

Ramsey Gateway Highway 10 Project

Future Conditions Traffic Memo

June, 2019





Table of Contents

Table	e of Contents 2
I.	Introduction
II.	Sunfish Lake Blvd Traffic Analysis3
A.	CAP-X Screening
В.	Detailed Traffic Analysis4
C.	Safety Analysis8
III.	Ramsey Blvd Traffic Analysis9
A.	CAP-X Screening9
В.	Detailed Traffic Analysis10
C.	Safety Analysis
IV.	Highway Access Improvements15
A.	Primary Intersection Spacing15
В.	Secondary Intersection Spacing15
C.	Other Improvements
V.	West End Traffic Analysis16
A.	TH 10 at Jarvis St16
В.	TH 10 at Bowers Dr21
C.	Safety Analysis
VI.	Conclusion







I. Introduction

This memorandum provides future traffic analysis for the Build conditions in Ramsey with the Highway 10 Corridor Improvements project. The project analysis was focused on the intersections of TH 10 at Ramsey Blvd and Sunfish Lake Blvd, but also included an analysis of TH 10 from Jarvis St to Armstrong Blvd. An initial screening of alternatives for each intersection was completed in CAP-X, followed by a more detailed analysis in Synchro/SimTraffic, HCS 7 and VISSIM. This memorandum also summarizes improvements to Highway 10 access spacing.

II. Sunfish Lake Blvd Traffic Analysis

A. CAP-X Screening

CAP-X is a planning level tool that was used to determine if at grade intersection designs or grade separated interchanges would serve the forecasted traffic. It was used as the first step to determine what could work and how long it would be anticipated to function. CAP-X shows the volume to capacity rate (v/c rate) for various intersection and interchange types. The v/c ratio is the total demand volume entering an intersection divided by the theoretical capacity of the intersection or interchange. A v/c ratio less than 0.85 shows adequate capacity is available and no significant delay or queueing is expected. A v/c ratio at or over 1.00 shows that the intersection is over capacity which would show high delay and problematic queuing issues. A v/c ratio between 0.85 and 1.00 would show some delay and queuing. The alternatives analyzed in CAP-X and the results are detailed below.

	0 /											
Dook Hour	2045	2045	2035	2035	2025	2025	2017	2017				
Реак пош	AM	PM	AM	PM	AM	PM	AM	PM				
V/C Ratio	1.20	1.21	1.10	1.11	0.99	1.02	0.90	0.96				

1. Existing Geometry

2. Six Lane TH 10 Section (*Add EBT and WBT lanes)

Dealellaur	2045	2045	2035	2035	2025	2025
Peak Hour	AM	PM	AM	PM	AM	PM
V/C Ratio	0.90	0.91	0.82	0.84	0.74	0.77

3. Partial Grade Separation (Only WB TH 10)

Deak Hour	2045	2045	2035	2035	2025	2025
Реак пош	AM	PM	AM	PM	AM	PM
V/C Ratio	1.20	0.98	1.10	0.88	0.99	0.78

4. Partial Grade Separation (Only EB TH 10)

Dook Hour	2045	2045	2035	2035	2025	2025						
Peak noui	AM	PM	AM	PM	AM	PM						
V/C Ratio	0.80	1.21	<.80	1.11	<.80	1.02						









5. Full Grade Separation

Dook Hour	2045	2045	2035	2035	2025	2025
Реак пош	AM	PM	AM	PM	AM	PM
V/C Ratio	0.49	0.60	<0.49	<0.60	<0.49	<0.60

The CAP-X analysis shows that the existing geometry is already close to capacity with 2017 volumes and would be over capacity in 2025. If an additional through lane was provided along TH 10 in both directions, the intersection is anticipated to operate well through 2035, but operations would start to worsen in 2045. The six-lane section would keep the intersection signalized, which is not desired in the future along TH 10. Additionally, adding lanes does not comply with the MetCouncil TPP guidance provided spot mobility improvements through grade separation appear to provide adequate capacity without adding lane miles to maintain. A 6-lane section would require additional right-of-way for frontage road construction due to a widened TH 10 footprint, and also would create an inconsistent typical section along TH 10 (4 lanes to the east and west of a short 6 lane section). Effects of the lane drops were not studied as part of this effort and could potentially create operational issues by themselves. For these reasons, a 6-lane section was dismissed from further consideration.

Partial grade separation would not operate well in 2025. Full grade separation of TH 10 and Sunfish Lake Blvd is recommended as it is the only option anticipated to operate well through 2045.

B. Detailed Traffic Analysis

1. Synchro/SimTraffic and HCS 7

Based on the CAP-X analysis, various grade separated concepts were evaluated at Sunfish Lake Blvd. The Standard Diamond and Tight Diamond options were dismissed prior to analyzing traffic operations. Operations were analyzed in Synchro/SimTraffic for all options except for the roundabouts. Roundabouts were analyzed using Highway Capacity Software (HCS) 7. Traffic operations were analyzed for the following options:

- Sunfish Overpass with Right-In/Right-Out (Option A)
- Sunfish Overpass with Right-In/Right-Out (Option B)
- SPUI
- Grade Separated Roundabout
- Center Turn
- High-T
- TH 10 Overpass with Right-In/Right-Out & WB Exit Ramp
- TH 10 Overpass with Right-In/Right-Out

The Sunfish Overpass with RI/RO Options A and B grade separate Sunfish Lake Blvd from TH 10 and the railroad. All other options grade separate TH 10 from Sunfish Lake Blvd and have an at-grade railroad crossing. With existing railroad grade separation at Armstrong Blvd and Thurston Ave and railroad grade separation options proposed at Ramsey Blvd, many options were analyzed at Sunfish Lake Blvd that have an at grade railroad crossing to save on cost. **Table 1** shows the traffic operations with each option during the 2045 peak hours.









								Max A	Approach Q	ueue
Option	Intersection	Peak Hour	Inters Dela	ection y (1.)	Maxi Delay (2	mum /-LOS 2.)	Limiting Movement (3.)	Direction	Average Queue (ft)	Max Queue (ft)
	Riverdale Dr & EB TH 10 RI/RO	AM	3	А	7	Α	SBL	SBL	50	100
	Stop Controlled	PM	2	А	6	Α	SBL	WBR	25	75
Sunfish	Sunfish Lake Blvd & Riverdale Dr	AM	3	А	11	В	WBT	EBL	50	75
Overpass	Stop Controlled	PM	3	А	23	С	WBT	EBL	50	75
with RI/RO	N Frontage Rd & WB TH 10 RI/RO	AM	2	А	9	А	EBT	WBT	50	75
(Option A)	Stop Controlled	PM	3	А	9	Α	WBT	WBT	50	100
	Sunfish Lake Blvd & N Frontage Rd	AM	4	А	19	С	WBL	EBT	50	75
	Stop Controlled	PM	7	А	34	D	WBL	WBL	50	150
	Riverdale Dr & EB TH 10 RI/RO	AM	3	А	7	А	SBL	EBL	50	125
	Stop Controlled	PM	2	А	6	А	SBL	WBR	25	75
	Sunfish Lake Blvd & Riverdale Dr	AM	3	А	15	С	WBT	EBL	50	75
Sunfich	Stop Controlled	PM	3	А	18	С	WBT	EBL	50	75
Overpass	Sunfish Lake Blvd & N Frontage Rd	AM	3	А	14	В	WBL	WBL	50	100
with RI/RO	Stop Controlled	PM	6	Α	37	Е	WBL	WBL	75	225
(Option B)	WB TH 10 RI/RO & Access Rd	AM	2	А	8	А	SBL	SBR	50	75
	Stop Controlled	PM	2	Α	9	Α	SBL	SBR	50	100
	N Frontage Rd & Access Rd	AM	2	Α	7	Α	EBT	EBR	50	75
	Stop Controlled	PM	3	Α	7	Α	EBT	EBR	50	75
	Sunfish Lake Blvd at TH 10 Ramps	AM	14	В	26	С	SBL	SBL	125	250
SPUI	Signalized Intersection	PM	15	В	30	С	WBL	SBL	150	300
Grade	Sunfish Lake Blvd at TH 10 Ramps	AM	9	А	10	В	NB	SB	-	100
Separated Roundabout	Roundabout (4.)	РМ	10	В	12	В	SB	SB	-	150
Center Turn	Sunfish Lake Blvd at TH 10 Ramps	AM	16	В	39	D	EBL	SBT	50	425
center runn	Signalized Intersection	PM	12	В	24	С	EBL	SBT	25	350
llich T	Sunfish Lake Blvd at TH 10 Ramps	AM	7	А	18	В	EBL	SBL	100	200
High-1	Signalized Intersection	PM	8	А	20	С	EBL	SBL	125	225
	Riverdale Dr & EB TH 10 RI/RO	AM	3	А	7	Α	SBL	SBL	50	100
TH 10	Stop Controlled	PM	2	Α	6	Α	SBL	WBR	25	75
Overpass	Sunfish Lake Blvd & Riverdale Dr	AM	3	А	11	В	WBT	EBL	50	75
WITH RI/ KU &	Stop Controlled	PM	3	Α	23	С	WBT	EBL	50	75
Ramp	Sunfish Lake Blvd & N Frontage Rd	AM	7	Α	8	Α	SB	SB	-	75
	Roundabout (4.)	PM	10	В	14	В	SB	SB	-	150
	Riverdale Dr & EB TH 10 RI/RO	AM	3	А	7	Α	SBL	SBL	50	100
	Stop Controlled	PM	2	Α	6	А	SBL	WBR	25	75
	Sunfish Lake Blvd & Riverdale Dr	AM	3	А	11	В	WBT	EBL	50	75
TH 10	Stop Controlled	PM	3	Α	23	С	WBT	EBL	50	75
Overpass	N Frontage Rd & WB TH 10 RI/RO	AM	2	Α	9	Α	EBT	WBT	50	75
	Stop Controlled	PM	3	Α	9	Α	WBT	WBT	50	100
	Sunfish Lake Blvd & N Frontage Rd	AM	8	Α	9	А	WB/SB	SB	-	75
	Roundabout (4.)	PM	11	В	14	В	SB	SB	-	150

Table 1. 2045 Build Traffic Operations - Sunfish Lake Blvd

1. Delay in seconds per vehicle

 ${\bf 2.}\ {\bf Maximum}\ {\rm delay}\ {\rm and}\ {\rm LOS}\ {\rm on}\ {\rm any}\ {\rm approach}\ {\rm and/or}\ {\rm movement}$

3. Limiting Movement is the highest delay movement.

4. Analysis completed in HCS7

City of

RÂMSÊY











Table 1 shows that all options are anticipated to operate acceptably with 2045 Build traffic volumes. The overall intersection delay is LOS A or B for all options during both peak hours. The SPUI was modeled with a dual southbound left turn lane. If modeled with a single lane the movement was found to operate with LOS E. Additionally, the Center Turn option is shown in Table 1 as a signalized intersection. The only option with queues extending beyond turn lanes as modeled is the Center Turn interchange. Average queues are not given for the roundabouts in Table 1 as HCS 7 only calculates the maximum queues. Tables A1 and A2 in the Appendix show the detailed traffic operations and queuing results for all the options.

Figure 1 below shows the total interchange delay for each option in seconds per vehicle.



Figure 1. 2045 Build Total Interchange Delay - Sunfish Lake Blvd

Figure 1 shows that again operations are acceptable for all options, but the Right-In/Right-Out options have the lowest delay per vehicle. The High-T and Grade Separated Roundabouts fall in the middle of the range and the SPUI and Center Turn interchange options have the most delay per vehicle of all the options.









2. VISSIM

The Sunfish Overpass with Right-In/Right-Out (Option A) alternative was analyzed in VISSIM. VISSIM allows the TH 10 traffic to be more accurately modeled with the option to ensure that traffic on the highway would not be disrupted. The results are shown in **Table 2**.

							Max A	Max Approach Queue			
Intersection	Peak Hour	Intersection Delay (1.)		Delay-LOS (2.)		Movement (3.)	Direction	Average Queue (ft)	Max Queue (ft)		
Riverdale Dr & EB TH 10 RI/RO	AM	6	А	13	В	EBL	SBL	25	125		
Stop Controlled	PM	3	А	11	В	SBL	SBL	25	125		
Ramsey Blvd & Riverdale Dr	AM	9	А	25	D	WBT	SB	25	275		
Stop Controlled	PM	5	А	16	С	WBT	EBT	25	150		
N Frontage Rd & WB TH 10 RI/RO	AM	6	А	13	В	EBT	WBT	25	100		
Stop Controlled	PM	8	А	14	В	EBT/EBR	WB	25	100		
Ramsey Blvd & N Frontage Rd	AM	2	А	13	В	WBL	SBT	25	100		
Stop Controlled	PM	3	А	11	В	WBL	WBL/SBT	25	150		

Table 2. 2045 Build Traffic Operations – Sunfish Overpass with Right-In Right Out (Option A)

1. Delay in seconds per vehicle

2. Maximum delay and LOS on any approach and/or movement

3. Limiting Movement is the highest delay movement.

Table 2 shows that in VISSIM the Right-In/Right-Out operations are shown to be acceptable and there are no queuing issues. The detailed operational analysis is included in **Tables A3** and **A4** of the **Appendix.**

Additionally, a flyover option was analyzed that grade separated TH 10 from Sunfish Lake Blvd, but eliminates access between TH 10 and Sunfish Lake Blvd. Traffic would be re-routed to Thurston Ave and Ramsey Blvd. Without direct access between TH 10 and Sunfish Lake Blvd, the 2045 AADT on the frontage road between Sunfish Lake Blvd to Thurston Avenue is anticipated to be 7,800. With an interchange at TH 10 and Sunfish Lake Blvd, the 2045 AADT for the frontage road is only 2,200 so removing this connection would greatly impact traffic volumes on the frontage road and at TH 10 and Thurston Ave. More details on the traffic forecasting can be found in the "Highway 10 Corridor Improvements Study – Daily Traffic Forecasts" memorandum.

