Date

Approved:



	5/18/2020
City of Shakopee City Engineer	Date

Lars Impola Digitally signed by Lars Impola
Date: 2020.05.20 13:07:00 -05'00'

MnDOT Metro District Traffic Engineer	Date

Julie Dresel Digitally signed by Julie Dresel
Date: 2020.05.21 12:58:16
-05'00'

MnDOT Metro District State-Aid Engineer	Date

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Introduction

The City of Shakopee, in partnership with Scott County and the Minnesota Department of Transportation (MnDOT), is developing an ultimate vision for County Road (CR) 15/Marystown Road/Adams Street from Vierling Drive to CR 16 (17th Avenue W) in Shakopee, Minnesota. The development and operations along the corridor have been discussed and evaluated in the following studies that were completed in 2019:

1) *Shakopee AUAR Transportation Analysis*, SRF Consulting (Draft - September 2019)

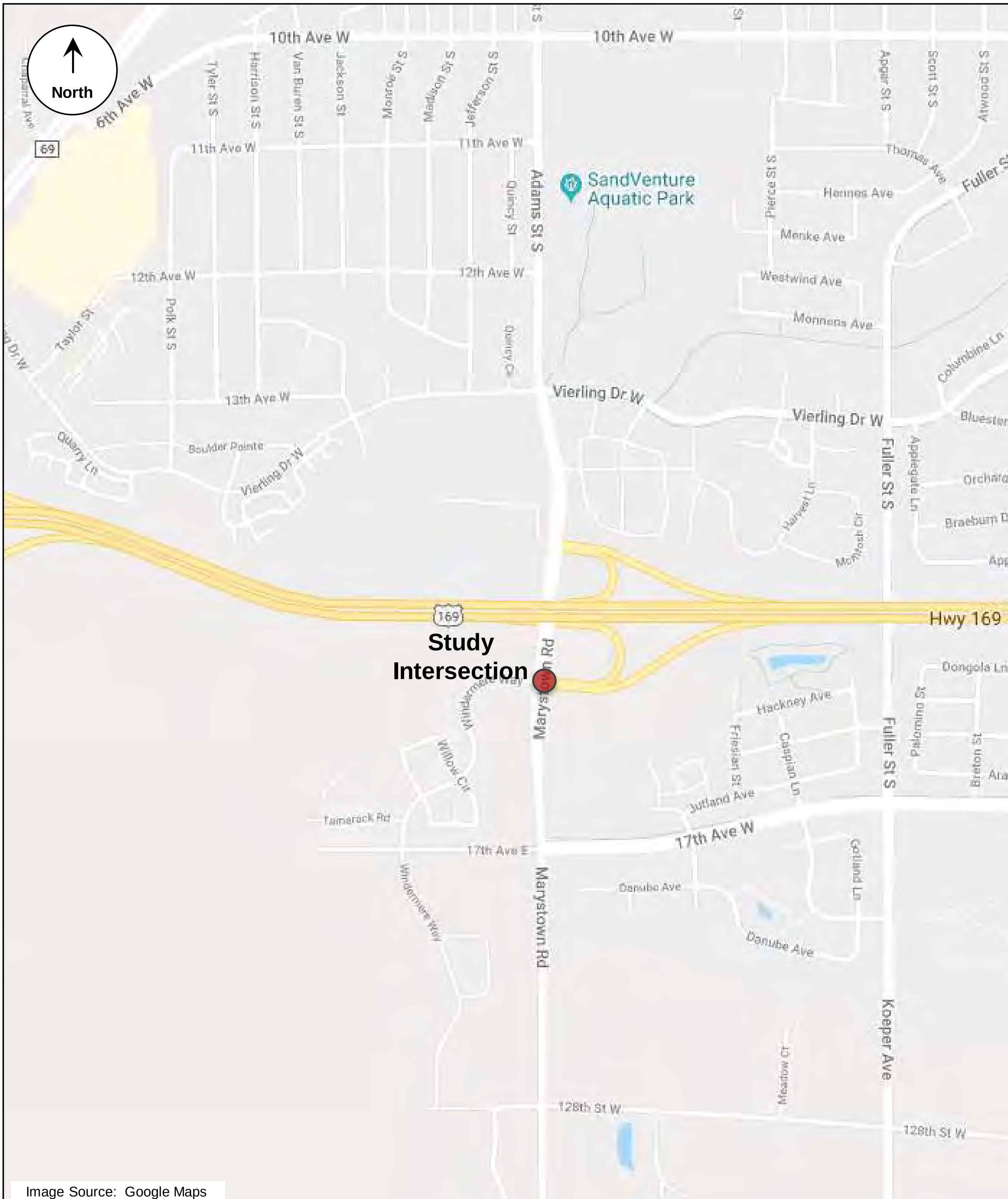
2) *Trident Development Transportation Study*, SRF Consulting (December 2019)

The previous studies identified that the current traffic control along the corridor is not expected to sufficiently accommodate future growth and planned development in the area by the year 2025. In addition, there are also safety concerns at the intersections, as CR 15/Marystown Road is a high-speed corridor (45/55 mph) and there has been a recent increase in crashes since construction of the Hy-Vee and Windermere developments (along with the addition of west approaches at the US 169 South Ramp and CR 16 intersections to accommodate the Windermere development). In addition to operations and safety, the City has a desire to repurpose the US 169 Bridge to provide a multi-use trail on both sides, thus connecting a gap in the City's trail system. Therefore, this intersection control evaluation was completed to support the *Marystown Road Corridor Study* that is being completed to determine the current and future needs of CR 15/Marystown Road that will inform the anticipated reconstruction project from Vierling Drive to CR 16 planned for the year 2022.

This report documents the intersection control evaluation results for the Marystown Road and US 169 South Ramp intersection in the City of Shakopee, Scott County, Minnesota (see Figure 1). The purpose of this evaluation was to analyze various intersection control alternatives under near-term and long-term conditions to identify a preferred intersection control alternative. The following intersection control alternatives were considered applicable:

- Side-Street Stop Control (existing)
- Traffic Signal Control
- Roundabout Control

The *Trident Development Transportation Study* identified all-way stop control as a potential short-term interim improvement if safety issues become a significant concern, however, an all-way stop control is not considered an applicable long-term intersection control. This is based on a cursory review of traffic volumes beyond 2025, that indicate an all-way stop-controlled intersection would be well overcapacity. All-way stop control would also require every vehicle on Marystown Road to come to a stop, which is undesirable due to the high volume on this corridor, and the existing number of lanes at the intersection (four northbound/southbound) would create driver confusion. Detailed warrants, operations, safety, and benefit-cost analyses were performed to determine a preferred intersection control alternative. In addition to the above analyses, other factors considered applicable to determining the long-term preferred intersection control included: Right of Way Considerations, Pedestrian Considerations, Transportation System Considerations, and Recent Intersection Improvements/Planning.



Intersection Location

Figure 1

Intersection Control Evaluation
Marystown Road at South TH 169 Ramp / Windermere Way
Shakopee, Minnesota

13195
April 2020

Intersection Characteristics

Existing Conditions

The Marystown Road at US 169 South Ramp/Windermere Way intersection is currently under two-way stop control (TWSC) with US 169 South Ramp/Windermere Way being controlled by stop signs. Marystown Road is a four-lane divided roadway at the study intersection and is functionally classified as an A-Minor Arterial with a posted speed limit of 55 mph. US 169 is a four-lane divided roadway that is functionally classified as a principal arterial with a posted speed limit of 65 mph. Windermere Way is a two-lane undivided local roadway with a statutory speed limit of 30 mph (no posted speed limit). Current intersection geometrics are listed below in Table 1 and shown in Figure 2.

Table 1. Existing Conditions

Approach	Lane Configurations
Northbound Marystown Road	One left-turn lane, two thru-lanes, and one right-turn lane
Southbound Marystown Road	One left-turn lane, two thru-lanes, and one right-turn lane
Eastbound Windermere Way (1)	One shared left-thru lane and one right-turn lane
Westbound US 169 Ramp	One shared left-thru lane and one right-turn lane

(1) Eastbound approach constructed in 2018.

The west approach of the intersection was constructed in 2018 to accommodate the Windermere development in the west quadrant of the intersection. The Windermere development, which is currently under construction, will consist predominantly of residential homes, with some neighborhood retail, office, and senior living. To date, approximately 60 single-family homes and a daycare center has been built in the Windermere development.

The Bruggeman development, which is expected to consist of single-family homes, is west of the Windermere development and is expected to be developed in conjunction with the CR 16 roadway extension to CR 69. In addition to the Windermere and Bruggeman developments, a mixed-used development (Trident development) is proposed for the northeast quadrant of the CR 15/CR 16 intersection, adjacent to Jackson Elementary School. All three developments are expected to be completed before 2025.

SRF

Existing Conditions

Figure 2

Intersection Control Evaluation
Marystown Road at South TH 169 Ramps / Windermere Way
Shakopee, Minnesota

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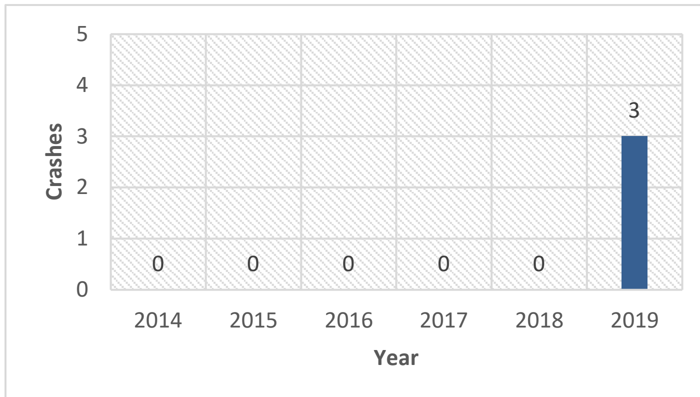
Crash History

Crash data was obtained from the City of Shakopee from 2014 through 2019 to identify any crash trends at the intersection and a summary of the crash data is shown below. The latest three-year period (2017-2019) was used for the crash analysis per MnDOT ICE report guidance and is summarized below and in Table 2. There was a total of three (3) crashes at the Marystown Road/US 169 South Ramp/Windermere Way intersection, with one (1) non-incapacitating injury crash and two (2) property damage only (PDO) crashes. All intersection crashes occurred in 2019 after the west approach of the intersection was constructed. Two of the three crashes at this intersection were right-angle crashes. A high number of right-angle crashes can indicate that there may be limited available gaps in traffic and drivers are having a difficult time determining gaps or are accepting smaller gaps. The intersection is below the critical crash rate, which indicates that there is not a statistically significant crash problem at the intersection. However, the recent increase in crashes in 2019 could indicate a trend due to a combination of the addition of the west approach and the increase in traffic volumes.



- Crash Severity:
  - 2 – Property Damage Only Crashes
  - 1 – Non-incapacitating Injury (Type B) Crashes
- Crash Type:
  - 1 – Rear End (2019)
  - 2 – Right-Angle Crashes (Both 2019)

Table 2. Crash History Summary

Location	Number of Crashes	Daily Entering Volume	Total Crash Rate (1)		
			Calculated	Average	Critical
Marystown Rd at US 169 South Ramp/ Windermere Way	3	9,500 (3)	0.29	0.19	0.58

(1) Intersection crash rates are expressed in crashes per million entering vehicles.
(2) Intersection crash rates are expressed in crashes per 100 million entering vehicles.
(3) Intersection Daily Entering Volume calculated based on combination of 13-hour counts collected as part of the *Trident Development Transportation Study* (SRF, 2019) and the latest available MnDOT AADT volumes.

Future Conditions

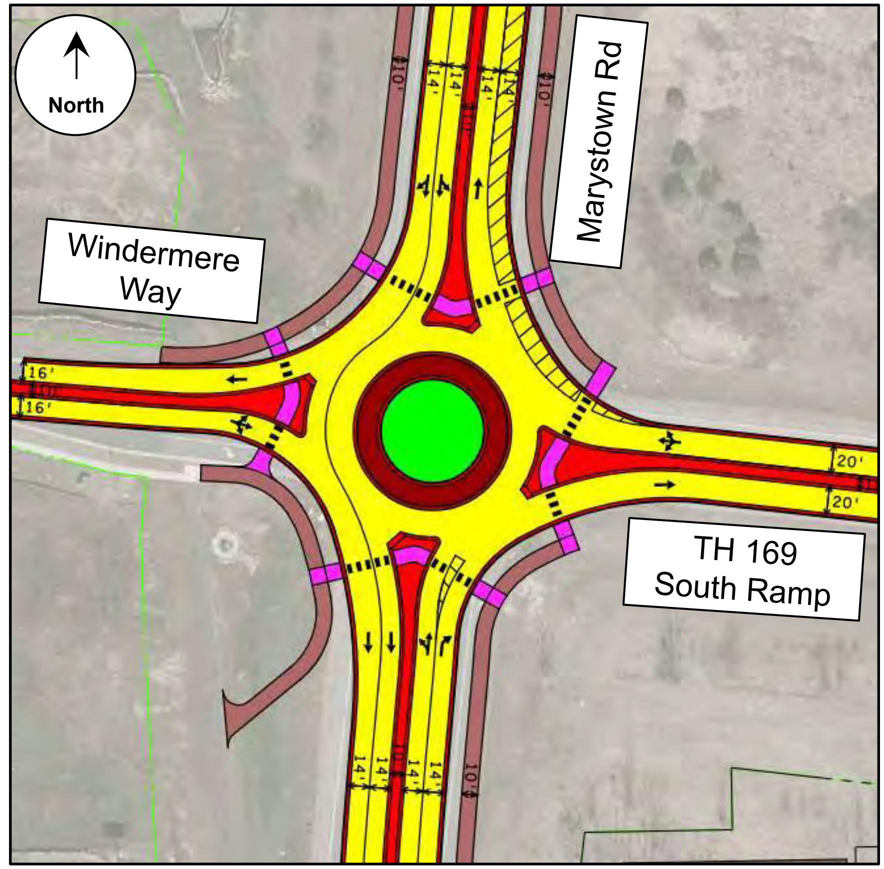
Future lane configurations were developed to accommodate projected traffic volumes and the corridor vision for CR 15/Marystown Road. For the side-street stop and traffic signal control alternatives, the existing lane configuration was assumed. For the roundabout control alternative, a hybrid roundabout was assumed for the purpose of this ICE report to accommodate 20-year volumes and beyond. However, the City is planning to construct a single-lane roundabout with the ability to be expanded in the future if/when needed. The assumed lane configurations for these alternatives are shown in Table 3 and can be seen in Figure 3.

