APPENDIX K:
INTERCHANGE DESIGN ALTERNATIVES ANALYSIS REPORT

Ministry of Transportation Ontario

Highway 401 Brockville

Preliminary Design and Environmental Assessment – Interchange Design Alternatives Analysis

Final Report

January 13, 2023

B001091C

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1. Introduction

CIMA+ Canada Inc. (CIMA+) was retained by Stantec as a sub-consultant to provide traffic engineering services in support of the Preliminary Design and Environmental Assessment Study, conducted by the Ministry of Transportation Ontario (MTO), for replacement/rehabilitation of structures along Highway 401 within the City of Brockville (City).

This memo summarizes the analysis that was conducted to evaluate different interchange design alternatives at locations within the study area, including the proposed Stewart Boulevard interchange (IC) and North Augusta Road IC, and the preferred design selected for the interchanges. The traffic operations were evaluated using a 3-hour (Pre-Peak, Peak, and Post-Peak Hour) microsimulation in Aimsun for the AM, PM, and Sunday peak periods. Section 2 of the memo provides the methodology for evaluating the traffic operational and safety impact of each design alternative at each location. Section 3 summarizes the findings of the traffic operation analysis for the three horizon years (2029, 2034, and 2044) on the ramp terminals and Highway 401 mainline for the different interchange design alternatives. Section 4 summarizes the expected impact of the preferred design selected on the traffic operation of the ramp terminals and Highway 401 mainline with different lane cross-sections (6-lane vs 8-lane) for the two horizon years (2034, and 2044). Section 5 summarizes the safety evaluation of the interchange design alternatives. The study area is presented in Figure 1 below.

Figure 1: Study Area

2. Data Collection and Methodology

2.1 Future Demand Estimation

The horizon years of 2029, 2034, and 2044 are used to assess the future traffic operations 5-, 10-, and 20-year beyond the construction year of 2024. The future traffic volumes were extrapolated by growing the existing conditions O-D Matrix by using a 2.1% annual growth rate for the highway traffic and 1% annual growth rate for the local traffic, as described in the *Growth Rate Estimation* memo.

2.2 Traffic Operations

The calibrated microsimulation model, as described in the *Calibration and Validation Report*, dated January 11, 2021, was updated to an 8-lane Highway 401 mainline with the following interchange configurations to evaluate its impact on traffic operations at:

- Stewart Boulevard
    - Minor Improvements Configuration
    - Parclo A4 Configuration
    - Diverging Diamond
    - Single Point Urban Interchange (SPUI)
- North Augusta Road
    - Minor Improvements Configuration
    - Parclo A4
    - Diverging Diamond
    - Single Point Urban Interchange (SPUI)
    - Diamond Configuration
    - Diamond with Roundabouts Configuration
    - Parclo A2 with Diamond

The traffic operations, such as travel speed, level-of-service (LOS), average and maximum queue lengths, were evaluated and compared across the interchange design alternatives during the AM, PM, and Sunday peak periods. The future horizon years' AM, PM, and Sunday peak hour traffic volumes are illustrated in Appendix A. The HCM LOS-Delay relationship is shown in Table 1.

Table 1: LOS-Delay for Signalized and Unsignalized Intersections

LOS	Signalized Intersection Delay (s)	Unsignalized Intersection Delay (s)
A	≤10	≤10
B	10-20	10-15
C	20-35	15-25
D	35-55	25-35
E	55-80	35-50
F	>80	>50

2.3 Safety Review

The safety performance of each interchange alternative was assessed based on the predicted collisions for each interchange configuration. Collisions were predicted using Safety Performance Functions (SPFs) from the MTO's Safety Analyst tool. SPFs are regression models used to predict collision frequencies for a specific site subtype. Property Damage Only (PDO) and Injury/Fatal (Severe) collision frequencies were calculated for all ramps, ramp terminals, and mainline segments that make up each interchange alternative.

SPFs for standard interchange designs (such as Parclo and Diamond) were directly applied; however, for non-standard configurations (such as Diverging Diamond and Diamond with Roundabouts) that do not have specific SPFs, Collison Modification Factors (CMFs) obtained from FHWA's CMF Clearinghouse website[1] were applied to the SPF results for the closest standard interchange design. CMFs are an estimate of the change in collisions expected after the implementation of a countermeasure. Due to the relatively low number of studies conducted regarding the safety performance of SPUIs, there were no CMFs available for this type of interchange. Hence, the predicted collisions for the SPUI ramp terminal assume that it performs similarly to a four-legged signalized diamond ramp terminal. The equations from the SafetyAnalyst (including the SPF coefficients) that were utilized to predict collision frequencies on the mainline segment, at the ramp terminals and on the ramps are provided in Appendix B.

3. Traffic Operations Analysis

The sections below summarize the results of interchange alternatives on the traffic operations at Stewart Boulevard and North Augusta Road, and Highway 401 mainline operations for 2029, 2034, and 2044. The detailed diagrams that showcase LOS and queueing information at key intersections for the peak hour and mainline traffic operations for the pre-peak and post-peak hours can be found in Appendix C – K.

In order to evaluate the alternatives, the LOS and queue lengths were analyzed at ramp terminals and significantly impacted intersections for the AM, PM, and Sunday peak hours. In addition, the impact of each interchange alternative on the Highway 401 mainline operations was evaluated by comparing the average travel speed and vehicle density on segments adjacent to the interchanges (including the weaving sections) for the pre-peak, peak, and post-peak hours.

[1] *CMF Clearinghouse, U.S. Department of Transportation Federal Highway Administration, http://www.cmfclearinghouse.org/index.cfm, 2021*

3.1 Horizon Year 2029

This subsection summarizes the traffic operations analysis results for Horizon Year 2029 on Stewart Boulevard and North Augusta Road ICs and the expected impact of interchange alternatives on Highway 401 mainline operations.

3.1.1 2029 Stewart Boulevard Interchange

The analysis results of ramp terminals traffic operations for each alternative at the Stewart Boulevard IC were evaluated based on the LOS, average and maximum queue length per the direction of movement, for AM, PM, and Sunday peak periods.

3.1.1.1 2029 Stewart Boulevard – Minor Improvements

The minor improvement configuration keeps the existing configurations, with the following changes:

- Dual Eastbound Left turn lanes at Stewart Boulevard and Central Avenue intersection, due to heavy left-turn volume.
- Optimize the Signal Timing Plans within the corridor

Figure 2 below provides an overview of the Stewart Boulevard interchange configuration.

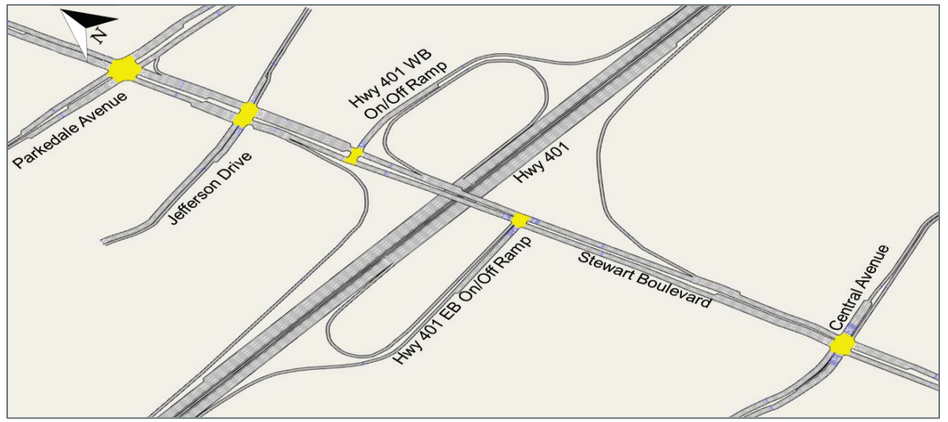


Figure 2: Stewart Boulevard - Minor Improvement Configuration

The 2029 peak hour traffic operation results for the Minor Improvement configuration are shown in Exhibit C-1 in Appendix C. The following observations can be made:

- All of the approaches at the north ramp terminal are expected to perform at LOS A in the AM, PM, and Sunday peak hour, with the exception of the westbound left-turn, which is expected to perform at LOS C in the AM, PM, and Sunday peak hour.
- All of the approaches at the south ramp terminal are expected to perform at LOS C or better in the AM peak hour, and LOS B or better in the PM and Sunday peak hour.
- At Stewart Boulevard and Central Avenue, all approaches are expected to perform at LOS D or better in the AM, PM, and Sunday peak hours. During the PM peak hour, the eastbound and westbound left turn's maximum queue may slightly exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At Stewart Boulevard and Jefferson Drive, all approaches are expected to perform at LOS C or better in the AM peak hour, with the exception of shared eastbound through-right and westbound left, which is expected to perform at LOS D. In the PM peak hour, all approaches are expected to perform at LOS C or better, with the exception of eastbound through-left shared lane, which is expected to perform at LOS D.
- At Stewart Boulevard and Parkedale Avenue, all of the approaches are expected to perform at LOS D or better in the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS C or better.

3.1.1.2 2029 Stewart Boulevard – Parclo A4

The Parclo A4 configuration keeps the existing configurations, with the following changes:

- Dual Eastbound Left turn lanes at Stewart Boulevard and Central Avenue intersection, due to heavy left-turn volume.
- Optimize the Signal Timing Plans within the corridor

Figure 3 below provides an overview of the Stewart Boulevard interchange configuration.

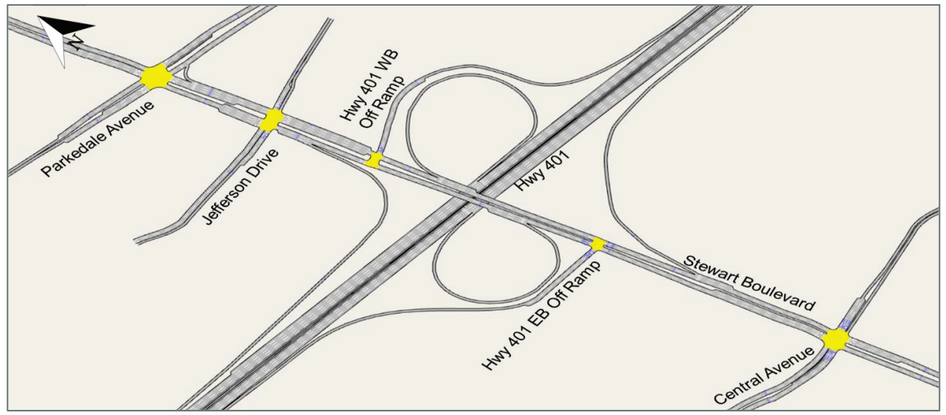


Figure 3: Stewart Boulevard – Parclo A4 Configuration

The 2029 peak hour traffic operation results for the Parclo A4 configuration are shown in Exhibit C-2 in Appendix C. The following observations can be made:

- All of the approaches at the north ramp terminal are expected to perform at LOS A in the AM, PM, and Sunday peak hour, with the exception of the westbound left-turn, which is expected to perform at LOS C or better in the AM, PM, and Sunday peak hour.
- All of the approaches at the south ramp terminal are expected to perform at LOS A in the AM, PM, and Sunday peak hour, with the exception of the eastbound left-turn, which is expected to perform at LOS C or better in the AM, PM, and Sunday peak hour.
- At Stewart Boulevard and Central Avenue, all approaches are expected to perform at LOS D or better in the AM, PM, and Sunday peak hours. During the PM peak hour, the eastbound and westbound left turn's maximum queue may exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At Stewart Boulevard and Jefferson Drive, all approaches are expected to perform at LOS C or better in the AM and PM peak hour, with the exception of shared eastbound through-left and westbound left, which is expected to perform at LOS D.
- At Stewart Boulevard and Parkedale Avenue, all of the approaches are expected to perform at LOS D or better in the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS C or better.

3.1.1.3 2029 Stewart Boulevard – Diverging Diamond

The Diverging Diamond configuration keeps the existing configurations, with the following changes:

- Dual Eastbound Left turn lanes at Stewart Boulevard and Central Avenue intersection, due to heavy left-turn volume.
- Three southbound lanes along Stewart Boulevard between the South ramp terminal and Central Avenue.
- Optimize the Signal Timing Plans within the corridor

The Diverging Diamond configuration allows for free-flow travel for the traffic utilizing the on- and off-ramps, resulting in minimal delays for the traffic utilizing the ramps. The signalization is provided for northbound and southbound through traffic at each ramp terminal. The signal timing plans for the north and south ramp terminals were developed by optimizing the signals in Synchro. Figure 4 below provides an overview of the Stewart Boulevard interchange configuration.

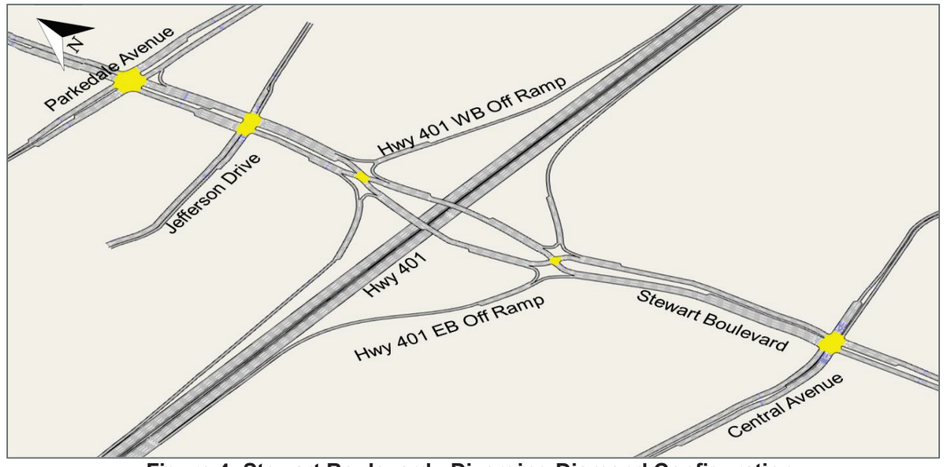


Figure 4: Stewart Boulevard - Diverging Diamond Configuration

The 2029 peak hour traffic operation results for the Diverging Diamond configuration are shown in Exhibit C-3 in Appendix C. The following observations can be made:

- All of the approaches at the north ramp terminal are expected to perform at LOS B or better in the AM, PM, and Sunday peak hours.
- All of the approaches at the south ramp terminal are expected to perform at LOS B or better in the AM, PM, and Sunday peak hours.
- At Stewart Boulevard and Central Avenue, all approaches are expected to perform at LOS D or better in the AM, PM, and Sunday peak hours. Additionally, during the PM peak hour, the eastbound and westbound left-turn's maximum queue may slightly exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.

- At Stewart Boulevard and Jefferson Drive, all approaches are expected to perform at LOS C or better in the AM peak hour. In the PM peak hour, all approaches are expected to perform at LOS C or better, with the exception of eastbound through-left and westbound through-right shared movements, which are expected to perform at LOS D.
- At Stewart Boulevard and Parkedale Avenue, all of the approaches are expected to perform at LOS D or better in the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS C or better.

3.1.1.4 2029 Stewart Boulevard – SPUI

The SPUI configuration keeps the existing configurations, with the following changes:

- Dual Eastbound Left turn lanes at Stewart Boulevard and Central Avenue intersection, due to heavy left-turn volume.
- Three southbound lanes along Stewart Boulevard between the SPUI terminal and Central Avenue.
- Optimize the Signal Timing Plans within the corridor

The SPUI configuration allows for free-flow travel for the traffic utilizing the on-ramps, resulting in minimal delays for the traffic utilizing the on-ramps. Additionally, it compresses the two typical north/south ramp terminals into one single intersection. The signalization is provided for the SPUI terminal. The signal timing plans for the SPUI ramp terminal were developed by optimizing the signals in Synchro. Figure 5 below provides an overview of the Stewart Boulevard interchange configuration.

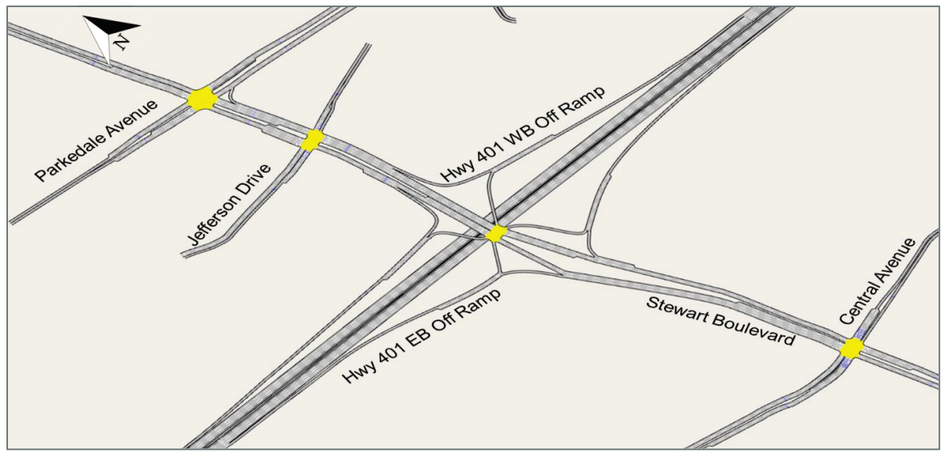


Figure 5: Stewart Boulevard - SPUI Configuration

The 2029 peak hour traffic operation results for the SPUI configuration are shown in Exhibit C-4 in Appendix C. The following observations can be made:

- All of the approaches at the SPUI ramp terminal are expected to perform at LOS C or better in the AM and PM peak hour and are expected to perform at LOS B or better during the Sunday peak hour. The maximum queue for the southbound left-turn movement may exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At Stewart Boulevard and Central Avenue, all approaches are expected to perform at LOS D or better in the AM, PM, and Sunday peak hours. Additionally, during the PM peak hour, the eastbound, and westbound left turn's maximum queue may slightly exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.

- At Stewart Boulevard and Jefferson Drive, all approaches are expected to perform at LOS C or better in the AM peak hour, with the exception of the westbound left-turn movement, which is expected to perform at LOS D. In the PM peak hour, all approaches are expected to perform at LOS C or better, with the exception of the eastbound through-left and westbound through-right shared movements, which are expected to perform at LOS D.
- At Stewart Boulevard and Parkedale Avenue, all of the approaches are expected to perform at LOS D or better in the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS C or better.