A traffic analysis was completed in VISSIM with the flyover option to determine how the frontage road and TH 10 at Thurston Ave would operate with the added traffic. The analysis was completed with the proposed teardrop roundabout interchange at TH 10 and Thurston and right-in/right-out at the Thurston Ave and Frontage Rd intersection. The 2045 PM peak hour analysis showed that delay and queuing is a major issue along the frontage road. The average vehicle queue is 1450 feet and the maximum queue is 4000 ft. This maximum queue extends nearly the entire length of the frontage road between Thurston Ave and Sunfish Lake Blvd. Additionally, vehicles would wait on average over five minutes to turn right onto Thurston Ave from the frontage road. This shows that









the flyover option would not be able to handle the increase in traffic along the frontage road without direct access between TH 10 and Sunfish Lake Blvd.

3. Warrant Analysis

The traffic analysis completed at TH 10 and Sunfish Lake Blvd showed that a signal was needed with the SPUI and Center Turn alternatives for acceptable operations. A signal warrant analysis was completed to determine if a signal is justified at this location. Traffic signal warrants have been developed as national guidelines to promote continuity of traffic control devices to ensure that traffic signals are installed at intersection that would benefit their use.

The MnMUTCD states that the investigation of the need for a traffic control signal shall include an analysis of the applicable factors contained in the following traffic signal warrants:

- Warrant 1: Eight-Hour Vehicular Volume
- Warrant 2: Four-Hour Vehicular Volume
- Warrant 3: Peak Hour
- Warrant 4: Pedestrian Volume
- Warrant 5: School Crossing
- Warrant 6: Coordinated Signal System
- Warrant 7: Crash Experience
- Warrant 8: Roadway Network
- Warrant 9: Intersection Near a Grade Crossing

A traffic signal shall not be installed unless one or more of the warrants can be met. Furthermore, a signal shall not be installed unless an engineering study indicates that the signal will improve the overall safety and operation of the intersection.

Forecasted 2025 and 2045 volumes were analyzed. With the major street speed limit exceeding 40 mph, the 70% volume threshold may be used for the warrant analysis. With 2025 volumes only 1 of the required 8 hours are met for Warrant 1A and 4 of the required 8 hours are met for Warrant 1B. With 2045 volumes only 2 of the required 8 hours are met for Warrant 1A and 5 of the required 8 hours are met for Warrant 1B. The results of the signal warrant analysis are documented in the **Appendix**.

C. Safety Analysis

The anticipated reduction in crashes was also calculated for each of the options at Sunfish Lake Blvd to analyze how safety is improved for vehicles. The anticipated reduction in crashes is shown in **Table 3** for each option. For consistency between options, the intersections of Riverdale Dr and N Frontage Rd with Sunfish Lake Blvd were included for each alternative.









Option	Anticipated Reduction in Crashes
Sunfish Overpass with RI/RO (Option A)	87%
Sunfish Overpass with RI/RO (Option B)	87%
SPUI	79%
Grade Separated Roundabout	85%
Center Turn	79%
High-T	88%
TH 10 Overpass with RI/RO & WB Exit Ramp	85%
TH 10 Overpass with RI/RO	82%

Table 3. Crash Reduction – Sunfish Lake Blvd

Table 3 shows that the High-T would have the greatest anticipated reduction in crashes. This is because the High-T option re-routes many movements to other intersections, reducing the traffic volumes at the intersections. The Sunfish Overpass with RI/RO have the next greatest reduction in crashes with an anticipated reduction of 87%. Overall all options effectively reduce crashes, improving the safety of vehicles using this intersection.

III. Ramsey Blvd Traffic Analysis

A. CAP-X Screening

A similar CAP-X screening was completed for Ramsey Blvd and TH 10 as was completed at Sunfish Lake Blvd. The CAP-X results are detailed below. Again, the results with the existing geometry were included as a point of reference.

1. Existing Geomet	ry
--------------------	----

Peak Hour	2045	2045	2035	2035	2025	2025	2017	2017
	AM	PM	AM	PM	AM	PM	AM	PM
V/C Ratio	1.03	1.00	0.95	0.92	0.87	0.84	0.77	0.76

2. Partial Grade Separation (Only WB TH 10)

Dook Hour	2045	2045	2035	2035	2025	2025
Реак пош	AM	PM	AM	PM	AM	PM
V/C Ratio	1.03	0.73	0.95	<.73	0.87	<.73

3. Partial Grade Separation (Only EB TH1 0)

Peak Hour	2045	2045	2035	2035	2025	2025
Peak noui	AM	PM	AM	PM	AM	PM
V/C Ratio	0.65	1.00	<.65	0.92	<.65	0.84









4. Full Grade Separation

Peak Hour	2045	2045	2035	2035	2025	2025
Реак пош	AM	PM	AM	PM	AM	PM
V/C Ratio	0.46	0.37	<0.46	<0.37	<0.46	<0.37

The results with the existing geometry were included as a point of reference as to the v/c ratio with the operations that are present today and how they would worsen overtime. The CAP-X analysis shows that partial grade separation options would not function well past 2035 so full grade separation is recommended.

B. Detailed Traffic Analysis

1. Synchro/SimTraffic

Based on the CAP-X analysis, various grade separated concepts were evaluated at Ramsey Blvd. The following concepts were dismissed prior to analyzing concepts in Synchro/SimTraffic:

- Standard Diamond
- Folded EB Entrance Ramp Tight Diamond
- Folded EB Entrance Ramp & WB Exit Ramp Tight Diamond
- Folded EB Entrance Ramp & Semi-Folded WB Exit Ramp Tight Diamond
- Single Point Urban Interchange (SPUI)

The Tier 2 Evaluation Memo details why these options were dismissed.

Operations for the following options were analyzed in Synchro/SimTraffic:

- Tight Diamond
- Folded WB Exit Ramp Tight Diamond
- Overpass with Right-In/Right-Out (Option A)
- Overpass with Right-In/Right-Out (Option B)
- Tight Diamond with West Frontage Rd

Table 4 shows the traffic operations with each option during the 2045 peak hours. Unless signalized, the Overpass with Right-In/Right-Out (Option B) and Folded WB Exit Ramps Tight Diamond options were shown to have excessive delay and queuing at the WB TH 10 Ramps and Ramsey Blvd intersection due to the heavy WB TH 10 to NB Ramsey Blvd movement. Queues are highlighted red that extend past turn lanes or subsequent intersections. All turn lanes were assumed to be 300 feet.









								Max Approach Queue		
Option	Intersection	Peak Hour	Yeak Intersection Iour Delay (1.)		Maxi Delay (2	mum /-LOS ?.)	Limiting Movement (3.)	Direction	Average Queue (ft)	Max Queue (ft)
	WB TH 10 Ramps at Ramsey Blvd	AM	5	Α	18	С	WBL	WBR	75	200
Tight	Stop Controlled	PM	5	Α	15	С	WBL	WBR	100	175
Diamond	EB TH 10 Ramps at Ramsey Blvd	AM	12	В	76	F	EBL	EBL	125	325
	Stop Controlled	PM	4	А	29	D	EBL	EBL	50	125
Folded WB	WB TH 10 Ramps at Ramsey Blvd	AM	23	С	48	D	WBT	EBT	125	450
Exit Ramp	Signalized Intersection	PM	28	С	54	D	NBL	SBT	200	575
Tight	EB TH 10 Ramps at Ramsey Blvd	AM	9	А	30	D	EBL	SBL	100	275
Diamond	Stop Controlled	PM	5	А	18	С	EBL	SBL	75	175
	Riverdale Dr & EB TH 10 RI/RO	AM	4	Α	16	С	EBL	SBL	50	125
	Stop Controlled	PM	2	А	9	А	EBL	SBL	50	75
	Ramsey Blvd & Riverdale Dr Stop Controlled	AM	5	Α	28	D	WBT	WBT	50	125
Overpass		PM	4	А	15	С	WBT	WBT	50	75
(Ontion A)	N Frontage Rd & WB TH 10 RI/RO	AM	2	Α	8	Α	EBT	EBR	50	75
(Option A)	Stop Controlled Ramsey Blvd & N Frontage Rd Stop Controlled	PM	3	А	11	В	WBT	EBR	50	100
		AM	3	Α	19	С	WBL	WBR	50	150
		PM	3	Α	20	С	WBL	WBR	75	200
	Riverdale Dr & EB RIRO	AM	5	А	23	С	EBL	SBL	50	150
	Stop Controlled	PM	3	Α	8	Α	EBL	SBL	50	75
Overpass	Ramsey Blvd & Riverdale Dr	AM	7	Α	26	D	WBT	WBT	50	125
(Ontion B)	Stop Controlled	PM	6	Α	17	С	WBT	WBT	50	100
(Option b)	Ramsey Blvd & WB TH 10 Ramps/N	AM	21	С	40	D	WBT	SBT	175	400
	Frontage Rd Signalized Intersection	PM	28	С	41	D	WBT	EBT	125	575
	WB TH 10 Ramps at Ramsey Blvd	AM	5	А	24	С	WBL	WBR	75	125
	Stop Controlled	PM	6	Α	17	С	WBL	WBR	100	225
	EB TH 10 Ramps at Ramsey Blvd	AM	4	Α	67	F	EBL	EBL	100	250
	Stop Controlled	PM	12	В	27	D	EBL	SBL	50	125
Tight	WB Exit Ramp at East Connection	AM	1	А	1	А	SBR	-	-	-
Diamond	Stop Controlled	PM	1	А	2	А	SBR	SBR	25	50
with West	N Frontage Rd at East Connection	AM	2	А	7	А	EBT	EBT	25	50
Frontage Rd	Stop Controlled	PM	4	А	7	А	EBT	WBT	50	75
	WB Entrance Ramp at West	AM	1	А	1	А	SBR	-	-	-
	Connection Stop Controlled	PM	1	А	1	А	SBR	-	-	-
	N Frontage Rd at West Connection	AM	4	Α	7	А	WBT	EBT	25	50
	Stop Controlled	PM	5	А	8	А	WBT	WBL	50	50

Table 4. 2045 Build Traffic Operations – Ramsey Blvd

1. Delay in seconds per vehicle

2. Maximum delay and LOS on any approach and/or movement

3. Limiting Movement is the highest delay movement.







Table 4 shows that all options operate with acceptable intersection delay during both peak hours. The delay is the lowest for the Overpass with Right-In/Right-Out (Option A). For this option all intersections are anticipated to operate with LOS A during the peak hours and only one movement is anticipated to operate with LOS D. The Tight Diamond and Tight Diamond with West Frontage Road options show that the EBL movement at the EB TH 10 Ramps and Ramsey Blvd is anticipated to operate with LOS F during the AM peak hour. The maximum EBT queue at the WB TH 10 Ramps extends beyond the modeled length of channelized turn lanes for the Folded WB Exit Ramps Tight Diamond and Overpass with Right-In/Right-Out (Option B) options, but the queue not anticipated to extend onto TH 10. The detailed operational analysis for all options are included in **Tables A5** and **A6** of the **Appendix**.

The delay for all intersections in each option were combined to determine the overall total interchange delay in seconds per vehicle. This is shown in **Figure 2** below.



Figure 2. 2045 Build Total Interchange Delay - Ramsey Blvd

Figure 2 shows that Overpass with Right-In/Right-Out (Option A) has the lowest delay per vehicle overall with three seconds of delay per vehicle during both peak hours. The Overpass with Right-In/Right-Out (Option B) and Folded WB Exit Ramp Tight Diamond options have the greatest delay per vehicle, but operations are still acceptable with LOS C or better.









2. VISSIM

The Overpass with Right-In/Right-Out (Option A) was also analyzed in VISSIM. The results of the VISSIM analysis are shown in **Table 5**.

							Max Approach Queue			
Intersection	Peak Hour	Inters Dela	Delay (1.) (2.) (3.)		Movement (3.)	Direction	Average Queue (ft)	Max Queue (ft)		
Riverdale Dr & EB TH 10 RI/RO Stop Controlled	AM	6	А	13	В	EBL	SBL	25	125	
	PM	3	А	11	В	SBL	SBL	25	125	
Ramsey Blvd & Riverdale Dr	AM	9	А	25	D	WBT	SB	25	275	
Stop Controlled	vd & Riverdale DrAM9A25IControlledPM5A160	С	WBT	EBT	25	150				
N Frontage Rd & WB TH 10 RI/RO	AM	6	А	13	В	EBT	WBT	25	100	
Stop Controlled	PM	8	А	14	В	EBT/EBR	WB	25	100	
Ramsey Blvd & N Frontage Rd	AM	2	A	13	В	WBL	SBT	25	100	
Stop Controlled	PM	3	А	11	В	WBL	WBL/SBT	25	150	

Table 5. 2045 Build Traffic Operations – Overpass with Right-In Right Out (Option A)

1. Delay in seconds per vehicle

2. Maximum delay and LOS on any approach and/or movement

3. Limiting Movement is the highest delay movement.

Table 5 shows that in VISSIM operations are very similar to what was found in Synchro/SimTraffic.This confirms that this option would function well with minimal delay and no queuing issuesaffecting TH 10 operations. The detailed operational analysis is included in Tables A3 and A4 of theAppendix.