Table 3. Future Intersection Lane Configurations

Approach	Side-Street Stop and Traffic Signal Control	Roundabout Control
Northbound Marystown Rd	• One left-turn lane • Two thru lanes • One right-turn lane	• One shared left-turn/thru lane • One right-turn lane
Southbound Marystown Rd	• One left-turn lane • Two thru lanes • One right-turn lane	• One shared left-turn/thru lane • One shared thru/right-turn lane
Eastbound Windermere Way	• One shared left-turn/thru lane (1) • One right-turn lane	• One shared left-turn/thru lane/right-turn lane
Westbound US 169 Ramp	• One shared left-turn/thru lane (1) • One right-turn lane	• One shared left-turn/thru lane/right-turn lane

(1) For the traffic signal alternative, the eastbound/westbound approaches could be shifted to one shared thru-right lane and one left-turn lane. This reconfiguration would align the left-turn movements. However, for the purposes of this ICE report, the existing geometry was assumed.

Side-Street Stop and Traffic Signal Alternatives



Hybrid Roundabout Alternative

Proposed Lane Configurations

Figure 3

Intersection Control Evaluation
Marystown Road at South TH 169 Ramp / Windermere Way
Shakopee, Minnesota

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Traffic Volumes

Existing hourly approach volumes at the study intersection were collected in October 2019 by SRF and are summarized in Figure 4 and included in the Appendix. It should be noted that adjustments were made to the existing turning movement counts to account for ongoing construction in the region, which is outlined further in the *Trident Development Transportation Study*.

The year 2025 volumes were developed as part of the *Trident Development Transportation Study* and account for the three on-going developments along the study corridor (Windermere, Bruggeman, Trident) and a general background growth rate of one and a half (1.5) percent. As previously mentioned, the three on-going developments are expected to be developed before 2025, therefore, the year 2025 represents one-year post-construction of the full-build out of the proposed development. Construction of a traffic control alternative is anticipated for the year 2022, with a year of opening anticipated for 2023. Therefore, due to the similar timeframes of the year of opening of the roadway construction and the development full-build out, the year 2025 is considered the year of opening.

The year 2040 turning movements were developed as part of the *Shakopee AUAR Transportation Study*, utilizing the Scott County Regional Travel Demand Model and the 2040 Scott County Comprehensive Plan. These 2040 turning movement counts were updated as part of the *Trident Development Transportation Study*. The projected peak hour year 2025 and year 2040 turning movement volumes are shown in Figure 5 and Figure 6, respectively.

Existing Volumes

Figure 4

Intersection Control Evaluation
Marystown Road at South TH 169 Ramps / Windermere Way
Shakopee, Minnesota

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SRF

Forecast Year 2025 Volumes

Intersection Control Evaluation
Marystown Road at South TH 169 Ramps / Windermere Way
Shakopee, Minnesota

Figure 5

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Forecast Year 2040 Volumes

Intersection Control Evaluation
Marystown Road at South TH 169 Ramps / Windermere Way
Shakopee, Minnesota

Figure 6

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Analysis of Alternatives

Warrants Analysis

The Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD) provides guidance on when it may be appropriate to use all-way stop or signal control at an intersection. This guidance is provided in the form of "warrants", or criteria, and engineering analysis of the intersection's design factors to determine when all-way stop or signal control may be justified.

Meeting a warrant at an intersection does not in itself require the installation of a particular control type. The particular control type also requires an engineering analysis of the intersection's design for it to be justified. Under the MnDOT ICE process, roundabouts are typically considered to be warranted if traffic volumes meet the criteria for either all-way stop or traffic signal control.

A warrants analysis was performed for the traffic signal control alternative as outlined in the December 2019 MN MUTCD. Analysis of signal warrants 1-3 was performed utilizing existing volumes. Signal warrants 4-9 were investigated and were determined to not be applicable to the study.

The lane geometry and approach speeds assumed for the warrant analysis are shown in Table 4.

Table 4. Warrants Analysis Assumptions

Approach	Geometry	Speed Limit
Northbound Marystown Road	Two or more approach lanes	55 mph
Southbound Marystown Road	Two or more approach lanes	55 mph
Eastbound Windermere Way	Two or more approach lanes	30 mph
Westbound US 169 Ramp	Two or more approach lanes	45 mph

For the analysis, right-turning vehicles on the minor approaches were not included as these turns are given a dedicated lane and thus do not significantly impact the thru-movement on both minor approaches.

The 70 percent traffic volume factor was used for the warrants analysis, as proposed conditions met the necessary criteria of the speed limit exceeding 45 mph on at least one of the approaches. Table 5 provides a summary of the warrants analysis results, while the detailed volume-based warrants analysis is included in the Appendix.

In addition to the signal warrants, Multiway Stop Applications Warrant Condition C (MWSA C) was also evaluated as outlined in the MN MUTCD. The results of the MWSA warrants analysis are also shown in Table 5.

Table 5. Warrants Analysis Summary

MN MUTCD Warrant	Hours Required	Existing Volumes		2025 Volumes (Year of Opening)		2040 Volumes	
		Hours Met	Warrant Met?	Hours Met	Warrant Met?	Hours Met	Warrant Met?
MWSA C: Minimum Volumes	8	0	No	11	Yes	13	Yes
Warrant 1A: Minimum Vehicular Volume	8	0	No	3	No	7	No
Warrant 1B: Interruption of Continuous Traffic	8	0	No	12	Yes	14	Yes
Warrant 1C: Combination of Warrants	8	0	No	7	No	8	Yes
Warrant 2: Four-Hour Volume	4	0	No	7	Yes	12	Yes
Warrant 3B: Peak Hour Volume	1	0	No	6	Yes	7	Yes
Warrants 4-9	Not Applicable						

The results of the warrants analysis indicate the intersection does not satisfy any MN MUTCD Signal Warrants with existing volumes. However, the intersection does satisfy Signal Warrants 1B, 2, and 3B with 2025 volumes and Signal Warrants 1B, 1C, 2, and 3B with 2040 volumes. The analysis also indicates that the intersection satisfies MWSA warrants under both 2025 and 2040 volumes.

Operations Analysis

An initial planning-level analysis was performed for the roundabout control alternative based on Highway Capacity Manual (HCM) 6th Edition methods. Planning-level analysis results for Forecast Year 2040 volumes are shown in Figure 8. As can be seen, the Forecast Year 2040 volumes are generally below the theoretical capacity of a single-lane roundabout. However, one entry approach is at the theoretical capacity of a single-lane roundabout. In addition to the planning-level analysis, capacity analysis tests were performed at the intersection using the Highway Capacity Software (HCS) 7. Results of the analysis indicates that a single-lane roundabout would be near capacity at the intersection during the p.m. peak hour with Forecast Year 2040 volumes. Therefore, for the purposes of this ICE report, a partial multi-lane roundabout, with two southbound circulating lanes was assumed. The following geometry assumed for analysis is shown in Table 6. It should be noted that the City is planning to construct a single-lane roundabout with the ability to be expanded in the future if/when needed. A year 2034 operations analysis was completed to determine near-term needs and is shown in the Appendix.

Figure 8. Marystown Rd at US 169 South Ramp Roundabout Entry Lane Capacity (Forecast Year 2040 Volumes)

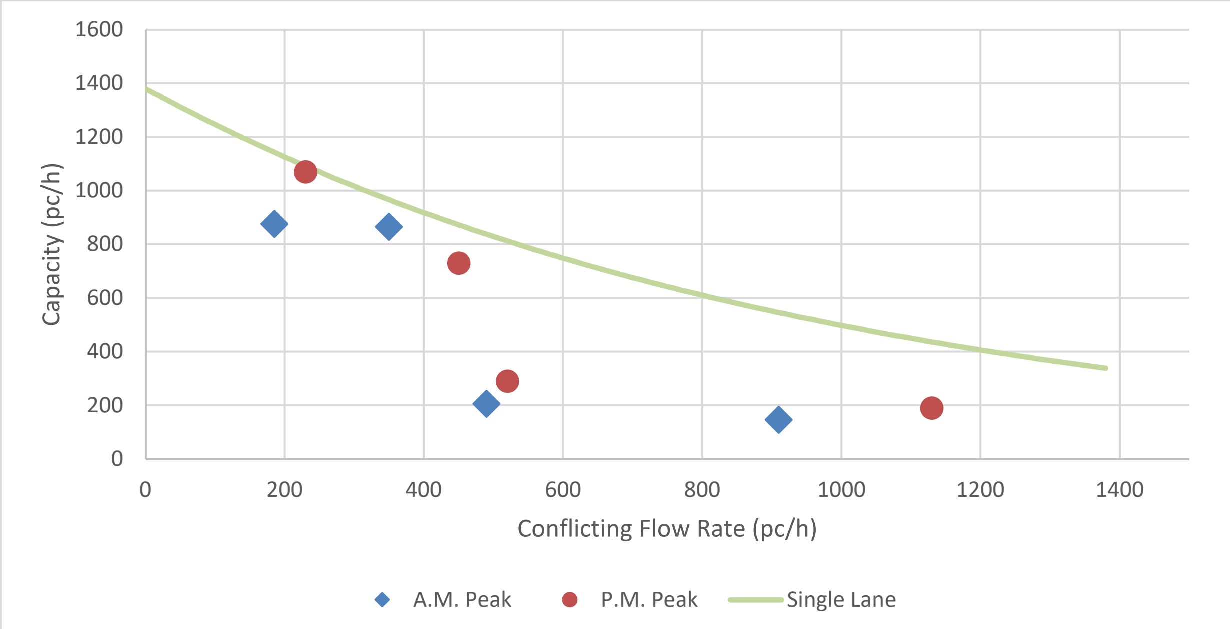

Table 6. Roundabout Lane Configuration

Approach	Geometry
Northbound Marystown Road	• Two-lane entry, One circulating lane
Southbound Marystown Road	• Two-lane entry, Two circulating lanes
Eastbound Windermere Way	• One-lane entry, One circulating lane
Westbound US 169 Ramp	• One-lane entry, One circulating lane

The traffic operations analysis identifies a Level of Service (LOS) which indicates how well an intersection is operating based on average delay per vehicle. Intersections are given a ranking from LOS A to LOS F. LOS A indicates the best traffic operation and LOS F indicates an intersection where demand exceeds capacity. LOS A through LOS D are considered acceptable because the intersection would be operating under capacity.

Operational analysis of the side-street stop and traffic signal control alternatives was performed using Synchro/SimTraffic. Traffic operations analysis of the roundabout alternative was conducted using RODEL software. RODEL is a software program that is based on existing roundabout operational research and uses an empirical formula method to determine roundabout delay based on geometric features and traffic flows.

Results of the Year 2025 traffic operations analysis indicate that both alternatives would perform at acceptable levels of service under the proposed lane configurations, with the roundabout alternative having less overall delay. The side-street stop alternative is expected to be overcapacity during both peak hours, with side-street stop approach delays of greater than three (3) minutes. Table 7 provides a summary of the Year 2025 operations analysis. The Year 2025 detailed analysis results are included in the Appendix.

Table 7. Operations Analysis Results – 2025 Conditions (Year of Opening)

Alternative	Analysis Tool	AM Peak Hour		PM Peak Hour	
		Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Side-Street Stop Control (existing) (1)	SimTraffic	33 / >3 min	D / F	48 / >3 min	E / F
Traffic Signal Control	SimTraffic	11	B	11	B
Roundabout Control	RODEL	10	A	9	A

(1) Overall results are followed by the worst approach results.

Table 8 provides a summary of the Forecast Year 2040 operations analysis. Results of the traffic operations analysis indicate that both the traffic signal and roundabout alternatives would continue to operate at acceptable levels of service under proposed lane configurations, with the roundabout alternative overall having less delay. The analysis indicated the side-street stop control alternative would operate well overcapacity during both peak hours. The detailed analysis can be found in the Appendix.

Table 8. Operations Analysis Results – 2040 Conditions

Alternative	Analysis Tool	AM Peak Hour		PM Peak Hour	
		Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Side-Street Stop Control (existing) (1)	SimTraffic	139 / >3 min	F / F	173 / >3 min	F / F
Traffic Signal Control	SimTraffic	14	B	15	B
Roundabout Control	RODEL	13	B	12	B

(1) Overall results are followed by the worst approach results.

Safety Analysis

The *Highway Safety Manual (HSM) Predictive Method* (referred to as the "predictive method") was used to predict crash frequency and severity at the study intersection based on future traffic volumes and roadway characteristics. The predictive method was evaluated for the traffic signal and roundabout control at the study intersection. It should be noted that based on the year 2040 operations, the side-street stop control is not considered a feasible option, therefore is not considered in the safety analysis comparison. Analysis was performed using the Interactive Highway Safety Design Model (IHSDM) site-based interface provided by the Federal Highway Administration (FWHA). The predictive method was analyzed for a 20-year time period, with the first full year of benefits estimated to be in year 2024. Table 9 is a summary of the total predicted fatal/injury and property damage only crashes expected over the 20-year period, along with the average crash frequency per year.

Table 9. Predicted Crash Frequency per Intersection Alternative

Alternative	Total Predicted Crashes for Evaluation Period (2024-2043)			Average Predicted Crashes/Year		
	FI	PDO	Total	FI	PDO	Total
Traffic Signal Control	16.9	33.6	50.5	0.8	1.7	2.5
Roundabout Control	11.1	33.9	45.0	0.6	1.7	2.3

Results indicate that property damage only crashes are expected to be similar between the traffic signal and roundabout, while fatal and injury crashes are expected to be approximately 0.2 less per year, with a total of 5.8 less fatal and injury crashes throughout the evaluation period. Furthermore, roundabouts typically have fewer conflict points than conventional intersections, and the geometry of a roundabout induces lower speeds for vehicles approaching and traversing an intersection. With lower speeds, the severity of injury crashes is anticipated to decrease. Also, two of the three crashes that have occurred at the intersection in the past three years were right-angle crashes, which are converted to low-speed, shallow-angle crashes with a roundabout.