3.1.1.5 2029 Stewart Boulevard – Overall Alternatives Comparison

Table 2 and Table 3 provide the expected overall intersection LOS and delay for the key intersections along Stewart Boulevard for the various alternatives for the 2029 horizon year. This is based on the average delay experienced at all approaches at the intersection. As noticeable, all interchange alternatives are expected to perform at LOS B or better at ramp terminals. The impact on the adjacent intersection is minimal, with Stewart Boulevard & Central Avenue performing at LOS C in the AM and Sunday peak hour for all alternatives and is expected to perform at LOS D or better in the PM peak hour. The intersection of Stewart Boulevard and Jefferson is expected to perform at LOS B or better for all alternatives during the AM and PM peak. The intersection of Stewart Boulevard and Parkedale Avenue is expected to perform at LOS C for all alternatives during the AM, PM, and Sunday peak hours.

Table 2: Stewart Boulevard – 2029 Overall Intersection LOS

Intersections	Minor Improvements			Parclo A4			Diverging Diamond			SPUI		
	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN
Stewart Boulevard & North Ramp Terminal	A	A	A	A	A	A	B	A	A	B	B	B
Stewart Boulevard & South Ramp Terminal	A	A	A	A	A	A	B	A	B			
Stewart Boulevard & Central Avenue	C	D	B	C	D	B	C	C	B	C	C	B
Stewart Boulevard & Jefferson Drive[2]	A	B		A	B		A	B		A	B	
Stewart Boulevard & Parkedale Avenue	C	C	C	C	C	C	C	C	C	C	C	C

Table 3: Stewart Boulevard – 2029 Overall Intersection Delay (s)

Intersections	Minor Improvements			Parclo A4			Diverging Diamond			SPUI		
	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN
Stewart Boulevard & North Ramp Terminal	10	9	6	9	8	8	10	10	8	18	20	16
Stewart Boulevard & South Ramp Terminal	7	7	10	6	6	5	11	9	10			
Stewart Boulevard & Central Avenue	30	37	18	32	37	18	30	35	16	30	35	16
Stewart Boulevard & Jefferson Drive	9	11		9	11		10	11		9	12	
Stewart Boulevard & Parkedale Avenue	26	24	27	26	24	26	27	25	29	26	23	27

[2] *The weekend model calibration/analysis was completed for select key intersections that did not include Jefferson drive*

3.1.2 2029 North Augusta Road Interchange

The following subsections summarize the ramp terminal operations for the alternatives at the North Augusta Road IC.

3.1.2.1 2029 North Augusta Road – Minor Improvements

The minor improvement configuration keeps the existing configurations with the optimized signal timing plans for 2029 traffic volume. Figure 6 provides an overview of the North Augusta Road interchange configuration.

The minor improvement configuration peak hour traffic operations results are shown in Exhibit D-1 in Appendix D. The following observations can be made:

- All of the approaches on the ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM and Sunday peak hours. During the PM peak hour, all of the approaches on the ramp terminal are expected to perform at LOS C or better.
- All of the approaches on the ramp terminal on Parkedale Avenue are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

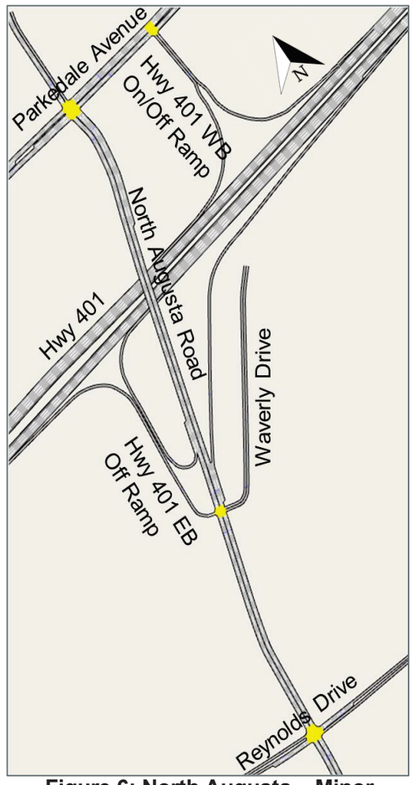


Figure 6: North Augusta – Minor Improvement Configuration

3.1.2.2 2029 North Augusta Road – Parclo A4

The Parclo A4 configuration is modelled for the north and south ramp terminals, as shown in Figure 7, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on Parkedale Avenue and Broome Road.
- Optimize the Signal Timing Plans within the corridor

The 2029 peak hour traffic operation results for the Parclo A4 configuration are shown in Exhibit D-2 in Appendix D. The following observations can be made:

- All of the approaches on the ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM, PM, and Sunday peak hours.
- All of the approaches on the ramp terminal on Parkedale Avenue are expected to perform at LOS B or better during the AM and Sunday peak hours. During the PM peak hour, the ramp terminal is expected to perform at LOS C or better.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

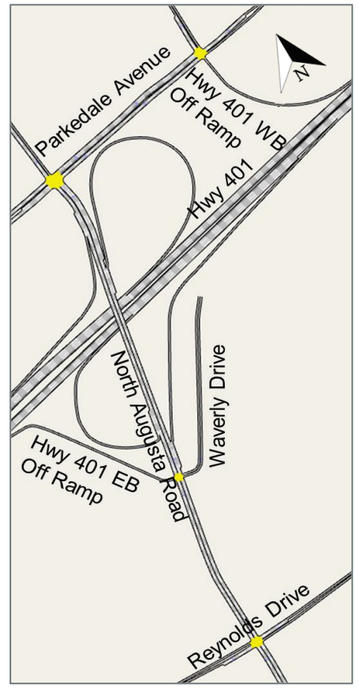


Figure 7: North Augusta – Parclo A4 Configuration

3.1.2.3 2029 North Augusta Road – Diverging Diamond

The Diverging Diamond configuration keeps the existing configurations, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on North Augusta Road.
- Optimize the Signal Timing Plans within the corridor

The Diverging Diamond configuration allows for free-flow travel for the traffic utilizing the on- and off-ramps, resulting in minimal delays for the traffic utilizing the ramps. The signalization is provided for northbound and southbound through traffic at each ramp terminal. The signal timing plans for the north and south ramp terminals were developed by optimizing the signals in Synchro. Figure 8 provides an overview of the North Augusta interchange configuration.

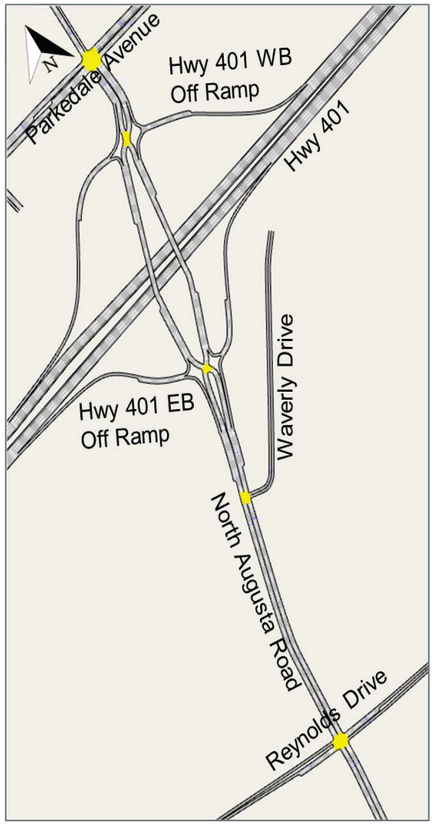


Figure 8: North Augusta - Diverging Diamond Configuration

The 2029 peak hour traffic operation results for the Diverging Diamond configuration are shown in Exhibit D-3 in Appendix D. The following observations can be made:

- All of the approaches on the north ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM, PM, and Sunday peak hours.
- All of the approaches on the south ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours. The maximum queue for northbound right movement at the intersection may exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

3.1.2.4 2029 North Augusta Road – SPUI

The SPUI configuration keeps the existing configurations, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on North Augusta Road.
- Optimize the Signal Timing Plans within the corridor

The SPUI configuration allows for free-flow travel for the traffic utilizing the on-ramps, resulting in minimal delays for the traffic utilizing the on-ramps. Additionally, it compresses the two typical north/south ramp terminals into one single intersection. The signalization is provided for the SPUI terminal. The signal timing plans for the SPUI ramp terminal were developed by optimizing the signals in Synchro. Figure 9 provides an overview of the North Augusta interchange configuration.

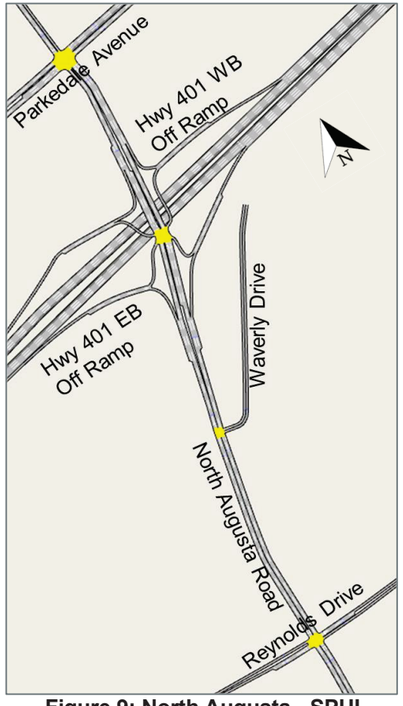


Figure 9: North Augusta - SPUI Configuration

The 2029 peak hour traffic operation results for the SPUI configuration are shown in Exhibit D-4 in Appendix D. The following observations can be made:

- All of the approaches on the SPUI ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM peak hour and are expected to perform at LOS C or better during the PM and Sunday peak hour.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

3.1.2.5 2029 North Augusta Road – Diamond

The Diamond configuration is modelled for the north and south ramp terminals, as shown in Figure 10, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on North Augusta Road.
- Optimize the Signal Timing Plans within the corridor

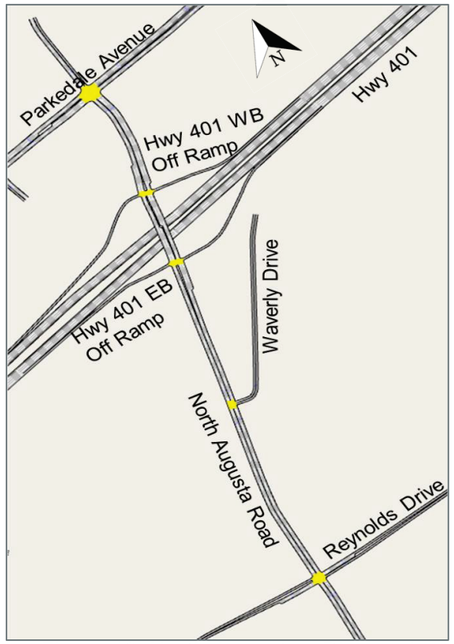


Figure 10: North Augusta – Diamond Configuration

The 2029 peak hour traffic operation results for the Diamond configuration are shown in Exhibit D-5 in Appendix D. The following observations can be made:

- All of the approaches on the north ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM, PM, and Sunday peak hour, with the exception of southbound through movement, which is expected to perform at LOS C during the PM peak hour. The maximum queue for the northbound left movement may exceed the available storage during the PM peak. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- All of the approaches on the south ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM, PM, and Sunday peak hour, with the exception of northbound through movement, which is expected to perform at LOS C during the PM peak hour. The maximum queue for the southbound left movement may exceed the available storage during the PM peak. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hour, with the exception of shared southbound through-right movement, which is expected to perform at LOS D during the PM peak hour.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

To accommodate the storage for vehicles utilizing the northbound left turn at the north ramp terminal and the southbound left turn at the south ramp terminal along North Augusta Road, it is recommended that the distance between the north and south ramp terminals to be at least 150 m.

3.1.2.6 2029 North Augusta Road – Diamond with Roundabout

The Diamond with Roundabout configuration is modelled for the north and south ramp terminals, as shown in Figure 11, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on North Augusta Road.
- Optimize the Signal Timing Plans within the corridor

The north and south ramp terminals include a 2-lane entry and exit for roundabouts. Figure 12 shows the lane configuration for north and south ramp terminal roundabouts.

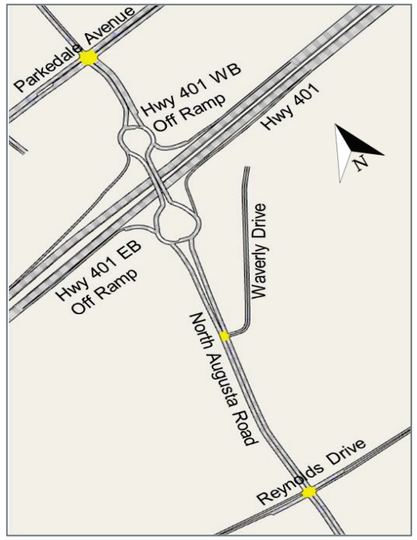


Figure 11: North Augusta – Diamond with Roundabout Configuration

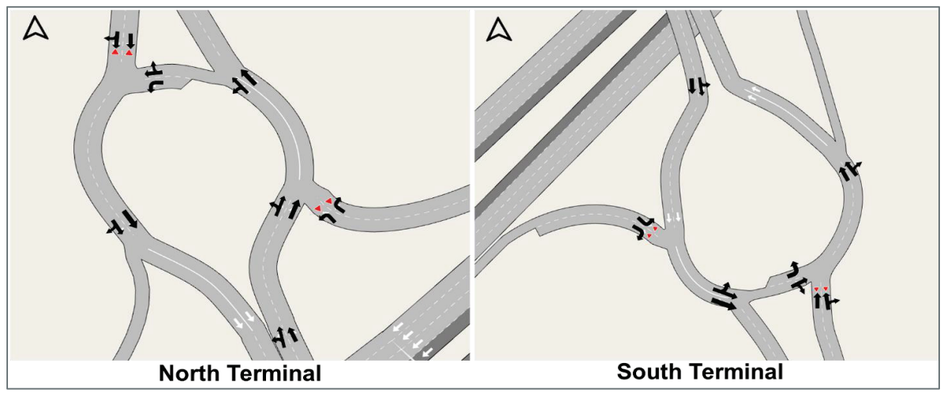


Figure 12: Roundabout Lane Configuration

The 2029 peak hour traffic operation results for the Diamond with Roundabouts configuration are shown in Exhibit D-6 in Appendix D. The following observations can be made:

- All of the approaches on the north ramp terminal on North Augusta Road are expected to perform at LOS A during the AM, PM, and Sunday peak hours.
- All of the approaches on the south ramp terminal on North Augusta Road are expected to perform at LOS A during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

3.1.2.7 2029 North Augusta Road – Parclo A2 with Diamond

The Parclo A2 (North Terminal) with Diamond (South Terminal) configuration is modelled, as shown in Figure 13, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on Parkedale Avenue and Broome Road.
- Optimize the Signal Timing Plans within the corridor

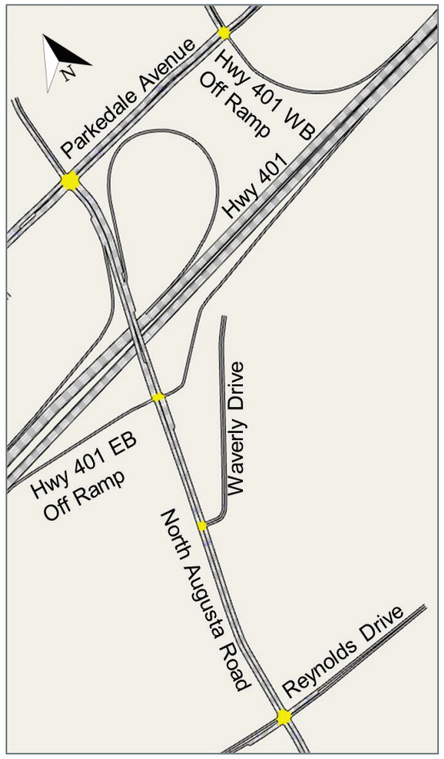


Figure 13: North Augusta – Parclo A2 with Diamond Configuration

The 2029 peak hour traffic operation results for the Parclo A2 with Diamond configuration are shown in Exhibit D-7 in Appendix D. The following observations can be made:

- All of the approaches on the ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM and Sunday peak hours. During the PM peak hour, all of the approaches are expected to perform at LOS C or better. The southbound left-turn maximum queue may exceed the available storage but is not expected to spill back to the North Augusta and Parkedale intersection and cause any significant interference to the through traffic.
- All of the approaches on the ramp terminal on Parkedale Avenue are expected to perform at LOS B or better during the AM and Sunday peak hours. During the PM peak hour, the ramp terminal is expected to perform at LOS C or better.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

3.1.2.8 2029 North Augusta Road – Overall Interchange Performance

Table 4 and Table 5 provide the expected overall intersection LOS and delay for the key intersections along North Augusta Road for the various alternatives for the 2029 horizon year. As noticeable, all alternatives at the north ramp terminal are expected to perform at LOS B or better, with the exception of Minor improvement in the PM peak hour, which is expected to perform at LOS C. At the south ramp terminal, all alternatives are expected to perform at LOS B or better. The North Augusta Road and Parkedale Avenue intersection is expected to perform at LOS C or better for all alternatives. Lastly, the North Augusta Road and Reynolds Drive intersection is expected to perform at LOS B for all alternatives.

Table 4: North Augusta Road – 2029 Overall Intersection LOS

Intersections	Minor Improvements			Parclo A4			Diverging Diamond			SPUI			Diamond			Diamond with Roundabout			Parclo A2 with Diamond		
	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN
N Augusta Rd & N Ramp Terminal	B	C	B	B	B	B	B	B	B	B	B	B	B	B	A	A	A	A	B	B	B
N Augusta Rd & S Ramp Terminal	A	A	A	A	A	A	B	A	B				A	B	B	A	A	A	B	B	B
N Augusta Rd & Parkedale Ave	B	C	B	C	C	B	C	C	B	B	C	B	B	C	B	B	C	B	C	C	B
N Augusta Rd & Reynolds Dr	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B

Table 5: North Augusta Road – 2029 Overall Intersection Delay (s)

Intersections	Minor Improvements			Parclo A4			Diverging Diamond			SPUI			Diamond			Diamond with Roundabout			Parclo A2 with Diamond		
	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN
N Augusta Rd & N Ramp Terminal	15	21	11	12	14	11	13	13	11	14	17	17	11	17	9	3	5	2	12	13	11
N Augusta Rd & S Ramp Terminal	3	5	1	8	9	5	12	10	13				9	14	10	3	6	2	10	18	10
N Augusta Rd & Parkedale Ave	14	21	14	21	24	17	20	26	18	19	25	14	19	25	17	19	25	17	21	27	17
N Augusta Rd & Reynolds Dr	11	13	11	12	11	14	11	13	12	11	12	12	11	12	11	12	13	11	12	13	11

3.1.3 2029 Highway 401 Mainline Operations

This subsection summarizes the expected impact of interchange alternatives on Highway 401 mainline operations with 8-lane cross-section in 2029 for the AM, PM, and Sunday peak period.

