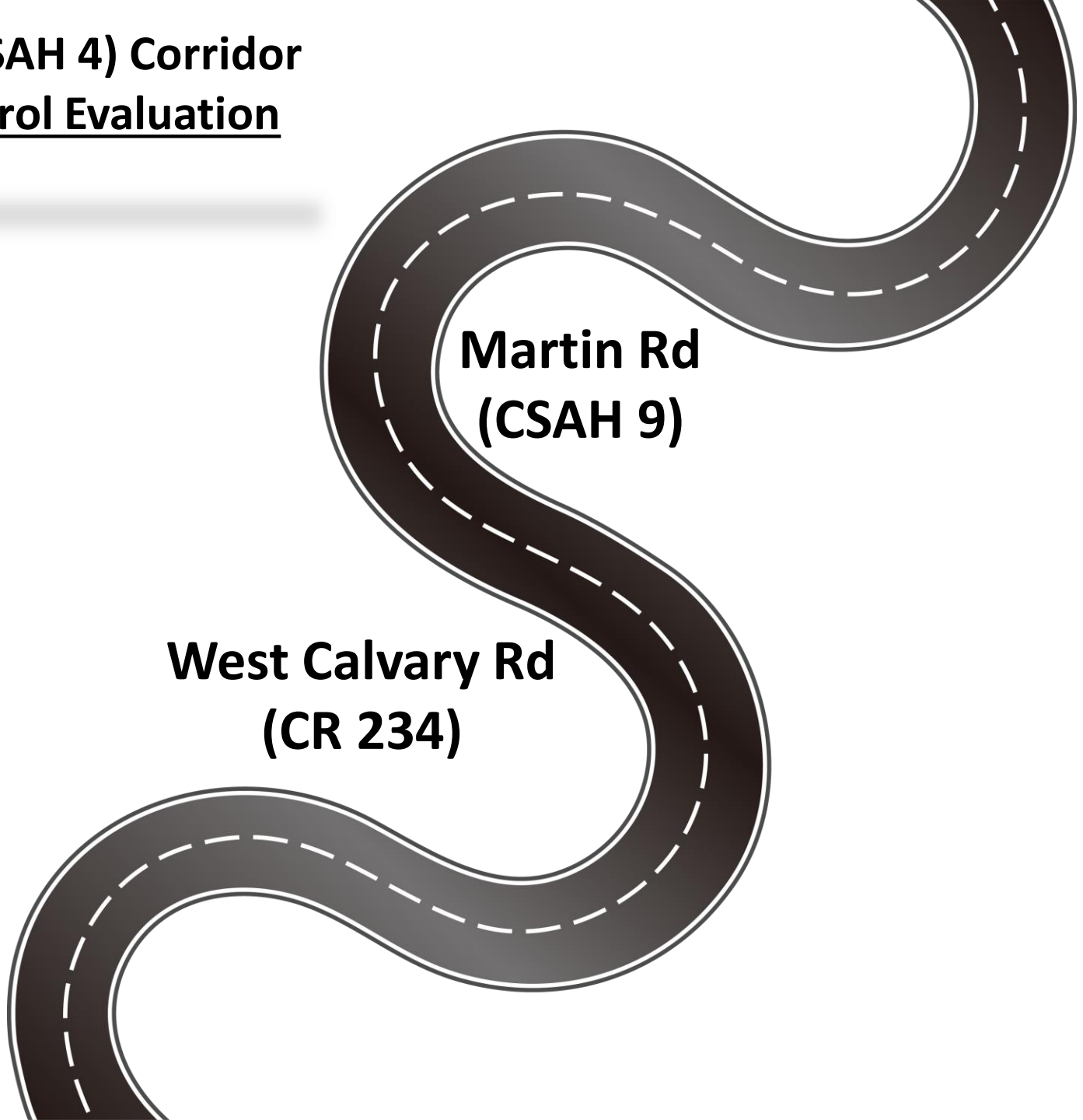
Rice Lake Road (CSAH 4) Corridor Project

Victor Lund, PE
Traffic Engineer
May 17, 2022

SAINT LOUIS COUNTY MINNESOTA

Rice Lake Road (CSAH 4) Corridor
Intersection Control Evaluation



West Tischer Rd
(CSAH 2)

Martin Rd
(CSAH 9)

West Calvary Rd
(CR 234)

Ridgeview Rd
(CR 694)

Discussion Points

- What is an Intersection Control Evaluation (ICE) Study?
- Project History
- Project Goals
- Summary of ICE Studies
- Close-Out Discussion

What is an Intersection Control Evaluation (ICE) Study?

- Answers the question, “What is the best, long-term intersection control for an intersection?”
- A comprehensive review of an intersection that considers geometry, traffic volumes and trends, and safety performance (crashes).
- Considers a range of intersection control alternatives.
  - Do Nothing
  - Side-Street STOP Control
  - All-Way STOP Control
  - Traffic Signal
  - Roundabout
  - Reduced Conflict Intersection
  - Other Non-Traditional


US 2 & Midway Road (CSAH 13)
Intersection Control Evaluation

City of Hermantown, MN

DEPARTMENT OF TRANSPORTATION

Prepared For:

MnDOT District 1
1123 Mesaba Ave
Duluth MN, 55811

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ALLIANT

Final Report
November 5, 2021

History
Duluth-Superior Metropolitan Interstate Council Study

- Duluth-Superior Metropolitan Interstate Council performed an ICE study at the intersection of Rice Lake Road (CSAH 4) and Martin Road (CSAH 9) in 2013.
- One of eight (8) intersections included in that ICE Study package.
- Findings
  - Found the intersection operated at an acceptable level of service (LOS C) in the AM and PM peak hours in 2013.
  - Estimated that the intersection (as is) would operate at an unacceptable level of service (LOS F) in the AM and PM peak hours in 2035.
  - The observed crash rate was found to be equal with the statewide average.
  - Recommended a roundabout as the best long-term option to increase intersection capacity for future traffic growth, minimize vehicle delay, and reduce crash frequency and severity.

Duluth News Tribune Article
February 21, 2013

Study: Roundabouts could reduce crashes in Duluth

Roundabouts — circular road intersections where motorists all drive in one direction to their separate exits — are becoming increasingly common

By **Steve Kuchera**, Duluth News Tribune

There may be a traffic roundabout in Duluth's future.

Roundabouts — circular road intersections where motorists all drive in one direction to their separate exits — are becoming increasingly common across Wisconsin, with one near Ashland and another planned for Superior.

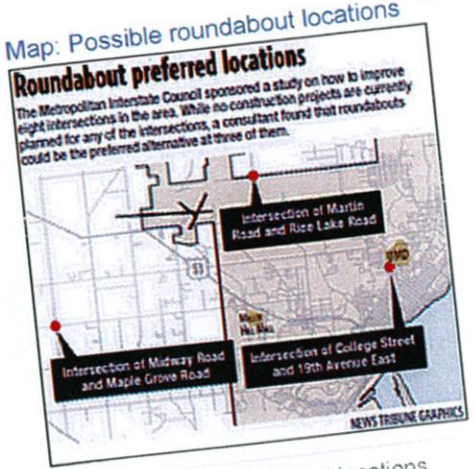
No immediate plans exist to convert any existing Minnesota intersections in or near Duluth to roundabouts. But a Duluth-Superior Metropolitan Interstate Council-sponsored study of eight intersections found roundabouts might work well at three of them.

"The thing about roundabouts is they are incredible safety improvements," said Rondi Watson, MIC planning assistant. "You take left turns out of the equation."

Since all the traffic in a roundabout travels in the same direction, head-on and T-bone collisions are eliminated.

A safety study of 24 roundabouts by the University of Wisconsin Traffic Operations and Safety Laboratory found a 52 percent reduction in fatal and injury crashes and a 9 percent reduction for all crashes

Map: Possible roundabout locations



Map: Possible roundabout locations

According to SRF, roundabouts may be the best solutions at the following intersections:

- College Street and 19th Avenue East
- Martin and Rice Lake roads
- Maple Grove and Midway roads

MIC officials stress that no roundabouts are actually yet planned for Duluth.

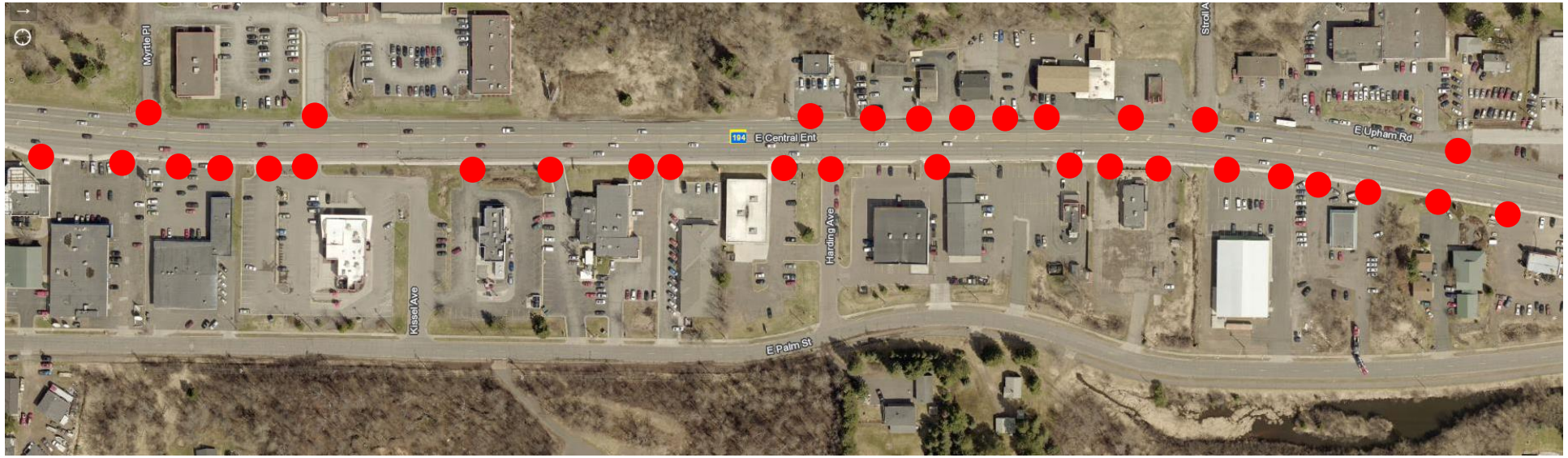
"We set the groundwork for work the city might do" sometime in the future, Chicka said.

Tags: ashland county, douglas county, news, auto, transportation, superior, construction

History
Requests to Install Additional Access on Rice Lake Road

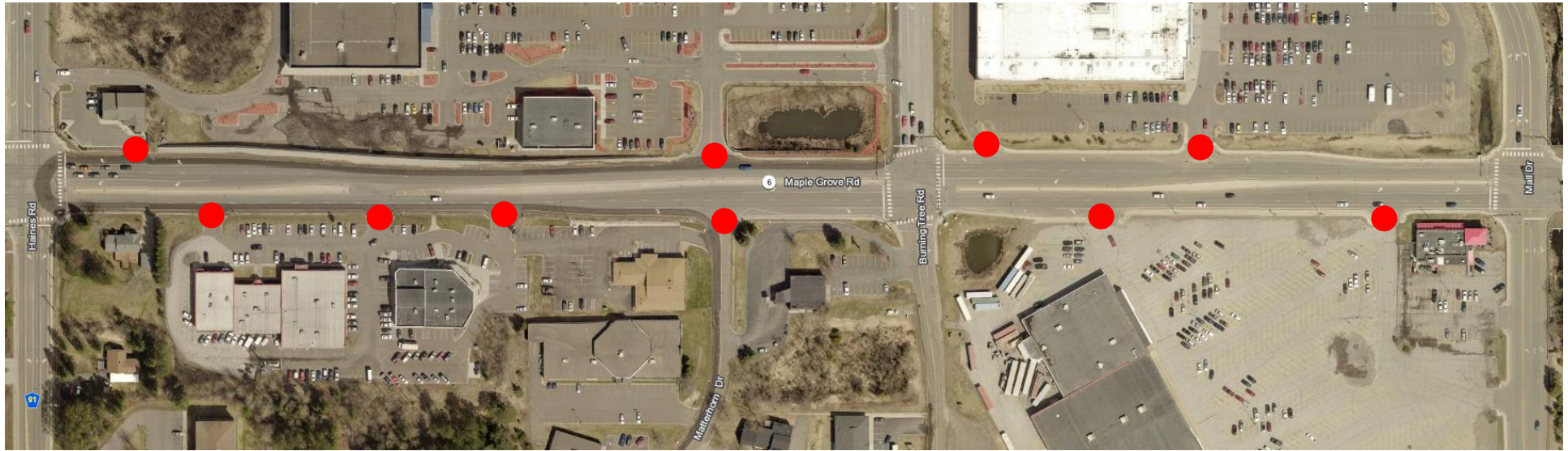
- St. Louis County has received multiple requests to allow additional access (driveways) be installed on Rice Lake Road for new development.
- Current challenges with granting additional access…
  - Rice Lake Road is functionally classified as a Minor Arterial. It's primary function is to move traffic with limited access to property.
  - Rice Lake Road is a controlled access corridor established by the County Board in the 1970s. The County invested significant resources to reconstruct Rice Lake Road to reduce access density. Controlled access is meant to preserve this investment by the County.
  - The costs of increasing access density are reduction in traffic capacity, increased traffic congestion, and increased crash frequency.
  - There are good and poor examples locally…