Incremental Benefit-Cost Comparison

A benefit-cost analysis provides an indication of the economic desirability of an alternative. Results must be weighed by decision-makers along with the assessment of other effects and impacts. Projects are considered cost-effective if the benefit-cost ratio is greater than 1.00, which reflects that project benefits exceed the expected life-cycle costs. The larger the ratio number, the greater the benefits per unit cost.

Incremental benefit-costs are a type of benefit-cost that compares two alternatives in a project, rather than comparing them both to a no-build condition that is considered unfeasible. The existing side-street stop intersection was not considered as a feasible alternative due to the expected decline in safety and operational performance, as mentioned above. Thus, the incremental benefit-cost analysis compares project life-cycle costs and benefits between the roundabout alternative and the traffic signal alternative. In this case, if the incremental benefit-cost is greater than 1.00, the roundabout alternative is considered cost-effective compared to the traffic signal alternative. Vice versa, if the benefit-cost is less than 1.00, the roundabout alternative is not considered cost effective compared to the traffic signal alternative. While similar to a standard benefit-cost analysis, an incremental benefit-cost can give greater insights into the relationship of costs/benefits of two alternatives. The following methodology and assumptions were used for the benefit-cost analysis:

Main Components Analyzed Include:

a. Crashes by severity.
b. Travel time/delay (Vehicle Hours Traveled – VHT).
c. Initial capital costs: These costs were divided into different categories in accordance with service life (consistent with the recommendations of MnDOT Office of Planning and Programming, July 2019).
d. Remaining Capital Value: The remaining capital value (value of the improvement beyond the analysis period) was not considered a reduction in cost.
e. Maintenance costs.

2. **Analysis Years:** The analysis assumed that each of the alternatives would be constructed in year 2022 and 2023. Therefore, year 2024 is the first full year that benefits would be realized from the project. The analysis focused on the twenty-year period from 2024 to 2043.
3. **Economic Assumptions:** The present value of all benefits and costs were calculated considering 2020 as the year of current dollars. The assumed discount rate of 1.2 percent was used per guidelines from the "*Recommended standard values for use in cost-effectiveness and benefit-cost analysis in SFY 2020*", Minnesota Department of Transportation, Office of Transportation System Management, July 2019. Value of time, crash costs, and remaining capital value assumptions were consistent with values also published by MnDOT.
4. **Development of Vehicle Hours Traveled (VHT)**: Vehicle Hours Traveled (VHT) were derived from the expected intersection vehicle delay over the analysis period. Peak hour intersection vehicle delay was obtained using Synchro/SimTraffic software for the traffic signal alternative. RODEL software was used to determine the peak hour delay for the roundabout control alternative. Analysis was performed for both year 2025 and forecast year

2040 conditions. Delay for years between 2025 and 2040 was interpolated based on a linear growth rate. Delay for years outside 2025 and 2040 were extrapolated using the same growth rate. VHT benefits were summarized by the difference in delay costs between the no build alternative and the build alternative. Savings due to reduction of VHT were calculated using costs per hour that account for vehicle occupancy and different vehicle types.

5. **Safety Analysis:** Safety benefits were estimated based on annual crashes by severity. The Highway Safety Manual (HSM) Predictive Method (referred to as the "predictive method") was used to predict crash frequency and severity at the study intersection based on future traffic volumes and roadway characteristics for each alternative. Crash predictions were produced for each year in the benefit-cost analysis period. Crash costs from each severity type were valued in accordance with "*Recommended standard values for use in B/C analysis in SFY 2020*", MnDOT Office of Transportation System Management, July 2019.
6. **Maintenance Costs**: Annual maintenance costs between the traffic signal and roundabout alternatives were monetized based on typical values observed in the state of Minnesota for similar traffic control types. Under the traffic signal alternative, costs typically include electricity and routine maintenance required to keep the signal in operation. The roundabout alternative was assumed to require lighting and routine landscaping. Annual maintenance costs for the traffic signal and roundabout, in terms of 2012 dollars, were $5,000 and $1,000, respectively. These dollar amounts were inflated to year 2020 dollars using an inflation rate of 1.1337, which was provided by the Consumer Price Index Inflation Calculator, Bureau of Labor Statistics.
7. **Calculation of Remaining Capital Value:** Because many components of the initial capital costs have service lives well beyond the 20-year benefit-cost analysis period, the remaining capital value was calculated for each alternative. The remaining capital value was subtracted from the initial capital cost to determine the net capital cost. In determining remaining capital value, the initial costs of the alternatives were separated into the following categories:
    a. Right-of-Way
    b. Major Structures
    c. Grading and Drainage
    d. Sub-Base and Base
    e. Surface
    f. Miscellaneous Costs – Includes mobilization, removal of temporary pavement and drainage, traffic control, and design and engineering costs. These were assumed to be sunk costs and assigned zero remaining capital value.
8. **Factors Not Quantified**: Several factors were not quantified as part of the analysis because review of initial data indicates low potential to yield substantial benefit. These factors included the following:
    a. All alternatives are not expected to cause traffic diversion; therefore, benefits derived from Vehicle Miles Traveled (VMT) were assumed to be negligible and have been excluded from the analysis for these alternatives.

b. A factor that was not quantified in the benefit-cost analysis was delay savings outside of the AM and PM peak hours. It is expected that the roundabout alternative would provide travel time benefits during non-peak hours of the day. This should be considered a conservative estimate for the roundabout alternative.

A planning level estimate of $320,000 was assumed for the traffic signal control alternative, which includes the construction of a new signal system with no geometric improvements to the existing lane configuration. The roundabout control alternative was estimated at $1,750,000 which includes the construction of a partial multi-lane roundabout as shown in the proposed conditions figure. It should be noted that the cost estimate includes half of the bridge reconstruction costs. Results of the benefit-cost analysis are included in Table 10. The benefit-cost ratio greater than one for the roundabout alternative is due to the alternative's expected positive impacts on intersection operations and safety compared to the traffic signal alternative.

The benefit-cost analysis workbook summaries are included in the Appendix. Detailed cost breakdowns for the traffic signal and roundabout alternatives are also included in the Appendix.

Table 10. Benefit-Cost Analysis Summary

Intersection Alternative	User Costs Savings (millions)	Project Costs (millions)	Benefit-Cost Ratio
Roundabout vs. Traffic Signal	$1.52	$0.84	1.80

User Costs Savings = the monetized user costs savings benefit of the roundabout versus the signal based on vehicular travel time and crash reduction savings.

Project Costs = the differential between the construction, maintenance, and capital value costs between the roundabout and the traffic signal alternatives. Capital value costs account for the difference in the value of the alternative investment beyond the analysis years.

Benefit-Cost Ratio = The user costs savings of the roundabout versus the traffic signal divided by the project costs differential.

Right-of-Way Considerations

All alternatives are not expected to require additional right-of-way. The traffic signal control alternative is not expected to change the existing lane configuration and thus are not expected to require additional right-of-way. While the roundabout control alternative is expected to require additional space, there appears to be sufficient right-of-way surrounding the existing intersection.

Pedestrian Considerations

One of the main objectives that supports the roundabout alternatives at the Marytsown Rd/US 169 Ramp intersections is the ability to repurpose the US 169 Bridge to provide a multi-use trail on both sides, thus connecting a gap in the City of Shakopee's trail system. The existing roadway configuration along the US 169 Bridge does not have adequate space to provide safe pedestrian facilities. The signal alternative would likely result in a trail/sidewalk being terminated before the bridge, unless existing turn lanes and/or travel lanes were reduced.

The current side-street stop intersection is not equipped with pedestrian pushbuttons or indications. If a signal system were to be installed, a more robust pedestrian system would be incorporated into the design to better match current pedestrian facility standards. This would result in increased pedestrian safety. In addition, the design of a roundabout allows pedestrians to cross one direction of traffic at a time on each leg of the roundabout and the geometry of the roundabout induces lower speeds thereby greatly reducing the severity of crashes. Furthermore, the pedestrians typically experience less delay at a roundabout compared to a traffic signal because they do not have to wait for the pedestrian walk phase to be served.

It is still unclear at this point which of the two alternatives (traffic signal or roundabout) would provide a safer pedestrian crossing. In theory, the roundabout would suggest a safer crossing as the high speeds (45 mph or greater) are reduced (generally 20 mph through a roundabout) and there are fewer conflict points, however, the traffic signal has a dedicated phase for pedestrians to cross, rather than relying entirely on pedestrian/vehicle interaction. Therefore, more research is needed to determine which of the traffic control alternatives would provide a safer pedestrian environment, however, both are considered improvements from existing conditions.

Transportation System Considerations

Currently, all intersections along the Marystown Rd/CR 15 corridor are stop-controlled. However, the three major intersections along the corridor, Adams Street/Vierling Drive, Marystown Road/US 169 North Ramp, and CR 15/CR 16, are all proposed roundabouts as part of the *Marystown Road Corridor Study*. If a roundabout was constructed at this intersection it would provide consistent traffic control at the major intersections along Marystown Road/CR 15. With adjacent partial multi-lane roundabouts, lane changing/weaving is inevitable for vehicles that may turn into one lane that are destined for another lane at the adjacent roundabout. The roundabouts along the corridor are generally at ¼-mile spacing, which is expected to be enough distance for vehicles to make these maneuvers

Recent Intersection Improvements/Planning

The west leg of the Marystown Road/US 169 South Ramp/Windermere Way intersection was just constructed in 2018. Roundabout construction will require the removal of recently constructed roadway, which was implemented for a future traffic signal.

Alternatives Summary

The following intersection control evaluation (ICE) conclusions are provided for the Marystown Road/US 169 South Ramp intersection in Shakopee, Scott County, Minnesota:

- *Warrants Analysis*
  The results of the warrant analyses indicate that the intersection satisfies Signal Warrants 1B, 2 and 3B with 2025 forecasted volumes and Signal Warrants 1B, 1C, 2, and 3B with 2040 forecasted volumes. The analysis also indicates that the intersection satisfies MWSA warrants using both 2025 and 2040 forecasted volumes.

- *Operations Analysis*
  Operational analysis results of the year 2025 and 2040 volumes indicate that both the traffic signal and roundabout alternatives are expected to perform with acceptable levels of service with proposed lane configurations and forecasted volumes. Long-term, side-street stop control will not be feasible from an intersection delay perspective

- *Safety Analysis*
  The HSM crash prediction methodologies were utilized to compare signal and roundabout control. From a safety perspective, the roundabout is anticipated to have similar property damage only crashes to the signal, but fewer fatal and injury crashes

- *Incremental Benefit-Cost Comparison*
  The benefit-cost ratio is greater than one for the roundabout alternative compared to the signal alternative due to the alternative's expected positive impacts on intersection operations and safety compared to the traffic signal alternative. Therefore, the roundabout is considered cost effective compared to the traffic signal.

- *Right-of-Way Considerations*
  None of the alternatives are expected to require additional right-of-way.

- *Pedestrian Considerations*
  The roundabout alternative would provide the opportunity to repurpose the US 169 Bridge to provide a multi-use trail on both sides, which would connect a gap in the City of Shakopee's trail system. The existing roadway configuration along the US 169 Bridge does not have adequate space to provide safe pedestrian facilities. The signal alternative would likely result in a trail/sidewalk being terminated before the bridge, unless existing turn lanes and/or travel lanes were reduced.

- *Transportation System Considerations*
  If a roundabout was constructed at this intersection it would provide consistent traffic control at the major intersections along Marystown Road/CR 15, assuming the proposed roundabouts are constructed at the other three major intersections.

- *Recent Intersection Improvements/Planning*
  The roundabout alternative would result in the removal of recently constructed roadway.

Recommended Intersection Control

Side-street stop control will not be feasible from an intersection delay perspective. As previously noted, traffic signal and roundabout control would be warranted by year 2025, and likely sooner depending on the expected timing of nearby development.

The traffic signal alternative would provide acceptable traffic operations and would be consistent with the vision and recently constructed/maintained roadway at the intersection.

One of the main objectives that supports the roundabout alternatives at the Marytsown Rd/US 169 Ramp intersections is the ability to repurpose the US 169 Bridge to provide a multi-use trail on both sides. Providing these pedestrian/bicycle facilities would connect a gap in the City of Shakopee's trail system.

The roundabout alternative would also provide less peak hour and non-peak hour vehicular delay, would reduce speeds along the corridor, is expected to have less fatal and injury crashes, and is considered cost effective compared to the signal alternative.

Based on the results of this Intersection Control Evaluation, a roundabout control is recommended for the intersection of Marystown Road at US 169 South Ramp intersection.

Appendix

- 2017-2019 Crash Analysis
- 2019 Warrants Analysis
- 2025 Warrants Analysis
- 2040 Warrants Analysis
- Detailed 2025 Network Operations Analysis Results
- Detailed 2040 Network Operations Analysis Results
- Year 2034 Roundabout Analysis
- Roundabout Layout and Cost Estimates
- Incremental Benefit-Cost Analysis
- *Trident Development Transportation Study* (SRF, 2019)
- *Shakopee AUAR Transportation Study* (SRF, 2019)

Intersection Control Evaluation

County Road 15 (Marystown Road) at County Road 16 (17th Avenue W)

City of Shakopee, Scott County, Minnesota

May 2020

SRF No. 020 13195

Intersection Control Evaluation

County Road 15 (Marystown Rd) at County Road 16 (17th Ave W)

Proposed Letting Date: TBD

Report Certification:

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Brent Clark — 57198
Print Name — Reg. No.