3.1.3.1 2029 AM Peak Period

Figure 14 and Figure 15 compare the impact on mainline density and speed of interchange configurations at Stewart Boulevard and North Augusta on the eastbound direction of Highway 401 during the 2029 AM peak hour. The Minor Improvements, Parclo A4, Diverging Diamond, and SPUI were modelled for both Stewart Boulevard and North Augusta Road interchanges, whereas Diamond, Diamond with Roundabouts, and Parclo A2 with Diamond were only modelled for North Augusta Road interchanges. As noticeable, Highway 401 EB (with 8-lane cross-section) mainline is expected to perform at LOS A with an average speed exceeding 100 km/h, during the 2029 AM peak hour, throughout the study area.

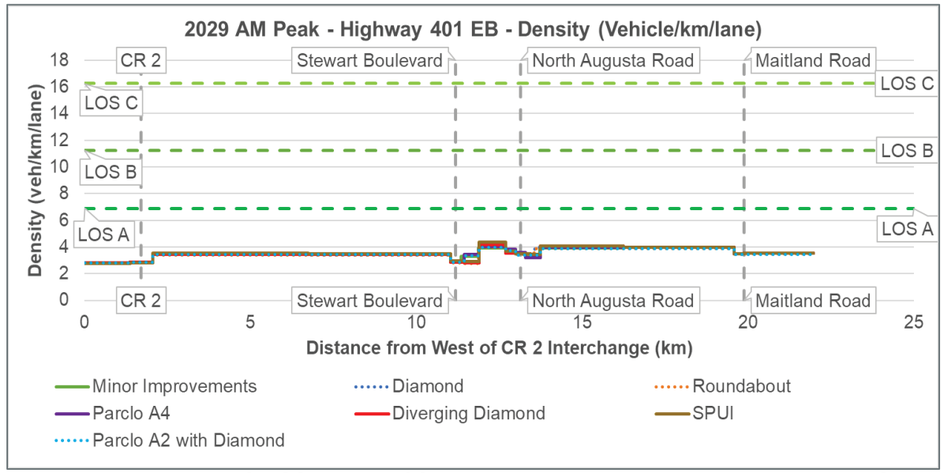


Figure 14: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 AM Peak Hour

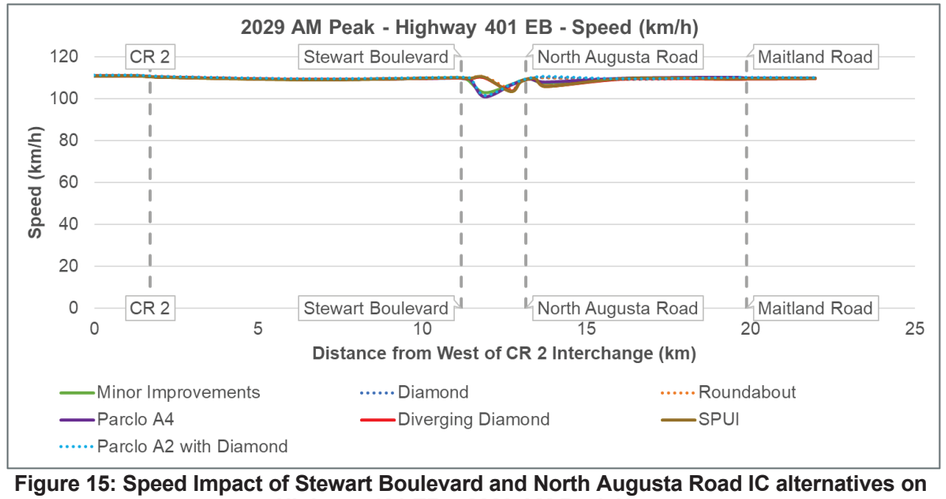
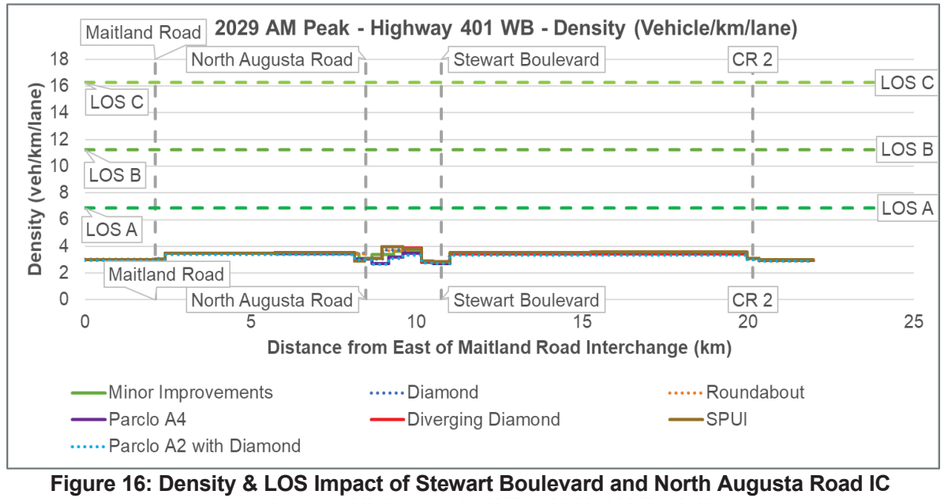


Figure 15: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 AM Peak Hour

Figure 16 and Figure 17 compare the impact on mainline density and speed of alternative interchange configurations at Stewart Boulevard and North Augusta on the westbound direction of Highway 401 during the 2029 AM peak hour. As noticeable, Highway 401 WB (with 8-lane cross-section) mainline is expected to perform at LOS A during the 2029 AM peak hour, with an average operating speed exceeding 100 km/h, during the 2029 AM peak hour throughout the study area. The 2029 AM Pre-Peak and Post-Peak hour analysis shows similar traffic operations to the peak hour along the highway mainline, as shown in Exhibit E-1 to Exhibit E-8 in Appendix E.



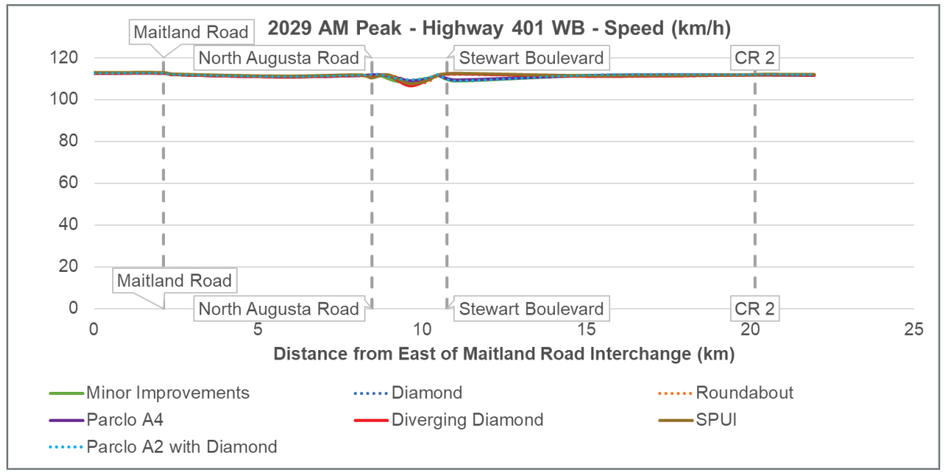


Figure 16: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 AM Peak Hour

Figure 17: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 AM Peak Hour

3.1.3.2 2029 PM Peak Period

Figure 18 and Figure 19 compare the impact on mainline density and speed of interchange configurations at Stewart Boulevard and North Augusta on the eastbound direction of Highway 401 during the 2029 PM peak hour. The Minor Improvements, Parclo A4, Diverging Diamond, and SPUI were modelled for both Stewart Boulevard and North Augusta Road interchanges, whereas Diamond, Diamond with Roundabouts, and Parclo A2 with Diamond were only modelled for North Augusta Road interchanges. As noticeable, Highway 401 EB (with 8-lane cross-section) mainline is expected to perform at LOS B or better with an average operating speed exceeding 100 km/h, during the 2029 PM peak hour, throughout the study area.

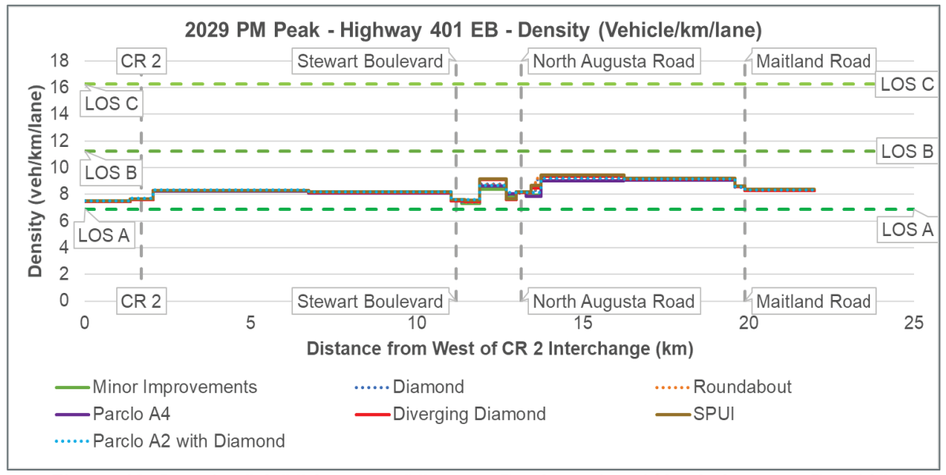


Figure 18: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 PM Peak Hour

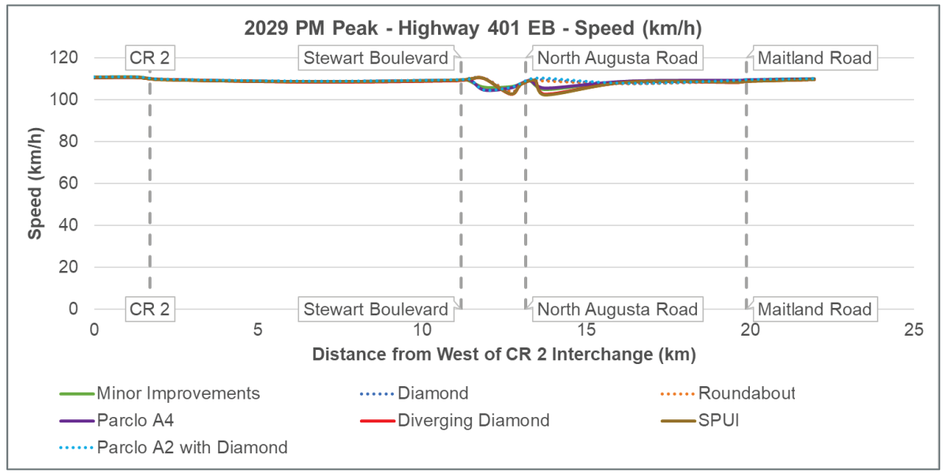


Figure 19: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 PM Peak Hour

Figure 20 and Figure 21 compare the impact on mainline density and speed of interchange configurations at Stewart Boulevard and North Augusta on the westbound direction of Highway 401 during the 2029 PM peak hour. As noticeable, Highway 401 WB (with 8-lane cross-section) mainline is expected to perform at LOS B or better, with an average operating speed exceeding 100 km/h, during the 2029 PM peak hour, throughout the study area. The 2029 PM Pre-Peak and Post-Peak hour analysis shows slightly better traffic operations when compared to the peak hour along the highway mainline, as shown in Exhibit E-9 to Exhibit E-16 in Appendix E.

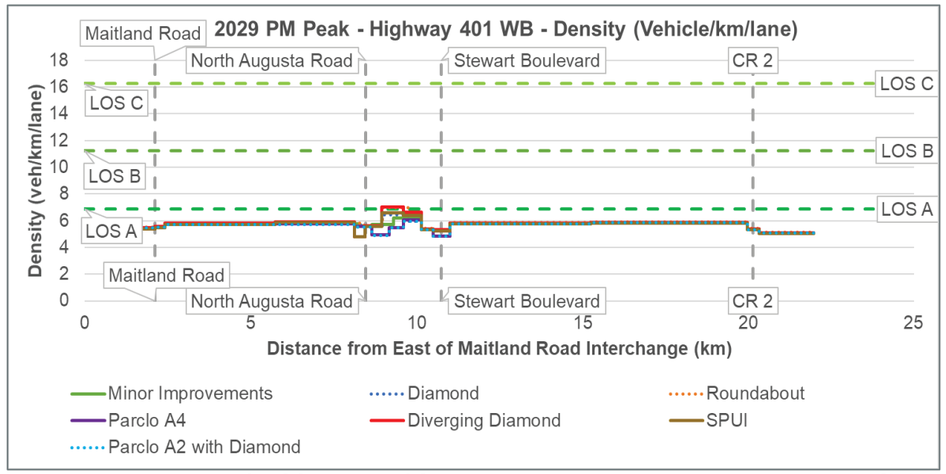


Figure 20: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 PM Peak Hour

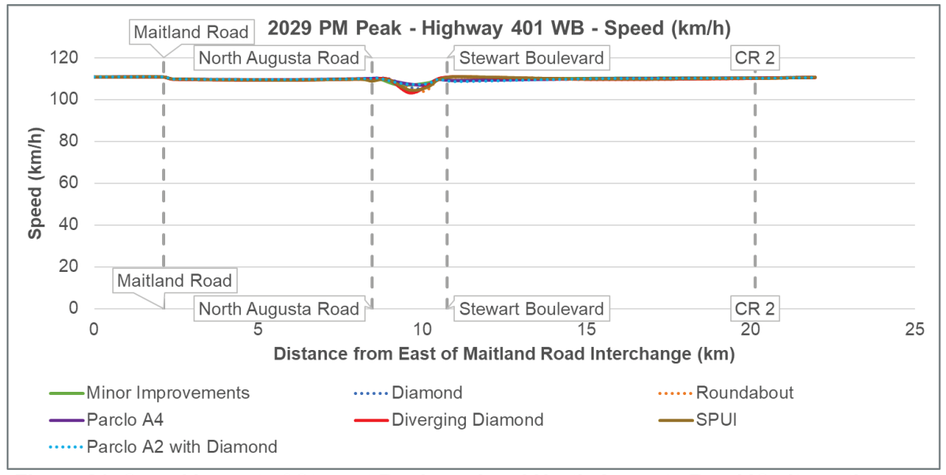


Figure 21: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 PM Peak Hour

3.1.3.3 2029 Sunday Peak Period

Figure 22 and Figure 23 compare the impact on mainline density and speed of interchange configurations at Stewart Boulevard and North Augusta on the eastbound direction of Highway 401 during the 2029 Sunday peak hour. The Minor Improvements, Parclo A4, Diverging Diamond, and SPUI were modelled for both Stewart Boulevard and North Augusta Road interchanges, whereas Diamond, Diamond with Roundabouts, and Parclo A2 with Diamond were only modelled for North Augusta Road interchanges. As noticeable, Highway 401 EB (with 8-lane cross-section) mainline is expected to perform at LOS A, with an average operating speed exceeding 100 km/h, during the 2029 Sunday peak hour, throughout the study area.

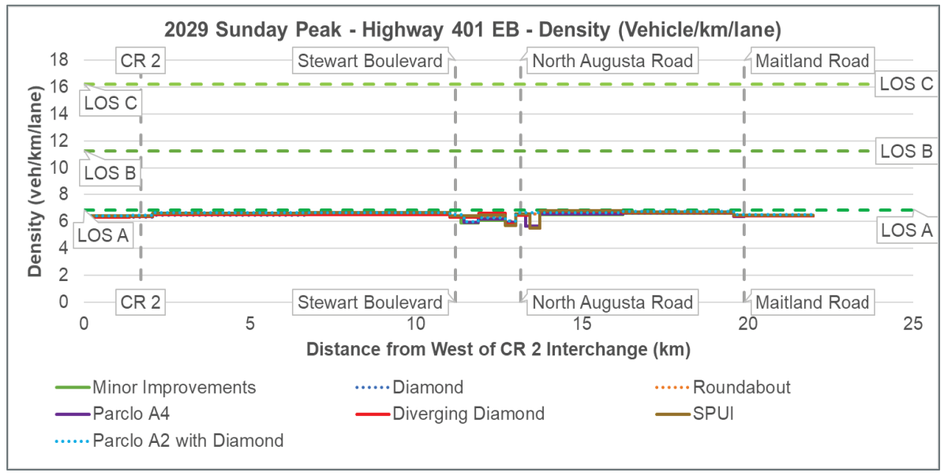


Figure 22: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 Sunday Peak Hour

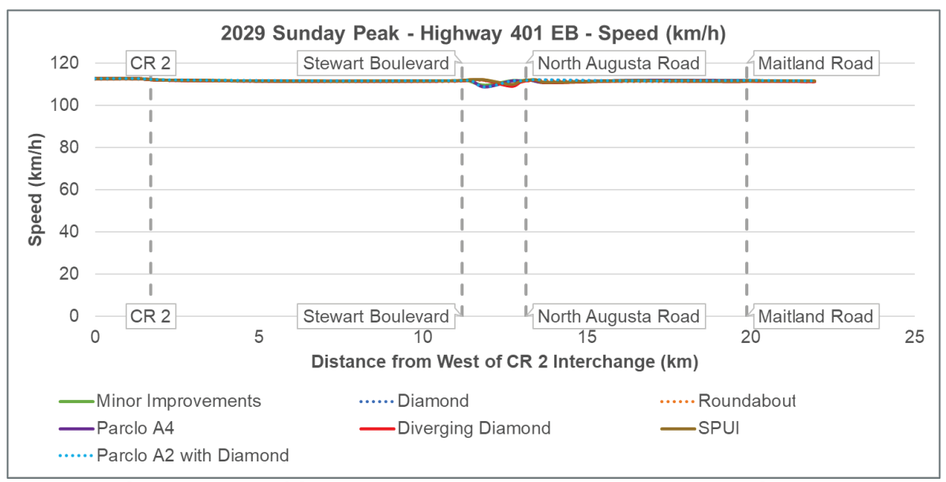


Figure 23: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 Sunday Peak Hour

Figure 24 and Figure 25 compare the impact on mainline density and speed of interchange configurations at Stewart Boulevard and North Augusta on the westbound direction of Highway 401 during the Sunday peak hour. As noticeable, Highway 401 WB (with 8-lane cross-section) mainline is expected to perform at LOS A, with an average operating speed exceeding 100 km/h, during the 2029 Sunday peak hour, throughout the study area. The 2029 Sunday Pre-Peak and Post-Peak hour analysis shows similar traffic operations to the peak hour along the highway mainline, as shown in Exhibit E-17 to Exhibit E-24 in Appendix E.