History
Requests to Install Additional Access on Rice Lake Road



Central Entrance
Begin: Arlington Avenue
End: Blackman Avenue

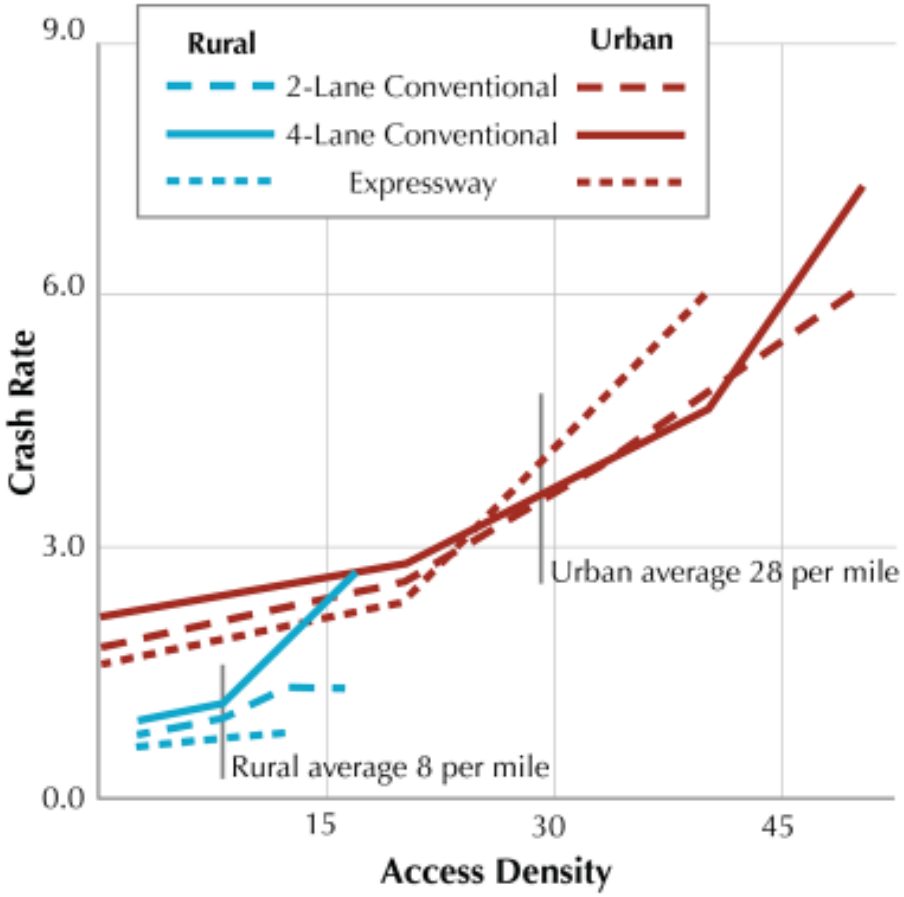
33 access points →
66 access points/mile



Maple Grove Road
Begin: Haines Road
End: Mall Drive

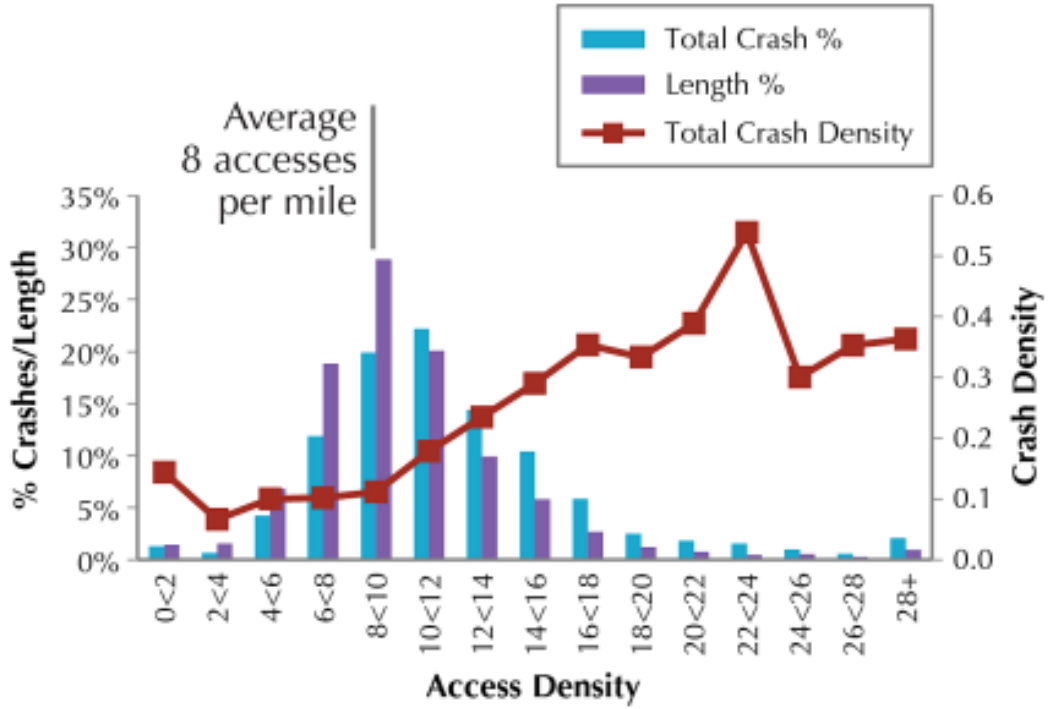
10 access points →
23 access points/mile

History
Requests to Install Additional Access on Rice Lake Road



MnDOT Research Report 1998-27
"Statistical Relationship between Vehicular Crashes and Highway Access"

"Rural" refers to a non-municipal area and cities with a population less than 5,000.



Minnesota County Road Safety Plans, Data 2007-2011

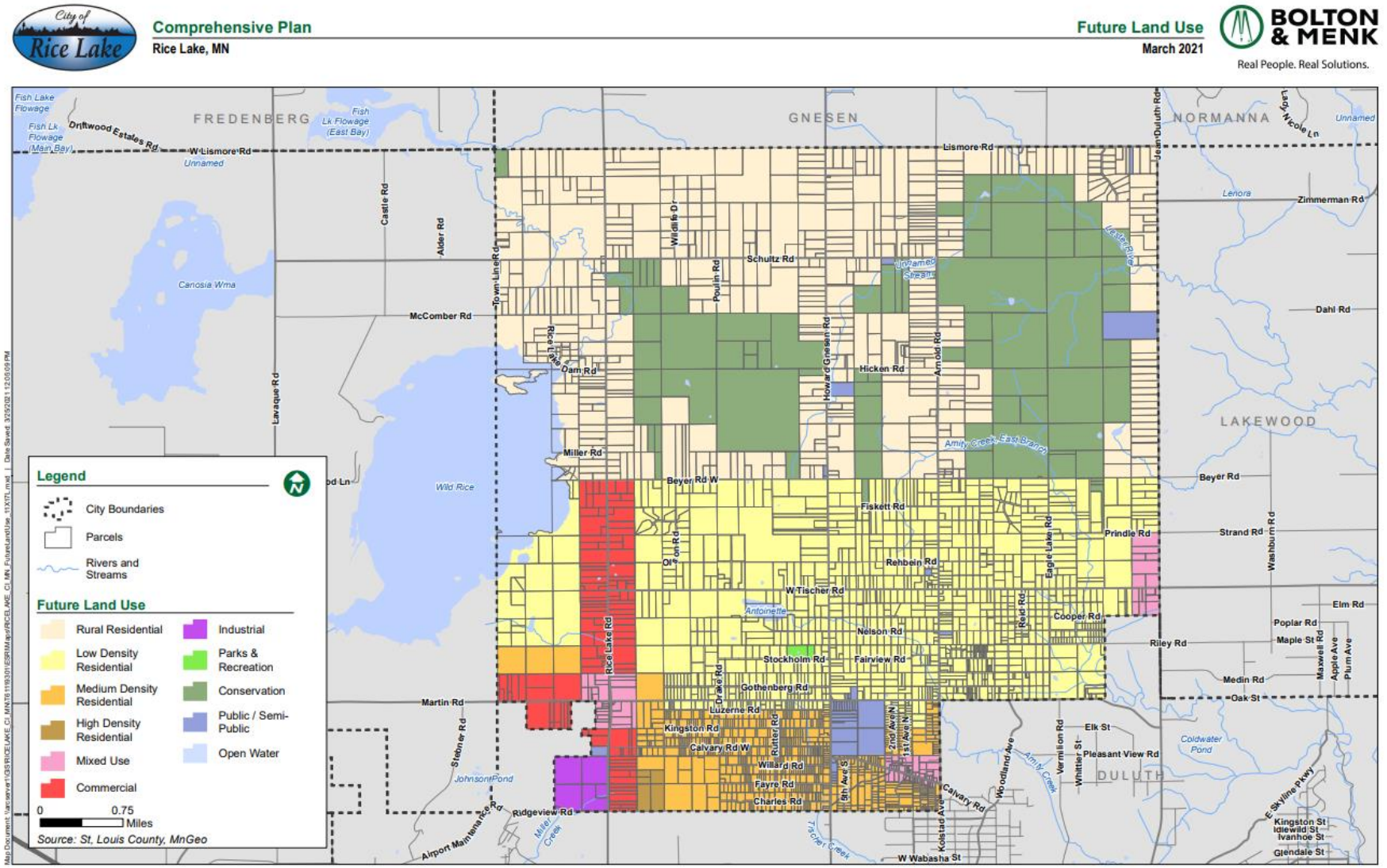
"Rural" refers to a non-municipal area and cities with a population less than 5,000.

Source: Minnesota Traffic Safety Fundamentals Handbook, 2015

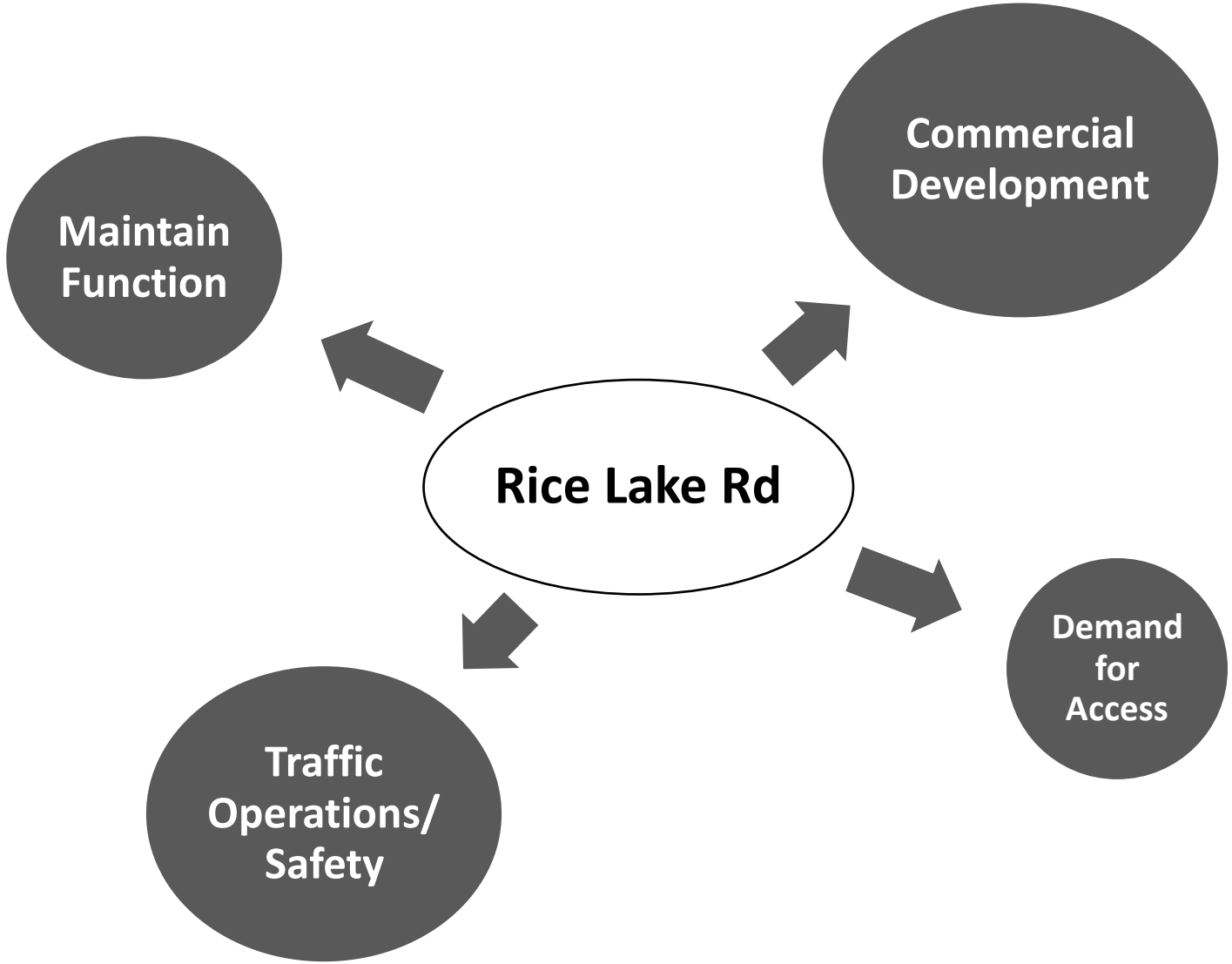
History
Rice Lake Road Corridor Planning Study

- St. Louis County proposed to the City of Rice Lake on October 22, 2018 to complete a corridor planning study for Rice Lake Road.
- Known challenges for the corridor
  - Concentration of recent and planned development
  - Demand for additional access
  - Traffic operations and safety of several intersections
  - Expected growth in the City of Rice Lake, and corresponding traffic volumes
- Objectives
  - Adjacent land use planning
  - City street network planning
  - City utility planning
  - Rice Lake Road corridor improvements