Signature — 5/14/2020
Date

Approved:

5/18/2020
City of Shakopee
City Engineer
Date

5/19/2020
Scott County
County Engineer
Date

5/21/2020
For MnDOT
Metro District State-Aid Engineer
Date

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Introduction

The City of Shakopee, in partnership with Scott County and the Minnesota Department of Transportation (MnDOT), is developing an ultimate vision for County Road (CR) 15/Marystown Road/Adams Street from Vierling Drive to CR 16 (17th Avenue W) in Shakopee, Minnesota. The development and operations along the corridor have been discussed and evaluated in the following studies that were completed in 2019:

1) *Shakopee AUAR Transportation Analysis*, SRF Consulting (Draft - September 2019)

2) *Trident Development Transportation Study*, SRF Consulting (December 2019)

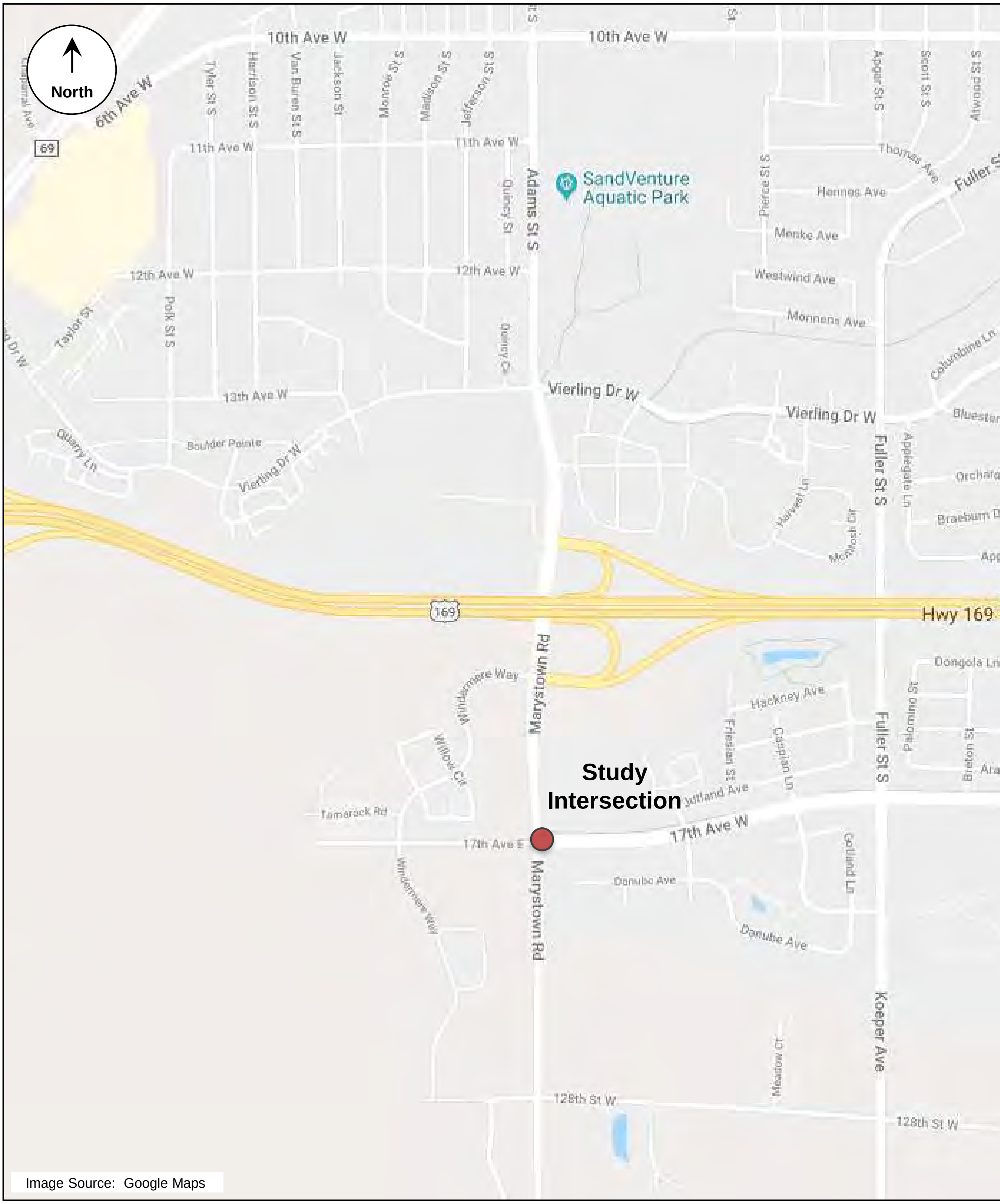
The previous studies identified that the current traffic control along the corridor is not expected to sufficiently accommodate future growth and planned development in the area by the year 2025. In addition, there are also safety concerns at the intersections, as CR 15/Marystown Road is a high-speed corridor (45/55 mph) and there has been a recent increase in crashes since construction of the Hy-Vee and Windermere developments (along with the addition of west approaches at the US 169 South Ramp and CR 16 intersections to accommodate the Windermere development). Therefore, this intersection control evaluation was completed to support the *Marystown Road Corridor Study* that is being completed to determine the current and future needs of CR 15/Marystown Road that will inform the anticipated reconstruction project from Vierling Drive to CR 16 planned for the year 2022.

This report documents the intersection control evaluation results for the CR 15 and CR 16 (17th Avenue W) intersection in the City of Shakopee, Scott County, Minnesota (see Figure 1). The purpose of this evaluation was to analyze various intersection control alternatives under near-term and long-term conditions to identify a preferred intersection control alternative. The following intersection control alternatives were considered applicable:

- Side-Street Stop Control (existing)
- Traffic Signal Control
- Roundabout Control

The *Trident Development Transportation Study* identified all-way stop control as a potential short-term interim improvement if safety issues become a significant concern, however, an all-way stop control is not considered an applicable long-term intersection control. This is based on a cursory review of traffic volumes beyond 2025, that indicate an all-way stop-controlled intersection would be well overcapacity. All-way stop control would also require every vehicle on CR 15 to come to a stop, which is undesirable due to the high volume on this corridor, and the existing number of lanes at the intersection (four eastbound/westbound, three northbound/southbound) would create driver confusion. Detailed warrants, operations, safety, and benefit-cost analyses were performed to determine a preferred intersection control alternative. In addition to the above analyses, other factors considered applicable to determining the long-term preferred intersection control included:

- Right-of-Way Considerations
- Pedestrian Considerations
- Transportation System Considerations
- Recent Intersection Improvements/Planning



Intersection Location

Intersection Control Evaluation
CR 15 (Marystown Road) at CR 16 (17th Ave W)
Shakopee, Minnesota

Figure 1

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April 2020

Intersection Characteristics

Existing Conditions

The CR 15 at CR 16 (17th Avenue W) intersection is currently under two-way stop control (TWSC) with CR 16 (17th Avenue W) being controlled by stop signs. CR 15 is a two-lane undivided roadway at the study intersection and is functionally classified as an A-Minor Arterial with a posted speed limit of 55 mph. CR 16 (17th Avenue W) is a four-lane divided roadway and is functionally classified as an A-Minor Arterial with a posted speed limit of 45 mph. Current intersection geometrics are listed below in Table 1 and shown in Figure 2.

Table 1. Existing Conditions

Approach	Lane Configurations
Northbound CR 15	One left-turn lane (1), one thru lane, and one right-turn lane
Southbound CR 15	One left-turn lane, one thru lane, and one right-turn lane (1)
Eastbound CR 16 (17th Avenue W) (2)	One left-turn lane, two thru lanes, and one right-turn lane
Westbound CR 16 (17th Avenue W)	One left-turn lane, two thru lanes, and one right-turn lane

(1) Southbound right-turn and northbound left-turn lanes were constructed in 2017.

(2) Eastbound approach constructed in 2018.

The west approach of the intersection was constructed in 2018, in addition to the southbound right-turn and northbound left-turn lane additions constructed in 2017 to accommodate the Windermere development in the west quadrant of the intersection. The Windermere development, which is currently under construction, will consist predominantly of residential homes, with some neighborhood retail, office, and senior living. To date, approximately 60 single-family homes and a daycare center has been built in the Windermere development.

The Bruggeman development, which is expected to consist of single-family homes, is west of the Windermere development and is expected to be developed in conjunction with the CR 16 roadway extension to CR 69. In addition to the Windermere and Bruggeman developments, a mixed-used development (Trident development) is proposed for the northeast quadrant of the intersection, adjacent to Jackson Elementary School. All three developments are expected to be completed before 2025. Beyond current development, the adjacent area is comprised mostly of residential land uses, with Jackson Elementary School and Shakopee High School located east of the intersection.

Existing Conditions

Intersection Control Evaluation
CR 15 (Marystown Road) at CR 16 (17th Avenue W)
Shakopee, Minnesota

Figure 2

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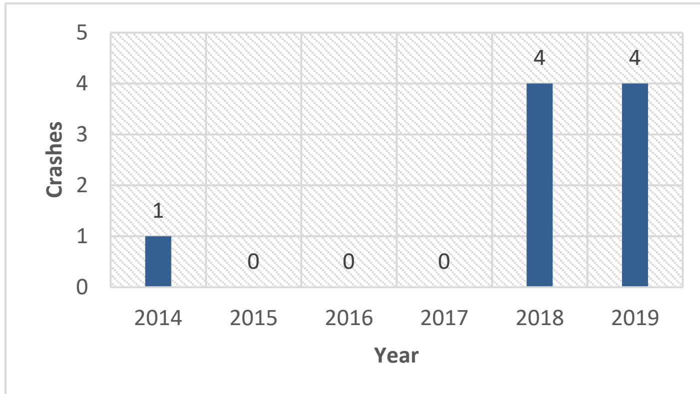
Crash History

Crash data was obtained from the City of Shakopee from 2014 through 2019 to identify any crash trends at the intersection and a summary of the historical crash data is shown below. The latest three-year period (2017-2019) was used for the crash analysis per MnDOT ICE report guidance and is summarized below and in Table 2. There was a total of eight (8) crashes at the CR 15/CR 16 (17th Avenue W) intersection, with four (4) non-incapacitating injury crashes, one (1) possible injury crash, and three (3) property damage only (PDO) crashes. All intersection crashes occurred in 2018 and 2019 after the west approach of the intersection was constructed. Six of the eight crashes at this intersection were right-angle crashes. A high number of right-angle crashes can indicate that there may be limited available gaps in traffic and drivers are having a difficult time determining gaps or are accepting smaller gaps. This intersection is also above the critical crash rate, which indicates that more crashes have occurred at this intersection than intersections with similar characteristics around the state.



- Crash Severity:
  - 3 – Property Damage Only Crashes
  - 1 – Possible Injury (Type C) Crash
  - 4 – Non-incapacitating Injury (Type B) Crashes
- Crash Type:
  - 1 – Lost Control Crash (2019)
  - 1 – Overtaking Sideswipe Crash (2019)
  - 6 – Right-Angle Crashes (All 2018 and 2019)

Table 2. Crash History Summary

Location	Number of Crashes	Daily Entering Volume	Total Crash Rate (1)		
			Calculated	Average	Critical
CR 15 at CR 16 (17th Avenue W)	8	7,400 (3)	0.99	0.19	0.64

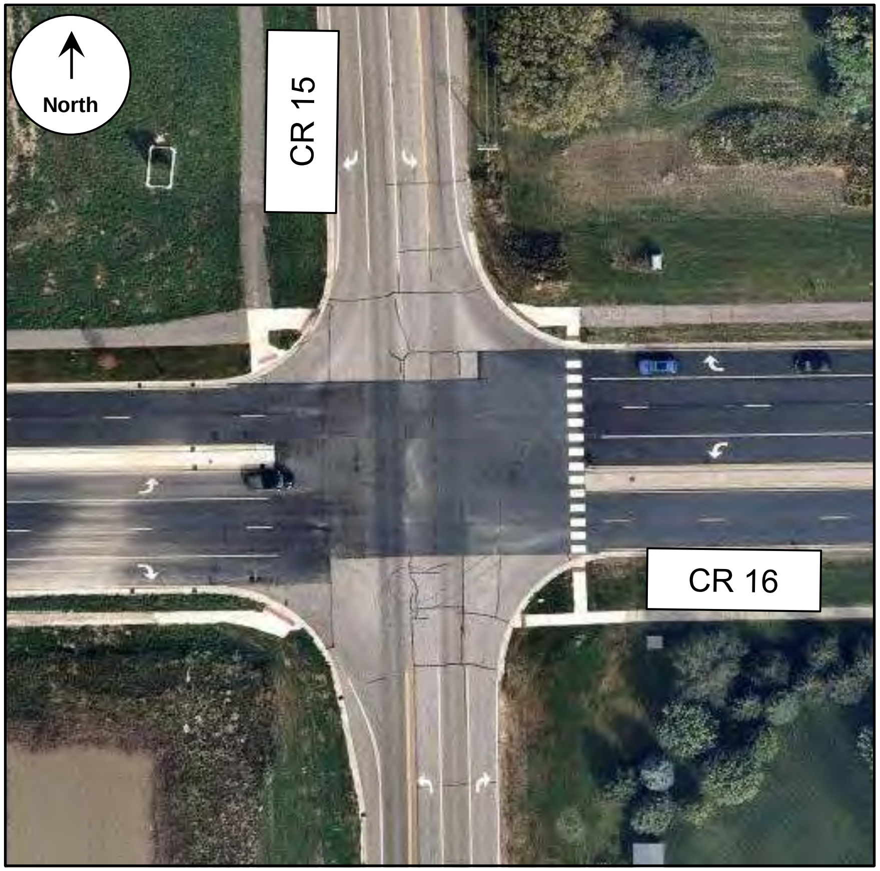
(1) Intersection crash rates are expressed in crashes per million entering vehicles.
(2) Intersection crash rates are expressed in crashes per 100 million entering vehicles.
(3) Intersection Daily Entering Volume calculated based on combination of 13-hour counts collected as part of the *Trident Development Transportation Study* (SRF, 2019) and the latest available MnDOT AADT volumes.