3. Warrant Analysis

The traffic analysis completed at TH 10 and Ramsey Blvd showed that a signal was needed for the intersection of WB TH 10 Ramps at Ramsey Blvd with the Overpass with Right-In/Right-Out (Option B) and Folded WB Exit Ramps Tight alternatives. A signal warrant analysis was completed to determine if a signal is justified at this location. Traffic signal warrants have been developed as national guidelines to promote continuity of traffic control devices to ensure that traffic signals are installed at intersection that would benefit their use.

The MnMUTCD states that the investigation of the need for a traffic control signal shall include an analysis of the applicable factors contained in the following traffic signal warrants:

- Warrant 1: Eight-Hour Vehicular Volume
- Warrant 2: Four-Hour Vehicular Volume
- Warrant 3: Peak Hour
- Warrant 4: Pedestrian Volume
- Warrant 5: School Crossing









- Warrant 6: Coordinated Signal System
- Warrant 7: Crash Experience
- Warrant 8: Roadway Network
- Warrant 9: Intersection Near a Grade Crossing

A traffic signal shall not be installed unless one or more of the warrants can be met. Furthermore, a signal shall not be installed unless an engineering study indicates that the signal will improve the overall safety and operation of the intersection.

With the major street speed limit exceeding 40 mph, the 70% volume threshold may be used for the warrant analysis. With 2025 volumes, Warrant 1A and Warrant 2 are met. The results of the signal warrant analysis are documented in the **Appendix**.

C. Safety Analysis

The anticipated reduction in crashes was calculated to see how safety is improved for vehicles with each alternative. This reduction was calculated by determining the anticipated crash rate for each intersection of the alternatives. The statewide average crash rate was assumed for each intersection, given the drastic change anticipated from existing conditions with any of the proposed alternatives. For traditional signalized and stop controlled intersections these averages are provided in the MnDOT intersection green sheets. For roundabouts, the average crash rates can be found in the MnDOT study, "The Study of the Traffic Safety at Roundabouts in Minnesota". The anticipated reduction in crashes is shown in **Table 6** for each option. For consistency between options, the intersections of Riverdale Dr and N Frontage Rd with Ramsey Blvd were included for each alternative.

Option	Anticipated Reduction in Crashes
Tight Diamond	75%
Folded WB Exit Ramp Tight Diamond	71%
Overpass with RI/RO (Option A)	75%
Overpass with RI/RO (Option B)	69%
Tight Diamond with West Frontage Rd	77%

Table 0. Clash Reduction – Rainsey Divu

Table 6 shows that all options are anticipated to effectively reduce crashes by grade-separating Ramsey Blvd from TH 10. The Tight Diamond with West Frontage Rd shows the greatest reduction. This option is slightly better than the Tight Diamond as the N Frontage Rd does not directly intersect Ramsey Blvd. Instead traffic along the frontage road would get to Ramsey Blvd via an access road and the WB Exit Ramp.









IV. Highway Access Improvements

A. Primary Intersection Spacing

According to the MnDOT Access Management Manual, Highway 10 is categorized as a Non-Interstate Freeway – Category 1AF. The spacing recommendation for Non-Interstate Freeways is to have interchanges only. The recommended interim spacing between two at grade full movement intersections on AF Highways is one mile.

The existing primary intersection spacing analysis showed that all primary intersections except Jarvis St and Alpine Dr meet the recommended spacing. Since Jarvis St and Alpine Dr do not meet the recommended spacing, only one is recommended to be full access in the future and the other intersection is recommended to have no or partial access.

The Elk River Comprehensive Plan proposes a future connection between Jarvis St and Fillmore St. This connection would change Jarvis St from a city street to a County Road. As a County Road, Jarvis St would change functional classification from Local Road to a Minor Arterial. The City of Ramsey 2030 Comprehensive Plan shows Alpine Drive near TH 10 as a Local Road today and a Minor Collector in the future.

Based on the proposed functional classification of the two roadways, Jarvis St was analyzed as a full access intersection and Alpine Dr was analyzed as a partial access intersection.

B. Secondary Intersection Spacing

There are currently 12 accesses between Armstrong Blvd and Ramsey Blvd, 20 accesses between Ramsey Blvd and Sunfish Lake Blvd, and 19 accesses between Sunfish Lake Blvd and the Ramsey City limits. With full grade separation recommended at Sunfish Lake Blvd and Ramsey Blvd, all of these accesses are recommended to be closed. Frontage roads are recommended to provide access to these parcels where possible.

From Jarvis St to Armstrong Blvd there are a total of 24 accesses. All accesses are recommended to be closed except:

- Alpine Dr: Convert from full to partial or no access
- Bowers Dr: Either convert from full to partial access or close access if frontage road connection to Armstrong Blvd is provided

C. Other Improvements

1. Weigh Station

There is a Highway 10 Weigh Station located between Alpine Dr and Beatty St. The weigh station acceleration and deceleration lanes should be lengthened to meet or come closer to meeting MnDOT design standards. Currently no full lanes are provided along TH 10 for vehicles to accelerate and decelerate, which limits the ability for the weigh station to remain opened during peak travel periods on TH 10 given the difficultly for large vehicles reentering the traffic stream. Also, since the weigh station is placed between eastbound and westbound TH 10,









vehicles must use left entrance and exit ramps to access it. That means there are merging and diverging movements from the "fast lane" without adequate acceleration or deceleration lanes.

2. Rest Area

The rest area is located directly south of the weigh station. Acceleration and deceleration lanes should be added that meet MnDOT design standards. Currently there is an approximately 150 feet turn lane provided for vehicles exiting at the rest area. For vehicles entering onto TH 10 from the rest area they have approximately 450 feet to accelerate before directly merging with TH 10 traffic.

3. Frontage Roads

Alpine to Jarvis Connection/Realignment

With full access recommended at Jarvis St and partial access recommended at Alpine Dr a connecting road is needed to accommodate vehicles along eastbound TH 10 destined for Alpine Dr. Without a connection, traffic would be rerouted to Armstrong Blvd, which is just over two miles from Alpine Dr. Multiple connections were analyzed. Some options realigned Alpine Dr to Jarvis St where others analyzed a connecting road that would T into both Alpine Dr and Jarvis St following the portion of Adams St constructed northeast of Lee's Riverside Auto. The improvement selected will need to retain the quiet zone crossing at the railroad at-grade crossing with Alpine Dr.

South Frontage Rd from Jarvis St to Armstrong Blvd

Adams St, Beatty St, Bowers Dr, and several residential driveways have access directly onto TH 10. A frontage road south of TH 10 was analyzed that would tie into all of these existing accesses and provide them with access to TH 10 at Jarvis St or Armstrong Blvd. As this improvement is likely to be completed in phases, opportunities exist to temporarily maintain partial access at these locations along TH 10 as needed before the frontage road can accommodate all traffic needs. An example of this could be a partial RCUT at Bowers Dr.

V. West End Traffic Analysis

The West End was taken to be Highway 10 from Jarvis St to Armstrong Blvd. Traffic operations for TH 10 at Jarvis St and TH 10 at Bowers St were analyzed.

A. TH 10 at Jarvis St

1. CAP-X Screening

The 2045 peak hour volumes were analyzed in CAP-X for TH 10 at Jarvis St. The analysis was completed assuming left and right turn lanes on all approaches, two through lanes on TH 10 and single through lanes on the side streets. CAP-X assumes the intersection types are signalized. The results are shown in **Table 7**.









Intersection Type	V/C Ratio				
intersection type	2045 AM	2045 PM			
Conventional	0.96	0.92			
Partial Displaced Left Turn	0.88	0.90			
Displaced Left Turn	0.82	0.89			
Restricted Crossing U-Turn	0.97	0.95			
Median U-Turn	0.93	1.00			
Partial Median U-Turn	0.89	0.94			

Table 7. TH 10 at Jarvis St

Table 7 shows that with the assumed lane configuration the Median U-Turn option would be over capacity in the 2045 PM peak hour. All other options are nearing capacity with 2045 traffic. This shows that dual turn lanes may be needed for better operations. The CAP-X analysis for an interchange showed that the v/c ratio would range from 0.09 to 0.23. A v/c ratio that low indicates that grade separation at this location could be over-building given current volume projections.

2. Detailed Traffic Analysis

A detailed traffic analysis was completed in VISSIM which analyzed TH 10 at Jarvis St as an RCUT and TH 10 at Alpine Dr as a Right-In/Right-Out. With access restricted at TH 10 and Alpine Dr the eastbound left and southbound left movements were displaced to TH 10 and Jarvis St and a future connection between Jarvis St and Alpine Dr was assumed. The results of this analysis with 2025 and 2045 Build traffic volumes are shown in **Tables 8** and **9**.

				Mari			Max A	pproach Q	ueue
Option	Peak Hour	Inters Dela	ection y (1.)	Delay (2	mum /-LOS 2.)	Movement (3.)	Direction	Average Queue (ft)	Max Queue (ft)
Unsignalized PCUT	AM	5	Α	510	F	NBT	NB	75	175
Unsignalized RCUI	PM	41	E	963	F	SBT	EBL	525	2100
Signalized PCUT	AM	9	Α	172	F	NBL	EBL	25	250
	PM	14	В	188	F	SBT	WBT	50	675

1. Delay in seconds per vehicle

2. Maximum delay and LOS on any approach and/or movement

3. Limiting Movement is the highest delay movement.

Table 8 shows that as an unsignalized RCUT delay would be excessive for the side streetmovements. The limiting movement delay was found to be over eight minutes during the 2025 AMpeak hour and over 16 minutes during the 2025 PM peak hour. Additionally, the maximumeastbound left turn queue during the PM peak hour would extend into the through lanes along TH10. A signalized RCUT would reduce the limiting movement delay to about three minutes pervehicle and would shorten the problematic queues. Note that the RCUT delay is taking into account







the full movement through the intersection. For example, and northbound left turn would then be a northbound right turn followed by an eastbound U-turn.

				Maxi			Max A	pproach Q	ueue
Option	Peak Hour	Inters Dela	ection y (1.)	Delay (2	num /-LOS 2.)	Movement (3.)	Direction	Average Queue (ft)	Max Queue (ft)
Signalized PCUT	AM	34	С	280	F	NBL	EBT	375	1550
Signalized RCOT	PM	42	D	341	F	SBT	WBT	325	1450
Signalized RCUT with	AM	25	С	220	F	NBL	EB	50	725
Dual Turn Lanes	PM	30	С	222	F	NBT	WBT	275	1300

Table 9. 2045 Build Traffic Operations - TH 10 at Jarvis St

1. Delay in seconds per vehicle

2. Maximum delay and LOS on any approach and/or movement

3. Limiting Movement is the highest delay movement.

Table 9 shows that with single turn lanes a signalized RCUT, the limiting movements would operate with over four minutes of delay during the AM peak hour and over five minutes during the PM peak hour. If dual NBR, SBR and U-Turns are provided, the limiting movement is reduced by one minute during the AM peak hour and two minutes during the PM peak hour. **Tables A7** and **A8** in the **Appendix** show the detailed traffic operations and queuing results for the RCUT options at TH 10 and Jarvis St.

The MnDOT Technical Memo, "RCUT Design and Implementation Guidelines," contains a graphic which provides guidance on determining when a stop controlled or signalized RCUT is warranted. This graphic is shown in **Figure 3** with the volumes plotted for referce.









Figure 3. RCUT Planning Capacity



The graphic shows that based on the forecasted volumes a signalized RCUT is not warranted until 2035. The operational analysis, however shows that delay will be excessive for the side streets in 2025 without signalization.

Figure 4 shows the average side street delay in minutes per vehicle during the PM peak hour for various scenarios and build years.



Page 19











The modeling for each scenario assumed vehicles would wait for an adequate gap based guidance from AASHTO (American Association of State Highway and Transportation Officials). The existing operational analysis suggested that vehicles are taking shorter gaps due to the lack of gaps in traffic, creating an unsafe environment. The future no build and build analysis was completed assuming vehicles would wait for the design gap. The 2025 PM peak hour no build analysis shows that vehicles from the side streets would have to wait on average over 10 minutes. Vehicles in 2025 with an unsignalized RCUT would wait on average over eight minutes to complete their desired movement. Signalizing the RCUT would reduce the overall wait to two minutes in 2025. Analysis shows that in 2035 PM peak hour delay would increase to three minutes per vehicle for the side streets and four minutes per vehicle by 2045. Adding dual NBR, SBR and U-Turns would reduce the delay to two and a half minutes per vehicle in 2045.

Installing an unsignalized RCUT at this location would be a proactive safety improvement, with little change in operations anticipated.

3. Other Options Analyzed

Overpass with Right-In/Right-Out

One of the other options analyzed at TH 10 and Jarvis St was an Overpass with Right-In/Right-Out. This option was not analyzed in VISSIM, however since the volumes are lower at this location than









at Ramsey Blvd or Sunfish Lake Blvd it can be assumed that delay and queuing would be minimal. An overpass would be more costly than an RCUT, but would not add traffic signals to TH 10.