History
City of Rice Lake Comprehensive Plan - 2020



There is Tension on the Corridor



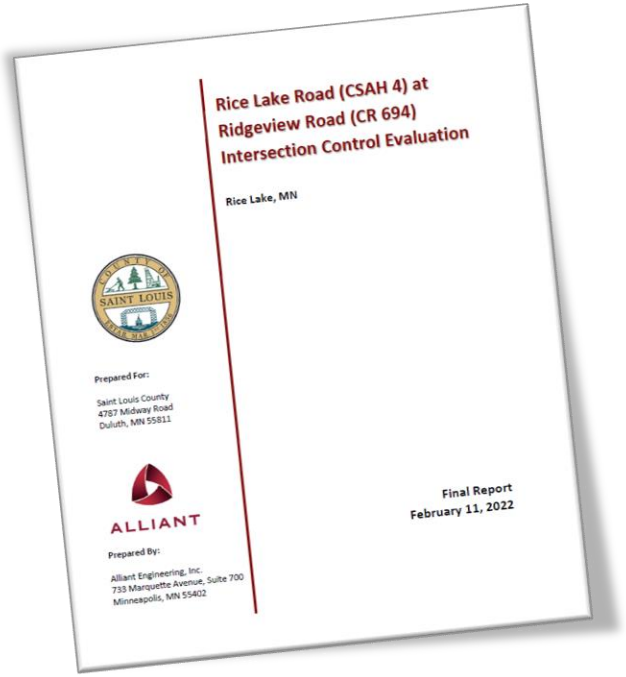
Rice Lake Road Corridor Goals

- **Improve** traffic operations and safety at the intersections
- **Preserve** the function of Rice Lake Road
- **Create** a commercial corridor that invites development
- **Manage** access and facilitate a new city street network
- **Support** traffic calming
- **Incorporate** accessibility for pedestrians and bicyclists

Gateway for the City of Rice Lake

Ridgeview Road (CR 694)
ICE Summary

- Known Issues
  - Northbound vehicles turning left onto Ridgeview Rd to access WLSSD
  - Intersection of Old Rice Lake Rd/Ridgeview Rd very close proximity to Rice Lake Rd
- Current Site Conditions
  - Side-street STOP control
  - Combination right-turn/bypass lane serving northbound traffic
  - Dedicated right-turn lane serving southbound traffic
- Safety Review
  - Crash rate (2011-2020) is less than statewide average
  - No fatalities or serious injuries in this time period
  - Predominate crash type was rear-end
- All-Way Stop and Signal Warrant Analysis
  - Does not satisfy warrants for an all-way stop → do not implement
  - Does not satisfy warrants for a traffic signal → do not implement


Rice Lake Road (CSAH 4) at
Ridgeview Road (CR 694)
Intersection Control Evaluation

Rice Lake, MN

Prepared For:

Saint Louis County
4787 Midway Road
Duluth, MN 55811

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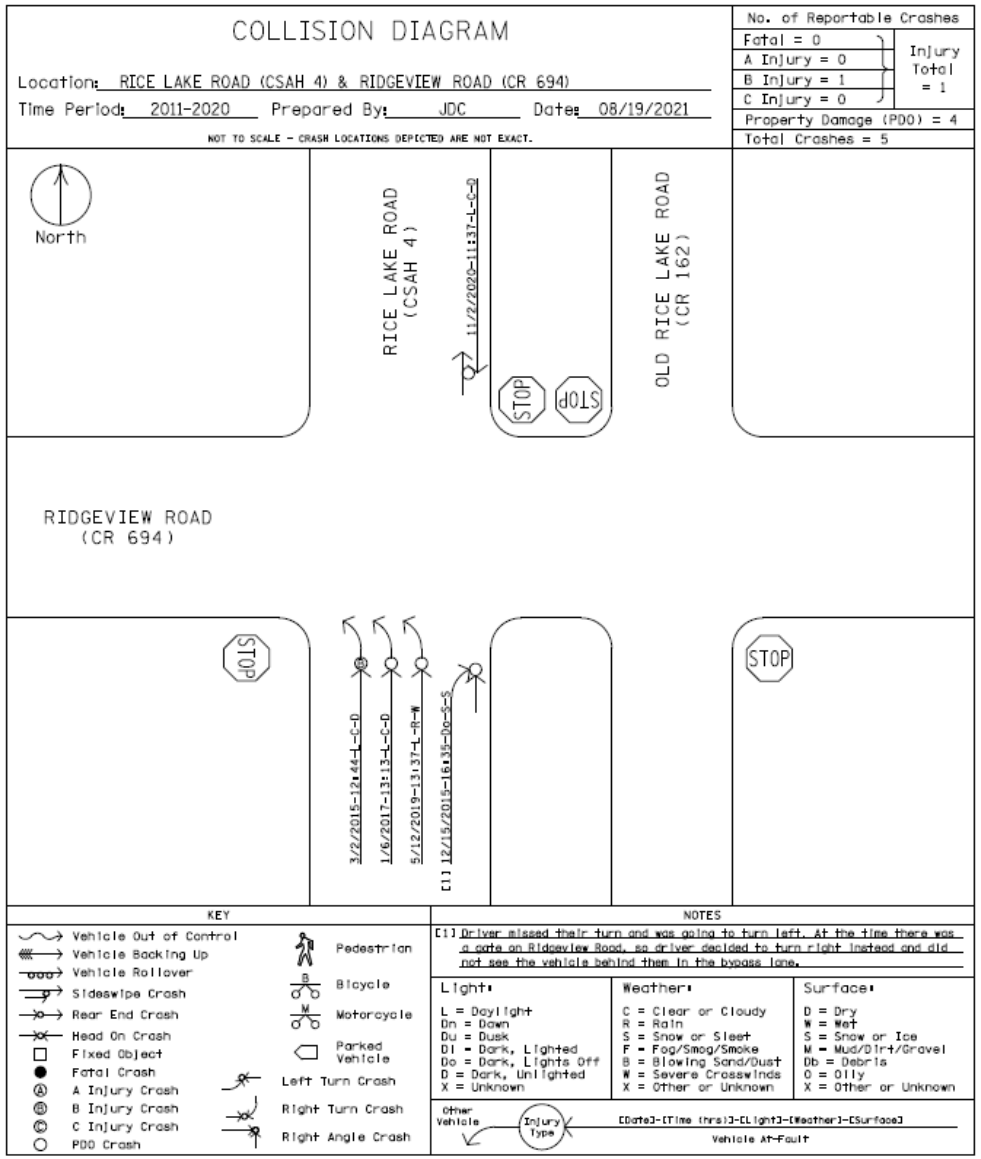
February 11, 2022

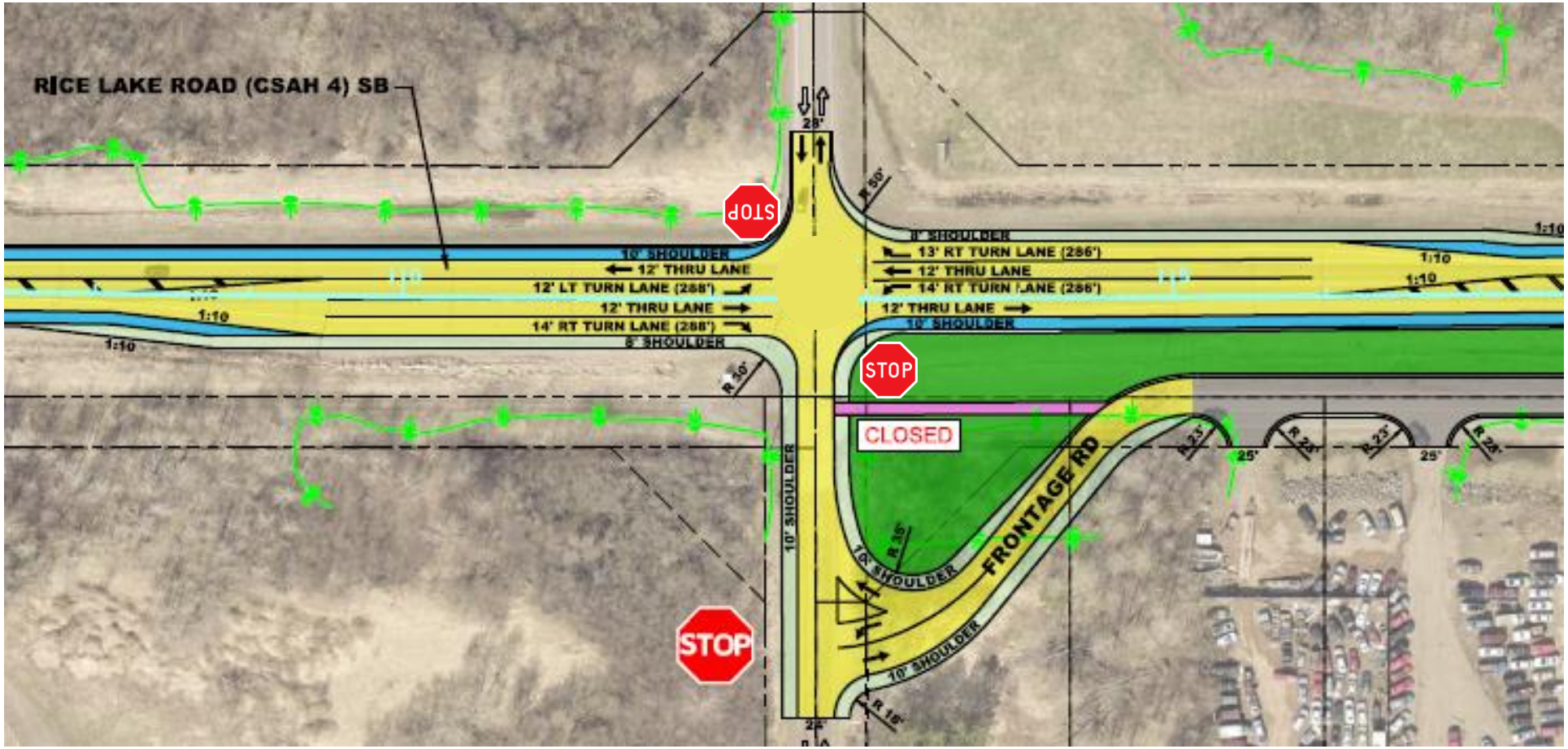
Ridgeview Road (CR 694)
ICE Summary



Ridgeview Road (CR 694)
ICE Summary

- Intersection Alternatives Analyzed
  - Construct a ¾ access intersection (maintain side-street STOP control)
  - Install dedicated turn lanes on Rice Lake Rd (maintain side-street STOP control)
  - Single Lane Roundabout
- Decision Points
  - ¾ access intersection and dedicated turn lanes have similar traffic delay present and future (slightly higher delay for ¾ access intersection)
  - ¾ access intersection and dedicated turn lanes have equivalent benefit/cost ratios (0.9) whereas a roundabout has a negative benefit/cost ratio assuming no future commercial development occurs
  - Roundabout has a benefit/cost ratio >1.0 only if significant commercial development occurs
  - ¾ access intersection would prevent left-turn movements from the side-street
  - Dedicated turn lanes would address the rear-end crash pattern
  - Dedicated turn lanes would maintain full access for the intersection
- Recommendation: Dedicated Turn Lanes on Rice Lake Road

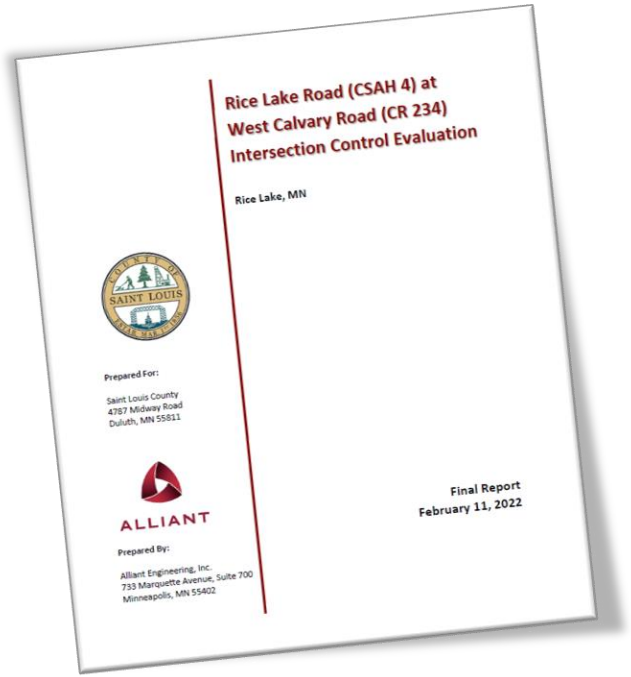
Ridgeview Road (CR 694)
ICE Summary



Conceptual layout

West Calvary Road (CR 234)
ICE Summary

- Known Issues
  - Periods of unacceptable delay on West Calvary Rd waiting to turn left onto Rice Lake Rd
  - Intersection of Old Rice Lake Rd and West Calvary Rd very close proximity to Rice Lake Rd
- Current Site Conditions
  - Side-street STOP control
  - Dedicated right-turn lane serving northbound traffic
- Safety Review
  - Crash rate (2011-2020) is less than statewide average
  - K/A crash rate (2011-2020) is greater than statewide average but less than the critical rate
  - No predominate crash type (mixture)
- All-Way Stop and Signal Warrant Analysis
  - Does not satisfy warrants for an all-way stop → do not implement
  - Does not satisfy warrants for a traffic signal → do not implement


Rice Lake Road (CSAH 4) at
West Calvary Road (CR 234)
Intersection Control Evaluation

Rice Lake, MN

Prepared For:

Saint Louis County
4787 Midway Road
Duluth, MN 55811

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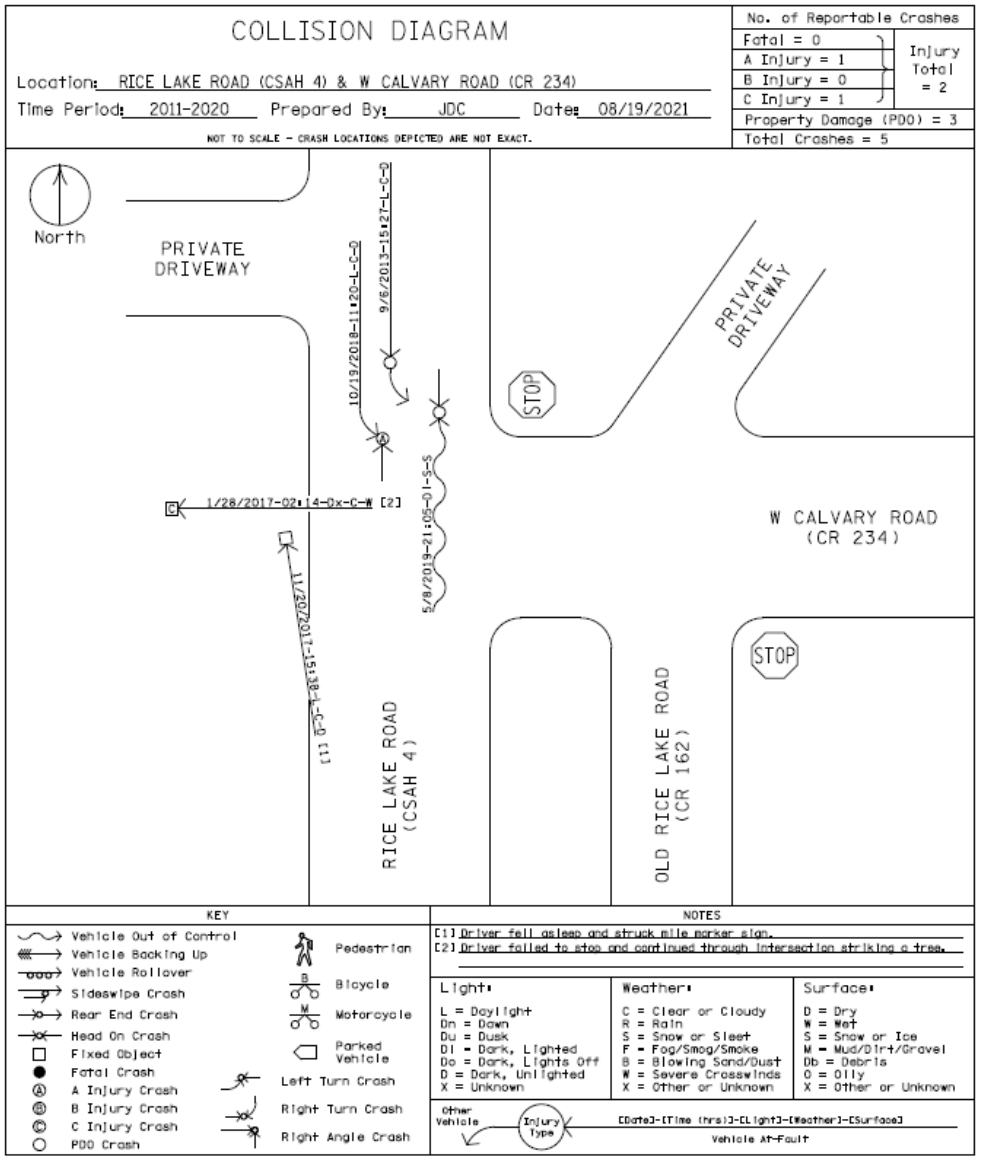
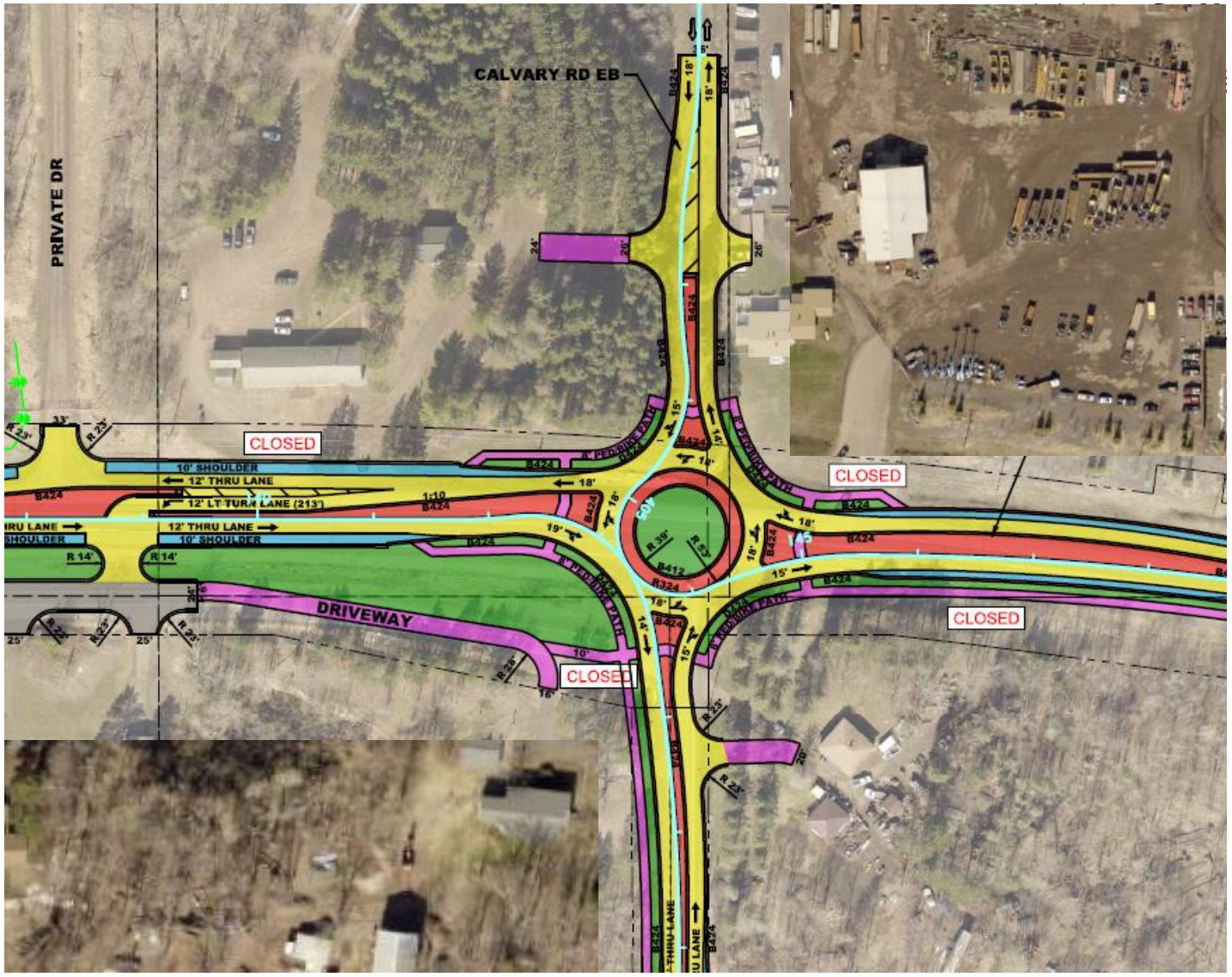
West Calvary Road (CR 234)
ICE Summary



West Calvary Road (CR 234)
ICE Summary

- Intersection Alternatives Analyzed
  - Intersection improvements (e.g. LED STOP Signs and dedicated left-turn lane, remain side-street STOP control)
  - Single Lane Roundabout
  - Continuous-T Intersection
- Decision Points
  - Continuous-T intersection does not allow full access on the west side of Rice Lake Rd
  - Intersection improvements and Continuous-T intersection fail sooner than a roundabout based upon future development scenarios
  - All alternatives have benefit/cost ratios > 1.0 assuming no future commercial development occurs; if development occurs, only the Continuous-T intersection and roundabout have benefit/cost ratios >1.0
  - Continuous-T intersection does not calm traffic and still includes a potential for a high-speed right-angle crash
  - Roundabout eliminates high-speed right-angle conflict points
  - Continuous-T intersection side-street traffic must still wait for gap in northbound traffic; roundabout equalizes right-of-way for all legs (first come, first serve)
  - Roundabout promotes traffic calming on the corridor
- Recommendation: Single Lane Roundabout

West Calvary Road (CR 234)
ICE Summary



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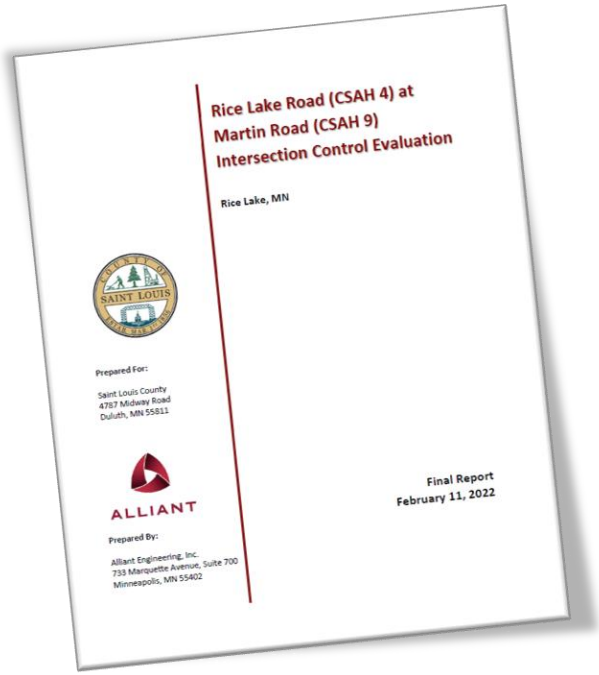
Conceptual layout

Martin Road (CSAH 9)
ICE Study Summary

- Known Issues
  - Periods of unacceptable delay on Rice Lake Road (especially northbound PM peak hour)
  - Limited intersection capacity for future traffic growth and commercial development
  - Traffic queue occasionally blocks driveways
- Current Site Conditions
  - All-Way STOP control
  - Dedicated right-turn lanes on all legs
- Safety Review
  - Crash rate (2011-2020) is less than statewide average
  - No fatalities or serious injuries in this time period
  - Crash types were right-angle (n=6) and rear-end (n=5)
- All-Way Stop and Signal Warrant Analysis
  - Satisfies warrants for an all-way stop → consider in the analysis
  - Satisfies warrants for a traffic signal → consider in the analysis


Rice Lake Road (CSAH 4) at
Martin Road (CSAH 9)
Intersection Control Evaluation

Rice Lake, MN

Prepared For:

Saint Louis County
4787 Midway Road
Duluth, MN 55811

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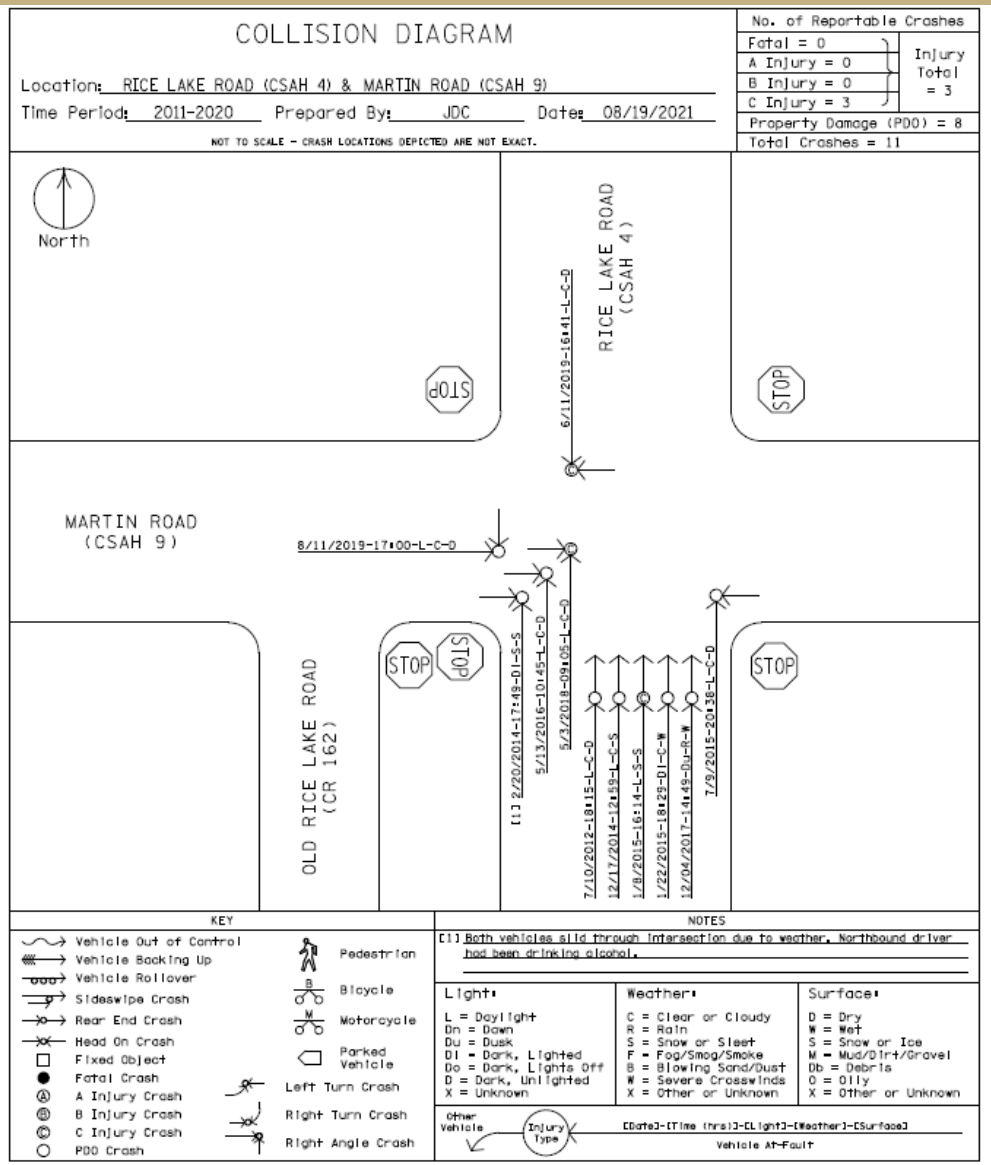
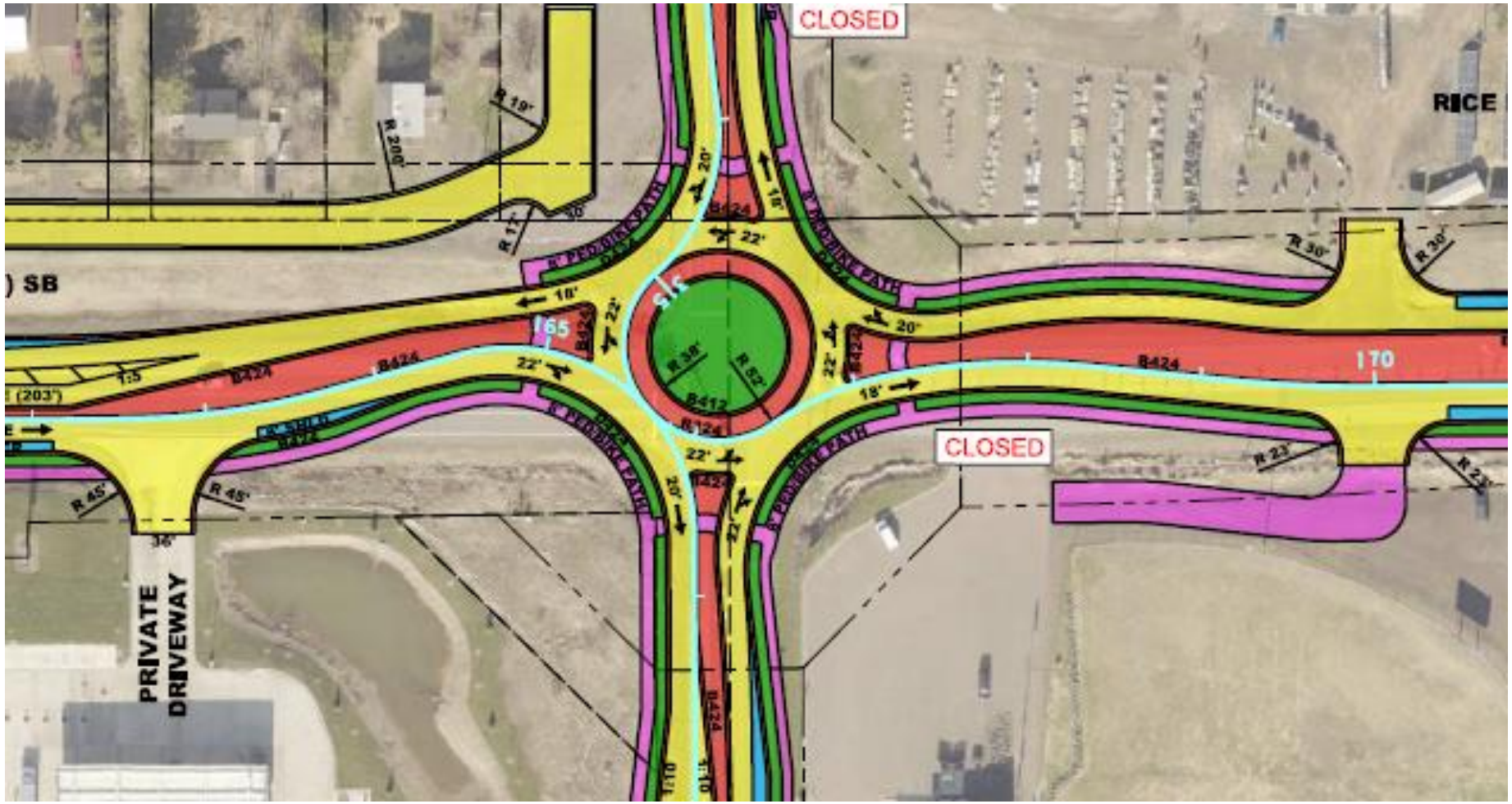
Martin Road (CSAH 9)
ICE Study Summary