Future Conditions

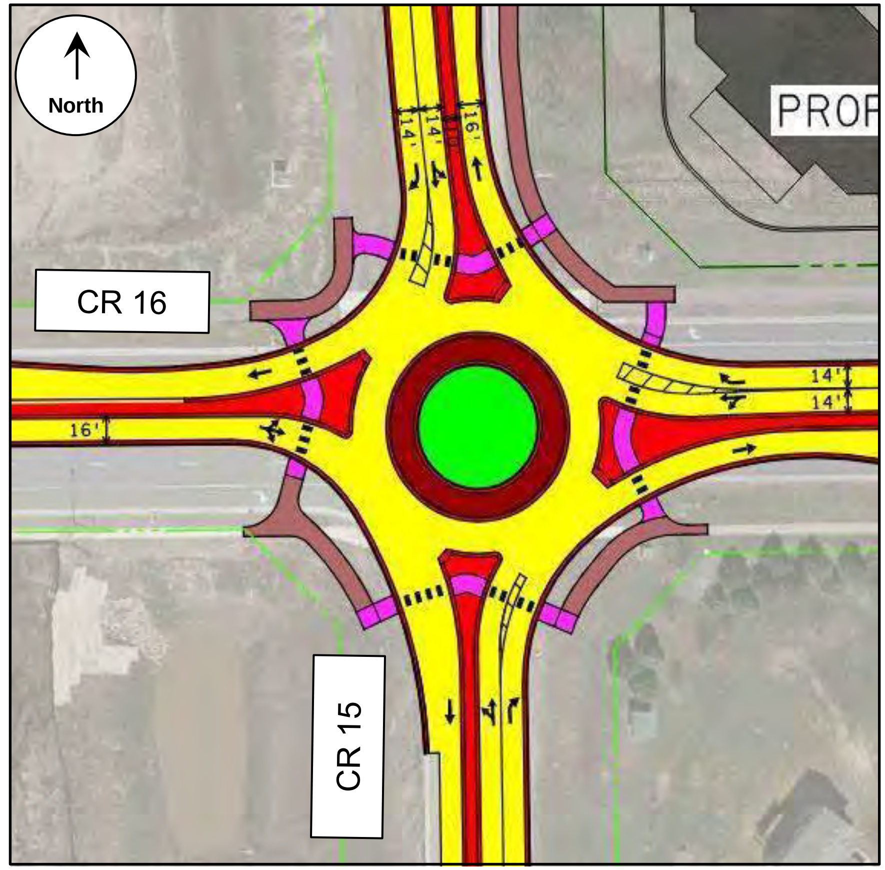
Future lane configurations were developed to accommodate projected traffic volumes and the corridor vision for CR 15/Marystown Road. For the side-street stop and traffic signal control alternatives, the existing lane configuration was assumed. For the roundabout control alternative, it was determined – through analysis described later in this report – that a single lane roundabout would be adequate at the study intersection through the forecast year 2040. For the purpose of this ICE report, turn lanes were assumed at the northbound, southbound, and westbound approaches to accommodate 20-year forecast volumes and beyond. However, the City is planning to construct single-lane approaches on all legs of the roundabout with the ability to construct turn lanes in the future if/when needed. The assumed lane configurations for these alternatives are shown in Table 3 and can be seen in Figure 3.

Table 3. Future Intersection Lane Configurations

Approach	Side-Street Stop and Traffic Signal Control	Roundabout Control
Northbound CR 15	• One left-turn lane • One thru lane • One right-turn lane	• One shared left-turn/thru lane • One right-turn lane
Southbound CR 15	• One left-turn lane • One thru lane • One right-turn lane	• One shared left-turn/thru lane • One right-turn lane
Eastbound CR 16 (17th Avenue W)	• One left-turn lane • Two thru lanes • One right-turn lane	• One shared left-turn/thru/right-turn lane
Westbound CR 16 (17th Avenue W)	• One left-turn lane • Two thru lanes • One right-turn lane	• One shared left-turn/thru lane • One right-turn lane



Side-Street Stop and Traffic Signal Alternatives



Roundabout Alternative

Proposed Lane Configurations

Figure 3

Intersection Control Evaluation
CR 15 (Marystown Road) at CR 16 (17th Ave W)
Shakopee, Minnesota

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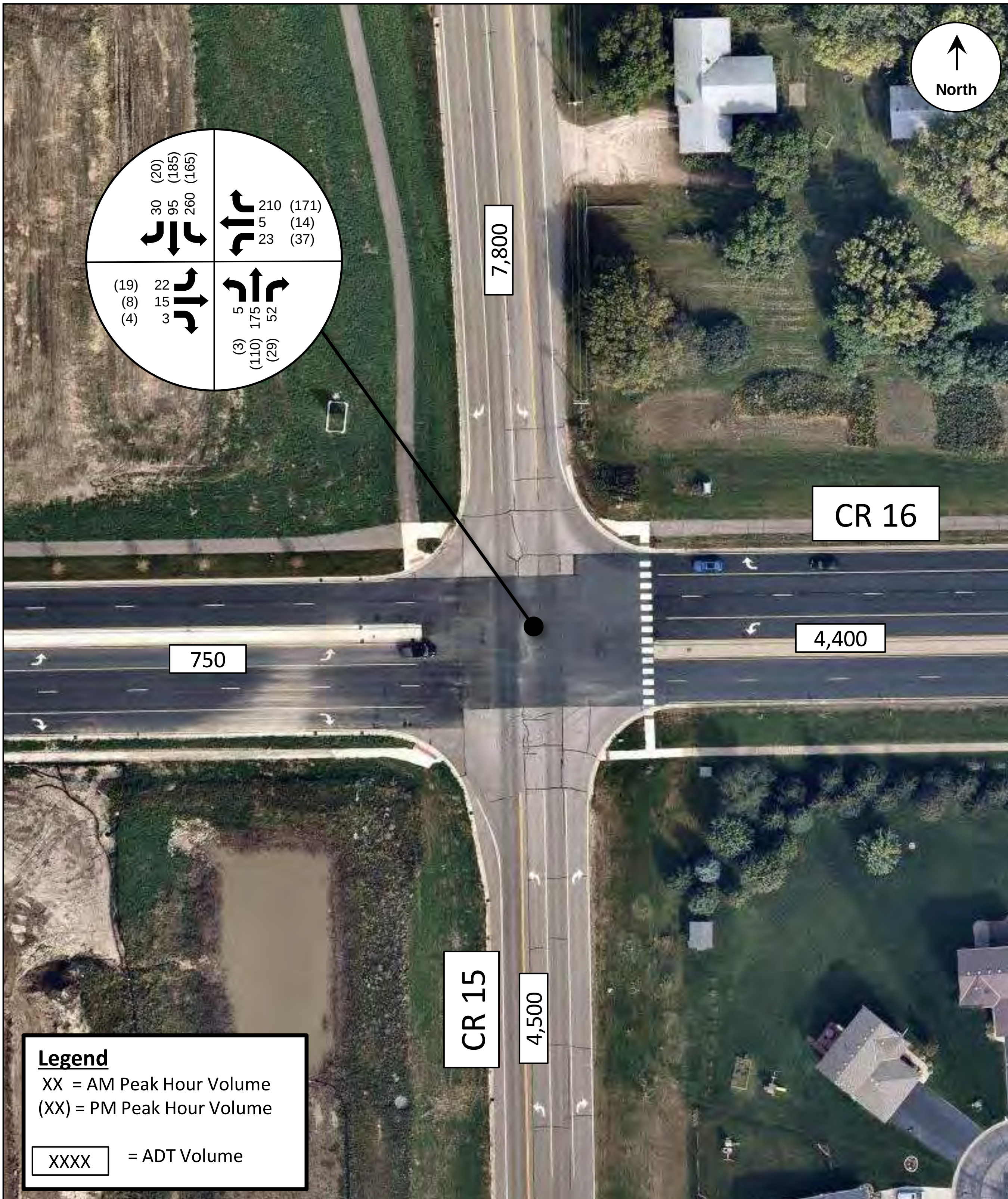
Traffic Volumes

Existing hourly approach volumes at the study intersection were collected in October 2019 by SRF and are summarized in Figure 4 and included in the Appendix. It should be noted that adjustments were made to the existing turning movement counts to account for ongoing construction in the region, which is outlined further in the *Trident Development Transportation Study*.

The year 2025 volumes were developed as part of the *Trident Development Transportation Study* and account for the three on-going developments along the study corridor (Windermere, Bruggeman, Trident) and a general background growth of one and a half (1.5) percent. As previously mentioned, the three on-going developments are expected to be developed before 2025, therefore, the year 2025 represents one-year post-construction of the full-build out of the proposed development. Construction of a traffic control alternative is anticipated for the year 2022, with a year of opening anticipated for 2023. Therefore, due to the similar timeframes of the year of opening of the roadway construction and the development full-build out, the year 2025 is considered the year of opening.

The year 2040 turning movements were developed as part of the *Shakopee AUAR Transportation Study*, utilizing the Scott County Regional Travel Demand Model and the 2040 Scott County Comprehensive Plan. These 2040 turning movement counts were updated as part of the *Trident Development Transportation Study*. The projected peak hour year 2025 and year 2040 turning movement volumes are shown in Figure 5 and Figure 6, respectively.



SRF

Existing Volumes

Intersection Control Evaluation
CR 15 (Marystown Road) at CR 16 (17th Ave W)
Shakopee, Minnesota

Figure 4

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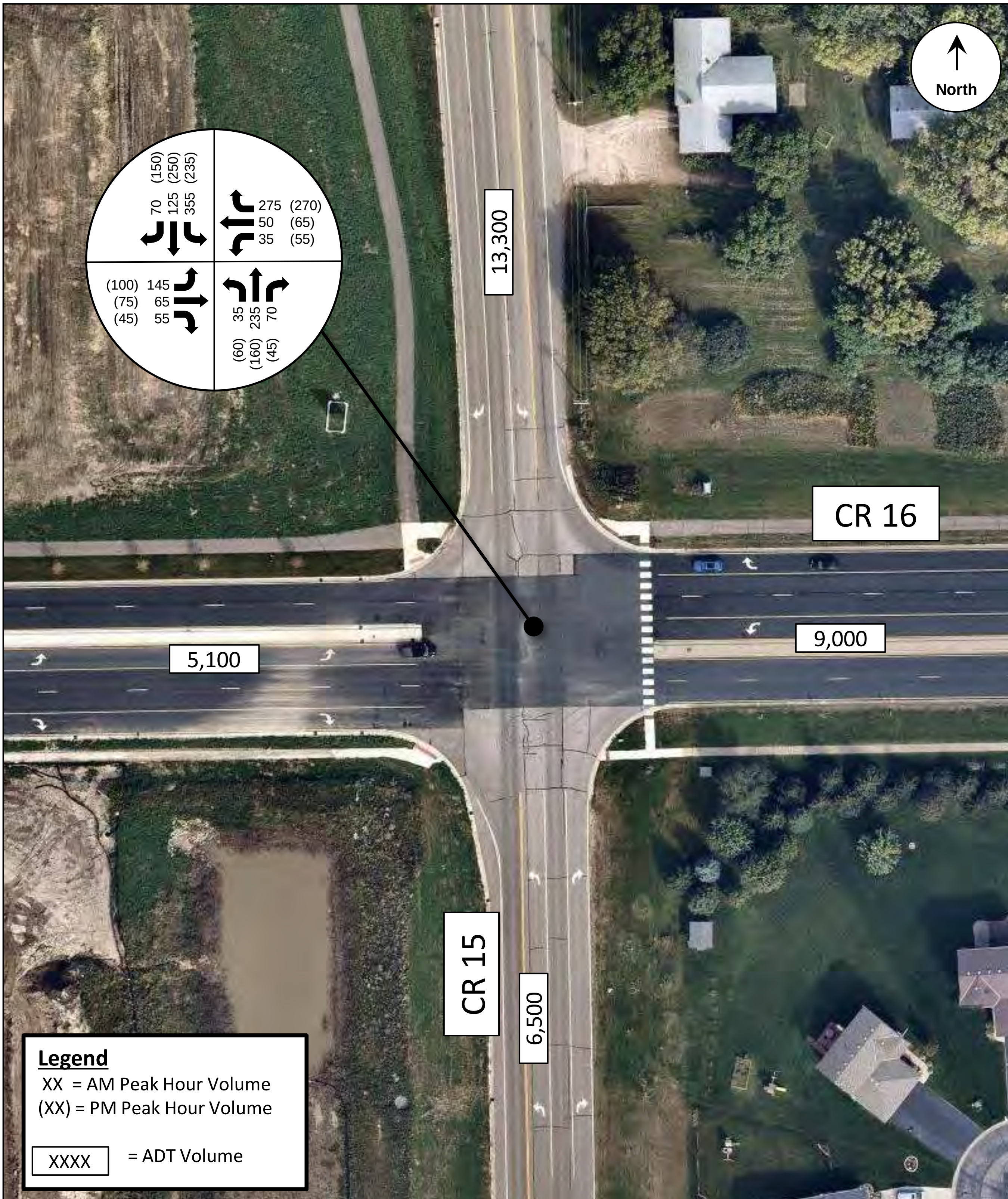

Forecast Year 2025 Volumes

Figure 5

Intersection Control Evaluation
CR 15 (Marystown Road) at CR 16 (17th Ave W)
Shakopee, Minnesota