Full RCUT at Jarvis St and Partial RCUT at Alpine Dr

Due to the uncertainties of TH 10 in Elk River, it is difficult to reach one recommended solution for TH 10 at Jarvis St and TH 10 at Alpine Dr. A study is needed of TH 10 to TH 101/TH 169 in Elk River to further analyze how these options and possibly others would work with the corridor. With a future study needed, an interim solution was devised to improve safety at a lower cost. The interim solution recommends a RCUT at Jarvis St and a partial RCUT at Alpine Dr. Both RCUTs would be unsignalized. There are many median openings near Jarvis St and Alpine Dr that could be used for the interim solution. **Figure 5** below shows the proposed interim solution. The yellow lines show the locations of current turn lanes and median openings that would need minor reconstruction. The solid pink lines show where a new turn lane and median opening for a U-turn would be needed.



Figure 5. Interim Solution for Jarvis St and Alpine Dr

B. TH 10 at Bowers Dr

1. Detailed Traffic Analysis

An unsignalized partial RCUT was analyzed at the intersection of TH 10 and Bowers Dr. There results of the analysis with 2025 and 2045 Build traffic volumes are shown in **Tables 10** and **11**.









			Mavi	mum	Limiting	Max A	pproach Q	ueue
Peak Hour	Inters Dela	ection y (1.)	Delay	/-LOS	LOS Movement		Average Queue	Max Queue
			(4)	(3.)		(ft)	(ft)
AM	2	А	31	D	WBL	WBL	25	50
PM	4	A	34	D	WBL	WBL	25	50

Table 10. 2025 Build Traffic Operations – Partial RCUT at TH 10 & Bowers Dr

1. Delay in seconds per vehicle

2. Maximum delay and LOS on any approach and/or movement

3. Limiting Movement is the highest delay movement.

			Mavi	mum	Limiting	Max A	pproach Q	ueue
Peak	Inters	ection			Movement		Average	Max
Hour	Dela	y (1.)		/-LU3	(2)	Direction	Queue	Queue
			(4)	(5.)		(ft)	(ft)
AM	4	Α	65	F	WBL	EBR	25	150
PM	2	A	44	E	WBL	WBL	25	75

Table 11. 2045 Build Traffic Operations - Partial RCUT at TH 10 & Bowers Dr

1. Delay in seconds per vehicle

2. Maximum delay and LOS on any approach and/or movement

3. Limiting Movement is the highest delay movement.

Tables 10 and **11** show that an unsignalized partial RCUT would operate well in 2025 with all movements operating with LOS D or better. In the 2045 AM peak hour the WBL movement would operate with just over one minute of delay. All other movements operate with acceptable delay. No queues are anticipated to back up beyond turn lanes. **Tables A9** and **A10** in the **Appendix** show the detailed traffic operations and queuing results for the partial RCUT options at TH 10 and Bowers Dr.

C. Safety Analysis

RCUTs greatly improve the safety of intersections. The number of vehicle conflict points is significantly lower with an RCUT than a conventional intersection. At TH 10 and Jarvis St, the existing number of conflict points is 40. With an RCUT the number of conflict points is reduced to 16. Additionally, RCUTs reduce the likelihood crashes, especially severe crashes. The MnDOT technical memorandum on RCUTs states that the 2016 MnDOT study, "A Study of the Traffic Safety at Reduced Conflict Intersections in Minnesota," found 100% reduction of fatal and serious injury right-angle crashes, 77% reduction in all right-angle crashes and a 50% reduction in injury crashes compared to standard intersections.









VI. Conclusion

Sunfish Lake Blvd and Ramsey Blvd Traffic Analysis

The analysis completed shows that grade separation of TH 10 with Ramsey Blvd and Sunfish Lake Blvd is needed for delay and queuing to be acceptable. Of the grade separated options analyzed, the Overpass with Right-In/Right-Out options were found to have the lowest delay at both locations. All options, however, are anticipated to operate acceptably with 2045 volumes. The anticipated crash reduction at Ramsey Blvd with the alternatives analyzed is between 69% and 77%. At Sunfish Lake Blvd, with the options analyzed, the anticipated crash reduction was found to be between 79% and 88%.

Highway Access Improvements

All accesses between Armstrong Blvd and Ramsey Blvd, Ramsey Blvd to Sunfish Lake Blvd, and Sunfish Lake Blvd to the City limits are recommended to be closed to meet the recommended spacing of interchanges only for Highway 10. This is the recommendation for Non-Interstate Freeways according to the MnDOT Access Management Manual.

All accesses are recommended to be closed from Jarvis St to Armstrong Blvd except Alpine Dr and Bowers Dr. Partial or no access is recommended at Alpine Dr. At Bowers Dr, the access is recommended to be closed only with completion of a frontage road from Bowers Dr to Armstrong Blvd; otherwise a partial RCUT is recommended.

West End Traffic Analysis

The traffic analysis completed at TH 10 and Jarvis St showed that an unsignalized RCUT would operate with excessive limiting movement delay of eight to 16 minutes during the 2025 peak hours. A signalized RCUT would reduce this delay between 60% and 80% during the peak hours while also minimizing queues. By 2045, the limiting movement delay for a signalized RCUT is anticipated to increase to five to six minutes of delay, but delay could be reduced by adding dual turn lanes.

Due to the uncertainties of TH 10 in Elk River a final solution for TH 10 at Jarvis St or Alpine Dr was not reached, however an interim solution of unsignalized RCUTs at Jarvis St and Alpine Dr is recommended to improve vehicular safety.









Appendix









Table A1: 2045 Build Traffic Operations Analysis - Sunfish Lake Blvd

		Deak	Intore	action											Mover	nent D	elay (se	ec/veh)										
Option	Intersection	Hour	Dela	y (1.)	N	IBL	N	вт	N	BR	S	BL	SI	зт	SE	BR	E	BL	E	вт	E	BR	w	/BL	w	вт	w	BR
	Riverdale Dr & EB TH 10 RI/RO	AM	3	Α		-		-		-	7	Α		-	3	А	5	Α	0	Α		-		-	1	Α	2	А
	Stop Controlled	PM	2	Α		-		-		-	6	Α		-	3	А	5	Α	0	Α		-		-	1	Α	2	А
Sunfish Overnass	Sunfish Lake Blvd & Riverdale Dr	AM	3	Α		-		-		-	0	Α		-	2	Α	5	Α	6	Α		-		-	11	В	3	А
with RI/RO	Stop Controlled	PM	3	Α		-		-		-	1	Α		-	2	Α	6	Α	6	Α		-		-	23	С	3	А
(Option A)	N Frontage Rd & WB TH 10 RI/RO	AM	2	Α	1	Α		-	0	Α		-		-		-		-	9	Α	4	Α	6	Α	8	Α		
(,	Stop Controlled	PM	3	Α	1	Α		-	0	Α		-		-		-		-	8	Α	4	Α	6	Α	9	Α		
	Sunfish Lake Blvd & N Frontage Rd	AM	4	Α	6	Α	1	Α	1	Α	2	Α	2	А	0	А	14	В	18	С	6	Α	19	С	13	В	2	А
	Stop Controlled	PM	7	Α	9	Α	1	Α	1	Α	2	Α	2	А	0	А	27	D	29	D	10	В	34	D	23	С	2	А
	Riverdale Dr & EB TH 10 RI/RO	AM	3	Α		-		-		-	7	Α		-	3	Α	5	Α	0	Α		-		-	1	Α	2	А
	Stop Controlled	PM	2	Α		-		-		-	6	Α		-	3	А	5	Α	0	Α		-		-	1	Α	2	А
	Sunfish Lake Blvd & Riverdale Dr	AM	3	Α		-		-		-	0	Α		-	2	А	5	Α	6	Α		-		-	15	С	3	А
Sunfish Overnass	Stop Controlled	PM	3	Α		-		-		-	1	Α		-	2	А	5	Α	6	Α		-		-	18	С	3	А
with RI/RO	Sunfish Lake Blvd & N Frontage Rd	AM	3	Α		-	1	Α	1	Α	2	Α	2	А		-		-		-		-	14	В		-	2	А
(Option B)	Stop Controlled	PM	6	Α		-	1	Α	1	Α	3	Α	2	А		-		-		-		-	37	E		-	2	А
., ,	WB TH 10 RI/RO & Access Rd	AM	2	Α		-		-		-	8	Α		-	5	А	4	Α	0	Α		-		-	1	Α	0	Α
	Stop Controlled	PM	2	Α		-		-		-	9	Α		-	5	Α	4	Α	0	Α		-		-	1	Α	0	А
	N Frontage Rd & Access Rd	AM	2	Α	0	Α		-	0	Α		-		-		-		-	7	Α	4	Α	5	Α	6	Α		
	Stop Controlled	PM	3	Α	0	Α		-	0	Α		-		-		-		-	7	Α	4	Α	6	Α	6	Α		
SPUI (Single SBL)	Sunfish Lake Blvd at TH 10 Ramps	AM	15	В	22	С	26	С	3	Α	27	С	6	А	3	А	30	С		-	1	Α	27	С			4	А
Si Ol (Single SE)	Signalized Intersection	PM	35	D	31	С	23	С	2	Α	64	Е	23	С	18	В	31	С		-	1	Α	27	С		-	2	А
SPUIL (Dual SBL)	Sunfish Lake Blvd at TH 10 Ramps	AM	14	В	18	В	16	В	3	Α	26	С	6	Α	2	А	23	С		-	1	Α	26	С			6	А
51 61 (Buul 582)	Signalized Intersection	PM	15	В	24	С	24	С	2	Α	23	С	6	А	3	Α	30	С		-	1	Α	30	С			2	А
Grado Soparatod	Sunfish Lake Blyd at TH 10 Pamps		-				NBL	./T/R			-		SBL	/T/R			-		EBL	/T/R			-		WBL	/T/R		
Roundabout	Roundabout (2)	AM	9	Α		-	10	В		-		-	9	Α		-		-	8	Α		-		-	8	A		
noundabout	1.0 <i>m</i> (2.)	PM	10	В		-	8	Α		-		-	12	В		-		-	8	Α		-		-	7	Α		
Center Turn	Sunfish Lake Blvd at TH 10 Ramps	AM	22	С	3	Α	1	Α	1	Α	6	Α	1	Α	1	Α	157	F		-	3	Α	36	E			18	С
	Stop Controlled	PM	14	В	3	Α	1	Α	0	Α	4	Α	1	Α	1	Α	86	F		-	9	Α	52	F		-	7	А
Center Turn	Sunfish Lake Blvd at TH 10 Ramps	AM	16	В	17	В	18	В	7	Α	24	С	6	Α	4	А	39	D		-	3	Α	19	В			7	А
	Signalized Intersection	PM	12	В	14	В	14	В	4	Α	14	В	5	Α	3	Α	24	С		-	4	Α	20	С		-	6	Α
High-T	Sunfish Lake Blvd at TH 10 Ramps	AM	7	Α		-		-	2	Α	8	Α		-	3	Α	18	В		-	4	Α		-			7	А
ingn-1	Signalized Intersection	PM	8	Α		-		-	2	Α	10	В		-	4	А	20	С		-	4	Α		-			7	А
	Riverdale Dr & EB TH 10 RI/RO	AM	3	Α		-		-		-	7	Α		-	3	Α	5	Α	0	Α		-			1	Α	2	А
	Stop Controlled	PM	2	Α		-		-		-	6	Α		-	3	Α	5	Α	0	Α		-			1	Α	2	А
TH 10 Overpass	Sunfish Lake Blvd & Riverdale Dr	AM	3	Α		-		-		-	0	Α		-	2	Α	5	Α	6	Α		-			11	В	3	А
with RI/RO & WB	Stop Controlled	PM	3	Α		-		-		-	1	Α		-	2	А	6	Α	6	Α		-			23	С	3	А
Exit Ramp	Sunfish Lake Blvd & N Frontage Rd		1	T	-		NBL	/T/R			-		SBL	/T/R					-				WBL	L/T/R	WB Exi	t Ramp		
	Roundabout (2.)	AM	7	Α		-	4	Α		-		-	8	А		-		-		-		-	6	Α	8	Α		
		PM	10	В		-	4	Α		-		-	14	В		-		-		-		-	7	Α	7	Α		
	Riverdale Dr & EB TH 10 RI/RO	AM	3	Α		-		-		-	7	Α		-	3	А	5	Α	0	Α		-		-	1	Α	2	А
	Stop Controlled	PM	2	Α		-		-		-	6	Α		-	3	А	5	Α	0	Α		-		-	1	Α	2	А
	Sunfish Lake Blvd & Riverdale Dr	AM	3	Α	ļ	-		-		-	0	Α		-	2	А	5	Α	6	Α	ļ	-	ļ	-	11	В	3	А
TH 10 Overnass	Stop Controlled	PM	3	Α		-		-		-	1	Α		-	2	Α	6	Α	6	Α		-		-	23	С	3	А
with RI/RO	N Frontage Rd & WB TH 10 RI/RO	AM	2	Α	1	Α		-	0	Α		-		-	· ·	-		-	9	Α	4	Α	6	Α	8	Α		
	Stop Controlled	PM	3	Α	1	Α		-	0	Α		-		-	· ·	-		-	8	Α	4	Α	6	Α	9	А		
	Sunfish I ake Blyd & N Frontage Dd				-		NBL	/T/R					SBL	/T/R			•		EBL	/T/R			•		WBL	/T/R		
	Roundahout (2)	AM	8	Α		-	5	A		-		-	9	А		-		-	7	A		-		-	9	А		
	1.0mma00m (2.)	PM	11	В		-	5	Α		-		-	14	В		-		-	9	Α		-		-	10	А		