Martin Road (CSAH 9)
ICE Study Summary

- Intersection Alternatives Analyzed
  - Intersection improvements (dedicated left-turn lanes on north/south legs, remain all-way stop)
  - Traffic Signal (dedicated left-turn and right-turn lanes on all legs)
  - Single Lane Roundabout
- Decision Points
  - Intersection improvements fail within the expected service life without including commercial development
  - Roundabout has the lowest delay for all future traffic growth and commercial development scenarios
  - The traffic signal and roundabout have benefit/cost ratios > 1.0 assuming no future commercial development occurs; if development occurs, the roundabout has the greater benefit/cost ratio
  - Traffic signal results in artificial delay due to the signal phase
  - Traffic signal does not calm traffic and still includes a potential for a high-speed right-angle crash
  - Roundabout eliminates high-speed right-angle conflict points
  - Roundabout promotes traffic calming on the corridor
- Recommendation: Single Lane Roundabout

Martin Road (CSAH 9)
ICE Study Summary



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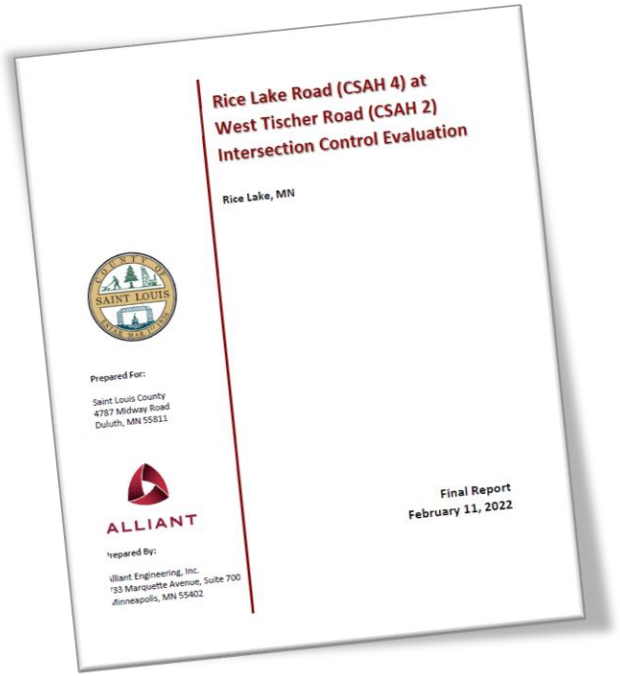
Conceptual layout

West Tischer Road (CSAH 2)
ICE Study Summary

- Known Issues
  - Potentially influenced by future development on the Rice Lake Road corridor
- Current Site Conditions
  - Side-street STOP control
  - Dedicated right-turn lane serving northbound traffic
- Safety Review
  - No reported crashes (2011-2020)
- All-Way Stop and Signal Warrant Analysis
  - Does not satisfy warrants for an all-way stop → do not implement
  - Does not satisfy warrants for a traffic signal → do not implement


Rice Lake Road (CSAH 4) at
West Tischer Road (CSAH 2)
Intersection Control Evaluation

Rice Lake, MN

Prepared For:

Saint Louis County
4787 Midway Road
Duluth, MN 55811

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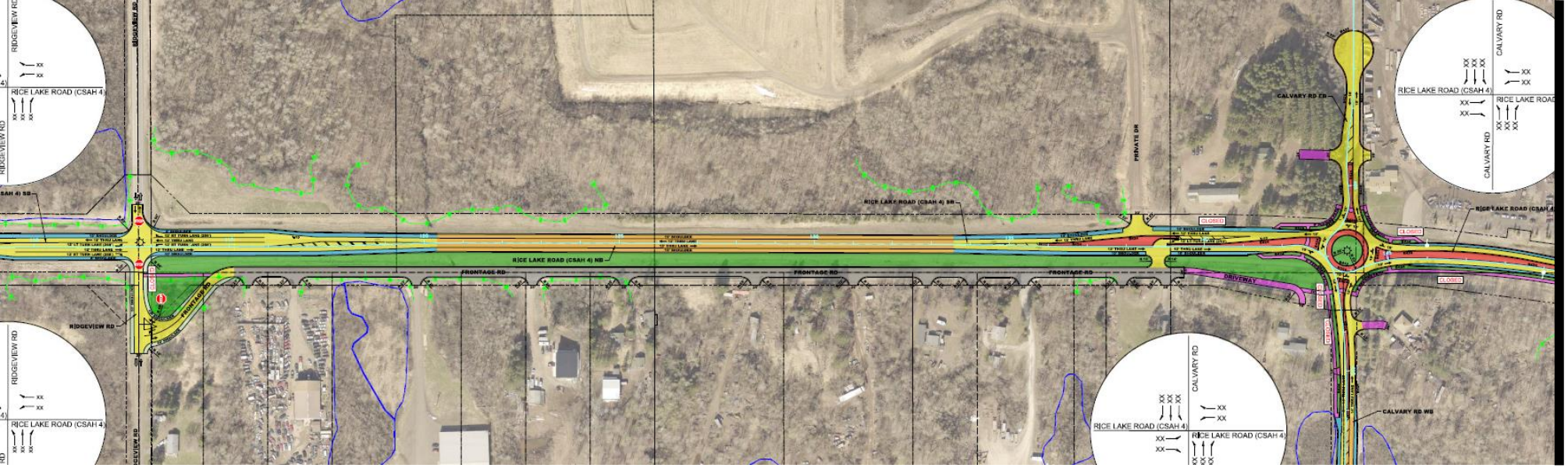
February 11, 2022

West Tischer Road (CSAH 2)
ICE Study Summary

- Intersection Alternatives Analyzed
  - Do Nothing
  - Intersection improvements (turn lanes)
- Decision Points
  - Do nothing and intersection improvements have equivalent delays (present and future) at LOS = A
  - Intersection improvements has a negative benefit/cost ratio assuming no future commercial development occurs; if development occurs, intersection improvements has a benefit/cost ratio <1.0
- Recommendation: Do Nothing



Break Line

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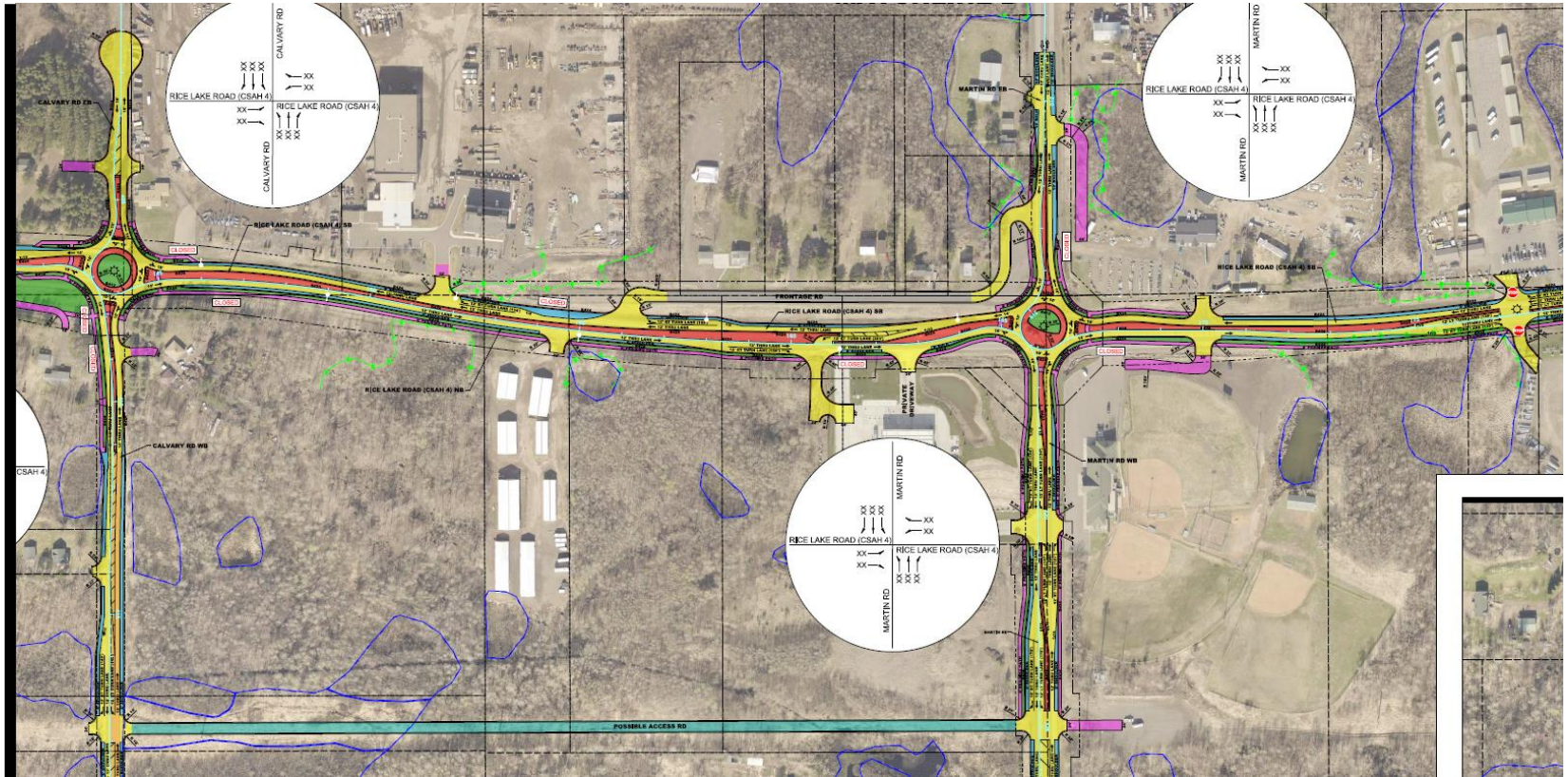
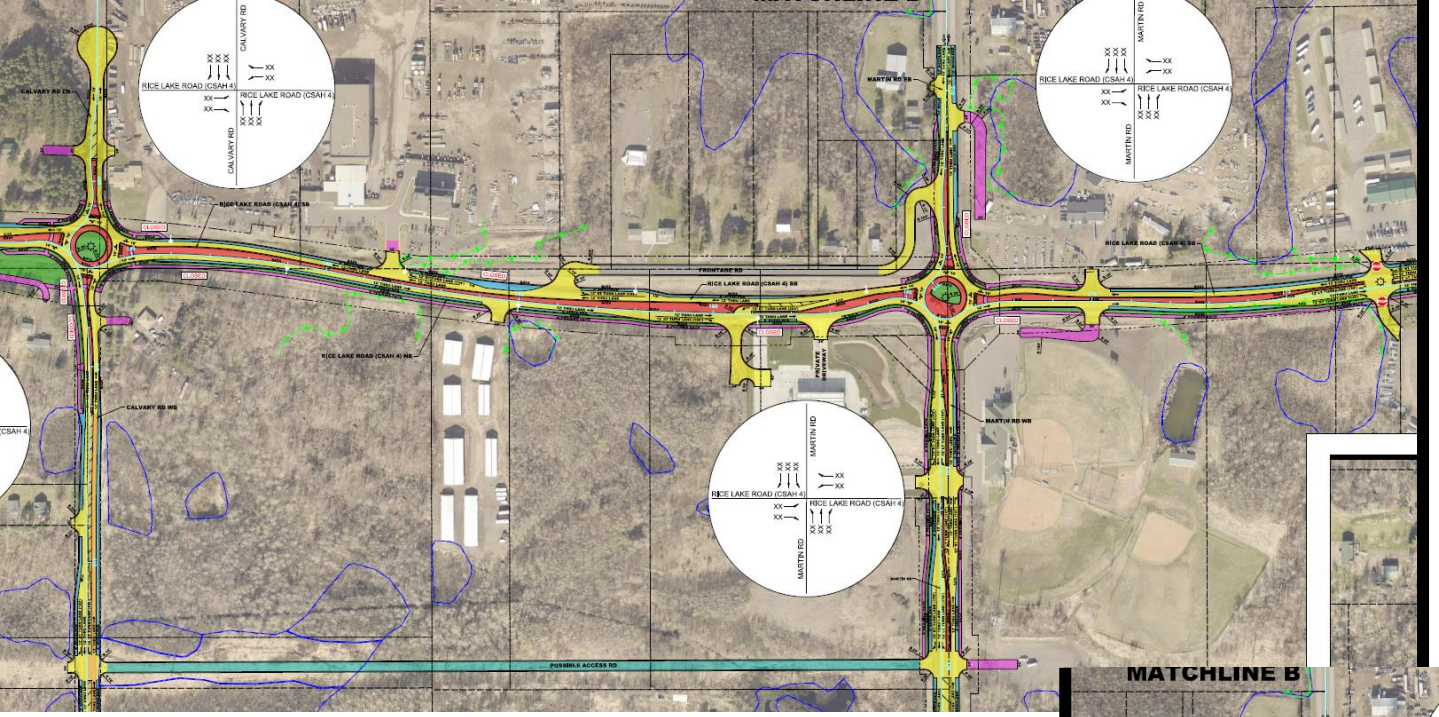
Break Line