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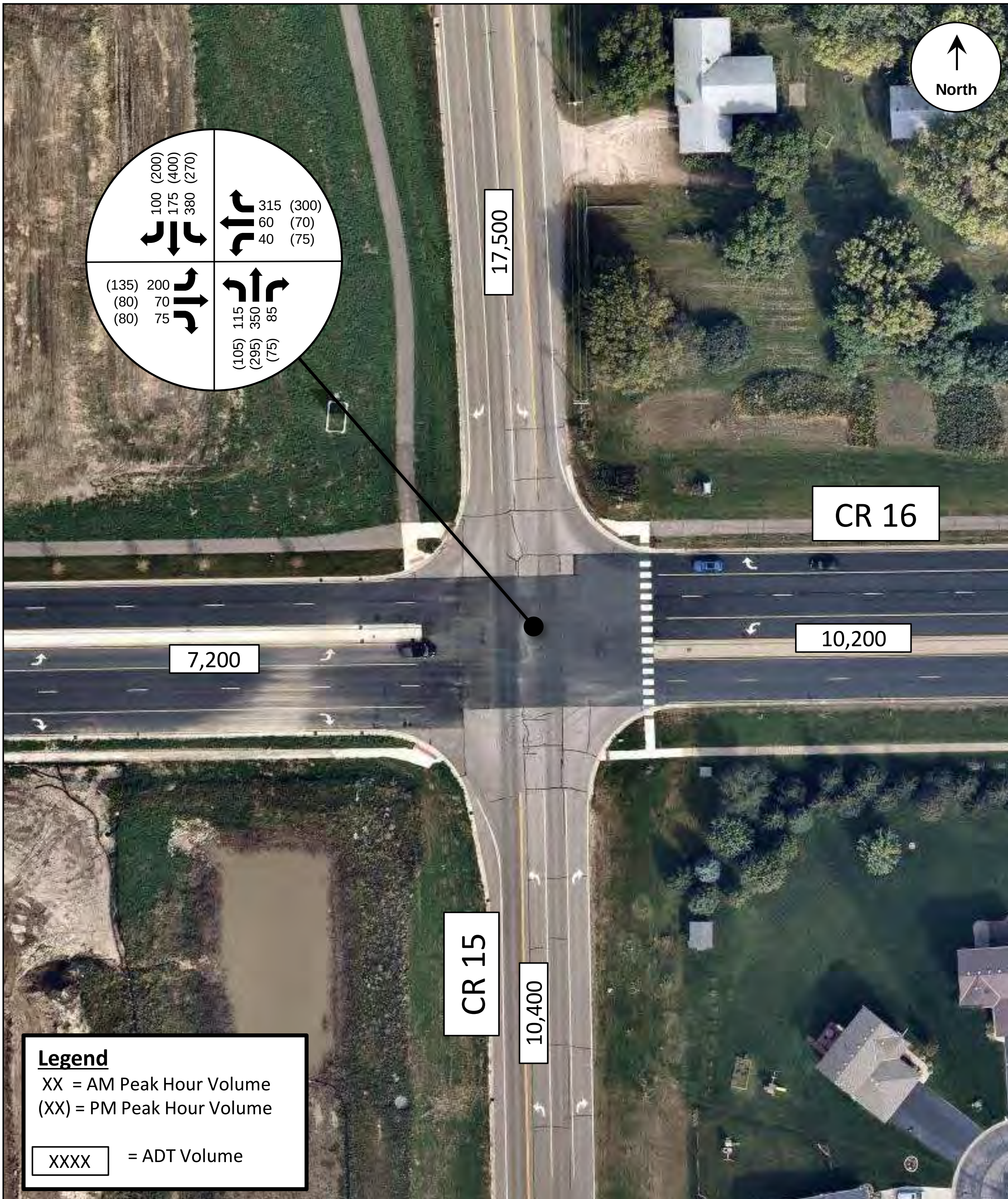

Forecast Year 2040 Volumes

Figure 6

Intersection Control Evaluation
CR 15 (Marystown Road) at CR 16 (17th Ave W)
Shakopee, Minnesota

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Analysis of Alternatives

Warrants Analysis

The Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD) provides guidance on when it may be appropriate to use all-way stop or signal control at an intersection. This guidance is provided in the form of "warrants", or criteria, and engineering analysis of the intersection's design factors to determine when all-way stop or signal control may be justified.

Meeting a warrant at an intersection does not in itself require the installation of a particular control type. The particular control type also requires an engineering analysis of the intersection's design for it to be justified. Under the MnDOT ICE process, roundabouts are typically considered to be warranted if traffic volumes meet the criteria for either all-way stop or traffic signal control.

A warrants analysis was performed for the traffic signal control alternative as outlined in the December 2019 MN MUTCD. Analysis of signal warrants 1-3 was performed utilizing existing volumes. Signal warrants 4-9 were investigated and were determined to not be applicable to the study.

The lane geometry and approach speeds assumed for the warrant analysis are shown in Table 4.

Table 4. Warrants Analysis Assumptions

Approach	Geometry	Speed Limit
Northbound CR 15	Two or more approach lanes	55 mph
Southbound CR 15	Two or more approach lanes	55 mph
Eastbound CR 16 (17th Ave W)	Two or more approach lanes	45 mph
Westbound CR 16 (17th Ave W)	Two or more approach lanes	45 mph

For the analysis, right-turning vehicles on the minor approaches were not included as these turns are given a dedicated lane and thus do not significantly impact the thru-movement on both minor approaches.

The 70 percent traffic volume factor was used for the warrants analysis, as proposed conditions met the necessary criteria of the speed limit exceeding 45 mph on at least one of the approaches. Table 5 provides a summary of the warrants analysis results, while the detailed volume-based warrants analysis is included in the Appendix.

In addition to the signal warrants, Multiway Stop Applications Warrant Condition C (MWSA C) was also evaluated as outlined in the MN MUTCD. The results of the MWSA warrants analysis are also shown in Table 5.

Table 5. Warrants Analysis Summary

MN MUTCD Warrant	Hours Required	Existing Volumes		2025 Volumes (Year of Opening)		2040 Volumes	
		Hours Met	Warrant Met?	Hours Met	Warrant Met?	Hours Met	Warrant Met?
MWSA C: Minimum Volumes	8	0	No	11	Yes	12	Yes
Warrant 1A: Minimum Vehicular Volume	8	0	No	8	Yes	10	Yes
Warrant 1B: Interruption of Continuous Traffic	8	0	No	4	No	10	Yes
Warrant 1C: Combination of Warrants	8	0	No	7	No	12	Yes
Warrant 2: Four-Hour Volume	4	0	No	5	Yes	11	Yes
Warrant 3B: Peak Hour Volume	1	0	No	4	Yes	6	Yes
Warrants 4-9	Not Applicable						

The results of the warrants analysis indicate the intersection does not satisfy any MN MUTCD Signal Warrants with existing volumes. However, the intersection does satisfy Signal Warrants 1A, 2, and 3B with 2025 volumes and Signal Warrants 1A, 1B, 1C, 2, and 3B with 2040 volumes. The analysis also indicates that the intersection satisfies MWSA warrants under both 2025 and 2040 volumes.

Operations Analysis

An initial planning-level analysis was performed for the roundabout control alternative based on Highway Capacity Manual (HCM) 6th Edition methods. Planning-level analysis results for Forecast Year 2040 volumes are shown in Figure 8. As can be seen, the Forecast Year 2040 volumes are below the theoretical capacity of a single-lane roundabout. In addition to the planning-level analysis, capacity analysis tests were performed at the intersection using the Highway Capacity Software (HCS) 7. Results of the analysis indicate that a single-lane roundabout would be under capacity at the intersection during both peak hours, however, right-turn lanes are expected to be needed at the northbound, southbound, and westbound approaches to accommodate Forecast Year 2040 volumes. Therefore, for the purposes of this ICE report, right-turn lanes at the northbound, southbound, and westbound approaches were assumed. The following geometry assumed for analysis is shown in Table 6. It should be noted that the City is planning to construct single-lane approaches on all legs of the roundabout with the ability to construct turn lanes in the future if/when needed. A year 2034 operations analysis was completed to determine near-term needs and is shown in the Appendix.

Figure 8. CR 15 at CR 16 Roundabout Entry Lane Capacity (Forecast Year 2040 volumes)

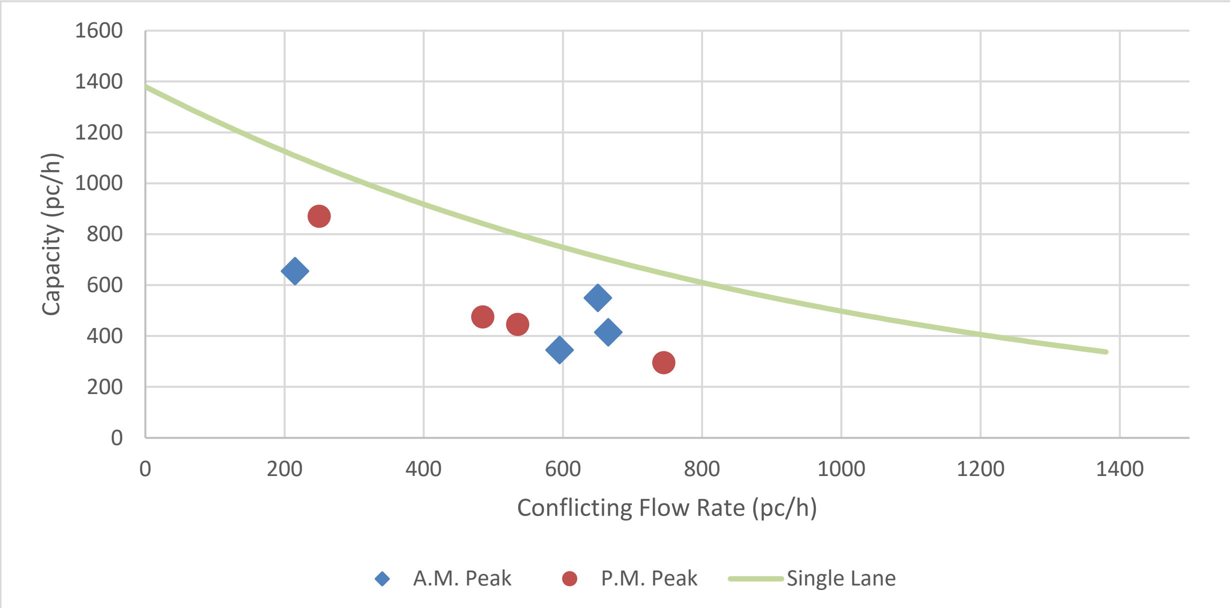


Table 6. Roundabout Lane Configuration

Approach	Geometry
Northbound CR 15	• Two-lane entry, One circulating lane
Southbound CR 15	• Two-lane entry, One circulating lanes
Eastbound CR 16 (17th Avenue W)	• One-lane entry, One circulating lane
Westbound CR 16 (17th Avenue W)	• Two-lane entry, One circulating lane

The traffic operations analysis identifies a Level of Service (LOS) which indicates how well an intersection is operating based on average delay per vehicle. Intersections are given a ranking from LOS A to LOS F. LOS A indicates the best traffic operation and LOS F indicates an intersection where demand exceeds capacity. LOS A through LOS D are considered acceptable because the intersection would be operating under capacity.

Operational analysis of the side-street stop and traffic signal control alternatives was performed using Synchro/SimTraffic. Traffic operations analysis of the roundabout alternative was conducted using RODEL software. RODEL is a software program that is based on existing roundabout operational research and uses an empirical formula method to determine roundabout delay based on geometric features and traffic flows.

Results of the Year 2025 traffic operations analysis indicate that both alternatives would perform at acceptable levels of service under the proposed lane configurations, with the roundabout alternative having less overall delay in the AM peak hour. The side-street stop alternative generally operates with acceptable overall levels of service, but the side-street approaches operate at LOS F during the AM peak hour. Table 7 provides a summary of the Year 2025 operations analysis. The Year 2025 detailed analysis results are included in the Appendix.

Table 7. Operations Analysis Results – 2025 Conditions (Year of Opening)

Alternative	Analysis Tool	AM Peak Hour		PM Peak Hour	
		Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Side-Street Stop Control (existing) (1)	SimTraffic	20 / 73	C / F	8 / 19	A / C
Traffic Signal Control	SimTraffic	14	B	11	B
Roundabout Control	RODEL	11	B	11	B

(1) Overall results are followed by the worst approach results.

Table 8 provides a summary of the Forecast Year 2040 operations analysis. Results of the traffic operations analysis indicate that both the traffic signal and roundabout alternatives would continue to operate at acceptable levels of service under proposed lane configurations, with the roundabout alternative overall having less delay during the AM peak hour, and more delay during the PM peak hour. The analysis indicated the side-street stop control alternative would operate over capacity on the minor leg approaches during both peak hours, with significant delays during the AM peak hour. The detailed analysis can be found in the Appendix.

Table 8. Operations Analysis Results – 2040 Conditions

Alternative	Analysis Tool	AM Peak Hour		PM Peak Hour	
		Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Side-Street Stop Control (existing) (1)	SimTraffic	136 / >3 min	F / F	21 / 77	C / F
Traffic Signal Control	SimTraffic	23	C	13	B
Roundabout Control	RODEL	18	C	17	C

(1) Overall results are followed by the worst approach results.

Safety Analysis

The *Highway Safety Manual (HSM) Predictive Method* (referred to as the "predictive method") was used to predict crash frequency and severity at the study intersection based on future traffic volumes and roadway characteristics. The predictive method was evaluated for the traffic signal and roundabout control at the study intersection. It should be noted that based on the year 2040 operations, the side-street stop control is not considered a feasible option, therefore is not considered in the safety analysis comparison. Analysis was performed using the Interactive Highway Safety Design Model (IHSDM) site-based interface provided by the Federal Highway Administration (FWHA). The predictive method was analyzed for a 20-year time period, with the first full year of benefits estimated to be in year 2024. Table 9 is a summary of the total predicted fatal/injury and property damage only crashes expected over the 20-year period, along with the average crash frequency per year.

Table 9. Predicted Crash Frequency per Intersection Alternative

Alternative	Total Predicted Crashes for Evaluation Period (2024-2043)			Average Predicted Crashes/Year		
	FI	PDO	Total	FI	PDO	Total
Traffic Signal Control	17.0	30.9	47.9	0.9	1.6	2.4
Roundabout Control	10.4	32.5	42.9	0.5	1.6	2.1

Results indicate that property damage only crashes are expected to be similar between the traffic signal and roundabout, while fatal and injury crashes are expected to be approximately 0.4 less per year, with a total of 6.6 less fatal and injury crashes throughout the evaluation period. Furthermore, roundabouts typically have fewer conflict points than conventional intersections, and the geometry of a roundabout induces lower speeds for vehicles approaching and traversing an intersection. With lower speeds, the severity of crashes is anticipated to decrease. Also, 75% of the crashes that have occurred at the intersection in the past three years were right-angle crashes, which are converted to low-speed, shallow-angle crashes with a roundabout.

Incremental Benefit-Cost Comparison

A benefit-cost analysis provides an indication of the economic desirability of an alternative. Results must be weighed by decision-makers along with the assessment of other effects and impacts. Projects are considered cost-effective if the benefit-cost ratio is greater than 1.00, which reflects that project benefits exceed the expected life-cycle costs. The larger the ratio number, the greater the benefits per unit cost.

Incremental benefit-costs are a type of benefit-cost that compares two alternatives in a project, rather than comparing them both to a no-build condition that is considered unfeasible. The existing side-street stop intersection was not considered as a feasible alternative due to the expected decline in safety and operational performance, as mentioned above. Thus, the incremental benefit-cost analysis compares project life-cycle costs and benefits between the roundabout alternative and the traffic signal alternative. In this case, if the incremental benefit-cost is greater than 1.00, the roundabout alternative is considered cost-effective compared to the traffic signal alternative. Vice versa, if the benefit-cost is less than 1.00, the roundabout alternative is not considered cost effective compared to the traffic signal alternative. While similar to a standard benefit-cost analysis, an incremental benefit-cost can give greater insights into the relationship of costs/benefits of two alternatives. The following methodology and assumptions were used for the benefit-cost analysis:

Main Components Analyzed Include:

a. Crashes by severity.
b. Travel time/delay (Vehicle Hours Traveled – VHT).
c. Initial capital costs: These costs were divided into different categories in accordance with service life (consistent with the recommendations of MnDOT Office of Planning and Programming, July 2019).
d. Remaining Capital Value: The remaining capital value (value of the improvement beyond the analysis period) was not considered a reduction in cost.
e. Maintenance costs.