1. Delay in seconds per vehicle

2. Analysis completed in HCS 7

Table A2: 2045 Build Peak Hour Queues By Movement - Sunfish Lake Blvd

		Deak											Q	ueue Le	engths (ft)										
Option	Intersection	Реак	E	BL	E	вт	E	BR	w	'BL	w	BT	W	'BR	N	BL	N	вт	N	BR	S	BL	S	вт	S	3R
		поиг	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max
	Riverdale Dr & EB TH 10 RI/RO	AM	50	75	-	-	-	-	-	-	-	-	25	75	-	-	-	-	-	-	50	100	-	-	25	50
	Stop Controlled	PM	25	75	-	-	-	-	-	-	-	-	25	75	-	-	-	-	-	-	50	75	-	-	25	75
	Sunfish Lake Blvd & Riverdale Dr	AM	50	75	25	75	-	-	-	-	25	50	25	75	-	-	-	-	-	-	-	-	-	-	25	25
Sunfish Overpass	Stop Controlled	PM	50	75	25	75	-	-	-	-	25	50	25	50	-	-	-	-	-	-	0	25	-	-	25	50
with RI/RO	N Frontage Rd & WB TH 10 RI/RO	AM	-	-	25	50	50	75	25	25	50	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(Option A)	Stop Controlled	PM	-	-	25	50	50	75	25	50	50	100	-	-	25	25	-	-	-	-	-	-	-	-	-	-
	Sunfish Lake Blvd & N Frontage Rd	AM	25	50	50	75	25	75	25	75	25	75	-	-	25	50	0	25	-	-	25	50	-	-	0	25
	Stop Controlled	PM	25	75	50	100	25	75	50	150	50	125	-	-	25	50	0	25	25	25	25	75	_	-	25	25
	Riverdale Dr & EB TH 10 RI/RO	АМ	50	125	-	_	-	_	_	-	_	_	25	75	_	_	_	_	-	_	50	100	-	-	25	50
	Stop Controlled	PM	25	75	-	-	-	-	-	-	-	-	2.5	75	-	-	_	-	-	-	50	50	-	-	25	50
	Sunfish Lake Blvd & Riverdale Dr	AM	50	75	25	75	-	_	_	_	25	50	25	75	_	-	_	_	_	_	-	-	_	_	0	25
	Stop Controlled	PM	50	75	25	50	-	_	_	_	25	50	25	50	_	_	_	_	_	_	_	-	_	-	25	50
Sunfish Overpass	Sunfish Lake Blyd & N Frontage Rd	ΔM	50	-	23	50			50	100	25	50	23	50	_	_	0	25	0	25	25	50		_	23	50
with RI/RO	Stop Controlled	PM							75	225			25	75		_	0		0	25	25	75	_		_	<u> </u>
(Option B)	WB TH 10 RI/RO & Access Rd		25	50					15	-			0	25		_			-	23	50	75	_		50	75
	Stop Controlled	PM	25	50	_	_	_			_		_	0	25	<u> </u>		_		_		50	75	_		50	100
	N Frontage Pd & Access Pd		25	50	25	50	50	75	50	75	25	50	-	25		_					50	15	_		50	100
	Stop Controlled	DM	_	_	25	50	50	75	50	75	25	75	_	-	-	- 25	_			_	_	_		-	-	<u> </u>
	Surfish Lake Divid at TU 10 Demos		- 75	-	23	50	50	75	25	125	23	15	- 25	-	25	23 50	- 25	-	-	-	- 200	250	- 25	- 200	-	
SPUI (Single SBL)	Sumish Lake Bive at 1H 10 Kamps	DM	75	150	-	-	-	-	2J 50	125	-	-	25	125	25	75	25	75	-	-	200	250	2.5	675	- 25	- 75
			75	150	-	-	-	-	50	123	-	-	23 50	123	25	73	25	75	-	-	125	250	323	50	23	/3
SPUI (Dual SBL)	Sunfish Lake Blvd at 1H 10 Ramps	AM	75	150	-	-	-	-	50	230	-	-	30	230	25	50	25	75	-	-	123	200	25	30	-	-
	Signulized Intersection	PIVI	73	130	-	- /T/D	-	-	30	130	-	- /T/D	23	30	23	30	23	/3 /T/D	-	-	130	300	23	1/3 /T/D	-	
Grade Separated	Sunfish Lake Blvd at TH 10 Ramps	AM			EDL	25					VVDL	/ I / K 75		1	1		INDL,	50					JDL	100		
Roundabout	Roundabout (1.)		-	-	-	25	-	-	-	-	-	73	-	-	-	-	-	25	-	-	-	-	-	100	-	-
		PM	-	-	-	25	-	-	-	-	-	50	-	-	-	-	-	25	-	-	-	-	-	150	-	-
Center Turn	Sunfish Lake Blvd at 1H 10 Ramps	AM	1/5	250	-	-	25	/5	25	/5	-	-	125	300	25	50	-	-	25	50	/5	200	-	-	0	25
		PM	100	350	-	-	25	150	/5	1/5	-	-	/5	150	25	50	-	-	25	25	50	125	-	-	0	25
Center Turn	Sunfish Lake Blvd at TH 10 Ramps	AM	/5	1/5	-	-	25	50	25	/5	-	-	/5	1/5	25	/5	25	100	50	125	1/5	325	50	425	25	/5
	Signalized Intersection	PM	75	150	-	-	25	50	50	100	-	-	75	150	25	50	25	75	25	75	150	325	25	350	50	75
High-T	Sunfish Lake Blvd at TH 10 Ramps	AM	50	125	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	200	-	-	0	25
	Signalized Intersection	PM	50	125	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	125	225	-	-	-	-
	Riverdale Dr & EB TH 10 RI/RO	AM	50	75	-	-	-	-	-	-	-	-	25	75	-	-	-	-	-	-	50	100	-	-	25	50
	Stop Controlled	PM	25	75	-	-	-	-	-	-	-	-	25	75	-	-	-	-	-	-	50	75	-	-	25	75
TH 10 Overpass	Sunfish Lake Blvd & Riverdale Dr	AM	50	75	25	75	-	-	-	-	25	50	25	75	-	-	-	-	-	-	-	-	-	-	25	25
with RI/RO & WB	Stop Controlled	PM	50	75	25	75	-	-	-	-	25	50	25	50	-	-	-	-	-	-	0	25	-	-	25	50
Exit Ramp	Sunfish Lake Blvd & N Frontage Rd		1	-		1		1	1	1	WBL	/T/R	WB Exi	it Ramp			NBL	/T/R		1	1		SBL	/T/R		
	Roundabout (1.)	AM	-	-	-	-	-	-	-	-	-	25	-	75	-	-	-	25	-	-	-	-	-	75	-	<u> </u>
		PM	-	-	-	-	-	-	-	-	-	25	-	50	-	-	-	25	-	-	-	-	-	150	-	-
	Riverdale Dr & EB TH 10 RI/RO	AM	50	75	-	-	-	-	-	-	-	-	25	75	-	-	-	-	-	-	50	100	-	-	25	50
	Stop Controlled	PM	25	75	-	-	-	-	-	-	-	-	25	75	-	-	-	-	-	-	50	75	-	-	25	75
	Sunfish Lake Blvd & Riverdale Dr	AM	50	75	25	75	-	-	-	-	25	50	25	75	-	-	-	-	-	-	-	-	-	-	25	25
TH 10 Overnoor	Stop Controlled	PM	50	75	25	75	-	-	-	-	25	50	25	50	-	-	-	-	-	-	0	25	-	-	25	50
with RI/RO	N Frontage Rd & WB TH 10 RI/RO	AM	-	-	25	50	50	75	25	25	50	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Stop Controlled	PM	-	-	25	50	50	75	25	50	50	100	-	-	25	25	-	-	-	-	-	-	-	-	-	-
	Sunfish I ake Divid & N Eventered DJ				EBL	/T/R					WBL	/T/R					NBL	/T/R					SBL	/T/R		
	Roundabout (1)	AM	-	-	-	25	-	-	-	-	-	75	-	-	-	-	-	25	-	-	-	-	-	75	-	-
		PM	-	-	-	25	-	-	-	-	-	100	-	-	-	-	-	25	-	-	-	-	-	150	-	-

1. Analysis completed in HCS 7

Table A3. 2045 AM - RI/RO Analysi	s
-----------------------------------	---

Table A3. 2045 AM - RI/RO Analysis																										Т	raffic Que	euing (fee	t)	
			Demand	volume	s		Modeled	l Volume	s		Мос	lel - Der	mand		To	tal Delay	by	Leve	l of Servi	ce by	LOS	S by	LC	os	Left	Turn	Throug	n Queue	Right	Turn
Location	Aprch		1	1	-		1	1			-	1	-	1	Move	ment (se	c/veh)		Novemer	t	Арри	roach		-				-		1
		L	т	R	Total	L	т	R	Total	L	т	R	Total	%	L	т	R	L	т	R	Delay	LOS	Delay	LOS	Avg	Max	Avg	Max	Avg	Max
Pamsov Rlvd at N Frontago Rd	WB	33		418	451	35		413	448	2	0	-5	-3	-1%	10		1	А		А	2	Α			25	75			0	0
Circulized Internetion	NB		181	74	255		181	75	256	0	0	1	1	0%		0	1		Α	А	3	Α	2	А			0	0	0	0
Signalized Intersection	SB	70	661		731	66	638		704	-4	-23	0	-27	-4%	4	3		А	Α		0	Α			25	75	25	150		
N Frontago Rd at WR TH 10 RI/RO (Ramsov)	EB		29	115	144		28	114	142	0	-1	-1	-2	-1%		13	7	А	В	А	5	Α					25	75	0	0
(ten Centrolled	WB	21	22		43	18	25		43	-3	3	0	0	0%	9	12		Α	В	Α	11	В	6	А	25	75	25	100		
Stop Controlled	NB	429		90	519	424		85	509	-5	0	-5	-10	-2%	4		4	А	Α	А	4	А			0	0			0	0
Pamsov Blyd at Pivordalo Dr	EB	133	114		247	130	106		236	-3	-8		-11	-4%	7	13		А	В	А	10	Α			25	125	25	125		
Ctop Controlled	WB		79	122	201		74	126	200		-5	4	-1	0%		26	7	А	D	А	14	В	9	А			25	125	0	0
Stop Controlled	SB	43		651	694	47		621	668	4		-30	-26	-4%	3		8	А	Α	А	8	А			25	275			25	275
Piverdale Dr at ER TH 10 PI/PO (Pameau)	EB	10	24		34	10	23		33		-1	0	-1	-3%	15	0		В	Α	А	5	А			25	50	0	0		
(Kiverdale Di at EB TT 10 Ki/KO (Kallisey)	WB		35	695	730		36	655	691		1	-40	-39	-5%		0	4	А	Α	А	4	Α	6	Α			0	0	0	0
Stop Controlled	SB	213		10	223	215		11	226	2	0	1	3	1%	10		7	В	Α	А	10	Α			25	150			25	50
	EB	15	50	50	115	16	50	49	115	1	0	-1	0	0%	9	11	8	А	В	А	10	А			25	75	25	100	25	100
N Frontage Rd at Sunfish Lake Blvd	WB	40	45	385	470	39	45	395	479	-1	0	10	9	2%	9	10	1	А	В	А	3	А	2	^	25	75	25	100	0	0
Stop Controlled	NB	15	145	25	185	14	146	25	185	-1	1	0	0	0%	3	0	1	А	Α	А	0	Α	5	A	25	75	0	0	0	0
	SB	70	429	15	514	73	428	13	514	3	-1	-2	0	0%	2	1	1	А	Α	А	1	Α			25	75	25	25	25	25
N Frontage Pd at W/R TH 10 PL/PO (Sunfish)	EB		10	135	145		10	139	149	0	0	4	4	3%		11	6	А	В	А	7	А					25	75	0	0
Stop Controlled	WB	5	75		80	6	74		80	1	-1	0	0	0%	8	13		А	В	Α	13	В	5	А	25	75	25	125		
Stop Controlled	NB	395		29	424	405		31	436	10	0	2	12	3%	3		2	А	Α	А	3	А			0	0			0	0
Riverdale Dr. at Sunfish Lake Blvd	EB	150	27		177	150	39		189	0	12	0	12	7%	8	8		А	Α	А	8	Α			25	125	25	100		
Ctop Controlled	WB		5	35	40		6	35	41	0	1	0	1	3%		12	7	А	В	А	8	Α	4	Α			25	75	0	0
Stop Controlled	SB	18		503	521	502		15	517	484	0	-488	-4	-1%	3		1	А	Α	А	3	Α			0	0			0	0
Riverdale Dr at FB TH 10 RI/RO (Sunfish) Ston	EB	168	49		217	164	53		217	-4	4	0	0	0%	11	0		В	Α	А	8	Α			25	150	0	0		
Controlled	WB		96	412	508		95	414	509	0	-1	2	1	0%		0	4	Α	Α	Α	3	Α	9	А			0	0	0	0
Controlled	SB	128		10	138	136		7	143	8	0	-3	5	4%	34		29	D	Α	D	34	D			25	125			25	75