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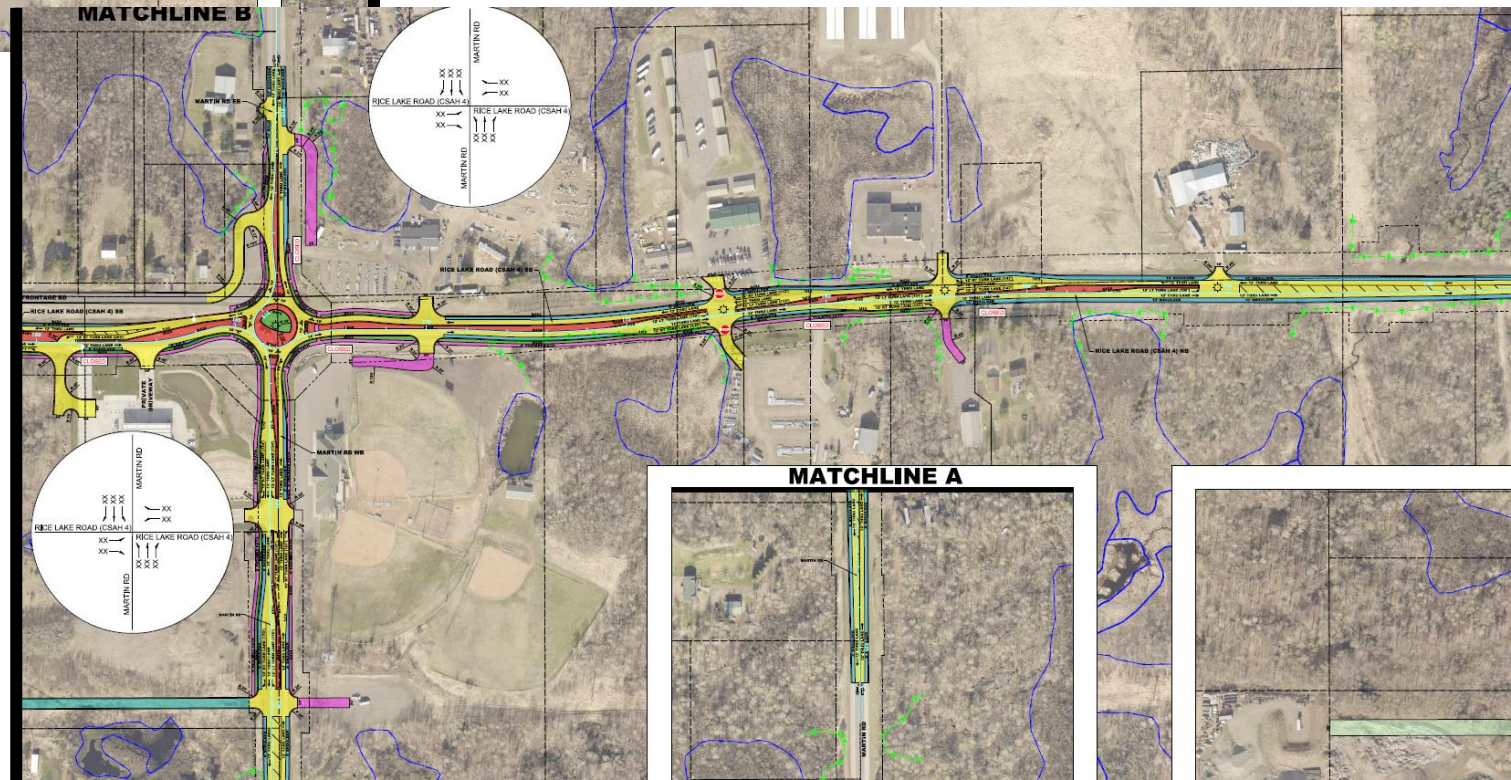

Break Line

Questions/Comments/Discussion

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Appendix Slides

Ridgeview Road (CR 694)
ICE Summary

Table 1. Crash Rate Summary – Ridgeview Road Intersection

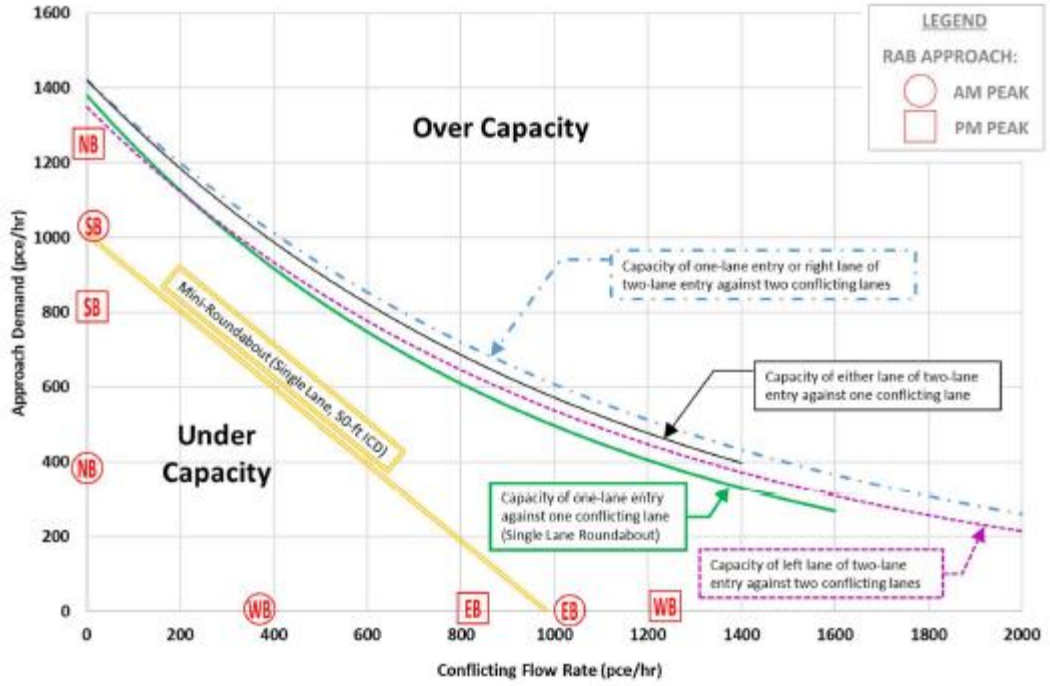
Intersection Crash Analysis (2011-2020)		Rate Category [3]	Crash	Severity	K/A
Traffic Control	Through/Stop Rural	Intersection	0.14	0.20	0.00
Total Crashes [1]	5	State Average [4]	0.27	0.43	1.14
Total Entering Volume [2]	35,344,167	Critical [5]	0.50	0.59	4.87
K/A Crashes	0	Critical Index	0.28	0.34	0.00

1: Crash data obtained from MnCMAT2 and detailed crash narratives.
2: AADT obtained from MnDOT's Traffic Mapping Application.
3: Severity rate factors: 5 for Fatal (Type K) crashes, 4 for Type A, 3 for Type B, 2 for Type C, and 1 for PDO crashes.
4: MnDOT's 2015 Green Sheets were used to determine state average rates.
5: A confidence level of 99% was assumed for critical crash rate and 90% assumed for critical severity and K/A rates.

Table 2. Signal Warrant Analysis Summary

Scenario	Warrant 1 - Eight-Hour Vehicular Volumes				Warrant 2 - Four-Hour Vehicular Volumes		Warrant 3 - Peak Hour		Warrant 7 - Crash History		
	1A	1B	1C	Met?	Hours	Met?	3B	Met?	7B	7C	Met?
Existing 2021	0	0	0	No	0	No	0	No	0	5	No
Foreast 2042 0%	0	2	0	No	0	No	0	No	0	7	No
Foreast 2042 100%	0	2	0	No	0	No	0	No	0	7	No

Figure 14. Planning Level Roundabout Capacity Analysis (Continued)



Forecast Year 2042 100% Build-out Roundabout Capacity Analysis - Rice Lake Rd. & Ridgeview Rd.

Ridgeview Road (CR 694)
ICE Summary

Table 3. Safety Analysis Summary (Year 2042 Estimate)

	ALT 0 (No Build)	ALT 1A (Turn Lanes)[1]	ALT 1B (3/4 Access)[1]	ALT 4 (RAB)[2]
	Observed	Estimated		
Crash Rate (Crashes/MEV)	0.14	0.11	0.11	0.32
Injury Crashes (Percent of Total Crashes)	20.0%	18.6%	18.6%	24.5%
2042 Estimated Crash Cost (2021 Dollars)	$31,666	$23,510	$23,510	$66,989

[1] Estimated using Crash Modification Factor (CMF) from the CMF Clearinghouse

[2] Estimated from statewide averages in *A Study of the Traffic Safety at Roundabouts in Minnesota (Oct. 2017)*

Table 5. Operations Analysis Summary

Alternative	Scenario	AM Peak Hour		PM Peak Hour	
		LOS[1]	Delay (s)[2]	LOS[1]	Delay (s)[2]
Alt 0: No Build Alt 1B: 3/4 Access Intersection	Existing Year 2021	A / A	2.4 / 5.1	A / B	3.9 / 10.2
	Forecast Year 2032 0% Build	A / A	2.8 / 9.1	A / A	4.3 / 8.1
	Forecast Year 2032 50% Build	A / A	3.0 / 5.7	D / F	34.8 / 51.6
	Forecast Year 2032 100% Build	A / A	3.0 / 9.4	F / F	248.2 / 385.5
	Forecast Year 2042 0% Build	A / A	2.9 / 6.7	A / A	4.2 / 9.4
	Forecast Year 2042 50% Build	A / A	3.1 / 5.5	F / F	61.7 / 92.2
	Forecast Year 2042 100% Build	A / A	2.8 / 8.7	F / F	268.8 / 422.5
Alt 1A: Mainline Dedicated Turn Lanes	Existing Year 2021	A / A	2.3 / 6.4	A / B	3.7 / 10.1
	Forecast Year 2032 0% Build	A / A	2.6 / 9.0	A / A	4.0 / 8.7
	Forecast Year 2032 50% Build	A / A	2.8 / 5.8	A / B	5.8 / 11.8
	Forecast Year 2032 100% Build	A / A	2.9 / 9.6	F / F	289.9 / 490.0
	Forecast Year 2042 0% Build	A / A	2.8 / 6.0	A / A	3.9 / 7.9
	Forecast Year 2042 50% Build	A / A	3.0 / 6.8	D / E	29.8 / 44.2
	Forecast Year 2042 100% Build	A / A	2.7 / 9.0	F / F	324.0 / 566.7
Alt 4: Roundabout	Existing Year 2021	A / A	2.7 / 5.4	A / A	3.0 / 3.0
	Forecast Year 2032 0% Build	A / A	3.0 / 3.3	A / A	3.4 / 3.5
	Forecast Year 2032 50% Build	A / A	3.5 / 6.7	A / A	6.4 / 7.3
	Forecast Year 2032 100% Build	A / A	4.7 / 7.3	F / F	57.6 / 101.9
	Forecast Year 2042 0% Build	A / A	3.1 / 5.4	A / A	3.8 / 4.0
	Forecast Year 2042 50% Build	A / A	4.0 / 4.3	A / A	9.0 / 10.0
	Forecast Year 2042 100% Build	A / A	4.9 / 5.3	F / F	66.7 / 121.6

[1] Overall Intersection LOS / Worst Approach LOS

[2] Overall Intersection Delay / Worst Approach Delay

Table 6. Construction Cost Estimate Summary

Alternative	Construction Cost Estimate (2021 Dollars)	Comments
Alternative 1A Intersection Improvements	$500,000	Construct NB right-turn lane and SB left-turn lane
Alternative 1B 3/4 Access Intersection	$250,000	Construct median on WB Ridgeview Road
Alternative 4 Single-Lane Roundabout	$2,000,000	Full reconstruction

Table 7. 20-Year (2021-2042) Benefit/Cost Analysis Summary for 0% Build Volumes

	Alternative 1A Intersection Improvements	Alternative 1B 3/4 Access Intersection	Alternative 4 Single-Lane Roundabout
Total Traffic Operation Benefit	$ 163,254	$ -	$ 288,468
Total Safety Benefit	$ 157,112	$ 150,067	$ (680,486)
Total Cost[1]	$ 344,527	$ 176,157	$ 1,397,576
Benefit to Cost Ratio	**0.9**	**0.9**	**-0.3**

[1] Total cost is a 20-year estimate (2021-2042) that includes the discounted construction cost plus professional fees minus the remaining capital value at the end of the analysis period.