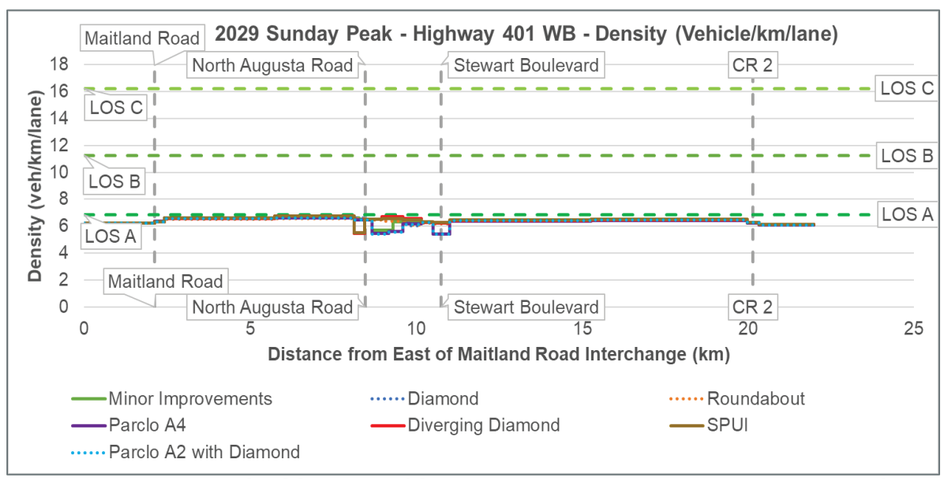


Figure 24: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 Sunday Peak Hour

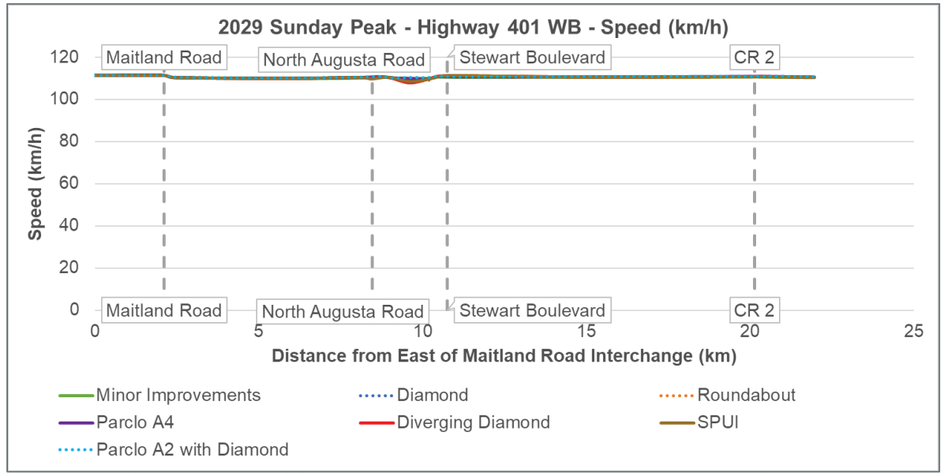


Figure 25: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 Sunday Peak Hour

3.2 Horizon Year 2034

This subsection summarizes the traffic operations analysis results for Horizon Year 2034 on Stewart Boulevard and North Augusta Road ICs. In addition to the expected traffic operation performance at key intersections, this subsection also summarizes the expected impact of interchange alternatives on Highway 401 mainline operations in 2034.

3.2.1 2034 Stewart Boulevard Interchange

The analysis results of ramp terminals traffic operations for each alternative at the Stewart Boulevard IC are summarized here after. The ramp terminal operations were evaluated based on the LOS, average and maximum queue length per the direction of movement, for the 2034 AM, PM, and Sunday peak periods.

3.2.1.1 2034 Stewart Boulevard – Minor Improvements

The minor improvement configuration keeps the existing configurations, with the following changes:

- Dual Eastbound Left turn lanes at Stewart Boulevard and Central Avenue intersection, due to heavy left-turn volume.
- Optimize the Signal Timing Plans within the corridor

Figure 26 below provides an overview of the Stewart Boulevard interchange configuration.

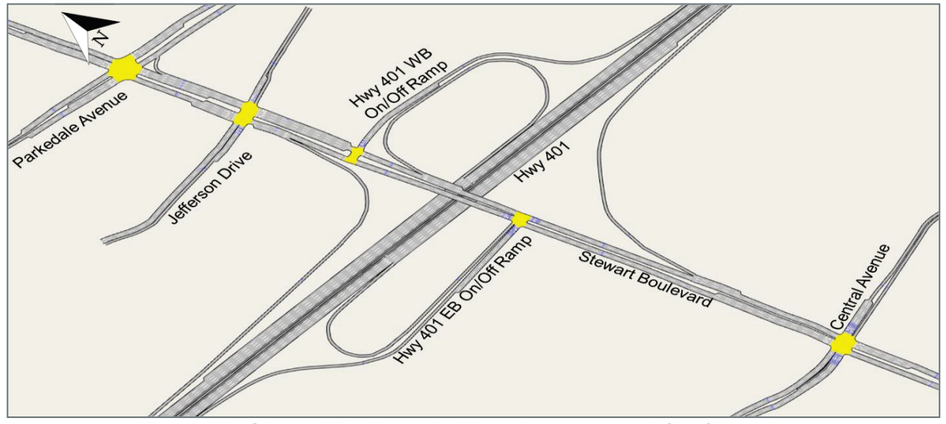


Figure 26: Stewart Boulevard - Minor Improvement Configuration

The 2034 peak hour traffic operation results for the Minor Improvement configuration are shown in Exhibit F-1 in Appendix F. The following observations can be made:

- All of the approaches at the north ramp terminal are expected to perform at LOS A in the AM, PM, and Sunday peak hour, with the exception of the westbound left-turn, which is expected to perform at LOS C in the AM, PM, and Sunday peak hour.
- All of the approaches at the south ramp terminal are expected to perform at LOS C or better in the AM peak hour, and LOS B or better in the PM and Sunday peak hour.

- At Stewart Boulevard and Central Avenue, all approaches are expected to perform at LOS D or better in the AM and PM peak hour and are expected to perform at LOS C or better during the Sunday peak hour. During the PM peak hour, the eastbound and westbound left turn's maximum queue may slightly exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At Stewart Boulevard and Jefferson Drive, all approaches are expected to perform at LOS C or better in the AM peak hour, with the exception of the westbound left-turn, which is expected to perform at LOS D. In the PM peak hour, all approaches are expected to perform at LOS C or better, with the exception of the eastbound through-left shared movement, which is expected to perform at LOS D.
- At Stewart Boulevard and Parkedale Avenue, all of the approaches are expected to perform at LOS D or better in the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS C or better.

3.2.1.2 2034 Stewart Boulevard – Parclo A4

The Parclo A4 configuration keeps the existing configurations, with the following changes:

- Dual Eastbound Left turn lanes at Stewart Boulevard and Central Avenue intersection, due to heavy left-turn volume.
- Optimize the Signal Timing Plans within the corridor

Figure 27 below provides an overview of the Stewart Boulevard interchange configuration.

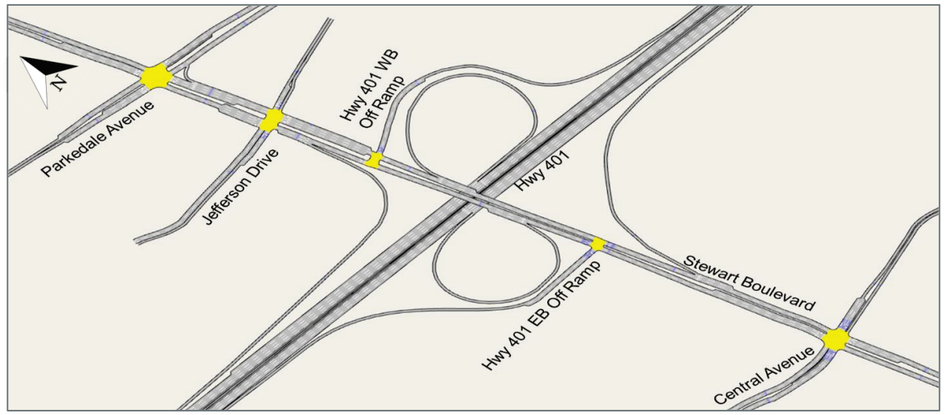


Figure 27: Stewart Boulevard – Parclo A4 Configuration

The 2034 peak hour traffic operation results for the Parclo A4 configuration are shown in Exhibit F-2 in Appendix F. The following observations can be made:

- All of the approaches at the north ramp terminal are expected to perform at LOS A in the AM, PM, and Sunday peak hour, with the exception of the westbound left-turn, which is expected to perform at LOS C or better in the AM, PM, and Sunday peak hour.
- All of the approaches at the south ramp terminal are expected to perform at LOS A in the AM, PM, and Sunday peak hour, with the exception of the eastbound left-turn, which is expected to perform at LOS C or better in the AM, PM, and Sunday peak hour.
- At Stewart Boulevard and Central Avenue, all approaches are expected to perform at LOS D or better in the AM, PM, and Sunday peak hours. During the PM peak hour, the westbound left turn's maximum queue may exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At Stewart Boulevard and Jefferson Drive, all approaches are expected to perform at LOS C or better in the AM peak hour, with the exception of the westbound left-turn, which is expected to perform at LOS D. In the PM peak hour, all approaches are expected to perform at LOS C or better, with the exception of the eastbound through-left and westbound through-right shared movements, which are expected to perform at LOS D.
- At Stewart Boulevard and Parkedale Avenue, all of the approaches are expected to perform at LOS D or better in the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS C or better.

3.2.1.3 2034 Stewart Boulevard – Diverging Diamond

The Diverging Diamond configuration keeps the existing configurations, with the following changes:

- Dual Eastbound Left turn lanes at Stewart Boulevard and Central Avenue intersection, due to heavy left-turn volume.
- Three southbound lanes along Stewart Boulevard between the South ramp terminal and Central Avenue.
- Optimize the Signal Timing Plans within the corridor

The Diverging Diamond configuration allows for free-flow travel for the traffic utilizing the on- and off-ramps, resulting in minimal delays for the traffic utilizing the ramps. The signalization is provided for northbound and southbound through traffic at each ramp terminal. The signal timing plans for the north and south ramp terminals were developed by optimizing the signals in Synchro. Figure 28 below provides an overview of the Stewart Boulevard interchange configuration.

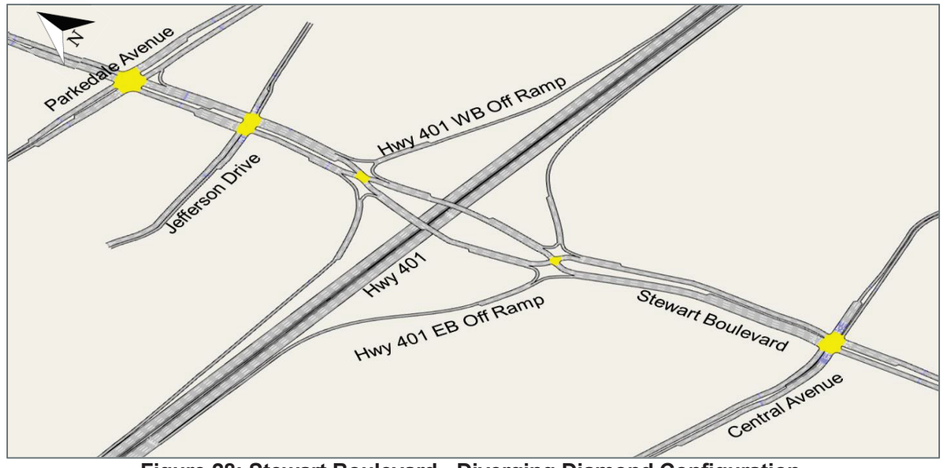


Figure 28: Stewart Boulevard - Diverging Diamond Configuration

The 2034 peak hour traffic operation results for the Diverging Diamond configuration are shown in Exhibit F-3 in Appendix F. The following observations can be made:

- All of the approaches at the north ramp terminal are expected to perform at LOS A in the AM, PM, and Sunday peak hour, with the exception of the northbound-through movement, which is expected to perform at LOS B during the AM and PM peak hour.
- All of the approaches at the south ramp terminal are expected to perform at LOS A in the AM, PM, and Sunday peak hour, with the exception of the northbound-through movement, which is expected to perform at LOS B during the AM, PM, and Sunday peak hour.
- At Stewart Boulevard and Central Avenue, all approaches are expected to perform at LOS D or better in the AM, PM, and Sunday peak hours. Additionally, during the PM peak hour, the eastbound and westbound left turn's maximum queue may slightly exceed the available

storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic

- At Stewart Boulevard and Jefferson Drive, all approaches are expected to perform at LOS C or better in the AM peak hour, with the exception of the westbound left-turn, which is expected to perform at LOS D. In the PM peak hour, all approaches are expected to perform at LOS C or better, with the exception of the eastbound through-left and westbound through-right shared movements, which are expected to perform at LOS D.
- At Stewart Boulevard and Parkedale Avenue, all of the approaches are expected to perform at LOS D or better in the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS C or better.

3.2.1.4 2034 Stewart Boulevard – SPUI

The SPUI configuration keeps the existing configurations, with the following changes:

- Dual Eastbound Left turn lanes at Stewart Boulevard and Central Avenue intersection, due to heavy left-turn volume.
- Three southbound lanes along Stewart Boulevard between the SPUI terminal and Central Avenue.
- Optimize the Signal Timing Plans within the corridor

The SPUI configuration allows for free-flow travel for the traffic utilizing the on-ramps, resulting in minimal delays for the traffic utilizing the on-ramps. Additionally, it compresses the two typical north/south ramp terminals into one single intersection. The signalization is provided for the SPUI terminal. The signal timing plans for the SPUI ramp terminal were developed by optimizing the signals in Synchro. Figure 29 below provides an overview of the Stewart Boulevard interchange configuration.

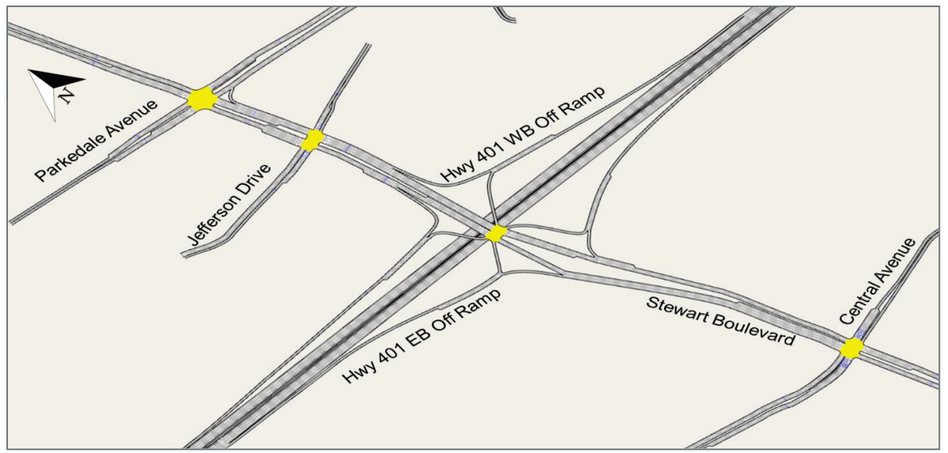


Figure 29: Stewart Boulevard - SPUI Configuration

The 2034 peak hour traffic operation results for the SPUI configuration are shown in Exhibit F-4 in Appendix F. The following observations can be made:

- All of the approaches at the SPUI ramp terminal are expected to perform at LOS C or better in the AM and PM peak hour and are expected to perform at LOS B or better during the Sunday peak hour. The maximum queue for the southbound left-turn movement may exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At Stewart Boulevard and Central Avenue, all approaches are expected to perform at LOS D or better in the AM, PM, and Sunday peak hours. Additionally, during the PM peak hour, the eastbound, and westbound left turn's maximum queue may slightly exceed the available

storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.

- At Stewart Boulevard and Jefferson Drive, all approaches are expected to perform at LOS C or better in the AM peak hour, with the exception of the westbound left-turn, which is expected to perform at LOS D. In the PM peak hour, all approaches are expected to perform at LOS C or better, with the exception of the eastbound through-left and westbound through-right shared movements, which are expected to perform at LOS D.
- At Stewart Boulevard and Parkedale Avenue, all of the approaches are expected to perform at LOS D or better in the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS C or better.

3.2.1.5 2034 Stewart Boulevard – Overall Alternatives Comparison

Table 6 and Table 7 provide the expected overall intersection LOS and delay for the key intersections along Stewart Boulevard for the various alternatives for the 2034 horizon year. This is based on the average delay experienced at all approaches at the intersection. As noticeable, all interchange alternatives except for SPUI are expected to perform at LOS B or better, whereas SPUI is expected to perform at LOS C or better. The impact on the adjacent intersections is minimal, with Stewart Boulevard & Central Avenue performing at LOS C in the AM and Sunday peak hour for all alternatives and is expected to perform at LOS D in the PM peak hour. The intersection of Stewart Boulevard and Jefferson is expected to perform at LOS B or better for all alternatives during the AM and PM peak. The intersection of Stewart Boulevard and Parkedale Avenue is expected to perform at LOS C for all alternatives during the AM, PM, and Sunday peak hours.