2. **Analysis Years:** The analysis assumed that each of the alternatives would be constructed in year 2022 and 2023. Therefore, year 2024 is the first full year that benefits would be realized from the project. The analysis focused on the twenty-year period from 2024 to 2043.
3. **Economic Assumptions:** The present value of all benefits and costs were calculated considering 2020 as the year of current dollars. The assumed discount rate of 1.2 percent was used per guidelines from the "*Recommended standard values for use in cost-effectiveness and benefit-cost analysis in SFY 2020*", Minnesota Department of Transportation, Office of Transportation System Management, July 2019. Value of time, crash costs, and remaining capital value assumptions were consistent with values also published by MnDOT.
4. **Development of Vehicle Hours Traveled (VHT)**: Vehicle Hours Traveled (VHT) were derived from the expected intersection vehicle delay over the analysis period. Peak hour intersection vehicle delay was obtained using Synchro/SimTraffic software for the traffic signal alternative. RODEL software was used to determine the peak hour delay for the roundabout control alternative. Analysis was performed for both year 2025 and forecast year

2040 conditions. Delay for years between 2025 and 2040 was interpolated based on a linear growth rate. Delay for years outside 2025 and 2040 were extrapolated using the same growth rate. VHT benefits were summarized by the difference in delay costs between the no build alternative and the build alternative. Savings due to reduction of VHT were calculated using costs per hour that account for vehicle occupancy and different vehicle types.

5. **Safety Analysis:** Safety benefits were estimated based on annual crashes by severity. The Highway Safety Manual (HSM) Predictive Method (referred to as the "predictive method") was used to predict crash frequency and severity at the study intersection based on future traffic volumes and roadway characteristics for each alternative. Crash predictions were produced for each year in the benefit-cost analysis period. Crash costs from each severity type were valued in accordance with "*Recommended standard values for use in B/C analysis in SFY 2020*", MnDOT Office of Transportation System Management, July 2019.
6. **Maintenance Costs**: Annual maintenance costs between the traffic signal and roundabout alternatives were monetized based on typical values observed in the state of Minnesota for similar traffic control types. Under the traffic signal alternative, costs typically include electricity and routine maintenance required to keep the signal in operation. The roundabout alternative was assumed to require lighting and routine landscaping. Annual maintenance costs for the traffic signal and roundabout, in terms of 2012 dollars, were $5,000 and $1,000, respectively. These dollar amounts were inflated to year 2020 dollars using an inflation rate of 1.1337, which was provided by the Consumer Price Index Inflation Calculator, Bureau of Labor Statistics.
7. **Calculation of Remaining Capital Value:** Because many components of the initial capital costs have service lives well beyond the 20-year benefit-cost analysis period, the remaining capital value was calculated for each alternative. The remaining capital value was subtracted from the initial capital cost to determine the net capital cost. In determining remaining capital value, the initial costs of the alternatives were separated into the following categories:
    a. Right-of-Way
    b. Major Structures
    c. Grading and Drainage
    d. Sub-Base and Base
    e. Surface
    f. Miscellaneous Costs – Includes mobilization, removal of temporary pavement and drainage, traffic control, and design and engineering costs. These were assumed to be sunk costs and assigned zero remaining capital value.
8. **Factors Not Quantified**: Several factors were not quantified as part of the analysis because review of initial data indicates low potential to yield substantial benefit. These factors included the following:
    a. All alternatives are not expected to cause traffic diversion; therefore, benefits derived from Vehicle Miles Traveled (VMT) were assumed to be negligible and have been excluded from the analysis for these alternatives.

b. A factor that was not quantified in the benefit-cost analysis was delay savings outside of the AM and PM peak hours. It is expected that the roundabout alternative would provide travel time benefits during non-peak hours of the day. This should be considered a conservative estimate for the roundabout alternative.

A planning level estimate of $320,000 was assumed for the traffic signal control alternative, which includes the construction of a new signal system with no geometric improvements to the existing lane configuration. If a traffic signal were constructed at the intersection, additional geometric improvements would likely be necessary, however, for the purpose of the ICE report, these additional costs were not assumed to provide a conservative incremental benefit cost analysis. The roundabout control alternative was estimated at $1,470,000 which includes the construction of a single-lane roundabout as shown in the proposed conditions figure. Results of the benefit-cost analysis are included in Table 10. The benefit-cost ratio greater than one for the roundabout alternative is due to the alternative's expected positive impacts on intersection operations and safety compared to the traffic signal alternative.

The benefit-cost analysis workbook summaries are included in the Appendix. Detailed cost breakdowns for the traffic signal and roundabout alternatives are also included in the Appendix.

Table 10. Benefit-Cost Analysis Summary

Intersection Alternative	User Costs Savings (millions)	Project Costs (millions)	Benefit-Cost Ratio
Roundabout vs. Traffic Signal	$1.54	$0.79	1.95

User Costs Savings = the monetized user costs savings benefit of the roundabout versus the signal based on vehicular travel time and crash reduction savings.

Project Costs = the differential between the construction, maintenance, and capital value costs between the roundabout and the traffic signal alternatives. Capital value costs account for the difference in the value of the alternative investment beyond the analysis years.

Benefit-Cost Ratio = The user costs savings of the roundabout versus the traffic signal divided by the project costs differential.

Right-of-Way Considerations

All alternatives are not expected to require additional right-of-way. The traffic signal control alternative is not expected to change the existing lane configuration and thus is not expected to require additional right-of-way. While the roundabout control alternative is expected to require additional space, there is sufficient right-of-way surrounding the existing intersection.

Pedestrian Considerations

The current side-street stop intersection is not equipped with pedestrian pushbuttons or indications. If a signal system were to be installed, a more robust pedestrian system would be incorporated into the design to better match current pedestrian facility standards. This would result in increased pedestrian safety. In addition, the design of a roundabout allows pedestrians to cross one direction of traffic at a time on each leg of the roundabout and the geometry of the roundabout induces lower speeds thereby greatly reducing the severity of crashes. Furthermore, pedestrians typically experience less delay at a roundabout compared to a traffic signal because they do not have to wait for the pedestrian walk phase to be served.

It is still unclear at this point which of the two alternatives (traffic signal or roundabout) would provide a safer pedestrian crossing. In theory, the roundabout would suggest a safer crossing as the high speeds (55 mph) are reduced (generally 20 mph through a roundabout) and there are fewer conflict points, however, the traffic signal has a dedicated phase for pedestrians to cross, rather than relying entirely on pedestrian/vehicle yielding interaction. Therefore, more research is needed to determine which of the traffic control alternatives would provide a safer pedestrian environment; however, both are considered improvements from existing conditions.

Transportation System Considerations

Currently, all intersections along the Marystown Rd/CR 15 corridor are stop-controlled. However, the three major intersections to the north, Marystown Road/US 169 South Ramp, Marystown Road/US 169 North Ramp, and Adams Street/Vierling Drive, are all proposed roundabouts as part of the *Marystown Road Corridor Study*. If a roundabout was constructed at this intersection it would provide consistent traffic control at the major intersections along Marystown Road/CR 15. In addition, land use south of this intersection is mainly rural, but land use to the north of this intersection is suburban. A roundabout would provide a transition to alert drivers coming from the south that they are entering a more suburban area and pedestrian activity could be higher.

Recent Intersection Improvements/Planning

The west leg of the CR 15/CR 16 was just constructed in 2018, along with the resurfacing of CR 16 from CR 15 to Independence in 2018-2019. Roundabout construction will require the removal of recently constructed/maintained roadway, which was implemented for a future traffic signal. Therefore, the roundabout construction would result in a loss in recent construction costs of an estimated $160,000.

Alternatives Summary

The following intersection control evaluation (ICE) conclusions are provided for the CR 15 at CR 16 (17th Avenue W) intersection in Shakopee, Scott County, Minnesota:

- *Warrants Analysis*
  The results of the warrant analyses indicate that the intersection satisfies Signal Warrants 1A, 2 and 3B with 2025 forecasted volumes and Signal Warrants 1A, 1B, 1C, 2, and 3B with 2040 forecasted volumes. The analysis also indicates that the intersection satisfies MWSA warrants using both 2025 and 2040 forecasted volumes.

- *Operations Analysis*
  Operational analysis results of the year 2025 and 2040 volumes indicate that both the traffic signal and roundabout alternatives are expected to perform with acceptable levels of service with proposed lane configurations and forecasted volumes. Long-term, side-street stop control will not be feasible from an intersection delay perspective.

- *Safety Analysis*
  The HSM crash prediction methodologies were utilized to compare signal and roundabout control. From a safety perspective, the roundabout is anticipated to have similar property damage only crashes to the signal, but fewer fatal and injury crashes.

- *Incremental Benefit-Cost Comparison*
  The benefit-cost ratio is greater than one for the roundabout alternative compared to the signal alternative due to the alternative's expected positive impacts on intersection operations and safety compared to the traffic signal alternative. Therefore, the roundabout is considered cost effective compared to the traffic signal.

- *Right-of-Way Considerations*
  None of the alternatives are expected to require additional right-of-way.

- *Pedestrian Considerations*
  The construction of the signal system within the intersection would include additions to the pedestrian facilities which would improve pedestrian safety. The roundabout alternative is also expected to increase pedestrian safety as speeds will be reduced, and pedestrians will cross less through lanes of travel.

- *Transportation System Considerations*
  A roundabout would provide a transition to alert drivers coming from the south that they are entering a more suburban area and pedestrian activity could be higher.

- *Recent Intersection Improvements/Planning*
  Recently constructed/maintained roadway was implemented for a potential traffic signal. Therefore, roundabout construction would result in a loss in recent construction costs of an estimated $160,000.

Recommended Intersection Control

Long-term, side-street stop control will not be feasible from an intersection delay perspective. As previously noted, traffic signal and roundabout control would be warranted by year 2025, and likely sooner depending on the expected timing of nearby development.

The traffic signal alternative would provide acceptable traffic operations and would be consistent with the vision and recently constructed/maintained roadway at the intersection.

Both alternatives' have benefits when it comes to pedestrian safety. The traffic signal alternative would provide pedestrians with a dedicated phase to cross the intersection and they would not have to rely as much on pedestrian/vehicle yielding interaction. Whereas the roundabout alternative would significantly reduce speeds and have less conflict points.

However, the roundabout alternative would provide less non-peak hour vehicular delay, would reduce speeds along the corridor, is expected to have fewer fatal and injury crashes, would provide a transition from rural to suburban, and is considered cost effective compared to the signal alternative.

Therefore, based on the results of this Intersection Control Evaluation, a roundabout control is recommended for the intersection of CR 15 at CR 16 (17th Avenue W).

Appendix G

Corridor Layout Design


CONCEPTUAL LAYOUT
MARYSTOWN ROAD CORRIDOR STUDY
CITY OF SHAKOPEE
LEGEND
PAVED ROADWAY
RAISED MEDIANS & CURBS
BITUMINOUS TRAILS & BIKEWAYS
CONCRETE TRAILS & SIDEWALKS
LANDSCAPED MEDIAN
CONCRETE TRUCK APRON
PAVEMENT MARKING
CROSS WALK PAVEMENT MARKING
TRAFFIC FLOW ARROW
EXISTING RIGHT OF WAY
PROPOSED RIGHT OF WAY
N
0 100 200
SCALE IN FEET
ADAMS ST S
VIERLING DR W
WB TH 169 RAMP
WB TH 169 LOOP
TH 169
EB TH 169 LOOP
EB TH 169 RAMP
WINDERMERE WAY
PROPOSED TRIDENT DEVELOPMENT
17TH AVE W
MARYSTOWN RD