Table 8. 20-Year (2021-2042) Benefit/Cost Analysis Summary for 100% Build Volumes

	Alternative 1A Intersection Improvements	Alternative 1B 3/4 Access Intersection	Alternative 4 Single-Lane Roundabout
Total Traffic Operation Benefit	$ (40,284,246)	$ -	$ 82,829,488
Total Safety Benefit	$ 157,112	$ 150,067	$ (680,486)
Total Cost[1]	$ 344,527	$ 176,157	$ 1,397,576
Benefit to Cost Ratio	**-116.5**	**0.9**	**58.8**

[1] Total cost is a 20-year estimate (2021-2042) that includes the discounted construction cost plus professional fees minus the remaining capital value at the end of the analysis period.

West Calvary Road (CR 234)
ICE Summary

Table 1. Crash Rate Summary – West Calvary Road Intersection

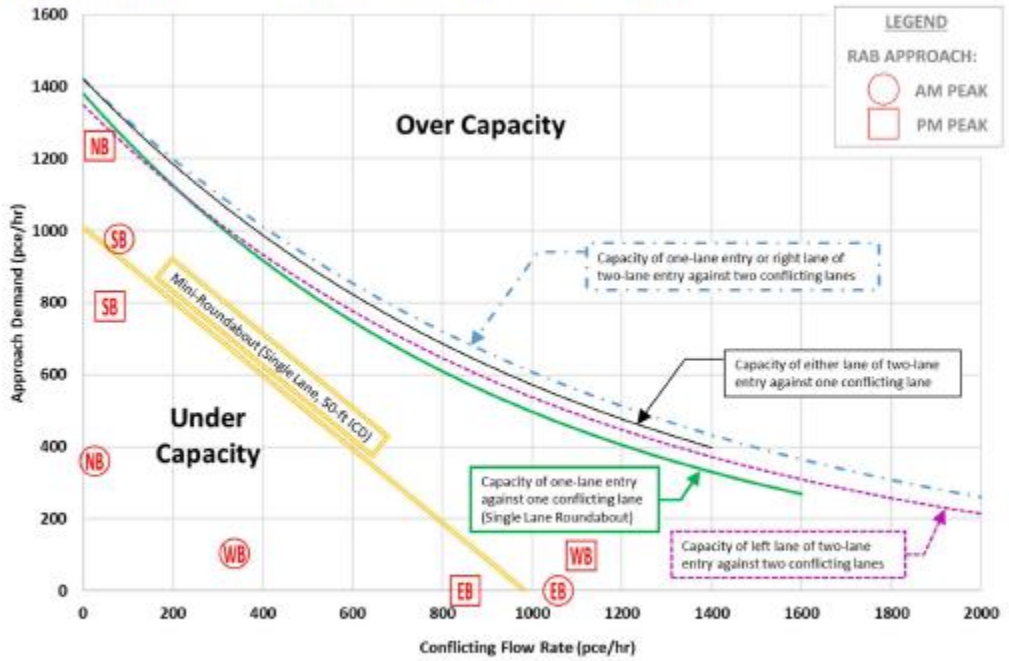
Intersection Crash Analysis (2011-2020)		Rate Category [3]	Crash	Severity	K/A
Traffic Control	Through/Stop Rural	Intersection	0.14	0.24	2.70
Total Crashes [1]	5	State Average [4]	0.27	0.43	1.14
Total Entering Volume [2]	36,986,667	Critical [5]	0.50	0.59	4.75
K/A Crashes	1	Critical Index	0.27	0.41	0.57

1: Crash data obtained from MnCMAT2 and detailed crash narratives.
2: AADT obtained from MnDOT's Traffic Mapping Application.
3: Severity rate factors: 5 for Fatal (Type K) crashes, 4 for Type A, 3 for Type B, 2 for Type C, and 1 for PDO crashes.
4: MnDOT's 2015 Green Sheets were used to determine state average rates.
5: A confidence level of 99% was assumed for critical crash rate and 90% assumed for critical severity and K/A rates.

Table 2. Signal Warrant Analysis Summary

Scenario	Warrant 1 - Eight-Hour Vehicular Volumes				Warrant 2 - Four-Hour Vehicular Volumes		Warrant 3 - Peak Hour		Warrant 7 - Crash History		
	1A	1B	1C	Met?	Hours	Met?	3B	Met?	7B	7C	Met?
Existing 2021	0	2	0	No	1	No	0	No	1	8	No
Foreast 2042 0%	0	3	0	No	1	No	0	No	1	10	No
Foreast 2042 100%	0	4	2	No	3	No	2	Yes	1	11	No

Figure 14. Planning Level Roundabout Capacity Analysis (Continued)



Forecast Year 2042 100% Build-out Roundabout Capacity Analysis - Rice Lake Rd. & W Calvary Rd.

Source: Highway Capacity Manual, 6th Edition, Chapter 22 Roundabouts

West Calvary Road (CR 234)
ICE Summary

Table 3. Safety Analysis Summary (Year 2042 Estimate)

	ALT 0 (No Build)	ALT 1 (SB LTL)[1]	ALT 4 (RAB)[2]	ALT 5 (Green-T)[3]
	Observed	Estimated		Forecasted
Crash Rate (Crashes/MEV)	0.14	0.12	0.32	0.10
Injury Crashes (Percent of Total Crashes)	40.0%	37.7%	24.5%	45.2%
2042 Estimated Crash Cost (2021 Dollars)	$102,131	$96,690	$70,143	$95,653

[1] Estimated using Crash Modification Factor (CMF) from the CMF Clearinghouse

[2] Estimated from statewide averages in *A Study of the Traffic Safety at Roundabouts in Minnesota (Oct. 2017)*

[3] Forecasted using a combination of CMFs to approximate multiple intersection improvements

Table 5. Operations Analysis Summary

Alternative	Scenario	AM Peak Hour LOS[1]	AM Peak Hour Delay (s)[2]	PM Peak Hour LOS[1]	PM Peak Hour Delay (s)[2]
Alt 0: No Build	Existing Year 2021	A / A	1.8 / 7.5	A / A	3.3 / 8.9
	Forecast Year 2032 0% Build	A / A	1.8 / 7.9	A / B	3.9 / 13.5
	Forecast Year 2032 50% Build	A / B	2.4 / 10.7	F / F	127.8 / 200.7
	Forecast Year 2032 100% Build	A / B	2.6 / 10.4	F / F	283.6 / 449.7
	Forecast Year 2042 0% Build	A / A	2.2 / 9.6	A / C	7.4 / 20.3
	Forecast Year 2042 50% Build	A / B	2.6 / 12.6	F / F	160.1 / 250.4
	Forecast Year 2042 100% Build	A / B	2.5 / 10.7	F / F	280.6 / 462.6
Alt 1: Thru/Stop w/ Improvements	Existing Year 2021	A / A	1.7 / 8.0	A / A	3.1 / 7.3
	Forecast Year 2032 0% Build	A / A	1.8 / 8.5	A / B	3.5 / 11.3
	Forecast Year 2032 50% Build	A / B	2.2 / 10.9	E / F	41.7 / 61.9
	Forecast Year 2032 100% Build	A / B	2.4 / 11.7	F / F	304.0 / 544.2
	Forecast Year 2042 0% Build	A / A	2.2 / 10.0	A / B	3.4 / 11.1
	Forecast Year 2042 50% Build	A / B	2.4 / 13.3	F / F	110.7 / 173.3
	Forecast Year 2042 100% Build	A / B	2.3 / 10.9	F / F	312.7 / 586.7
Alt 4: Roundabout	Existing Year 2021	A / A	2.3 / 2.5	A / A	3.3 / 3.5
	Forecast Year 2032 0% Build	A / A	2.6 / 2.8	A / A	3.7 / 4.1
	Forecast Year 2032 50% Build	A / A	3.3 / 3.5	A / A	6.7 / 7.7
	Forecast Year 2032 100% Build	A / A	4.7 / 5.0	F / F	137.3 / 265.7
	Forecast Year 2042 0% Build	A / A	2.6 / 2.9	A / A	4.2 / 4.5
	Forecast Year 2042 50% Build	A / A	3.5 / 3.7	B / C	13.7 / 18.7
	Forecast Year 2042 100% Build	A / A	5.0 / 5.4	F / F	147.4 / 294.2
Alt 5: Continuous Green-T	Existing Year 2021	A / A	0.8 / 3.8	A / A	1.0 / 7.4
	Forecast Year 2032 0% Build	A / A	0.9 / 3.9	A / A	1.1 / 8.0
	Forecast Year 2032 50% Build	A / A	0.9 / 4.3	D / F	25.2 / 56.9
	Forecast Year 2032 100% Build	A / A	0.9 / 4.6	F / F	77.9 / 167.5
	Forecast Year 2042 0% Build	A / A	0.9 / 4.2	A / A	1.2 / 8.2
	Forecast Year 2042 50% Build	A / A	0.9 / 4.4	E / F	37.9 / 69.5
	Forecast Year 2042 100% Build	A / A	1.0 / 4.8	F / F	79.5 / 148.5

[1] Overall Intersection LOS / Worst Approach LOS

[2] Overall Intersection Delay / Worst Approach Delay

Table 6. Construction Cost Estimate Summary

Alternative	Construction Cost Estimate (2021 Dollars)	Comments
Alternative 1 Intersection Improvements	$500,000	Construct SB left-turn lane and additional warning devices for WB motorists
Alternative 4 Single-Lane Roundabout	$2,000,000	Full reconstruction
Alternative 5 Continuous-T Intersection	$1,000,000	Construct SB left-turn lane, SB through by-pass lane, and median(s)

Table 7. 20-Year (2021-2042) Benefit/Cost Analysis Summary for 0% Build Volumes

	Alternative 1 Intersection Improvements	Alternative 4 Single-Lane Roundabout	Alternative 5 Continuous-T Intersection
Total Traffic Operation Benefit	$ 1,276,540	$ 860,518	$ 2,953,654
Total Safety Benefit	$ 104,793	$ 616,034	$ 119,169
Total Cost[1]	$ 363,994	$ 1,397,576	$ 765,579
Benefit to Cost Ratio	**3.8**	**1.1**	**4.0**

[1] Total cost is a 20-year estimate (2021-2042) that includes the discounted construction cost plus professional fees minus the remaining capital value at the end of the analysis period.

Table 8. 20-Year (2021-2042) Benefit/Cost Analysis Summary for 100% Build Volumes

	Alternative 1 Intersection Improvements	Alternative 4 Single-Lane Roundabout	Alternative 5 Continuous-T Intersection
Total Traffic Operation Benefit	$ (33,788,636)	$ 47,587,241	$ 90,424,884
Total Safety Benefit	$ 104,793	$ 616,034	$ 119,169
Total Cost[1]	$ 363,994	$ 1,397,576	$ 765,579
Benefit to Cost Ratio	**-92.5**	**34.5**	**118.3**

[1] Total cost is a 20-year estimate (2021-2042) that includes the discounted construction cost plus professional fees minus the remaining capital value at the end of the analysis period.