Table 6: Stewart Boulevard – 2034 Overall Intersection LOS

Intersections	Minor Improvements			Parclo A4			Diverging Diamond			SPUI		
	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN
Stewart Boulevard & North Ramp Terminal	B	A	A	A	A	A	B	A	A	B	C	B
Stewart Boulevard & South Ramp Terminal	A	A	B	A	A	A	B	A	B			
Stewart Boulevard & Central Avenue	C	D	B	C	D	B	C	D	B	C	D	B
Stewart Boulevard & Jefferson Drive[3]	A	B		A	B		A	B		A	B	
Stewart Boulevard & Parkedale Avenue	C	C	C	C	C	C	C	C	C	C	C	C

Table 7: Stewart Boulevard – 2034 Overall Intersection Delay (s)

Intersections	Minor Improvements			Parclo A4			Diverging Diamond			SPUI		
	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN
Stewart Boulevard & North Ramp Terminal	10	9	6	10	9	9	10	10	7	19	21	16
Stewart Boulevard & South Ramp Terminal	7	8	11	6	7	5	11	9	10			
Stewart Boulevard & Central Avenue	30	38	18	34	38	18	31	36	16	32	36	16
Stewart Boulevard & Jefferson Drive	8	12		10	12		10	11		9	12	
Stewart Boulevard & Parkedale Avenue	26	25	27	27	24	26	27	26	29	26	24	27

[3] *The weekend model calibration/analysis was completed for select key intersections that did not include Jefferson drive.*

3.2.2 2034 North Augusta Road Interchange

The following subsections summarize the ramp terminal operations for the alternatives at the North Augusta Road IC. The ramp terminal operations were evaluated based on the LOS and maximum queue length per the direction of movement, for the 2034 AM, PM, and Sunday Peak hour scenarios.

3.2.2.1 2034 North Augusta Road – Minor Improvements

The minor improvement configuration keeps the existing configurations with the optimized signal timing plans for 2034 traffic volume. Figure 30 provides an overview of the North Augusta Road interchange configuration.
The minor improvement configuration peak hour traffic operations results are shown in Exhibit G-1 in Appendix G. The following observations can be made:

- All of the approaches on the ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM and Sunday peak hours. During the PM peak hour, all of the approaches on the ramp terminal are expected to perform at LOS C or better.
- All of the approaches on the ramp terminal on Parkedale Avenue are expected to perform at LOS C or better during the AM and Sunday peak hours. During the PM peak hour, all of the approaches on the ramp terminal are expected to perform at LOS C or better with the exception of the westbound left-turn movement, which is expected to perform at LOS D.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

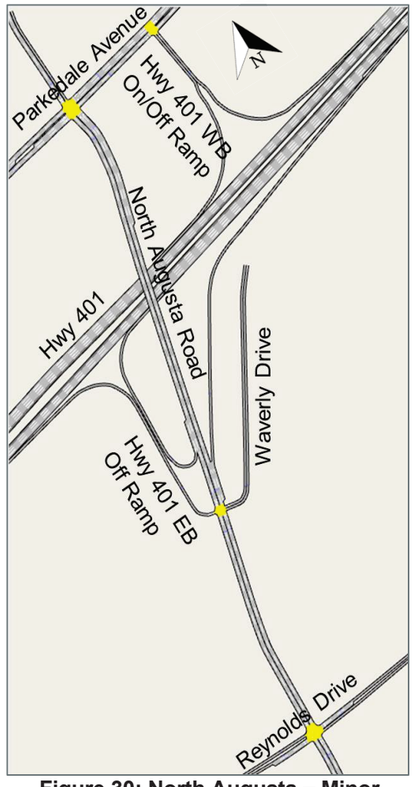


Figure 30: North Augusta – Minor Improvement Configuration

3.2.2.2 2034 North Augusta Road – Parclo A4

The Parclo A4 configuration is modelled for the north and south ramp terminals, as shown in Figure 31, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on Parkedale Avenue and Broome Road.
- Optimize the Signal Timing Plans within the corridor

The 2034 peak hour traffic operation results for the Parclo A4 configuration are shown in Exhibit G-2 in Appendix G. The following observations can be made:

- All of the approaches on the ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM, PM, and Sunday peak hours.
- All of the approaches on the ramp terminal on Parkedale Avenue are expected to perform at LOS B or better during the AM and Sunday peak hours. During the PM peak hour, the ramp terminal is expected to perform at LOS C or better.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS D or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

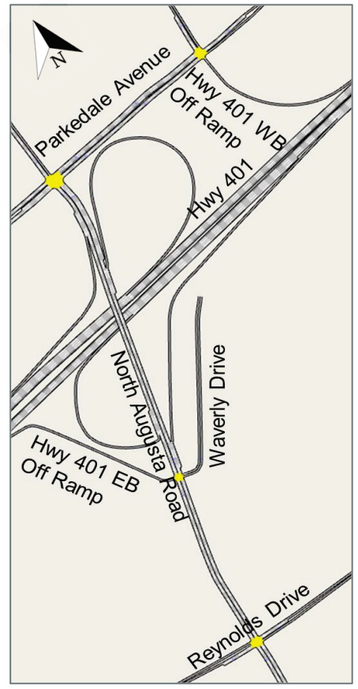


Figure 31: North Augusta – Parclo A4 Configuration

3.2.2.3 2034 North Augusta Road – Diverging Diamond

The Diverging Diamond configuration keeps the existing configurations, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on North Augusta Road.
- Optimize the Signal Timing Plans within the corridor

The Diverging Diamond configuration allows for free-flow travel for the traffic utilizing the on- and off-ramps, resulting in minimal delays for the traffic utilizing the ramps. The signalization is provided for northbound and southbound through traffic at each ramp terminal. The signal timing plans for the north and south ramp terminals were developed by optimizing the signals in Synchro. Figure 32 provides an overview of the North Augusta interchange configuration.

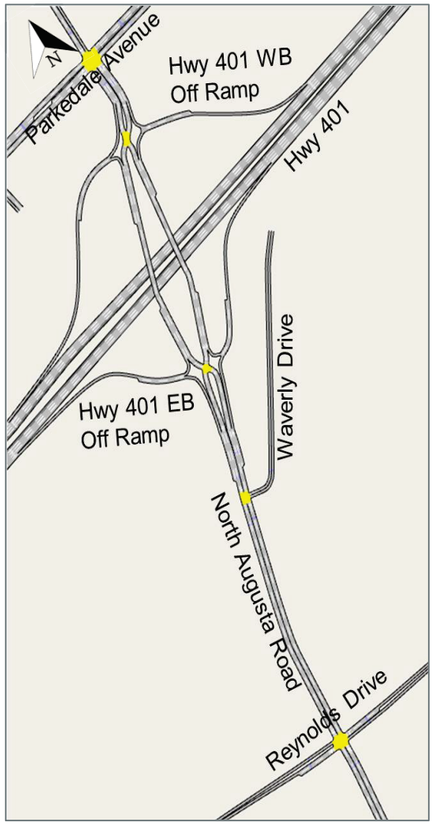


Figure 32: North Augusta - Diverging Diamond Configuration

The 2034 peak hour traffic operation results for the Diverging Diamond configuration are shown in Exhibit G-3 in Appendix G. The following observations can be made:

- All of the approaches on the north ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM, PM, and Sunday peak hours.
- All of the approaches on the south ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS D or better during the AM, PM, and Sunday peak hours. The maximum queue for northbound right movement at the intersection may exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

3.2.2.4 2034 North Augusta Road – SPUI

The SPUI configuration keeps the existing configurations, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on North Augusta Road.
- Optimize the Signal Timing Plans within the corridor

The SPUI configuration allows for free-flow travel for the traffic utilizing the on-ramps, resulting in minimal delays for the traffic utilizing the on-ramps. Additionally, it compresses the two typical north/south ramp terminals into one single intersection. The signalization is provided for the SPUI terminal. The signal timing plans for the SPUI ramp terminal were developed by optimizing the signals in Synchro. Figure 33 provides an overview of the North Augusta interchange configuration.

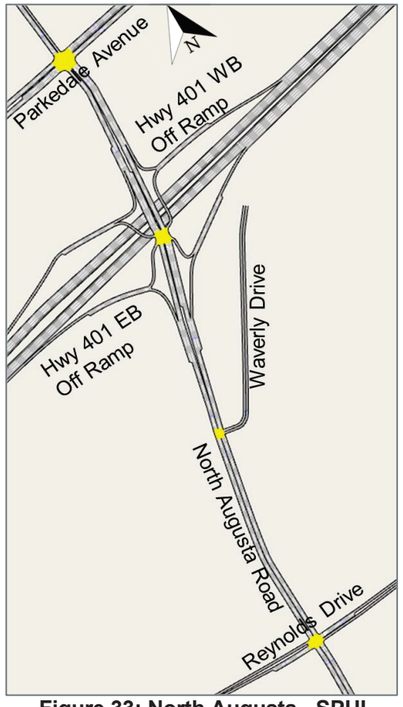


Figure 33: North Augusta - SPUI Configuration

The 2034 peak hour traffic operation results for the SPUI configuration are shown in Exhibit G-4 in Appendix G. The following observations can be made:

- All of the approaches on the SPUI ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM peak hour and are expected to perform at LOS C or better during the PM and Sunday peak hour.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS B or better during the AM, PM, and Sunday peak hours.

3.2.2.5 2034 North Augusta Road – Diamond

The Diamond configuration is modelled for the north and south ramp terminals, as shown in Figure 34, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on North Augusta Road.
- Optimize the Signal Timing Plans within the corridor

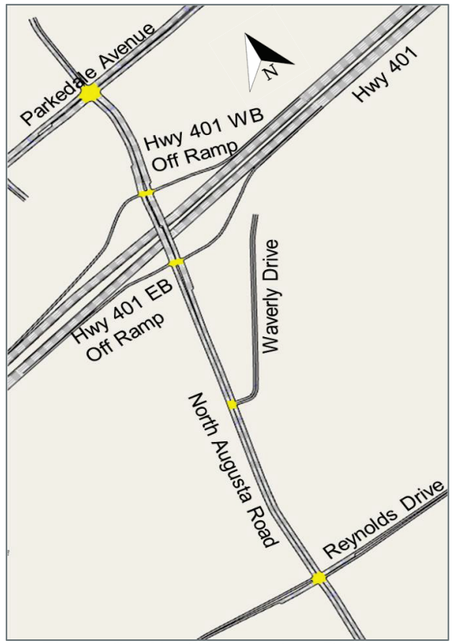


Figure 34: North Augusta – Diamond Configuration

The 2034 peak hour traffic operation results for the Diamond configuration are shown in Exhibit G-5 in Appendix G. The following observations can be made:

- All of the approaches on the north ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM, PM, and Sunday peak hour, with the exception of the southbound through movement, which is expected to perform at LOS C during the PM peak hour. The maximum queue for the northbound left-turn movement may exceed the available storage during the PM peak. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- All of the approaches on the south ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM, PM, and Sunday peak hour, with the exception of the northbound through movement, which is expected to perform at LOS C during the PM peak hour. The maximum queue for the southbound left-turn movement may exceed the available storage during the PM peak. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hour, with the exception of the shared southbound through-right movement, which is expected to perform at LOS D during the PM peak hour.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

To accommodate the storage for vehicles utilizing the northbound left turn at the north ramp terminal and the southbound left turn at the south ramp terminal along North Augusta Road, it is recommended that the distance between the north and south ramp terminals should be at least 150 m.

3.2.2.6 2034 North Augusta Road – Diamond with Roundabout

The Diamond with Roundabout configuration is modelled for the north and south ramp terminals, as shown in Figure 35, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on North Augusta Road.
- Optimize the Signal Timing Plans within the corridor

The north and south ramp terminals include a 2-lane entry and exit for roundabouts. Figure 60 shows the lane configuration for north and south ramp terminal roundabouts.

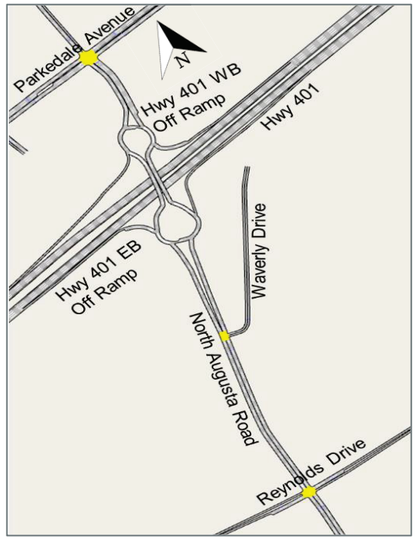


Figure 35: North Augusta – Diamond with Roundabout Configuration

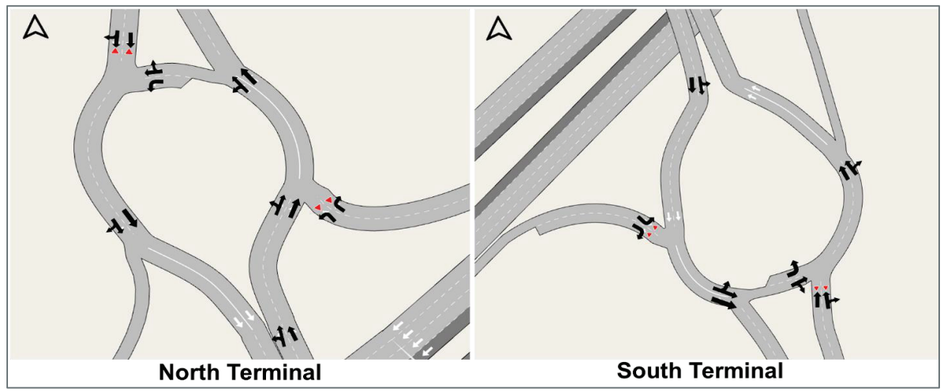


Figure 36: Roundabout Lane Configuration

The 2034 peak hour traffic operation results for the Diamond with Roundabouts configuration are shown in Exhibit G-6 in Appendix G. The following observations can be made:

- All of the approaches on the north ramp terminal on North Augusta Road are expected to perform at LOS A during the AM, PM, and Sunday peak hours.
- All of the approaches on the south ramp terminal on North Augusta Road are expected to perform at LOS A during the AM and Sunday peak hours. During the PM peak hour, all approaches are expected to perform at LOS B or better.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS C or better during the AM and Sunday peak hours. During the PM peak hour, all of the approaches are expected to perform at LOS D or better.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS B or better during the AM, PM, and Sunday peak hour, with the exception of the shared eastbound through-left movement, which is expected to perform at LOS C during the AM peak hour.

3.2.2.7 2034 North Augusta Road – Parclo A2 with Diamond

The Parclo A2 (North Terminal) with Diamond (South Terminal) configuration is modelled, as shown in Figure 37, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on Parkedale Avenue and Broome Road.
- Optimize the Signal Timing Plans within the corridor

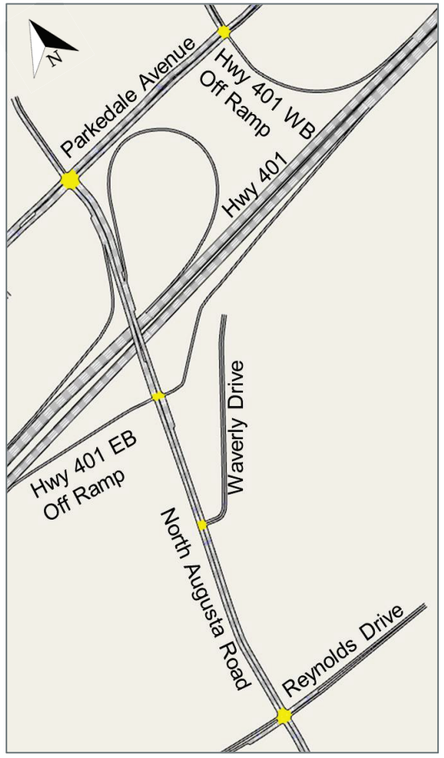


Figure 37: North Augusta – Parclo A2 with Diamond Configuration

The 2034 peak hour traffic operation results for the Parclo A2 with Diamond configuration are shown in Exhibit G-7 in Appendix G. The following observations can be made:

- All of the approaches on the ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM and Sunday peak hours. During the PM peak hour, all of the approaches are expected to perform at LOS C or better. The maximum queue for the southbound left-turn may exceed the available storage but is not expected to spill back to the North Augusta and Parkedale intersection and cause any significant interference to the through traffic.
- All of the approaches on the ramp terminal on Parkedale Avenue are expected to perform at LOS B or better during the AM and Sunday peak hours. During the PM peak hour, the ramp terminal is expected to perform at LOS C or better.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS D or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS B or better during the AM, PM, and Sunday peak hours.

3.2.2.8 2034 North Augusta Road – Overall Interchange Performance

Table 8 and Table 9 provide the expected overall intersection LOS and delay for the key intersections along North Augusta Road for the various alternatives for the 2034 horizon year. As noticeable, all alternatives at the north ramp terminal are expected to perform at LOS B or better, with the exception of Minor improvement in the PM peak hour, which is expected to perform at LOS C. At the south ramp terminal, all alternatives are expected to perform at LOS B or better. The North Augusta Road and Parkedale Avenue intersection is expected to perform at LOS C or better for all alternatives. Lastly, the North Augusta Road and Reynolds Drive intersection is expected to perform at LOS B for all alternatives.