Location	Anroh		Demand	volume	s		Modele	d Volum	es		Мос	lel - Der	mand		To Move	tal Delay ment (se	r by c/veh)	Leve N	l of Serv ⁄Ioveme	ice by nt	LOS Appi	i by oac
Location	Aprch	L	т	R	Total	L	т	R	Total	L	т	R	Total	%	L	т	R	L	т	R	Delay	L
Pamsov Plud at N Frontago Pd	WB	85		578	663	76		526	602	-9	0	-52	-61	-9%	11		2	В		Α	3	
Cignalized Interportion	NB		131	76	207		130	75	205	0	-1	-1	-2	-1%		0	1		Α	А	3	
Signalized Intersection	SB	133	530		663	154	525		679	21	-5	0	16	2%	6	2		А	Α		0	
N Frontage Rd at W/B TH 10 RI/RO (Ramsey)	EB		38	183	221		33	197	230	0	-5	14	9	4%		13	14	Α	В	В	14	
Ston Controlled	WB	51	36		87	50	34		84	-1	-2	0	-3	-3%	13	11		В	В	Α	12	
Stop Controlled	NB	627		39	666	568		40	608	-59	0	1	-58	-9%	6		6	Α	Α	Α	6	
Ramsey Blyd at Riverdale Dr	EB	82	82		164	81	79		160	-1	-3		-4	-2%	7	9		Α	Α	Α	8	
Stop Controlled	WB		57	125	182		57	125	182		0	0	0	0%		15	7	Α	В	A	9	
	SB	55		560	615	56		545	601	1		-15	-14	-2%	2		3	A	A	A	3	
Riverdale Dr at FB TH 10 RI/RO (Ramsev)	EB	5	27		32	5	26		31		-1	0	-1	-3%	4	0		A	A	A	1	
Stop Controlled	WB		66	551	617		60	541	601		-6	-10	-16	-3%		0	1	A	A	A	1	
	SB	137		10	147	135		8	143	-2	0	-2	-4	-3%	11		10	В	A	Α	11	
	EB	15	50	50	115	16	50	49	115	1	0	-1	0	0%	10	13	8	В	В	A	11	
N Frontage Rd at Sunfish Lake Blvd	WB	94	100	335	529	93	98	329	520	-1	-2	-6	-9	-2%	11	11	1	В	В	A	5	
Stop Controlled	NB	15	120	25	160	16	120	23	159	1	0	-2	-1	-1%	3	0	1	A	A	A	0	
	SB	140	520	15	675	144	515	11	670	4	-5	-4	-5	-1%	2	1	1	A	A	A	1	
N Frontage Rd at WB TH 10 RI/RO (Sunfish)	EB		25	188	213		26	191	217	0	1	3	4	2%		12	7	A	В	A	8	
Ston Controlled	WB	0	141		141	0	141		141	0	0	0	0	0%	0	16		A	C	A	16	
	NB	389		0	389	376		0	376	-13	0	0	-13	-3%	3		0	A	A	A	3	
Riverdale Dr at Sunfish Lake Blvd	EB	142	10		152	140	24		164	-2	14	0	12	8%	7	8		A	A	A	7	
Stop Controlled	WB	25	10	21	31	20	12	20	32	0	2	-1	1	3%		23	6	A	C	A	12	L
	SB	25	50	648	6/3	28		631	659	3	0	-1/	-14	-2%	1		3	A	A	A	3	
Riverdale Dr at EB TH 10 RI/RO (Sunfish) Stop	EB	56	50	405	106	55	50	407	105	-1	0	0	-1	-1%	11	0	_	В	A	A	6	L
Controlled	WB	110	163	495	658	114	154	487	641	0	-9	-8	-1/	-3%	11	0	3	A	A	A	3	┣—
	SB	110		U	110	114		U	114	-2	U	U	-2	-2%	11		U	В	A	A	11	1

Table A4. 2045 PM - RI/RO Analysis

				T	raffic Que	euing (fee	t)	
by ach	LC	DS .	Left	Turn	Through	n Queue	Right	Turn
LOS	Delay	LOS	Avg	Max	Avg	Max	Avg	Max
A	з	۸	25	100	0	0	0	0
A	5	~	25	125	25	125	U	U
B B	8	A	25 0	100 0	25 25	75 100	0	0
A A A	5	А	0 25	0 50	25 25	125 100	0	0
A A B	3	А	25 25	25 125	0 0	0 0	0 25	0 50
B A A A	3	A	25 25 25 25	75 100 50 75	25 25 0 25	100 125 0 25	25 0 0 25	100 0 0 25
A C A	7	А	0 0	0 0	25 25	75 175	0 0	0 0
A B A	4	А	25 0	125 0	25 25	100 75	0 0	0 0
A A B	4	А	25 25	75 100	0 0	0 0	0 0	0 0



SIGNAL WARRANTS ANALYSIS FOR

Real People. Real Solutions.

Sunfish Lake Blvd at TH 10 Ramps

2025 BUILD

LOCATION:	Sunfish Lake	Blvd at TH 1	0 Ramps						
COUNTY:	Anoka								
REF. POINT:			Speed	Approach De	scription				Lanes
DATE:	1/29/2019		45	Major App1:	NORTHBOU	JND			2
			45	Major App3:	WESTBOU	ND			1
OPERATOR:	KR		45	Minor App2:	SOUTHBOL	JND			3
			45	Minor App4:	EASTBOUN	ID			1
0.70 FACTOR L	JSED?	YES							
POPULATION <	< 10,000?	No							
N/A		No -	Ĩ						
THRESHOLDS	1A/1B:			420/630			140/70	105/52	
	MAJOR	MAJOR	TOTAL	MAJOR	MINOR	MINOR 2	MINOR	MINOR 4	MET SAME
HOUR	APP. 1	APP. 3	1+3	1A/1B	APP. 2	1A/1B	APP. 4	(1A/1B
0:00 - 1:00			0	/		/		/	1
1:00 - 2:00			0	/		/		/	1
2:00 - 3:00			0	/		/		/	1
3:00 - 4:00			0	/		/		/	1
4:00 - 5:00			0	/		/		/	1
5:00 - 6:00			0	/		/		/	1
6:00 - 7:00	95	520	615	X/	15	/	110	X/X	X/
7:00 - 8:00	175	645	820	X/X	20	/	100	/X	/X
8:00 - 9:00	80	410	490	X/	45	/	70	/X	1
9:00 - 10:00	45	360	405	/	35	/	60	/X	1
10:00 - 11:00	65	320	385	/	30	/	55	/X	1
11:00 - 12:00	80	435	515	X/	35	/	70	/X	1
12:00 - 13:00	75	415	490	X/	45	/	60	/X	1
13:00 - 14:00	70	360	430	X/	50	/	65	/X	1
14:00 - 15:00	70	460	530	X/	65	/	65	/X	1
15:00 - 16:00	65	695	760	X/X	45	/	80	/X	/X
16:00 - 17:00	75	735	810	X/X	45	/	95	/X	/X
17:00 - 18:00	60	625	685	X/X	45	/	75	/X	/X
18:00 - 19:00	45	340	385	/	45	/	60	/X	1
19:00 - 20:00			0	/		/		/	1
20:00 - 21:00			0	/		/		/	1
21:00 - 22:00			0	/		/		/	1
22:00 - 23:00			0	/		/		/	1
23:00 - 24:00			0	/		/		/	1
	Met (Hr)	Required (I	Hr)						
Warrant 1A	1	8		Not satisfied	d				
Warrant 1B	4	8		Not satisfied	b				

Warrant 1A	1	8	Not satisfied
Warrant 1B	4	8	Not satisfied
Warrant 2	1	4	Not satisfied
Warrant 3	0	1	Not satisfied
Warrant 7	7	8	Not satisfied







Note: For data points outside the graph range, check the minor street volume against the lower thresholds

	Warrant Criteria		Actual	Hourly Count
Major	Warrant 2, F	Warrant 3, Pe	Major	Actual Hourly Count
200	420		Ő	Ō
300	350	500	0	0
400	285	435	0	0
500	230	370	0	0
600	175	315	0	0
700	135	260	0	0
800	103	215	615	110
900	80	175	820	100
1000	80	140	490	70
1100	80	115	405	60
1200	80	100	385	55
1300	80	100	515	70
1400	80	100	490	60
1500	80	100	430	65
1600	80	100	530	65
1700	80	100	760	80
1800	80	100	810	95
			685	75
			385	60
			0	0
			0	0
			0	0
			0	0
			0	0



SIGNAL WARRANTS ANALYSIS FOR

Real People. Real Solutions.

Sunfish Lake Blvd at TH 10 Ramps

2045 BUILD

LOCATION:	Sunfish Lake	Blvd at TH 1	0 Ramps						
COUNTY:	Anoka								
REF. POINT:			Speed	Approach De	scription				Lanes
DATE:	1/29/2019		45	Major App1:	NORTHBOL	JND			2
			45	Major App3:	WESTBOUI	ND			1
OPERATOR:	KR		45	Minor App2:	SOUTHBOL	JND			3
			45	Minor App4:	EASTBOUN	1D			1
0.70 FACTOR L	JSED?	YES							
POPULATION <	< 10,000?	No 🔻	I						
N/A		No	Ī						
THRESHOLDS	1A/1B:		-	420/630			140/70	105/52	
	MAJOR	MAJOR	TOTAL	MAJOR	MINOR	MINOR 2	MINOR	MINOR 4	MET SAME
HOUR	APP. 1	APP. 3	1+3	1A/1B	APP. 2	1A/1B	APP. 4	(1A/1B
0:00 - 1:00			0	/		/		/	1
1:00 - 2:00			0	/		/		/	1
2:00 - 3:00			0	/		/		/	1
3:00 - 4:00			0	/		/		/	1
4:00 - 5:00			0	/		/		/	1
5:00 - 6:00			0	/		/		/	1
6:00 - 7:00	155	545	700	X/X	15	/	120	X/X	X/X
7:00 - 8:00	285	680	965	X/X	25	/	110	X/X	X/X
8:00 - 9:00	125	430	555	X/	60	/	75	/X	1
9:00 - 10:00	75	380	455	X/	45	/	65	/X	1
10:00 - 11:00	105	335	440	X/	40	/	60	/X	1
11:00 - 12:00	125	465	590	X/	45	/	75	/X	1
12:00 - 13:00	120	440	560	X/	55	/	65	/X	1
13:00 - 14:00	105	385	490	X/	60	/	70	/X	1
14:00 - 15:00	105	485	590	X/	80	/X	70	/X	1
15:00 - 16:00	115	740	855	X/X	55	/	85	/X	/X
16:00 - 17:00	125	780	905	X/X	55	/	100	/X	/X
17:00 - 18:00	85	660	745	X/X	55	/	80	/X	/X
18:00 - 19:00	70	360	430	X/	55	/	65	/X	1
19:00 - 20:00			0	/		/		/	1
20:00 - 21:00			0	/		/		/	1
21:00 - 22:00			0	/		/		/	1
22:00 - 23:00			0	/		/		/	1
23:00 - 24:00			0	/		/		/	1
	Met (Hr)	Required (I	Hr)						
Warrant 1A	2	8		Not satisfied	l				
Warrant 1B	5	8		Not satisfied	l				
Warrant 2	2	4		Not satisfied	l				
Warrant 3	0	1		Not satisfied	l				

Warrant 3 Warrant 7

8

9

Not satisfied Satisfied, check accident record





Note: For data points outside the graph range, check the minor street volume against the lower thresholds

	Warrant Criteria	ı	Actual	Hourly Count
Major	Warrant 2, F	Warrant 3, Pe	Major	Actual Hourly Count
200	420		0	0
300	350	500	0	0
400	285	435	0	0
500	230	370	0	0
600	175	315	0	0
700	135	260	0	0
800	103	215	700	120
900	80	175	965	110
1000	80	140	555	75
1100	80	115	455	65
1200	80	100	440	60
1300	80	100	590	75
1400	80	100	560	65
1500	80	100	490	70
1600	80	100	590	80
1700	80	100	855	85
1800	80	100	905	100
			745	80
			430	65
			0	0
			0	0
			0	0
			0	0
			0	0