SRF Consulting Group, Inc. — Engineers Planners Designers

PROJECT: MARYSTOWN CORRIDOR STUDY

Concept Cost Estimate

Prepared By: SRF Consulting Group, Inc., 04/30/2020

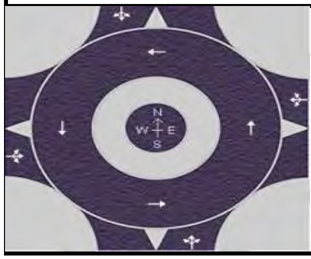
				ROUNDABOUT #1 - ADAMS STREET/VIERLING DRIVE		ROUNDABOUT #2 - MARYSTOWN ROAD/US 169 NORTH RAMP		ROUNDABOUT #3 - MARYSTOWN ROAD/US 169 SOUTH RAMP		ROUNDABOUT #4 - CR 15/CR 16		TRIDENT DEVELOPMENT TURN LANE		TOTAL	
	ITEM DESCRIPTION	UNIT	UNIT PRICE	EST. QUANTITY	EST. AMOUNT	EST. QUANTITY	EST. AMOUNT	EST. QUANTITY	EST. AMOUNT	EST. QUANTITY	EST. AMOUNT	EST. QUANTITY	EST. AMOUNT	EST. QUANTITY	EST. AMOUNT
PAVING AND GRADING COSTS															
GrP 1a	2106 Excavation - common & subgrade	cu. yd.	$8.00	3,300	$26,400	4,000	$32,000	3,750	$30,000	4,650	$37,200	350	$2,800	16,050	$128,400
GrP 1d	2106 Subgrade Preparation	road sta.	$500.00	20.72	$10,360	28.27	$14,135	25.58	$12,790	30.23	$15,115	1.20	$600	106	$53,000
GrP 2e	2211 Aggregate Base Class 5 (CV)	cu. yd.	$15.00	1,800	$27,000	2,560	$38,400	2,300	$34,500	2,250	$33,750	190	$2,850	9,100	$136,500
GrP 3a	Mainline Pavement - 5" HMA	sq. yd.	$21.00	6,450	$135,450	7,525	$158,025	7,250	$152,250	7,650	$160,650	800	$16,800	29,675	$623,175
GrP 3b	Mainline - Truck Apron - 10" Concrete	sq. yd.	$100.00	350	$35,000	375	$37,500	375	$37,500	375	$37,500			1,475	$147,500
GrP 4a	Concrete Walk / Trail / Median	sq. yd.	$125.00	1,140	$142,500	1,760	$220,000	1,325	$165,625	1,775	$221,875	55	$6,875	6,055	$756,875
GrP 4b	Bituminous Walk / Trail	sq. yd.	$25.00			2,215	$55,375	1,780	$44,500	755	$18,875			4,750	$118,750
GrP 4c	ADA Pedestrian Curb Ramp - Truncated Domes	sq. ft.	$60.00	130	$7,800	144	$8,640	120	$7,200	130	$7,800	16	$960	540	$32,400
GrP 5	Concrete Curb and Gutter	lin. ft.	$21.00	5,177	$108,717	3,870	$81,270	3,553	$74,613	5,240	$110,040	110	$2,310	17,950	$376,950
GrP 8a	Removals - Pavement (Bituminous)	sq. yd.	$4.00	10,700	$42,800	11,850	$47,400	11,300	$45,200	15,650	$62,600			49,500	$198,000
GrP 8d	Removals - Pavement (Concrete)	sq. yd.	$18.00			300	$5,400	1,300	$23,400					1,600	$28,800
GrP 8e	Removals - Curb & Gutter	lin. ft.	$3.50	3,430	$12,005	2,300	$8,050	350	$1,225	2,420	$8,470			8,500	$29,750
GrP 8f	Removals - Concrete Walk	sq. ft.	$1.50	2,200	$3,300			150	$225	1,650	$2,475			4,000	$6,000
GrP 8g	Removals - Concrete Median	sq. ft.	$5.00	1,150	$5,750	12,525	$62,625	8,675	$43,375	5,350	$26,750			27,700	$138,500
GrP 8h	Removals - Bituminous Walk	sq. ft.	$1.00	1,575	$1,575			200	$200			1,125	$1,125	2,900	$2,900
	SUBTOTAL PAVING AND GRADING COSTS:				**$558,657**		**$768,820**		**$672,603**		**$743,100**		**$34,320**		**$2,777,500**
DRAINAGE, UTILITIES AND EROSION CONTROL															
Dr 5	Drainage - urban	lump sum	$476,000		$93,041		$126,974		$114,866		$135,724		$5,395	1	$476,000
Dr 7	Turf Establishment & Erosion Control	lump sum	$250,000		$48,866		$66,688		$60,329		$71,283		$2,834	1	$250,000
	SUBTOTAL DRAINAGE, UTILITIES AND EROSION CONTROL				**$141,907.000**		**$193,662.000**		**$175,195.000**		**$207,007.000**		**$8,229.000**		**$726,000**
BRIDGE COSTS															
Br 1	Bridge - No. 70011 Modification	lump sum	$900,000				$450,000		$450,000					1	$900,000
	SUBTOTAL BRIDGE COSTS:						**$450,000**		**$450,000**						**$900,000**
SIGNAL AND LIGHTING COSTS															
SGL 4	Mainline Lighting (permanent)	lump sum	$125,000		$24,433		$33,344		$30,164		$35,642		$1,417	1	$125,000
	SUBTOTAL SIGNAL AND LIGHTING COSTS:				**$24,433**		**$33,344**		**$30,164**		**$35,642**		**$1,417**		**$125,000**
SIGNING & STRIPING COSTS															
SGN 1	Mainline Signing (C&D)	lump sum	$84,000		$16,419		$22,407		$20,270		$23,952		$952	1	$84,000
SGN 2	Mainline Striping	lump sum													
	SUBTOTAL SIGNING & STRIPING COSTS:				**$16,419**		**$22,407**		**$20,270**		**$23,952**		**$952**		**$84,000**
	SUBTOTAL CONSTRUCTION COSTS:				**$741,416**		**$1,468,233**		**$1,348,232**		**$1,009,701**		**$44,918**		**$4,612,500**
MISCELLANEOUS COSTS															
M 1	Mobilization	4%	$190,000		$37,138		$50,683		$45,850		$54,176		$2,154	1	$190,000
M 2	Non Quantified Minor Items	20%	$700,000		$136,824		$186,726		$168,921		$199,594		$7,935	1	$700,000
M 8	Traffic Control	3%	$84,000		$16,419		$22,407		$20,270		$23,951		$952	1	$84,000
	SUBTOTAL MISCELLANEOUS COSTS:				**$190,381**		**$259,816**		**$235,041**		**$277,721**		**$11,041**		**$974,000**
ESTIMATED TOTAL CONSTRUCTION COSTS without Contingency:					**$931,797**		**$1,728,049**		**$1,583,273**		**$1,287,422**		**$55,959**		**$5,586,500**
1	Contingency or "risk"	10%			$94,000		$173,000		$159,000		$129,000		$6,000		**$561,000**
ESTIMATED TOTAL CONSTRUCTION COSTS PLUS CONTINGENCY:					**$1,025,797**		**$1,901,049**		**$1,742,273**		**$1,416,422**		**$61,959**		**$6,147,500**

	OTHER PROJECT COSTS:														
	DESIGN ENG. & CONSTRUCTION ADMIN.	Lump Sum	20%		$206,000		$381,000		$349,000		$284,000		$13,000		$1,233,000
	SUBTOTAL OTHER PROJECT COSTS				**$206,000**		**$381,000**		**$349,000**		**$284,000**		**$13,000**		**$1,233,000**
	TOTAL PROJECT COST				**$1,231,797**		**$2,282,049**		**$2,091,273**		**$1,700,422**		**$74,959**		**$7,380,500**

NOTES No right of way costs assumed.
Minimal impacts assumed to the the gas facility in the SW quadrant of the Adams St/Vierling Dr roundabout, therefore no cost estimate was included.
Assumed existing subbase would be able to be reused with minimal modifications. Assumed 5" of HMA to match as-built plans for the corridor.


FUTURE CONCEPTUAL LAYOUT
(ALTERNATIVE - 2 LANE SOUTHBOUND)
MARYSTOWN ROAD CORRIDOR STUDY
CITY OF SHAKOPEE
LEGEND
PAVED ROADWAY
RAISED MEDIANS & CURBS
BITUMINOUS TRAILS & BIKEWAYS
CONCRETE TRAILS & SIDEWALKS
LANDSCAPED MEDIAN
CONCRETE TRUCK APRON
PAVEMENT MARKING
CROSS WALK PAVEMENT MARKING
TRAFFIC FLOW ARROW
EXISTING RIGHT OF WAY
PROPOSED RIGHT OF WAY
N
0
100
200
SCALE IN FEET
ADAMS ST S
VIERLING DR W
POSSIBLE GAS UTILITY IMPACT
WB TH 169 LOOP
WB TH 169 RAMP
TH 169
EB TH 169 LOOP
EB TH 169 RAMP
WINDERMERE WAY
PROPOSED TRIDENT DEVELOPMENT
17TH AVE W
MARYSTOWN RD

Adams St/Vierling Dr - Year 2034 (10-year forecasts) Operations Analysis (HCS 7)

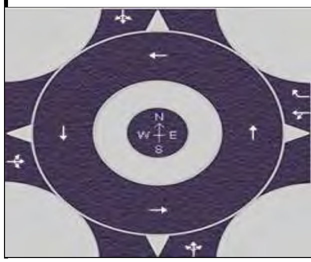
		A.M. Peak Hour					P.M. Peak Hour					Notes
Single Approach - Single-Lane Alternative												
		Overall	EB	WB	NB	SB	Overall	EB	WB	NB	SB	
	Delay	B	B	C	A	B	C	B	C	C	C	
	Queue		40	123	75	60		35	135	183	168	

Marystown Rd/US 169 North Ramp - Year 2034 (10-year forecasts) Operations Analysis (HCS 7)

Single Approach - Single-Lane Alternative

	A.M. Peak Hour					P.M. Peak Hour					Notes
	Overall	EB	WB	NB	SB	Overall	EB	WB	NB	SB	
Delay	B	A	B	A	C	**E**	A	**F**	A	D	
Queue		3	110	68	185		5	590	73	300	

Single-Lane Alternative - Westbound Right Turn Lane



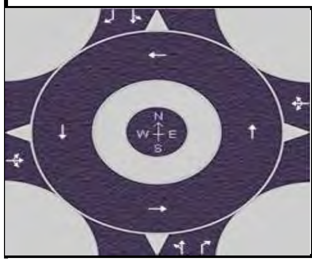
	A.M. Peak Hour					P.M. Peak Hour					Notes
	Overall	EB	WB	NB	SB	Overall	EB	WB	NB	SB	
Delay	B	A	A	A	C	C	A	B	A	D	
Queue		3	35	68	185		5	80	73	300	

Marystown Rd/US 169 South Ramp - Year 2034 (10-year forecasts) Operations Analysis (HCS 7)

Single Approach - Single-Lane Alternative

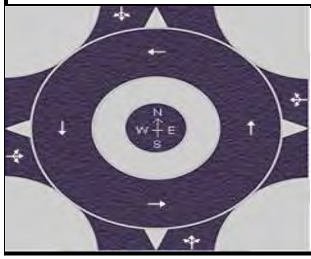
	A.M. Peak Hour					P.M. Peak Hour					Notes
	Overall	EB	WB	NB	SB	Overall	EB	WB	NB	SB	
Delay	D	B	A	**E**	C	**D/E**	C	A	D	**F**	**Confirmed with Rodel*
Queue		30	15	408	253		65	43	265	488	

Single-Lane Alternative - NBR/SBR Right-Turn Lanes



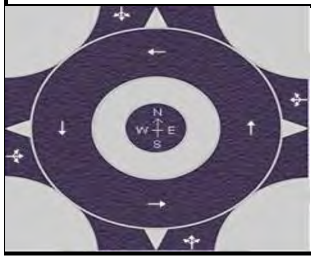
	A.M. Peak Hour					P.M. Peak Hour					Notes
	Overall	EB	WB	NB	SB	Overall	EB	WB	NB	SB	
Delay	B	B	A	B	B	C	C	A	A	C	
Queue		35	30	80	178		65	43	68	273	

CR 15 and CR 16 - Year 2034 (10-year forecasts) Operations Analysis (HCS 7)



	A.M. Peak Hour					P.M. Peak Hour					Notes
Single Approach - Single-Lane Alternative											
	Overall	EB	WB	NB	SB	Overall	EB	WB	NB	SB	
Delay	C	B	C	D	B	C	B	B	B	C	
Queue		83	130	215	125		63	78	83	233	

Adams St/Vierling Dr - Year 2044 (20-year forecasts) Operations Analysis (HCS 7)

		A.M. Peak Hour					P.M. Peak Hour					Notes
Single Approach - Single-Lane Alternative												
		Overall	EB	WB	NB	SB	Overall	EB	WB	NB	SB	
	Delay	C	B	D	B	C	C	B	C	C	D	
	Queue		60	210	113	90		43	173	223	210	

Marystown Rd/US 169 North Ramp - Year 2044 (20-year forecasts) Operations Analysis (HCS 7)

	A.M. Peak Hour					P.M. Peak Hour					Notes
Single Approach - Single-Lane Alternative											
	Overall	EB	WB	NB	SB	Overall	EB	WB	NB	SB	
Delay	C	A	C	A	C	**F**	B	**F**	A	**F**	
Queue		3	145	80	228		5	1150	88	615	
Single-Lane Alternative - Westbound Right Turn Lane											
	Overall	EB	WB	NB	SB	Overall	EB	WB	NB	SB	
Delay	B	A	A	A	C	**E**	B	B	A	**F**	**Confirmed in Rodel*
Queue		3	40	80	228		5	123	88	615	
Single Lane Alternative - Dual Southbound Lanes											
	Overall	EB	WB	NB	SB	Overall	EB	WB	NB	SB	
Delay	A	A	A	A	A	B	A	B	A	B	
Queue		3	40	80	50		5	123	88	85	

Marystown Rd/US 169 South Ramp - Year 2044 (20-year forecasts) Operations Analysis (HCS 7)

	A.M. Peak Hour					**P.M. Peak Hour**					**Notes**

Single Approach - Single-Lane Alternative

	Overall	EB	WB	NB	SB	Overall	EB	WB	NB	SB	Notes
Delay	**F**	B	A	**F**	**E**	**F**	D	B	**F**	**F**	
Queue		43	38	825	400		98	63	580	1028	

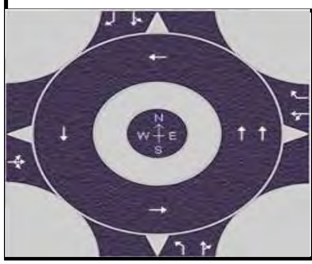
Single-Lane Alternative - NBR/SBR Right-Turn Lanes

	Overall	EB	WB	NB	SB	Overall	EB	WB	NB	SB	Notes
Delay	B	B	A	B	C	**E**	D	B	B	**F**	**Confirmed in Rodel*
Queue		43	38	78	233		98	63	88	633	

Single Lane Alternative - NB/SB/WB Right-Turn Lanes

	Overall	EB	WB	NB	SB	Overall	EB	WB	NB	SB	Notes
Delay	A	B	A	B	A	B	C	B	B	B	
Queue		30	38	100	65		63	63	88	113	

CR 15 and CR 16 - Year 2044 (20-year forecasts) Operations Analysis (HCS 7)

		A.M. Peak Hour					P.M. Peak Hour					Notes
Single Approach - Single-Lane Alternative												
		Overall	EB	WB	NB	SB	Overall	EB	WB	NB	SB	
	Delay	**F**	C	**E**	**F**	C	E	C	C	C	**F**	
	Queue		123	263	573	215		113	128	195	543	
Single Lane Alternative - NB/SB/WB Right-Turn Lanes												
		Overall	EB	WB	NB	SB	Overall	EB	WB	NB	SB	
	Delay	C	C	C	D	B	C	C	C	B	B	
	Queue		123	93	280	118		113	128	105	183	
Single Lane Alternative - Hybrid NB Left												
		Overall	EB	WB	NB	SB	Overall	EB	WB	NB	SB	
	Delay	C	C	B	C	B	B	C	B	B	B	
	Queue		123	83	203	118		113	93	88	183	