Table 8: North Augusta Road – 2034 Overall Intersection LOS

Intersections	Minor Improvements			Parclo A4			Diverging Diamond			SPUI			Diamond			Diamond with Roundabout			Parclo A2 with Diamond		
	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN
N Augusta Rd & N Ramp Terminal	B	C	B	B	B	B	B	B	B	B	B	B	B	B	A	A	A	A	B	B	B
N Augusta Rd & S Ramp Terminal	A	A	A	A	A	A	B	A	B				A	B	B	A	A	A	B	B	B
N Augusta Rd & Parkedale Ave	B	C	B	C	C	B	C	C	B	B	C	B	B	C	B	B	C	B	C	C	B
N Augusta Rd & Reynolds Dr	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B

Table 9: North Augusta Road – 2034 Overall Intersection Delay (s)

Intersections	Minor Improvements			Parclo A4			Diverging Diamond			SPUI			Diamond			Diamond with Roundabout			Parclo A2 with Diamond		
	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN
N Augusta Rd & N Ramp Terminal	15	23	11	12	14	11	13	12	12	13	17	18	10	17	10	3	6	2	12	13	11
N Augusta Rd & S Ramp Terminal	3	6	1	8	9	5	12	10	12				10	15	10	3	7	2	10	18	10
N Augusta Rd & Parkedale Ave	14	22	14	21	26	17	20	29	18	20	25	15	19	26	17	19	26	17	21	27	17
N Augusta Rd & Reynolds Dr	12	13	11	12	12	14	12	13	12	12	13	11	12	13	11	12	13	11	12	13	11

3.2.3 2034 Highway 401 Mainline Operations

This subsection summarizes the expected impact of interchange alternatives on Highway 401 mainline operations with 8-lane cross-section in 2034 for the AM, PM, and Sunday peak period.

3.2.3.1 2034 AM Peak Period

Figure 38 and Figure 39 compare the impact on mainline density and speed of interchange configurations at Stewart Boulevard and North Augusta on the eastbound direction of Highway 401 during the 2034 AM peak hour. The Minor Improvements, Parclo A4, Diverging Diamond, and SPUI were modelled for both Stewart Boulevard and North Augusta Road interchanges, whereas Diamond, Diamond with Roundabouts, and Parclo A2 with Diamond were only modelled for North Augusta Road interchanges. As noticeable, Highway 401 EB (with 8-lane cross-section) mainline is expected to perform at LOS A with an average speed exceeding 100 km/h, during the 2034 AM peak hour, throughout the study area.

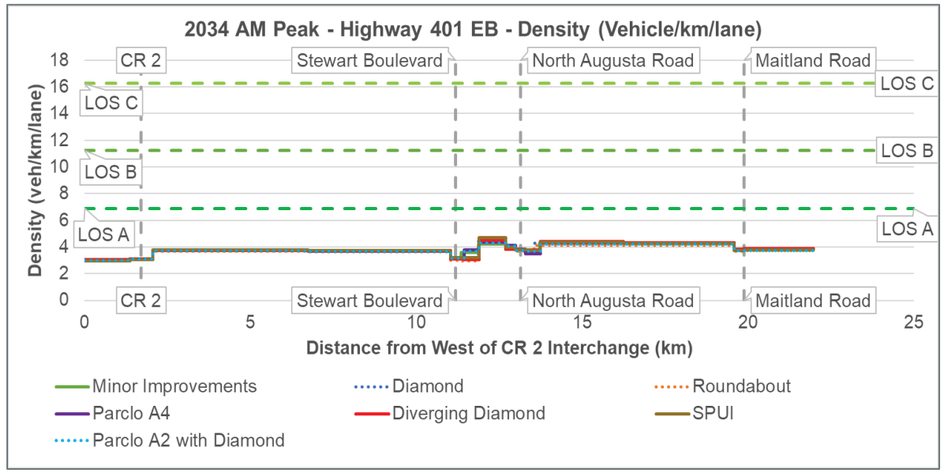


Figure 38: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 AM Peak Hour

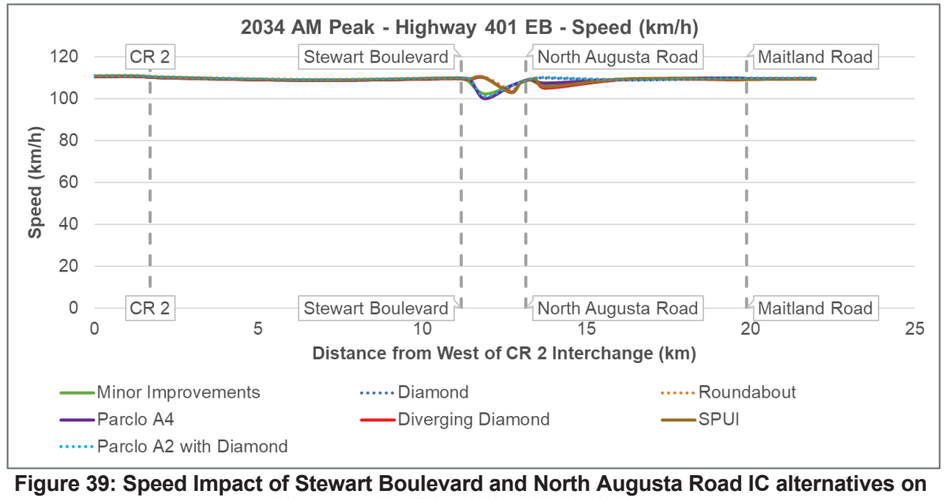


Figure 39: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 AM Peak Hour

Figure 40 and Figure 41 compare the impact on mainline density and speed of alternative interchange configurations at Stewart Boulevard and North Augusta on the westbound direction of Highway 401 WB during the 2034 AM peak hour. As noticeable, Highway 401 WB (with 8-lane cross-section) mainline is expected to perform at LOS A during the 2034 AM peak hour, with an average operating speed exceeding 100 km/h, during the 2034 AM peak hour throughout the study area. The 2034 AM Pre-Peak and Post-Peak hour analysis shows similar traffic operations to the peak hour along the highway mainline, as shown in Exhibit H-1 to Exhibit H-8 in Appendix H.

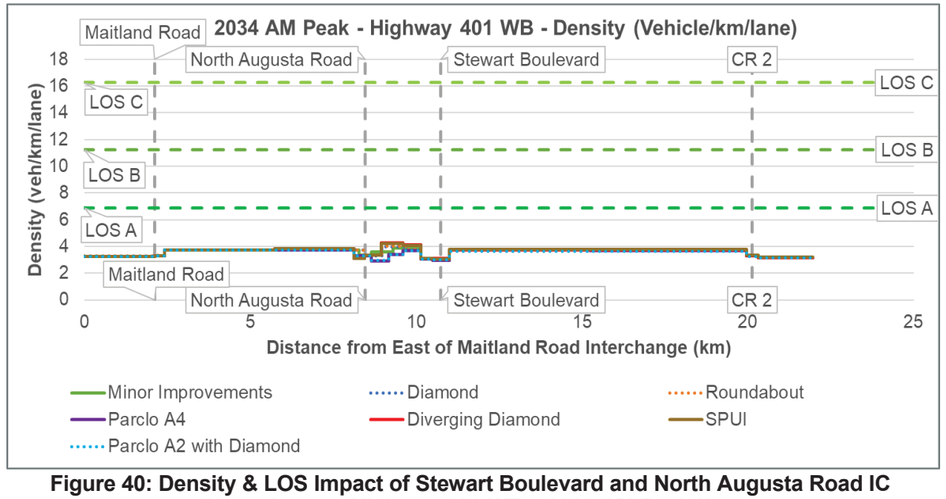


Figure 40: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 AM Peak Hour

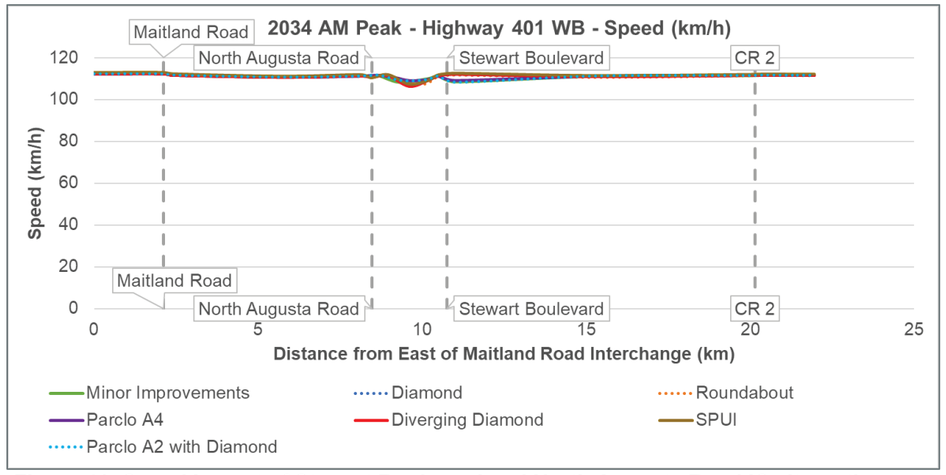


Figure 41: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 AM Peak Hour

3.2.3.2 2034 PM Peak Period

Figure 42 and Figure 43 compare the impact on mainline density and speed of interchange configurations at Stewart Boulevard and North Augusta on the eastbound direction of Highway 401 during the 2034 PM peak hour. The Minor Improvements, Parclo A4, Diverging Diamond, and SPUI were modelled for both Stewart Boulevard and North Augusta Road interchanges, whereas Diamond, Diamond with Roundabouts, and Parclo A2 with Diamond were only modelled for North Augusta Road interchanges. As noticeable, Highway 401 EB (with 8-lane cross-section) mainline is expected to perform at LOS B with an average operating speed exceeding 100 km/h, during the 2034 PM peak hour, throughout the study area.

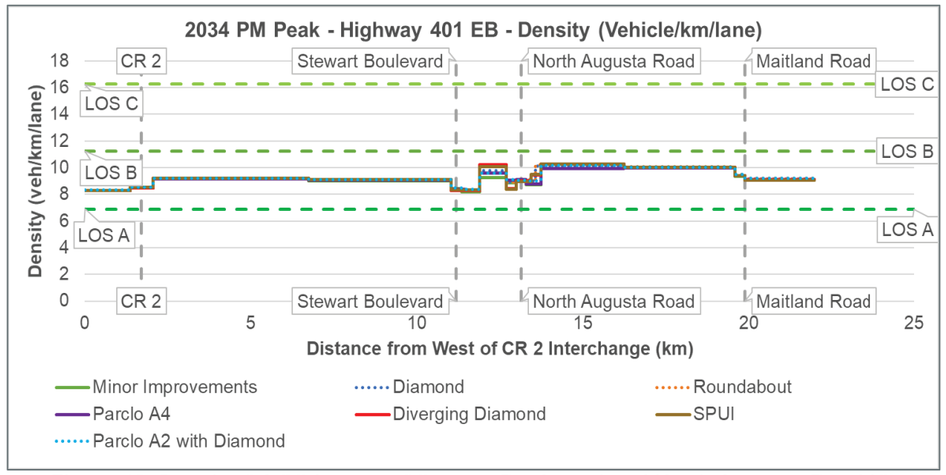


Figure 42: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 PM Peak Hour

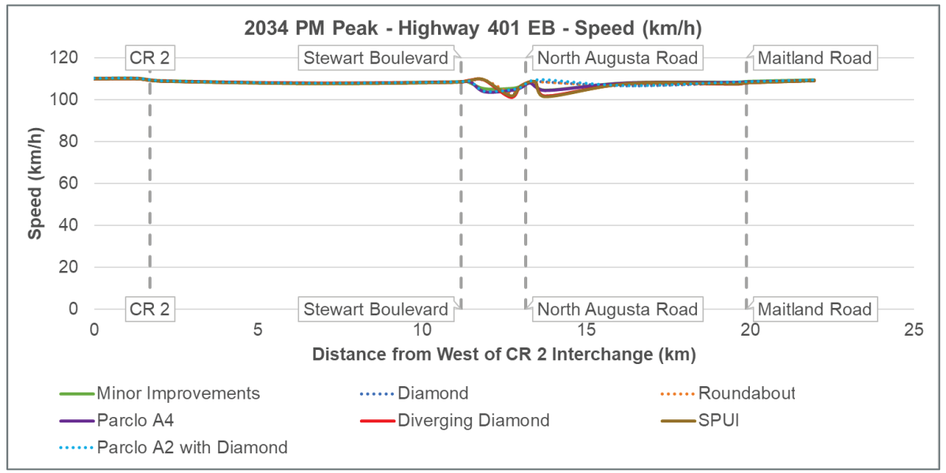


Figure 43: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 PM Peak Hour

Figure 44 and Figure 45 compare the impact on mainline density and speed of interchange configurations at Stewart Boulevard and North Augusta on the westbound direction of Highway 401 during the 2034 PM peak hour. As noticeable, Highway 401 WB (with 8-lane cross-section) mainline is expected to perform at LOS B or better, with an average speed exceeding 100 km/h, during the 2034 PM peak hour, throughout the study area. The 2034 PM Pre-Peak and Post-Peak hour analysis shows slightly better traffic operations when compared to the peak hour along the highway mainline, as shown in Exhibit H-9 to Exhibit H-16 in Appendix H.

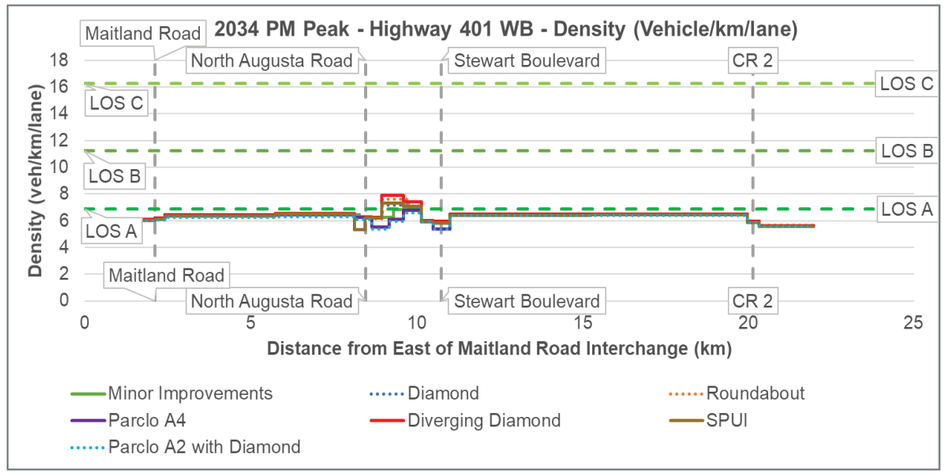


Figure 44: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 PM Peak Hour

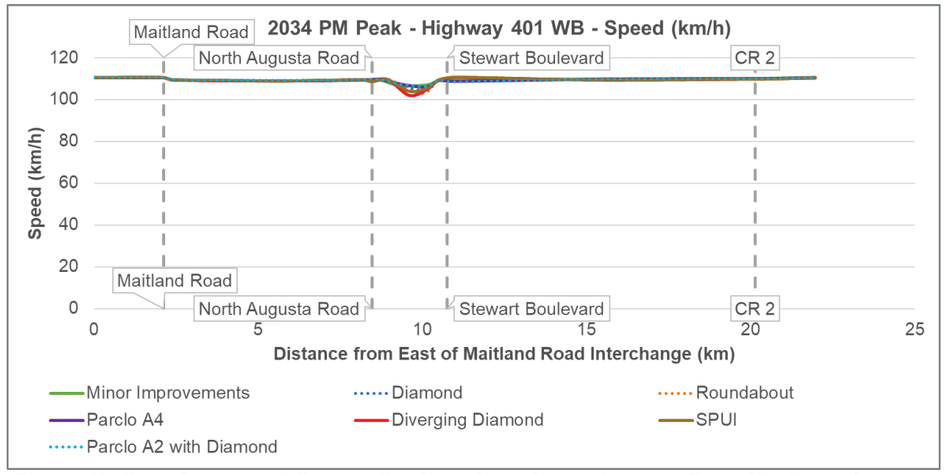


Figure 45: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 PM Peak Hour

3.2.3.3 2034 Sunday Peak Period

Figure 46 and Figure 47 compare the impact on mainline density and speed of interchange configurations at Stewart Boulevard and North Augusta on the eastbound direction of Highway 401 during the 2034 Sunday peak hour. The Minor Improvements, Parclo A4, Diverging Diamond, and SPUI were modelled for both Stewart Boulevard and North Augusta Road interchanges, whereas Diamond, Diamond with Roundabouts, and Parclo A2 with Diamond were only modelled for North Augusta Road interchanges. As noticeable, Highway 401 EB (with 8-lane cross-section) mainline is expected to perform at LOS B, with an average speed exceeding 100 km/h, during the 2034 Sunday peak hour, throughout the study area.

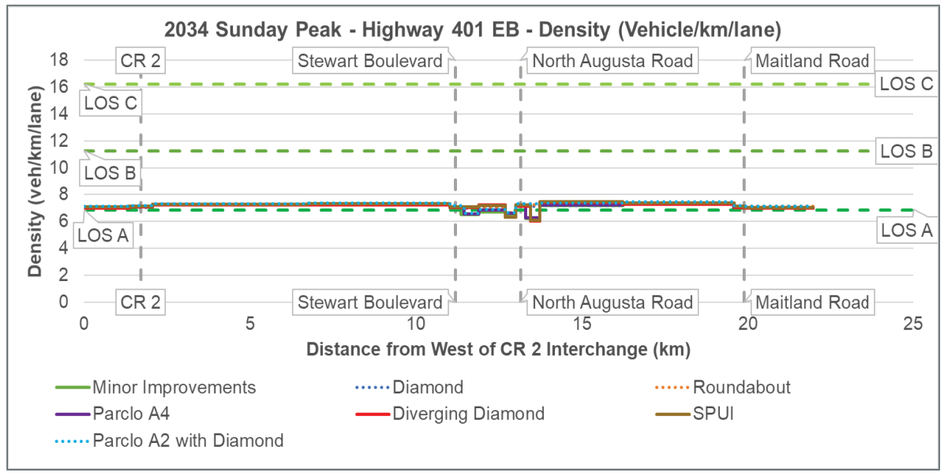


Figure 46: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 Sunday Peak Hour

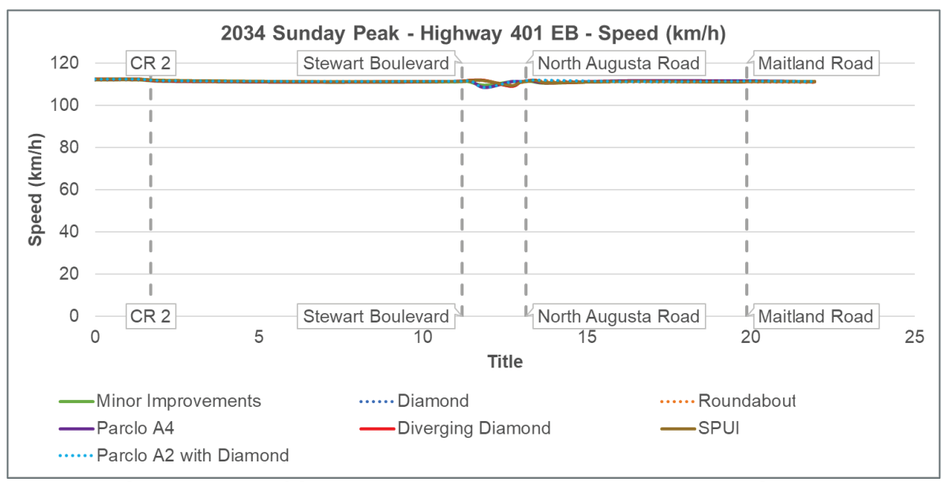


Figure 47: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 Sunday Peak Hour

Figure 48 and Figure 49 compare the impact on mainline density and speed of interchange configurations at Stewart Boulevard and North Augusta on the westbound direction of Highway 401 during the Sunday peak hour. As noticeable, Highway 401 WB (with 8-lane cross-section) mainline is expected to perform at LOS B or better, with an average speed exceeding 100 km/h, during the 2034 Sunday peak hour, throughout the study area. The 2034 Sunday Pre-Peak and Post-Peak hour analysis shows similar traffic operations to the peak hour along the highway mainline, as shown in Exhibit H-17 to Exhibit H-24 in Appendix H.