Table A5: 2045 Build Traffic Operations Analysis - Ramsey Blvd

		Deak	Intore	action											Move	ment D	elay (se	c/veh)										
Option	Intersection	Hour	Dela	y (1.)	N	IBL	N	вт	N	BR	SI	BL	S	вт	S	BR	E	BL	E	вт	E	BR	w	BL	w	вт	w	BR
	WB TH 10 Ramps at Ramsey Blvd	AM	5	Α	9	А	1	Α		-		-	4	Α	0	Α		-		-		-	18	С	-	-	7	Α
Tight Diamond	Stop Controlled	PM	5	Α	8	А	0	Α		-		-	4	Α	1	Α		-		-		-	15	С		-	8	Α
	EB TH 10 Ramps at Ramsey Blvd	AM	12	В		-	1	Α	1	А	5	Α	0	Α		-	76	F		-	4	Α		-		-		-
	Stop Controlled	PM	4	Α		-	1	Α	1	Α	4	А	0	Α		-	29	D		-	4	Α		-	-	-		-
Folded WB Evit	WB TH 10 Ramps at Ramsey Blvd	AM	211	F	12	В	1	Α	1	Α	2	Α	4	Α	0	Α	803	F	690	F	402	F	24	С	37	E	5	Α
Ramp Tight	Stop Controlled	PM	317	F	9	Α	1	Α	0	Α	2	Α	4	Α	1	Α	994	F	886	F	928	F	25	D	43	E	5	Α
Diamond	EB TH 10 Ramps at Ramsey Blvd	AM	10	В		-	1	Α	1	Α	5	А	0	A		-	62	F		-	4	Α		-		-		
	Stop Controlled	PM	4	Α		-	1	A	0	Α	4	Α	0	A		-	21	С		-	3	A		-	-	-		-
Folded WB Exit	WB TH 10 Ramps at Ramsey Blvd	AM	23	C	43	D	10	В	3	A	14	В	19	С	1	A	36	D	27	С	8	A	45	D	48	D	5	A
Ramp Tight	Signalized Intersection	PM	28	C	54	D	15	С	3	A	26	D	30	D	3	A	32	С	22	С	12	В	43	D	42	D	5	A
Diamond	EB TH 10 Ramps at Ramsey Blvd	AM	9	A		-	1	A	1	A	8	A	1	A		-	30	D		-	3	A		-	-	-		-
	Stop Controlled	PM	5	A		-	1	A	0	Α	7	Α	1	A		-	18	С		-	3	A		-		-		-
	Riverdale Dr & EB TH 10 RI/RO	AM	4	A		-		-		-	7	A		-	3	A	16	С	0	A		-		-	1	A	3	A
	Stop Controlled	PM	2	A		-		-		-	6	A		-	2	A	9	A	0	A		-		-	1	A	2	A
	Ramsey Blvd & Riverdale Dr	AM	5	A		-		-		-	1	A		-	2	A	7	A	7	A		-		-	28	D	4	A
RIRO (Option	Stop Controlled	PM	4	A		-		-		-	1	A		-	2	A	6	A	7	A		-		-	15	C	4	A
7A)	N Frontage Rd & WB TH 10 RI/RO	AM	2	A	1	A		-	0	A		-		-		-		-	8	A	3	A	7	A	8	A		-
	stop Controlled	PM	3	A	I	A	1	-	0	A		-	2	-		-		-	10	В	4	A	10	B	11	В	2	-
	Ramsey Blvd & N Frontage Rd	AM	3	A		-	1	A	1	A	2	A	2	A		-		-		-		-	19	C	-	-	3	A
		PM	3	A		-	l	A	l	А	3	A	2	A	2	-	1.5	-	0	-		-	20	C	1	-	4	A
	Riverdale Dr & EB TH 10 RI/RO	AM	3	A		-		-		-	6	A		-	3	A	15	C	0	A		-		-	1	A	3	A
		PM	5	A		-		-		-	5	A		-	3	A	6	A	0	A		-		-	1	A	2	A
RIRO (Option	Ramsey Blvd & Riverdale Dr Stop Controlled	AM	5	A		-		-		-	1	A		-	2	A		A	/	A		-		-	26	D	4	A
76)			4	A F	0	-	1	-	1	-	1	A	2	-	2	A	0	A F	052	A F	022	Б	20	D	14 22	В	4	A
	Ramsey Blvd & N Frontage Rd Stop Controlled		330	Г	9	A	1	A	1	A	2	A	2	A	1	A	104/	Г	955	Г	922	Г	20	D	20 20	D	5	A
			437	Г	0	A	1	A	1	A	2	A	Z	A	1	A	22	Г С	1005	Г	1195	Г	19	C	1		3	A
	Stop Controlled	PM	3	A A							6	A			3	A	23		0	A					1	A	3	A
RIPO (Option	Pameay Blyd & Piyerdala Dr	AM	7	Δ		_		_		_	3	Δ	2	Δ	5	Δ	7	Δ	8	Δ		_		_	26	D	4	Δ
	Stop Controlled	PM	6	Δ		_		_		_	3	Δ	2	Δ	5	Δ	6	Δ	7	Δ		_		_	17	C	4	Δ
,	Ramsey Blyd & N Frontage Rd	AM	21	C	19	В	7	А	2	А	13	B	17	B	2	A	39	D	22	C	11	В	39	D	40	D	6	A
	Signalized Intersection	PM	28	C	22	C	13	B	2	A	19	B	26	C	3	A	41	D	17	B	11	B	39	D	41	D	6	A
	WB TH 10 Ramps at Ramsey Blvd	AM	5	A	9	A	1	A	-	-			4	A	0	A		-	17	-		-	24	C		-	6	A
	Stop Controlled	PM	6	A	8	A	0	A		-		_	4	A	1	A		-		-		-	17	C		-	9	A
	EB TH 10 Ramps at Ramsey Blvd	AM	4	A	-	-	1	A	1	А	5	А	0	A	-	-	67	F		-	4	А		-		-	-	-
	Stop Controlled	PM	12	В		-	1	А	0	А	4	А	0	А		-	27	D		-	3	А		-		-		-
	WB Exit Ramp at East Connection Stop	AM	1	А		-		-		-		-		-	1	Α		-		-		-		-	1	А	0	Α
Tight Diamond	Controlled	PM	1	А		-		-		-		_		-	2	Α		-		-		-		-	1	А	0	Α
with West	N Frontage Rd at East Connection Stop	AM	2	А	0	А		-	0	Α		-		-		-		-	7	Α	4	Α	4	А	6	А		-
Frontage Kd	Controlled	PM	4	А	0	А		-	0	А		-		-		-		-	7	Α	3	А	4	А	6	А		-
	WB Entrance Ramp at West Connection	AM	1	А		-		-		-		-		-	1	Α		-		-		-		-	0	А	0	А
	Stop Controlled	PM	1	А		-		-		-		_		-	1	Α		-		-		-		-	0	А	0	Α
	N Frontage Rd at West Connection Stop	AM	4	Α	0	А		-	0	Α		-		-		-			6	Α	3	Α	5	Α	7	Α	_	
	Controlled	PM	5	Α	0	А		-	0	Α		-		-		-		-	6	Α	2	А	6	А	8	А		-

1. Delay in seconds per vehicle

Table A6: 2045 Build Peak Hour Queues By Movement - Ramsey Blvd

		Dook											Q	ueue Le	engths ((ft)										
Option	Intersection	Peak	EI	BL	EI	вт	EE	BR	v	BL	W	вт	v	BR	N	BL	Ν	вт	N	BR	S	BL	SI	вт	SE	3R
		Hour	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max
	WB TH 10 Ramps at Ramsey Blvd	AM	-	-	-	-	-	-	25	75	-	-	75	200	25	75	-	-	-	-	-	-	-	-	-	-
	Stop Controlled	PM	-	-	-	-	-	-	50	75	-	-	100	175	25	75	-	-	-	-	-	-	-	-	25	25
Tight Diamond	EB TH 10 Ramps at Ramsey Blvd	AM	125	325	-	-	50	150	-	-	-	-	-	-	-	-	-	-	25	50	75	200	-	-	-	-
	Stop Controlled	PM	50	125	-	-	50	75	-	-	-	-	-	-	-	-	-	-	25	25	50	125	-	-	-	-
	WB TH 10 Ramps at Ramsev Blvd	AM	225	225	1900	3500	25	50	25	50	25	75	25	50	25	75	0	25	0	25	25	25	0	25	0	25
Folded WB Exit	Stop Controlled	PM	225	225	2825	3550	25	50	25	75	50	125	25	50	25	75	0	25	-	_	25	25	0	25	25	25
Ramp Tight	EB TH 10 Ramps at Ramsey Blvd	AM	100	250	-	-	50	75	-	-	-	-	-	-	-	-	-	-	25	50	75	175	-	-	-	-
Diamond	Stop Controlled	PM	50	100	-	-	50	75	-	-	-	-	-	-	-	-	-	-	25	25	50	150	-	-	-	-
	WB TH 10 Ramps at Ramsey Blvd	AM	175	225	125	450	25	50	25	50	25	75	25	50	50	125	50	150	25	50	25	50	175	375	25	50
Folded WB Exit	Signalized Intersection	PM	200	225	200	525	25	100	50	100	50	125	25	50	50	100	50	125	25	25	25	125	200	575	25	75
Ramp Tight	EB TH 10 Ramps at Ramsey Blvd	AM	75	175	_	_	50	75	_	_	_	-	-	-	-	-	_	-	25	50	100	275	_	_	_	-
Diamond	Stop Controlled	PM	50	100	-	-	50	75	-	-	-	-	-	-	-	-	0	25	25	50	75	175	-	-	-	-
	Riverdale Dr & EB TH 10 RI/RO	AM	25	50	-	-	-	-	-	-	-	-	25	50	-	-	-	-	-	-	50	125	-	-	25	25
	Stop Controlled	PM	2.5	50	-	-	-	-	_	-	-	-	25	25	_	-	-	-	_	_	50	75	_	_	25	25
	Ramsey Blvd & Riverdale Dr	AM	50	100	50	75	-	_	-	_	50	125	50	75	_	-	-	-	-	_	0	25	-	-	25	50
RIRO (Option	Stop Controlled	PM	50	75	50	75	-	_	-	_	50	75	50	75	_	-	-	-	-	_	0	25	-	-	25	50
7A)	N Frontage Rd & WB TH 10 RI/RO	AM	-	-	25	75	50	75	25	50	25	50	-	_	25	25	-	-	-	_	-		-	-	-	-
,	Stop Controlled	PM	-	_	50	75	50	100	50	75	50	75	-	_	25	25	-	_	0	25	-	-	-	_	-	_
	Ramsey Blvd & N Frontage Rd	AM	-	-	-	-	-	-	25	75	-	-	50	150			-	-	0	25	25	50	-	-	-	_
	Stop Controlled	PM	_	_	_	_	-	-	50	125	_	-	75	200	_	_	-	_	25	25	25	75	_	_	-	_
	Riverdale Dr & FB TH 10 RI/RO	AM	25	50	_	_	-	-	-	-	_	-	25	50	_	_	-	-	-	-	50	100	_	_	25	25
	Stop Controlled	PM	25	50	-	-	-	-	_	-	-	-	0	25	_	-	-	-	_	_	50	75	_	_	25	25
RIRO (Ontion	Ramsey Blyd & Riverdale Dr	AM	50	75	50	75	-	-	_	_	50	125	50	75	_	-	-	-	_	_	25	25	_	_	25	50
7B)	Stop Controlled	PM	50	75	50	75	-	-	_	_	50	75	50	75	_	-	-	-	_	_	-	-	_	_	25	50
,	Ramsey Blvd & N Frontage Rd	AM	350	350	3425	4625	25	75	25	75	25	75	25	50	25	75	-	-	0	25	25	50	-	-	-	-
	Stop Controlled	PM	350	350	4375	4950	25	75	25	75	50	100	2.5	50	25	75	0	2.5	-	_	25	25	0	25	25	25
	Riverdale Dr & FB TH 10 RI/RO	AM	25	50	-	-	-	-	-	-	-	-	25	50	-	-	-	-	-	_	50	150	-	-	25	25
	Stop Controlled	PM	25	50	_	_	-	-	_	_	_	_	25	25	_	_	_	-	-	_	50	75	_	_	25	25
RIRO (Option	Ramsey Blyd & Riverdale Dr	AM	50	100	50	75	-	_	-	-	50	125	50	100	_	-	-	-	-	_	-	-	-	-	25	50
7B)	Stop Controlled	PM	50	75	50	75	-	-	_	-	50	100	50	75	_	-	-	-	_	_	_	-	_	_	25	25
,	Ramsey Blvd & N Frontage Rd	AM	200	325	100	375	25	125	25	75	25	75	25	50	25	75	50	125	25	50	25	50	175	400	25	50
	Signalized Intersection	PM	275	350	125	575	25	125	25	75	50	125	25	50	50	100	50	125	25	25	25	50	200	400	25	100
	WB TH 10 Ramps at Ramsey Blvd	АМ	_	_	-	_	_	_	25	75	_	_	75	125	25	75	_	_	-	_	-	_	-	_	0	25
	Stop Controlled	PM	-	-	-	-	-	_	50	75	-	_	100	225	25	75	-	-	-	_	-	-	-	-	0	25
	EB TH 10 Ramps at Ramsey Blvd	AM	100	250	-	-	50	75	-	-	-	-		-		-	-	-	25	25	75	150	-	-	-	-
	Stop Controlled	PM	50	100	-	-	50	75	-	-	-	-	-	_	_	-	-	-	25	25	50	125	-	-	-	_
	WB Exit Ramp at East Connection Stop	AM	-	-	-	-	-	-	-	-	-	-	-	_	_	-	-	-		_	-	-	-	-	-	_
Tight Diamond	Controlled	PM	-	-	-	-	-	_	-	_	-	_	-	-	-	-	-	_	-	-	-	-	-	-	_	-
with West	N Frontage Rd at East Connection Stop	AM	-	-	25	50	25	50	25	50	25	50	-	-	-	-	-	-	0	25	-	-	-	-	-	-
Frontage Rd	Controlled	PM	-	-	25	50	25	50	25	50	50	75	-	-	-	-	-	_	-		-	-	-	-	_	-
	WB Entrance Ramp at West Connection	AM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	_	-	-	-	_	-	-	_	-
	Stop Controlled	PM	-	-	-	-	_		-	_	-	_	-	_	-	-	-	_	-	_	-	-	-	-	_	-
	N Frontage Rd at West Connection Stop	AM	-	-	25	50	25	50	25	50	25	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Controlled	PM	-	-	25	50	25	50	50	50	25	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-



Real People. Real Solutions.