Martin Road (CSAH 9)
ICE Summary

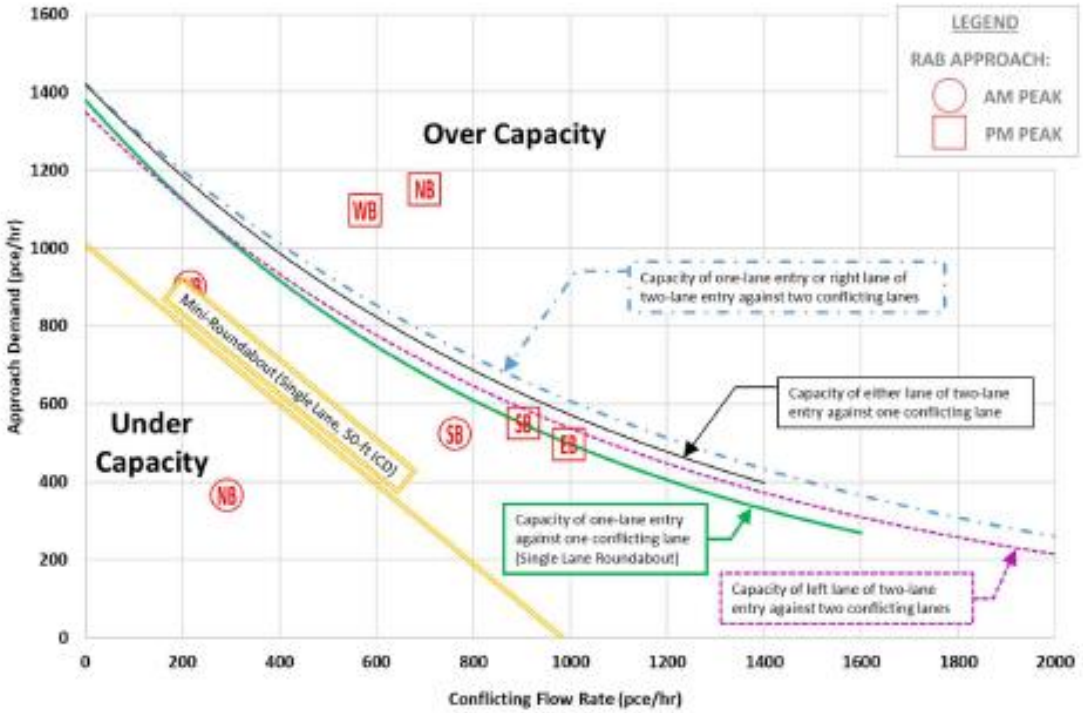
Table 1. Crash Rate Summary – Martin Road Intersection

Intersection Crash Analysis (2011-2020)		Rate Category [3]	Crash	Severity	K/A
Traffic Control	All Way Stop	Intersection	0.23	0.30	0.00
Total Crashes [1]	11	State Average [4]	0.35	0.51	0.60
Total Entering Volume [2]	47,419,583	Critical [5]	0.58	0.65	3.10
K/A Crashes	0	Critical Index	0.40	0.46	0.00

1: Crash data obtained from MnCMAT2 and detailed crash narratives.
2: AADT obtained from MnDOT's Traffic Mapping Application.
3: Severity rate factors: 5 for Fatal (Type K) crashes, 4 for Type A, 3 for Type B, 2 for Type C, and 1 for PDO crashes.
4: MnDOT's 2015 Green Sheets were used to determine state average rates.
5: A confidence level of 99% was assumed for critical crash rate and 90% assumed for critical severity and K/A rates.

Table 2. Signal Warrant Analysis Summary

Scenario	Warrant 1 - Eight-Hour Vehicular Volumes				Warrant 2 - Four-Hour Vehicular Volumes		Warrant 3 - Peak Hour		Warrant 7 - Crash History		
	1A	1B	1C	Met?	Hours	Met?	3B	Met?	7B	7C	Met?
Existing 2021	12	3	7	Yes	4	Yes	1	Yes	2	12	No
Foreast 2042 0%	12	4	11	Yes	6	Yes	2	Yes	2	12	No
Foreast 2042 100%	12	5	11	Yes	7	Yes	4	Yes	2	12	No



Forecast Year 2042 100% Build-out Roundabout Capacity Analysis - Rice Lake Rd. & Martin Rd.

Source: Highway Capacity Manual, 6th Edition, Chapter 22 Roundabouts

Martin Road (CSAH 9)
ICE Summary

Table 3. Safety Analysis Summary (Year 2042 Estimate)

	ALT 0 (No Build)	ALT 1 (NB&SB LTL)[1]	ALT 2 (Signal)[2]	ALT 3 (RAB)[3]
	Observed	Estimated		
Crash Rate (Crashes/MEV)	0.23	0.18	0.45	0.32
Injury Crashes (Percent of Total Crashes)	27.3%	26.4%	37.7%	24.5%
2042 Estimated Crash Cost (2021 Dollars)	$53,609	$39,540	$206,376	$92,476

[1] Estimated using Crash Modification Factor (CMF) from the CMF Clearinghouse
[2] Estimated from statewide averages in MnDOT 2011 and 2015 Intersection Green Sheets (Low Volume, High Speed)
[3] Estimated from statewide averages in *A Study of the Traffic Safety at Roundabouts in Minnesota (Oct. 2017)*

Table 6. Construction Cost Estimate Summary

Alternative	Construction Cost Estimate (2021 Dollars)	Comments
Alternative 1 Intersection Improvements	$500,000	Construct NB and SB left-turn lanes
Alternative 2 Traffic Signal	$1,000,000	Full reconstruction, new signal system
Alternative 3 Single-Lane Roundabout	$2,500,000	Full reconstruction

Table 5. Operations Analysis Summary

Alternative	Scenario	AM Peak Hour LOS[1]	AM Peak Hour Delay (s)[2]	PM Peak Hour LOS[1]	PM Peak Hour Delay (s)[2]
Alt 0: No Build	Existing Year 2021	B / C	13.3 / 18.0	D / E	27.0 / 39.4
	Forecast Year 2032 0% Build	C / D	19.2 / 28.8	F / F	52.8 / 93.6
	Forecast Year 2032 50% Build	F / F	119.2 / 249.5	F / F	351.4 / 805.9
	Forecast Year 2032 100% Build	F / F	382.0 / 808.8	F / F	576.7 / 1050.0
	Forecast Year 2042 0% Build	C / E	24.3 / 40.3	F / F	94.0 / 177.5
	Forecast Year 2042 50% Build	F / F	182.6 / 355.3	F / F	404.6 / 861.3
	Forecast Year 2042 100% Build	F / F	426.6 / 885.6	F / F	642.1 / 1106.1
Alt 1: AWS w/ Improvements	Existing Year 2021	B / C	13.5 / 18.2	C / C	18.2 / 19.8
	Forecast Year 2032 0% Build	C / D	19.0 / 28.5	D / D	25.8 / 29.3
	Forecast Year 2032 50% Build	F / F	95.6 / 219.1	F / F	314.8 / 788.8
	Forecast Year 2032 100% Build	F / F	320.8 / 778.3	F / F	468.4 / 1062.9
	Forecast Year 2042 0% Build	C / E	22.9 / 36.4	E / F	41.2 / 60.4
	Forecast Year 2042 50% Build	F / F	151.8 / 344.1	F / F	348.5 / 859.5
	Forecast Year 2042 100% Build	F / F	344.9 / 861.0	F / F	509.4 / 1153.5
Alt 2: Traffic Signal	Existing Year 2021	B / B	15.3 / 19.6	B / C	18.1 / 26.0
	Forecast Year 2032 0% Build	B / C	17.1 / 24.0	B / C	19.6 / 27.3
	Forecast Year 2032 50% Build	D / F	45.2 / 94.8	F / F	157.7 / 467.5
	Forecast Year 2032 100% Build	F / F	213.2 / 478.2	F / F	306.5 / 1228.3
	Forecast Year 2042 0% Build	B / C	19.1 / 27.7	C / C	21.1 / 29.3
	Forecast Year 2042 50% Build	D / F	50.8 / 106.9	F / F	157.8 / 481.1
	Forecast Year 2042 100% Build	F / F	227.3 / 530.5	F / F	329.4 / 1304.2
Alt 3: Roundabout	Existing Year 2021	A / A	2.8 / 3.7	A / A	4.4 / 5.4
	Forecast Year 2032 0% Build	A / A	3.1 / 4.4	A / A	5.3 / 6.8
	Forecast Year 2032 50% Build	A / A	4.5 / 6.6	C / D	19.3 / 34.9
	Forecast Year 2032 100% Build	A / B	8.0 / 14.6	F / F	103.7 / 249.0
	Forecast Year 2042 0% Build	A / A	3.2 / 4.7	A / A	5.8 / 7.6
	Forecast Year 2042 50% Build	A / A	5.1 / 8.3	E / F	43.3 / 98.3
	Forecast Year 2042 100% Build	A / C	9.2 / 16.1	F / F	110.3 / 265.8

[1] Overall Intersection LOS / Worst Approach LOS
[2] Overall Intersection Delay / Worst Approach Delay

Table 7. 20-Year (2021-2042) Benefit/Cost Analysis Summary for 0% Build Volumes

	Alternative 1 Intersection Improvements	Alternative 2 Traffic Signal	Alternative 3 Single-Lane Roundabout
Total Traffic Operation Benefit	$ 27,684,840	$ 33,598,632	$ 50,973,169
Total Safety Benefit	$ 267,161	$ (2,900,957)	$ (738,052)
Total Cost[1]	$ 344,527	$ 776,589	$ 1,768,016
Benefit to Cost Ratio	**81.1**	**39.5**	**28.4**

[1] Total cost is a 20-year estimate (2021-2042) that includes the discounted construction cost plus professional fees minus the remaining capital value at the end of the analysis period.

Table 8. 20-Year (2021-2042) Benefit/Cost Analysis Summary for 100% Build Volumes

	Alternative 1 Intersection Improvements	Alternative 2 Traffic Signal	Alternative 3 Single-Lane Roundabout
Total Traffic Operation Benefit	$ 418,265,454	$ 210,389,175	$ 573,796,856
Total Safety Benefit	$ 267,161	$ (2,900,957)	$ (738,052)
Total Cost[1]	$ 344,527	$ 776,589	$ 1,768,016
Benefit to Cost Ratio	**1214.8**	**267.2**	**324.1**

[1] Total cost is a 20-year estimate (2021-2042) that includes the discounted construction cost plus professional fees minus the remaining capital value at the end of the analysis period.

West Tischer Road (CSAH 2)
ICE Summary

Table 1. Crash Rate Summary – West Tischer Road Intersection

Intersection Crash Analysis (2011-2020)		Rate Category [3]	Crash	Severity	K/A
Traffic Control	Through/Stop Rural	Intersection	0.00	0.00	0.00
Total Crashes [1]	0	State Average [4]	0.27	0.43	1.14
Total Entering Volume [2]	21,681,000	Critical [5]	0.57	0.64	6.40
K/A Crashes	0	Critical Index	0.00	0.00	0.00

1: Crash data obtained from MnCMAT2 and detailed crash narratives.
2: AADT obtained from MnDOT's Traffic Mapping Application.
3: Severity rate factors: 5 for Fatal (Type K) crashes, 4 for Type A, 3 for Type B, 2 for Type C, and 1 for PDO crashes.
4: MnDOT's 2015 Green Sheets were used to determine state average rates.
5: A confidence level of 99% was assumed for critical crash rate and 90% assumed for critical severity and K/A rates.

Table 2. Signal Warrant Analysis Summary

Scenario	Warrant 1 - Eight-Hour Vehicular Volumes				Warrant 2 - Four-Hour Vehicular Volumes		Warrant 3 - Peak Hour		Warrant 7 - Crash History		
	1A	1B	1C	Met?	Hours	Met?	3B	Met?	7B	7C	Met?
Existing 2021	0	0	0	No	0	No	0	No	0	2	No
Foreast 2042 0%	0	0	0	No	0	No	0	No	0	4	No
Foreast 2042 100%	0	3	0	No	2	No	0	No	0	5	No

West Tischer Road (CSAH 2)
ICE Summary

Table 3. Safety Analysis Summary (Year 2042 Estimate)

	ALT 0 (No Build)	ALT 1 (WB RTL)[1]
	Observed	Estimated
Crash Rate (Crashes/MEV)	0.00	0.00
Injury Crashes (Percent of Total Crashes)	0.0%	0.0%
2042 Estimated Crash Cost (2021 Dollars)	$0	$0

[1] Estimated using Crash Modification Factor (CMF) from the CMF Clearinghouse

Table 5. Operations Analysis Summary

Alternative	Scenario	AM Peak Hour		PM Peak Hour	
		LOS[1]	Delay (s)[2]	LOS[1]	Delay (s)[2]
Alt 0: No Build	Existing Year 2021	A / A	2.2 / 4.9	A / A	2.0 / 5.6
	Forecast Year 2032 0% Build	A / A	2.4 / 4.7	A / A	2.1 / 6.0
	Forecast Year 2032 50% Build	A / A	2.5 / 4.8	A / A	2.4 / 7.3
	Forecast Year 2032 100% Build	A / A	2.7 / 5.4	A / A	2.8 / 7.0
	Forecast Year 2042 0% Build	A / A	2.6 / 4.6	A / A	2.2 / 5.7
	Forecast Year 2042 50% Build	A / A	2.6 / 5.3	A / A	2.7 / 8.1
	Forecast Year 2042 100% Build	A / A	2.8 / 5.3	A / A	3.5 / 9.5
Alt 1: Thru/Stop w/ Improvements	Existing Year 2021	A / A	2.3 / 4.9	A / A	2.1 / 6.4
	Forecast Year 2032 0% Build	A / A	2.4 / 4.6	A / A	2.1 / 6.7
	Forecast Year 2032 50% Build	A / A	2.4 / 4.9	A / A	2.4 / 7.3
	Forecast Year 2032 100% Build	A / A	2.6 / 5.1	A / A	2.8 / 7.7
	Forecast Year 2042 0% Build	A / A	2.6 / 4.7	A / A	2.3 / 6.7
	Forecast Year 2042 50% Build	A / A	2.5 / 5.3	A / A	2.7 / 8.7
	Forecast Year 2042 100% Build	A / A	2.7 / 5.6	A / A	3.0 / 7.7

[1] Overall Intersection LOS / Worst Approach LOS
[2] Overall Intersection Delay / Worst Approach Delay

Table 6. Construction Cost Estimate Summary

Alternative	Construction Cost Estimate (2021 Dollars)	Comments
Alternative 1 Intersection Improvements	$500,000	Construct SB and WB left-turn lanes

Table 7. 20-Year (2021-2042) Benefit/Cost Analysis Summary for 0% Build Volumes

	Alternative 1 Intersection Improvements	
Total Traffic Operation Benefit	$	(37,781)
Total Safety Benefit	$	-
Total Cost[1]	$	344,527
Benefit to Cost Ratio	**-0.1**	

[1] Total cost is a 20-year estimate (2021-2042) that includes the discounted construction cost plus professional fees minus the remaining capital value at the end of the analysis period.

Table 8. 20-Year (2021-2042) Benefit/Cost Analysis Summary for 100% Build Volumes

	Alternative 1 Intersection Improvements	
Total Traffic Operation Benefit	$	127,647
Total Safety Benefit	$	-
Total Cost[1]	$	344,527
Benefit to Cost Ratio	**0.4**	

[1] Total cost is a 20-year estimate (2021-2042) that includes the discounted construction cost plus professional fees minus the remaining capital value at the end of the analysis period.