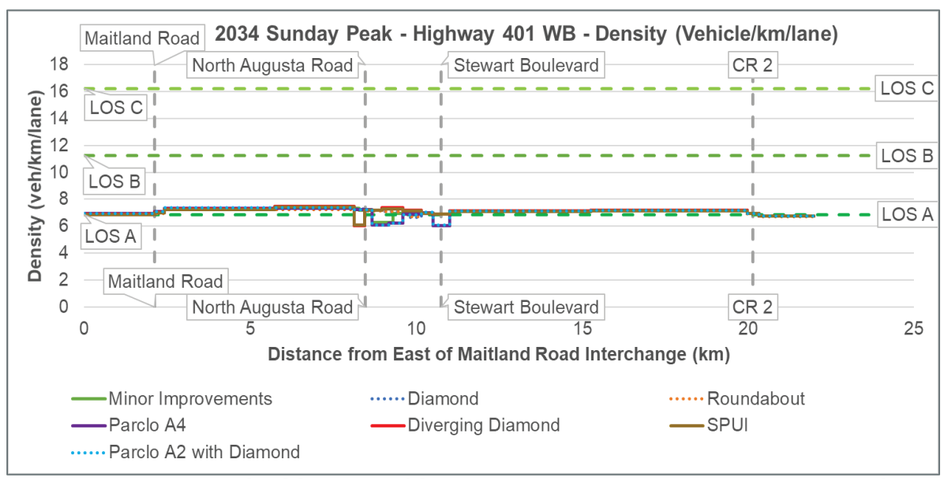


Figure 48: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 Sunday Peak Hour

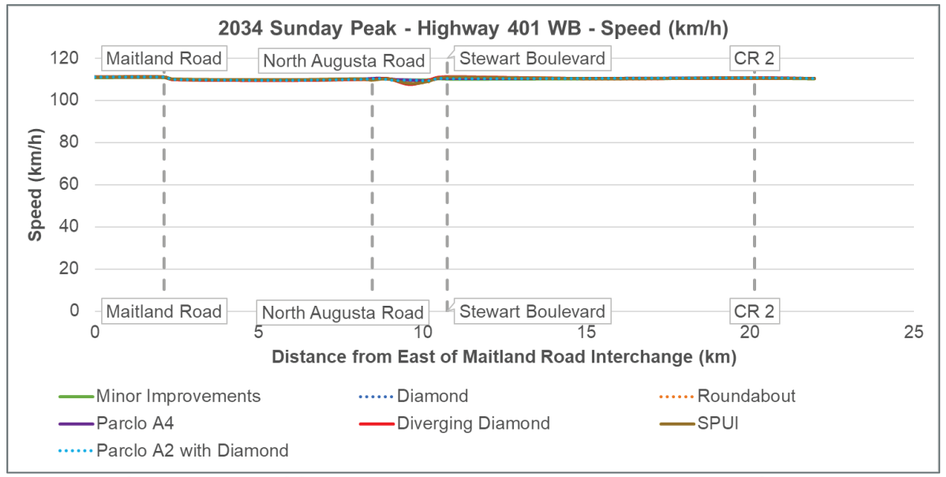


Figure 49: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 Sunday Peak Hour

3.3 Horizon Year 2044

This subsection summarizes the traffic operations analysis results for Horizon Year 2044 on Stewart Boulevard and North Augusta Road ICs. In addition to the expected traffic operation performance at key intersections, this subsection also summarizes the expected impact of interchange alternatives on Highway 401 mainline operations in 2044.

3.3.1 2044 Stewart Boulevard IC

The analysis results of ramp terminals traffic operations for each alternative at the Stewart Boulevard IC are summarized hereafter. The ramp terminal operations were evaluated based on the LOS, average and maximum queue length per the direction of movement, for the 2044 AM, PM, and Sunday peak periods.

3.3.1.1 2044 Stewart Boulevard – Minor Improvements

The minor improvement configuration keeps the existing configurations, with the following changes:

- Dual Eastbound Left turn lanes at Stewart Boulevard and Central Avenue intersection, due to heavy left-turn volume.
- Optimize the Signal Timing Plans within the corridor

Figure 50 below provides an overview of the Stewart Boulevard interchange configuration.

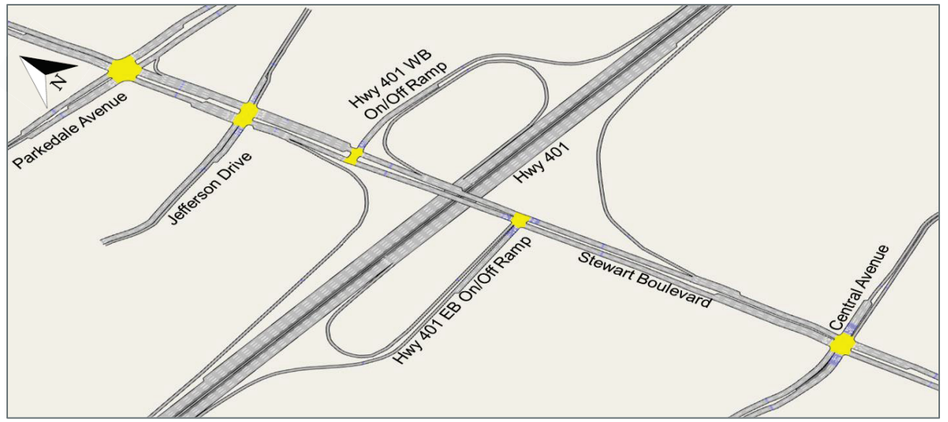


Figure 50: Stewart Boulevard - Minor Improvement Configuration

The 2044 peak hour traffic operation results for the Minor Improvement configuration are shown in Exhibit I-1 in Appendix I. The following observations can be made:

- All of the approaches at the north ramp terminal are expected to perform at LOS B or better in the AM peak hour, and at LOS C or better in the PM peak hour and Sunday peak hour.
- All of the approaches at the south ramp terminal are expected to perform at LOS C or better in the AM and PM peak hour, and LOS B or better in the Sunday peak hour.
- At Stewart Boulevard and Central Avenue, all approaches are expected to perform at LOS D or better in the AM, PM, and Sunday peak hours. During the PM peak hour, the eastbound and westbound left turn's maximum queue may slightly exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At Stewart Boulevard and Jefferson Drive, all approaches are expected to perform at LOS C or better, with the exception of the westbound left-turn, which is expected to perform at LOS D in the AM peak hour. In the PM peak hour, all approaches are expected to perform at LOS C or better, with the exception of the eastbound through-left shared movement, which is expected to perform at LOS D.
- At Stewart Boulevard and Parkedale Avenue, all of the approaches are expected to perform at LOS D or better in the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS C or better.

3.3.1.2 2044 Stewart Boulevard – Parclo A4

The Parclo A4 configuration keeps the existing configurations, with the following changes:

- Dual Eastbound Left turn lanes at Stewart Boulevard and Central Avenue intersection, due to heavy left-turn volume.
- Optimize the Signal Timing Plans within the corridor

Figure 51 below provides an overview of the Stewart Boulevard interchange configuration.

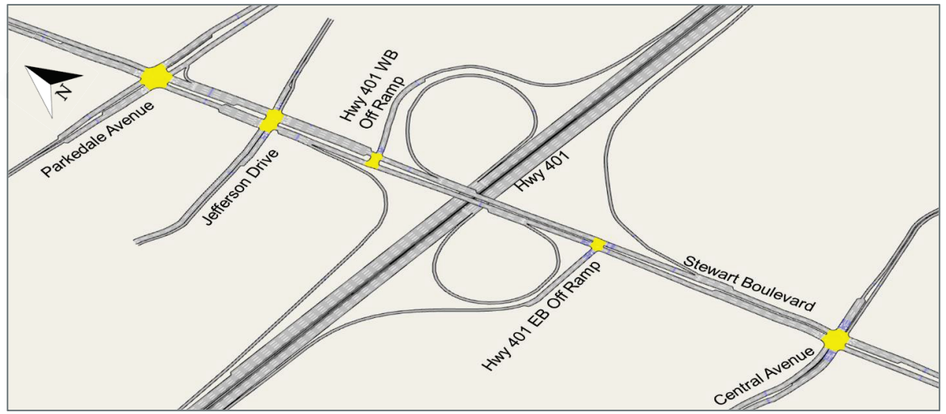


Figure 51: Stewart Boulevard – Parclo A4 Configuration

The 2044 peak hour traffic operation results for the Parclo A4 configuration are shown in Exhibit I-2 in Appendix I. The following observations can be made:

- All of the approaches at the north ramp terminal are expected to perform at LOS B or better in the AM peak hour, LOS C or better in the PM peak hour and Sunday peak hour.
- All of the approaches at the south ramp terminal are expected to perform at LOS C or better in the AM and PM peak hour, and LOS B or better in the Sunday peak hour.
- At Stewart Boulevard and Central Avenue, all approaches are expected to perform at LOS D or better in the AM, PM, and Sunday peak hours. During the PM peak hour, the southbound and westbound left turn's maximum queue may exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At Stewart Boulevard and Jefferson Drive, all approaches are expected to perform at LOS C or better. In the PM peak hour, all approaches are expected to perform at LOS C or better, with the exception of the eastbound through-left shared movement, which is expected to perform at LOS D.
- At Stewart Boulevard and Parkedale Avenue, all of the approaches are expected to perform at LOS D or better in the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS C or better.

3.3.1.3 2044 Stewart Boulevard – Diverging Diamond

The Diverging Diamond configuration keeps the existing configurations, with the following changes:

- Dual Eastbound Left turn lanes at Stewart Boulevard and Central Avenue intersection, due to heavy left-turn volume.
- Three southbound lanes along Stewart Boulevard between the South ramp terminal and Central Avenue.
- Optimize the Signal Timing Plans within the corridor

The Diverging Diamond configuration allows for free-flow travel for the traffic utilizing the on- and off-ramps, resulting in minimal delays for the traffic utilizing the ramps. The signalization is provided for northbound and southbound through traffic at each ramp terminal. The signal timing plans for the north and south ramp terminals were developed by optimizing the signals in Synchro. Figure 52 below provides an overview of the Stewart Boulevard interchange configuration.

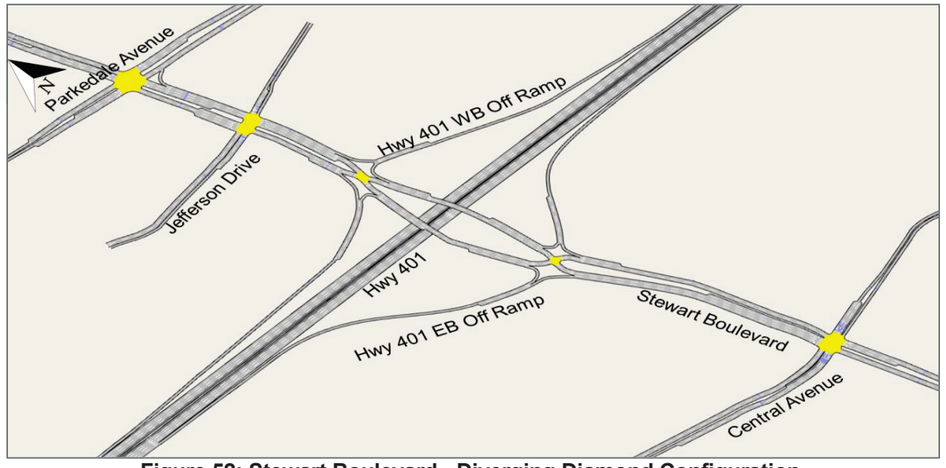


Figure 52: Stewart Boulevard - Diverging Diamond Configuration

The 2044 peak hour traffic operation results for the Diverging Diamond configuration are shown in Exhibit I-3 in Appendix I. The following observations can be made:

- All of the approaches at the north ramp terminal is expected to perform at LOS B or better in the AM, PM, and Sunday peak hour.
- All of the approaches at the south ramp terminal is expected to perform at LOS B or better in the AM, PM, and Sunday peak hour.
- At Stewart Boulevard and Central Avenue, all approaches are expected to perform at LOS D or better in the AM, PM, and Sunday peak hour, with the exception of the northbound through movement, which is expected to perform at LOS E during the PM peak hour. Additionally, during the PM peak hour, the eastbound and westbound left turn's maximum

queue may slightly exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic

- At Stewart Boulevard and Jefferson Drive, all approaches are expected to perform at LOS C or better, except for the westbound left-turn movement, which is expected to perform at LOS D. In the PM peak hour, all approaches are expected to perform at LOS C or better, with the exception of eastbound through-left shared lane, which is expected to perform at LOS D.
- At Stewart Boulevard and Parkedale Avenue, all of the approaches are expected to perform at LOS D or better in the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS C or better.

3.3.1.4 2044 Stewart Boulevard – SPUI

The SPUI configuration keeps the existing configurations, with the following changes:

- Dual Eastbound Left turn lanes at Stewart Boulevard and Central Avenue intersection, due to heavy left-turn volume.
- Three southbound lanes along Stewart Boulevard between the SPUI terminal and Central Avenue.
- Optimize the Signal Timing Plans within the corridor

The SPUI configuration allows for free-flow travel for the traffic utilizing the on-ramps, resulting in minimal delays for the traffic utilizing the on-ramps. Additionally, it compresses the two typical north/south ramp terminals into one single intersection. The signalization is provided for the SPUI terminal. The signal timing plans for the SPUI ramp terminal were developed by optimizing the signals in Synchro. Figure 53 below provides an overview of the Stewart Boulevard interchange configuration.

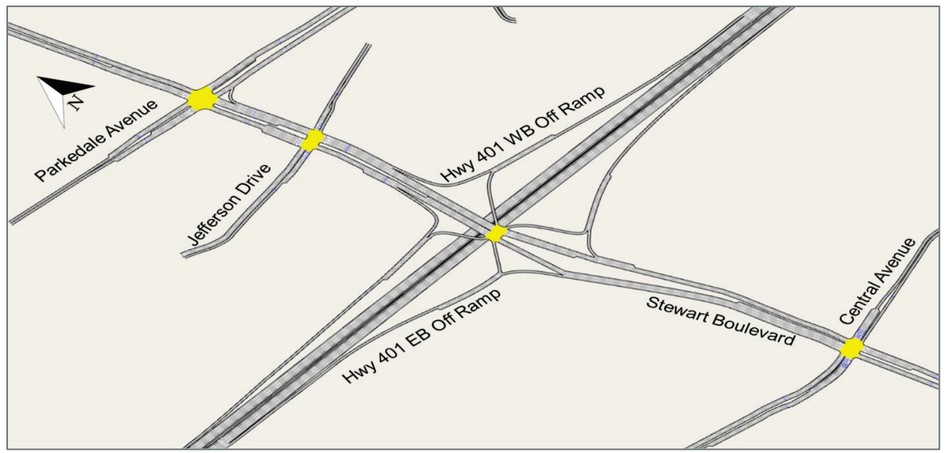


Figure 53: Stewart Boulevard - SPUI Configuration

The 2044 peak hour traffic operation results for the SPUI configuration are shown in Exhibit I-4 in Appendix I. The following observations can be made:

- All of the approaches at the SPUI ramp terminal are expected to perform at LOS C or better in the AM and PM peak hour and are expected to perform at LOS B or better during the Sunday peak hour. The maximum queue for the southbound left-turn movement may exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At Stewart Boulevard and Central Avenue, all approaches are expected to perform at LOS D or better in the AM, PM, and Sunday peak hour, with the exception of the northbound through movement, which is expected to perform at LOS E during the PM peak hour. Additionally, during the PM peak hour, the southbound, eastbound, and westbound left

turn's maximum queue may slightly exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.

- At Stewart Boulevard and Jefferson Drive, all approaches are expected to perform at LOS C or better, except for the westbound left-turn movement, which is expected to perform at LOS D. In the PM peak hour, all approaches are expected to perform at LOS C or better, with the exception of eastbound through-left shared lane, which is expected to perform at LOS D.
- At Stewart Boulevard and Parkedale Avenue, all of the approaches are expected to perform at LOS D or better in the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS C or better.

3.3.1.5 2044 Stewart Boulevard – Overall Alternatives Comparison

Table 10 and Table 11 provide the expected overall intersection LOS and delay for the key intersections along Stewart Boulevard for the various alternatives for the 2044 horizon year. This is based on the average delay experienced at all approaches at the intersection. As noticeable, all interchange alternatives except for SPUI are expected to perform at LOS B or better, whereas SPUI is expected to perform at LOS C or better. The impact on the adjacent intersections is minimal, with Stewart Boulevard & Central Avenue performing at LOS C in the AM peak for all alternatives except Parclo A4, which is performing at LOS D. The intersection of Stewart Boulevard and Jefferson is expected to perform at LOS B or better for all alternatives during the AM and PM peak. The intersection of Stewart Boulevard and Parkedale Avenue is expected to perform at LOS C for all alternatives during the AM, PM, and Sunday peak hours.