SIGNAL WARRANTS ANALYSIS FOR Ramsey Blvd at N Frontage Rd-TH 10 WB 2025 BUILD

LOCATION: Ramsey at N Frontage Rd-TH 10 WB

COUNTY: Anoka

REF. POINT:			Speed	Approach De	escription				Lanes
DATE:	1/29/2019		45	Major App1:	NORTHBOL	JND			2
			45	Major App3:	SOUTHBOL	JND			2
OPERATOR:	KR		45	Minor App2:	WESTBOUN	ND			2
			45	Minor App4:	EASTBOUN	D			2
0.70 FACTOR L	JSED?	YES							
POPULATION <	< 10,000?	No 🖛	Ĩ						
N/A		No	Ī						
THRESHOLDS	1A/1B:		4	420/630			140/70	140/70	
	MAJOR	MAJOR	TOTAL	MAJOR	MINOR	MINOR 2	MINOR	MINOR 4	MET SAME
HOUR	APP. 1	APP. 3	1+3	1A/1B	APP. 2	1A/1B	APP. 4	(1A/1B
0:00 - 1:00			0	/		/		Ì	1
1:00 - 2:00			0	/		/		/	1
2:00 - 3:00			0	/		/		/	1
3:00 - 4:00			0	/		/		/	1
4:00 - 5:00			0	/		/		/	1
5:00 - 6:00			0	/		/		/	1
6:00 - 7:00	145	495	640	X/X	40	/	180	X/X	X/X
7:00 - 8:00	205	520	725	X/X	50	/	380	X/X	X/X
8:00 - 9:00	125	410	535	X/	35	/	245	X/X	X/
9:00 - 10:00	95	380	475	X/	25	/	200	X/X	X/
10:00 - 11:00	95	300	395	/	30	/	175	X/X	/
11:00 - 12:00	100	360	460	X/	40	/	230	X/X	X/
12:00 - 13:00	125	370	495	X/	35	/	305	X/X	X/
13:00 - 14:00	135	305	440	X/	45	/	305	X/X	X/
14:00 - 15:00	150	355	505	X/	50	/	380	X/X	X/
15:00 - 16:00	170	455	625	X/	60	/	390	X/X	X/
16:00 - 17:00	170	485	655	X/X	80	/X	455	X/X	X/X
17:00 - 18:00	140	360	500	X/	45	/	445	X/X	X/
18:00 - 19:00	105	320	425	X/	30	/	450	X/X	X/
19:00 - 20:00			0	/		/		/	1
20:00 - 21:00			0	/		/		/	1
21:00 - 22:00			0	/		/		/	1
22:00 - 23:00			0	/		1		/	1
23:00 - 24:00			0	/		1		/	1
	Met (Hr)	Required (I	Hr)						
Warrant 1A	12	8		Satisfied					

Warrant 1B3Warrant 210Warrant 36Warrant 713

Satisfied Not satisfied Satisfied Satisfied

8

4

1

8

Satisfied, check accident record







Note: For data points outside the graph range, check the minor street volume against the lower thresholds

	Warrant Criteria	a l	Actual	Hourly Count
Major	Warrant 2, F	Warrant 3, Pe	Major	Actual Hourly Count
200	420		0	0
300	350	500	0	0
400	285	435	0	0
500	230	370	0	0
600	175	315	0	0
700	135	260	0	0
800	103	215	640	180
900	80	175	725	380
1000	80	140	535	245
1100	80	115	475	200
1200	80	100	395	175
1300	80	100	460	230
1400	80	100	495	305
1500	80	100	440	305
1600	80	100	505	380
1700	80	100	625	390
1800	80	100	655	455
			500	445
			425	450
			0	0
			0	0
			0	0
			0	0
			0	0

Table A7. 2025	RCUT T	raffic Ana	alysis																										Traffic	Queuing	; (feet)			
Ontion	Peak	Aprob	[Demand	Volume	es		Modeled	Volum	es		Mod	lel - Den	nand	•	Total De	lay by Mo (sec/veh)	ovement	Leve N	l of Servi Novemer	ice by nt	LOS by A	Approach	L L	os		Left Turn		Thr	ough Qu	eue	R	ight Turn	1
Option	Hour	Apren	L	т	R	Total	L	т	R	Total	L	т	R	Total	%	L	т	R	L	т	R	Delay	LOS	Delay	LOS	Storage	Avg	Max	Link Length	Avg	Max	Storage	Avg	Max
		EB	69	1980	13	2062	64	1984	16	2064	-5	4	3	2	0%	21	1	1	С	А	Α	1	Α			350	25	100		25	50	350	25	50
		WB	4	1305	16	1325	5	1212	12	1229	1	-93	-4	-96	-7%	33	1	1	D	A	Α	1	A	5	Δ	350	25	50		0	0	350	25	100
		NB	18	4	1	23	19	5	2	26	1	1	1	3	13%	373	510	311	F	F	F	395	F	5	~		75	175		75	175		75	175
Unsignalized		SB	50	3	9	62	45	4	10	59	-5	1	1	-3	-5%	40	45	54	E	E	F	43	E				25	150		25	150		25	150
RCUT		EB	161	1565	11	1737	128	1548	11	1687	-33	-17	0	-50	-3%	413	34	59	F	D	F	63	F			350	525	2100		300	1400	350	150	1400
	РМ	WB	3	2159	40	2202	3	2049	38	2090	0	-110	-2	-112	-5%	54	3	2	F	А	Α	6	Α	41	F	350	200	1025		25	100	350	200	1025
		NB	17	1	7	25	17	0	9	26	0	-1	2	1	4%	200	78	131	F	F	F	176	F		-		50	125		50	125		50	125
		SB	60	5	25	90	37	6	19	62	-23	1	-6	-28	-31%	740	963	390	F	F	F	654	F				250	525		250	525		250	525
		EB	69	1980	13	2062	64	1984	16	2064	-5	4	3	2	0%	108	4	4	F	A	A	7	A			350	25	250		25	200	350	25	200
	ΔМ	WB	4	1305	16	1325	5	1207	12	1224	1	-98	-4	-101	-8%	91	3	3	F	A	A	5	A	q	Δ	350	25	225		25	225	350	25	225
	/	NB	18	4	1	23	17	4	2	23	-1	0	1	0	0%	172	167	48	F	F	D	160	F	Ĵ	~		25	75		25	75		25	75
Signalized		SB	50	3	9	62	46	4	10	60	-4	1	1	-2	-3%	133	123	39	F	F	D	117	F				25	100		25	100		25	100
RCUT		EB	161	1565	11	1737	157	1572	10	1739	-4	7	-1	2	0%	102	3	4	F	A	Α	12	В			350	75	475		25	150	350	25	150
	РM	WB	3	2159	40	2202	3	2083	38	2124	0	-76	-2	-78	-4%	100	8	5	F	A	A	9	A	14	в	350	25	675		50	675	350	25	675
		NB	17	1	7	25	18	0	8	26	1	-1	1	1	4%	158	97	38	F	F	D	121	F	17			25	75		25	75		25	75
		SB	60	5	25	90	56	6	23	85	-4	1	-2	-5	-6%	164	188	63	F	F	E	138	F				25	175		25	175		25	175

Table A8. 2045	RCUT TI	raffic Ana	alysis																										Traffic Qu	ieuing (feet)			
Ontion	Peak	Aproh	0	Demand	Volume	S	ſ	Vodeled	Volume	S		Mod	el - Der	nand		Total De	lay by Mo (sec/veh)	vement	Leve N	l of Servio Novemen	ce by t	LOS by A	pproach	LC	DS	I	eft Turn		Throug	gh Quei	ue	R	ght Turn	
Option	Hour	Apren	L	т	R	Total	L	т	R	Total	L	т	R	Total	%	L	т	R	L	т	R	Delay	LOS	Delay	LOS	Storage	Avg	Max	Link Length	Avg	Max	Storage	Avg	Max
		EB	230	1750	97	2077	214	1744	98	2056	-16	-6	1	-21	-1%	107	14	9	F	В	А	24	С			350	175	1100	1	L75	1075	350	100	1075
		WB	49	2578	60	2687	44	2456	55	2555	-5	-122	-5	-132	-5%	104	24	21	F	C	С	27	D	42	П	350	175	1450	3	325	1450	350	175	1450
		NB	142	18	115	275	132	21	119	272	-10	3	4	-3	-1%	341	308	171	F	F	F	264	F	42	U		350	850	3	350	850		350	850
Signalized		SB	106	15	30	151	94	14	28	136	-12	-1	-2	-15	-10%	207	199	87	F	F	F	181	F				75	425		75	425		75	425
RCUT		EB	96	2375	71	2542	88	2362	69	2519	-8	-13	-2	-23	-1%	111	18	13	F	В	В	21	С			350	225	1550	Э	375	1550	350	200	1550
	DM	WB	115	1425	18	1558	41	1444	16	1501	-74	19	-2	-57	-4%	108	8	8	F	A	Α	13	В	24	C	350	25	225		25	225	350	25	225
	FIVI	NB	154	45	55	254	146	46	55	247	-8	1	0	-7	-3%	280	278	143	F	F	F	249	F	54	C		250	825	2	250	825		250	825
		SB	90	10	13	113	83	11	12	106	-7	1	-1	-7	-6%	157	142	49	F	F	D	143	F				25	200		25	200		25	200
		EB	96	2375	71	2542	88	2378	69	2535	-8	3	-2	-7	0%	108	9	7	F	А	А	12	В			350	50	725		50	725	350	50	725
	<u> </u>	WB	115	1425	18	1558	43	1481	17	1541	-72	56	-1	-17	-1%	112	6	6	F	А	Α	11	В	25	C	350	25	300		25	300	350	25	300
Duallane	AIVI	NB	154	45	55	254	148	46	55	249	-6	1	0	-5	-2%	220	213	85	F	F	F	189	F	25	C		75	300		75	300		75	300
Signalized		SB	90	10	13	113	83	11	12	106	-7	1	-1	-7	-6%	144	138	39	F	F	D	132	F				25	125		25	125		25	125
Signalized RCUT		EB	230	1750	97	2077	215	1745	100	2060	-15	-5	3	-17	-1%	104	8	6	F	А	Α	18	С			350	100	700		50	650	350	25	650
		WB	49	2578	60	2687	44	2423	55	2522	-5	-155	-5	-165	-6%	106	17	16	F	В	В	20	С	20	c	350	150	1300	2	275	1300	350	150	1300
	PIVI	NB	142	18	115	275	134	21	119	274	-8	3	4	-1	0%	221	222	69	F	F	E	155	F	50	L		75	300		75	300		75	300
		SB	106	15	30	151	99	14	28	141	-7	-1	-2	-10	-7%	168	148	72	F	F	E	147	F				50	200		50	200		50	200

Table A9. 2025 - Partia	I RCUT																																		Tra	affic Que	euing (fee	t)				
Location	Peak	Apreh		Den	and vo	lumes			Mod	eled Vo	lumes			I	Model -	Dema	nd		Total	Delay b (sec,	y Move /veh)	ement	Le	vel of Mov	Service k vement	ру	LO App	S by roach	L	.05		U-Turn		L	Left Turn	I	Thro	ough Qu	eue	F	Right Turr	n
Location	Hour	Apren	U	L	т	R	Total	U	L	т	R	Total	U	L	т	R	Total	%	U	L	т	R	U	L	т	R	Delay	LOS	Delay	LOS	Storage	Avg	Max	Storage	Avg	Max	Link Length	Avg	Max	Storage	Avg	Max
		EB	2		2047	3	2050	1	1	2036	2	2039	-1	1	-11	-1	-11	-1%	7		2	2	Α	-	А	Α	2	Α			600	25	50					0	0	500	25	50
	AM	WB		17	1282		1299		9	1178		1187		-8	-104	0	-112	-9%		31	2		-	D	Α	-	2	Α	2	А				300	25	50		0	0			
TH 10 at Bowers St		NB		6		12	18		5		13	18		-1	0	1	0	0%		11		1	-	В	-	Α	4	Α							25	25					25	25
Stop Controlled		EB	2		1672	6	1680	2		1643	5	1650	0		-29	-1	-30	-2%	9		2	2	Α	-	А	Α	2	Α			600	25	25					0	0	500	25	25
	PM	WB		12	2208		2220		11	2142		2153		-1	-66	0	-67	-3%		34	6		-	D	Α	-	6	Α	4	А				300	25	50		0	0			
		NB		3		17	20		2		18	20		-1	0	1	0	0%		11		1	-	В	-	А	2	Α							25	25					25	25

Table A10. 2045 - Parti	ial RCU1	-																																	Tra	affic Que	euing (fe	et)				
Location	Peak	Aprch		Dema	and vol	umes			Mod	leled Vo	lumes			N	1odel -	Demar	nd		Total	Delay b (sec)	y Move 'veh)	ement	L	evel of S Move	ervice b ment	у	LO: App	i by oach	L	os		U-Turn			Left Turn	I	Thr	ough Qu	eue	R	ight Turr	ı
	Hour		U	L	Т	R	Total	U	L	Т	R	Total	U	L	Т	R	Total	%	υ	L	Т	R	U	L	Т	R	Delay	LOS	Delay	LOS	Storage	Avg	Max	Storage	Avg	Max	Link	Avg	Max	Storage	Avg	Max
		EB	2		2560	3	2563	2		2529	3	2532	0		-31	0	-31	-1%	9		4	3	Α	-	А	Α	4	Α			600	25	50					25	150	500	25	150
	AM	WB		17	1591		1608		9	1418		1427		-8	-173	0	-181	-11%		65	3		-	F	А	-	3	Α	4	Α				300	25	50		0	0			
TH 10 at Bowers St		NB		6		20	26		8		18	26		2	0	-2	0	0%		23		1	-	С	-	Α	8	Α							25	50					25	50
Stop Controlled		EB	2		2054	6	2062	1		1980	5	1986	-1		-74	-1	-76	-4%	32		3	5	D	А	А	А	3	Α			600	25	50					25	25	500	25	50
	PM	WB		12	2711		2723		9	2601		2610		-3	-110	0	-113	-4%		44	2			E	Α	А	2	Α	2	А				300	25	75		0	0			
		NB		3		17	20		2		18	20		-1	0	1	0	0%		16		1		С	Α	Α	3	Α	1						25	25					25	25