Table 10: Stewart Boulevard – 2044 Overall Intersection LOS

Intersections	Minor Improvements			Parclo A4			Diverging Diamond			SPUI		
	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN
Stewart Boulevard & North Ramp Terminal	B	A	A	B	A	A	B	A	A	C	C	B
Stewart Boulevard & South Ramp Terminal	A	A	B	A	A	A	B	A	A			
Stewart Boulevard & Central Avenue	C	D	B	D	D	B	C	D	B	C	D	B
Stewart Boulevard & Jefferson Drive[4]	A	B		A	B		B	B		A	B	
Stewart Boulevard & Parkedale Avenue	C	C	C	C	C	C	C	C	C	C	C	C

Table 11: Stewart Boulevard – 2044 Overall Intersection Delay (s)

Intersections	Minor Improvements			Parclo A4			Diverging Diamond			SPUI		
	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN
Stewart Boulevard & North Ramp Terminal	11	9	6	11	9	9	10	9	7	21	23	17
Stewart Boulevard & South Ramp Terminal	8	8	11	6	7	5	10	9	10			
Stewart Boulevard & Central Avenue	33	41	18	38	42	18	34	40	17	35	40	17
Stewart Boulevard & Jefferson Drive	9	12		10	12		10	12		10	13	
Stewart Boulevard & Parkedale Avenue	27	26	27	28	24	26	28	26	29	27	24	27

[4] *The weekend model calibration/analysis was completed for select key intersections that did not include Jefferson drive.*

3.3.2 2044 North Augusta Road Interchange

The following subsections summarize the ramp terminal operations for the alternatives at the North Augusta Road IC. The ramp terminal operations were evaluated based on the LOS and maximum queue length per the direction of movement, for the 2044 AM, PM, and Sunday Peak hour scenarios.

3.3.2.1 2044 North Augusta Road – Minor Improvements

The minor improvement configuration keeps the existing configurations with the optimized signal timing plans for 2044 traffic volume. Figure 54 provides an overview of the North Augusta Road interchange configuration.

The minor improvement configuration peak hour traffic operations results are shown in Exhibit J-1 in Appendix J. The following observations can be made:

- All of the approaches on the ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM and Sunday peak hours. During the PM peak hour, all of the approaches on the ramp terminal are expected to perform at LOS C or better, with the exception of the eastbound approach, which is expected to perform at LOS D.
- All of the approaches on the ramp terminal on Parkedale Avenue are expected to perform at LOS B or better during the AM peak hour. During the PM peak hour, all of the approaches on the ramp terminal are expected to perform at LOS D or better. During the Sunday peak hour, all of the approaches on the ramp terminal are expected to perform at LOS C or better.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

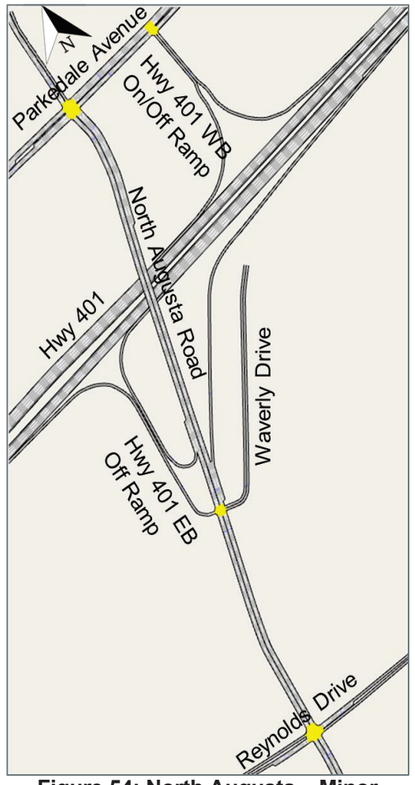


Figure 54: North Augusta – Minor Improvement Configuration

3.3.2.2 2044 North Augusta Road – Parclo A4

The Parclo A4 configuration is modelled for the north and south ramp terminals, as shown in Figure 55, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on Parkedale Avenue and Broome Road.
- Optimize the Signal Timing Plans within the corridor

The 2044 peak hour traffic operation results for the Parclo A4 configuration are shown in Exhibit J-2 in Appendix J. The following observations can be made:

- All of the approaches on the ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM, PM, and Sunday peak hours.
- All of the approaches on the ramp terminal on Parkedale Avenue are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS D or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

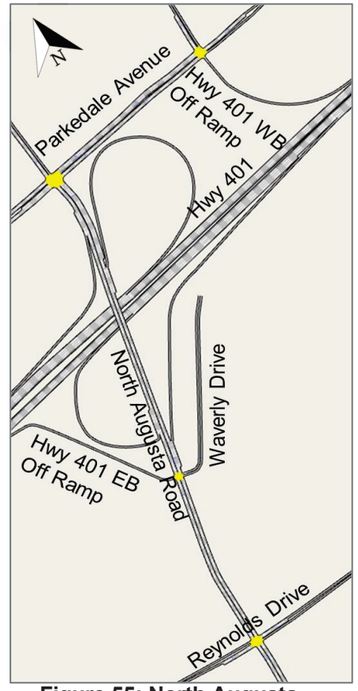


Figure 55: North Augusta – Parclo A4 Configuration

3.3.2.3 2044 North Augusta Road – Diverging Diamond

The Diverging Diamond configuration keeps the existing configurations, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on North Augusta Road.
- Optimize the Signal Timing Plans within the corridor

The Diverging Diamond configuration allows for free-flow travel for the traffic utilizing the on- and off-ramps, resulting in minimal delays for the traffic utilizing the ramps. The signalization is provided for northbound and southbound through traffic at each ramp terminal. The signal timing plans for the north and south ramp terminals were developed by optimizing the signals in Synchro. Figure 56 provides an overview of the North Augusta interchange configuration.

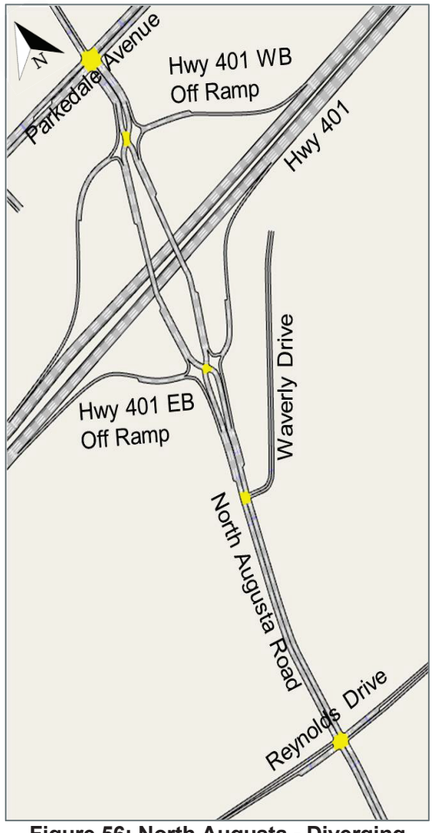


Figure 56: North Augusta - Diverging Diamond Configuration

The 2044 peak hour traffic operation results for the Diverging Diamond configuration are shown in Exhibit J-3 in Appendix J. The following observations can be made:

- All of the approaches on the north ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM, PM, and Sunday peak hours.
- All of the approaches on the south ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS D or better during the AM, PM, and Sunday peak hours. The maximum queue for northbound right movement at the intersection may exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

3.3.2.4 2044 North Augusta Road – SPUI

The SPUI configuration keeps the existing configurations, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on North Augusta Road.
- Optimize the Signal Timing Plans within the corridor

The SPUI configuration allows for free-flow travel for the traffic utilizing the on-ramps, resulting in minimal delays for the traffic utilizing the on-ramps. Additionally, it compresses the two typical north/south ramp terminals into one single intersection. The signalization is provided for the SPUI terminal. The signal timing plans for the SPUI ramp terminal were developed by optimizing the signals in Synchro. Figure 57 provides an overview of the North Augusta interchange configuration.

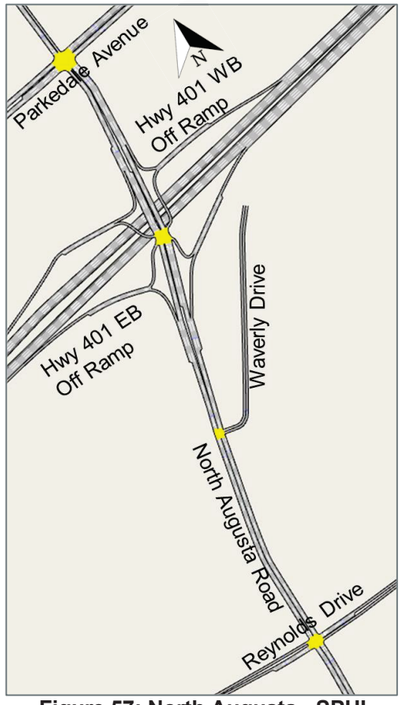


Figure 57: North Augusta - SPUI Configuration

The 2044 peak hour traffic operation results for the SPUI configuration are shown in Exhibit J-4 in Appendix J. The following observations can be made:

- All of the approaches on the SPUI ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM peak hour and are expected to perform at LOS C or better during the PM and Sunday peak hour.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS D or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

3.3.2.5 2044 North Augusta Road – Diamond

The Diamond configuration is modelled for the north and south ramp terminals, as shown in Figure 58, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on North Augusta Road.
- Optimize the Signal Timing Plans within the corridor

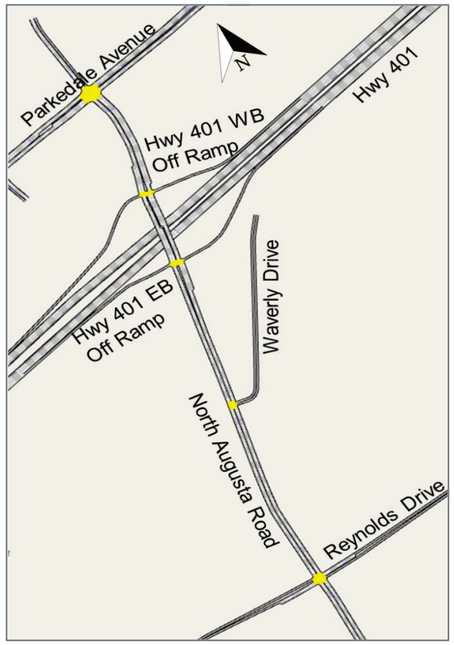


Figure 58: North Augusta – Diamond Configuration

The 2044 peak hour traffic operation results for the Diamond configuration are shown in Exhibit J-5 in Appendix J. The following observations can be made:

- All of the approaches on the north ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM, PM, and Sunday peak hours. The maximum queue for the northbound left movement may exceed the available storage during the PM peak. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic
- All of the approaches on the south ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM and Sunday peak hours. During the PM peak hour, all approaches are expected to perform at LOS C or better. The maximum queue for the southbound left movement may exceed the available storage during the PM peak hour. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS D or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

To accommodate the storage for vehicles utilizing the northbound left turn at the north ramp terminal and the southbound left turn at the south ramp terminal along North Augusta Road, it is recommended that the distance between the north and south ramp terminals should be at least 150 m.

3.3.2.6 2044 North Augusta Road – Diamond with Roundabout

The Diamond with Roundabout configuration is modelled for the north and south ramp terminals, as shown in Figure 59, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on North Augusta Road.
- Optimize the Signal Timing Plans within the corridor

The north and south ramp terminals include a 2-lane entry and exit for roundabouts. Figure 60 shows the lane configuration for north and south ramp terminal roundabouts.

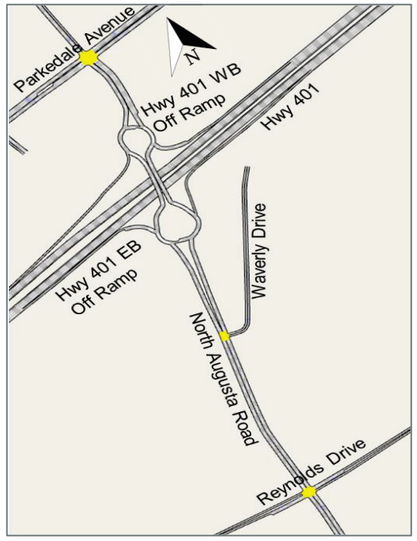


Figure 59: North Augusta – Diamond with Roundabout Configuration

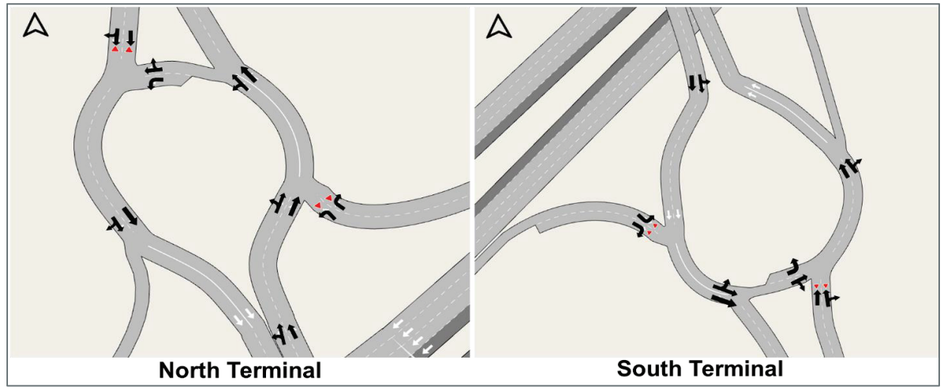


Figure 60: Roundabout Lane Configuration

The 2044 peak hour traffic operation results for the Diamond with Roundabouts configuration are shown in Exhibit J-6 in Appendix J. The following observations can be made:

- All of the approaches on the north ramp terminal on North Augusta Road are expected to perform at LOS A during the AM, PM, and Sunday peak hours.
- All of the approaches on the south ramp terminal on North Augusta Road are expected to perform at LOS A during the AM and Sunday peak hours. During the PM peak hour, all approaches are expected to perform at LOS C or better.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS C or better during the AM and Sunday peak hours. During the PM peak hour, all of the approaches are expected to perform at LOS D or better.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

3.3.2.7 2044 North Augusta Road – Parclo A2 with Diamond

The Parclo A2 (North Terminal) with Diamond (South Terminal) configuration is modelled, as shown in Figure 61, with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on Parkedale Avenue and Broome Road.
- Optimize the Signal Timing Plans within the corridor

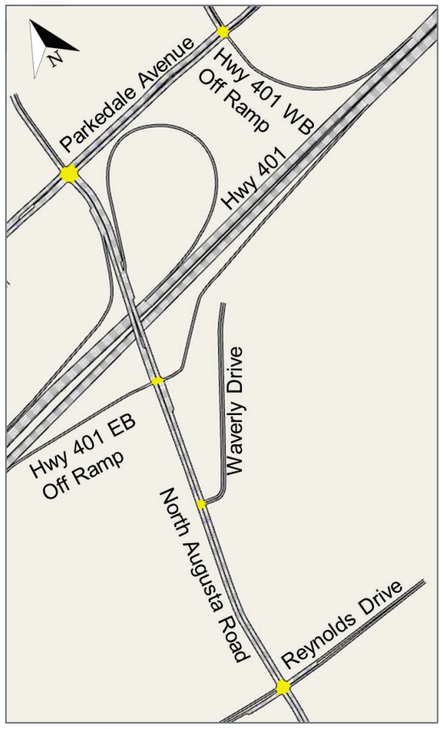


Figure 61: North Augusta – Parclo A2 with Diamond Configuration

The 2044 peak hour traffic operation results for the Parclo A2 with Diamond configuration are shown in Exhibit J-7 in Appendix J. The following observations can be made:

- All of the approaches on the ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM and Sunday peak hours. During the PM peak hour, all of the approaches are expected to perform at LOS C or better. The southbound left turn maximum queue may exceed the available storage but is not expected to spill back to the North Augusta and Parkedale intersection and cause any significant interference to the through traffic.
- All of the approaches on the ramp terminal on Parkedale Avenue are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS D or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

3.3.2.8 2044 North Augusta Road – Overall Interchange Performance

Table 12 and Table 13 provides the expected overall intersection LOS and delay for the key intersections along North Augusta Road for the various alternatives for the 2044 horizon year. As noticeable, all alternatives at the north ramp terminal are expected to perform at LOS B or better, with the exception of Minor improvement in the PM peak hour, which is expected to perform at LOS C. At the south ramp terminal, all alternatives are expected to perform at LOS B or better, with the exception of Parclo A2 with Diamond, which is expected to perform at LOS C. The North Augusta Road and Parkedale Avenue intersection is expected to perform at LOS C or better for all alternatives. Lastly, the North Augusta Road and Reynolds Drive intersection is expected to perform at LOS B for all alternatives.

Table 12: North Augusta Road – 2044 Overall Intersection LOS

Intersections	Minor Improvements			Parclo A4			Diverging Diamond			SPUI			Diamond			Diamond with Roundabout			Parclo A2 with Diamond		
	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN
N Augusta Rd & N Ramp Terminal	B	C	B	B	B	B	B	B	B	B	B	B	B	B	A	A	A	A	B	B	B
N Augusta Rd & S Ramp Terminal	A	A	A	A	A	A	B	A	B				B	B	B	A	A	A	B	C	B
N Augusta Rd & Parkedale Ave	B	C	B	C	C	B	C	C	B	B	C	B	B	C	B	B	C	B	C	C	B
N Augusta Rd & Reynolds Dr	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B

Table 13: North Augusta Road – 2044 Overall Intersection Delay (s)

Intersections	Minor Improvements			Parclo A4			Diverging Diamond			SPUI			Diamond			Diamond with Roundabout			Parclo A2 with Diamond		
	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN	AM	PM	SUN
N Augusta Rd & N Ramp Terminal	18	27	11	12	15	11	13	12	12	14	18	18	11	19	10	4	6	2	12	15	11
N Augusta Rd & S Ramp Terminal	4	8	1	9	10	5	13	9	13				11	20	11	4	9	2	11	20	10
N Augusta Rd & Parkedale Ave	15	25	14	23	30	18	21	34	18	20	29	15	19	28	17	20	28	17	23	31	18
N Augusta Rd & Reynolds Dr	12	13	12	12	12	14	12	14	12	12	13	11	12	13	11	12	13	11	12	13	12

3.3.3 2044 Highway 401 Mainline Operations

This subsection summarizes the expected impact of interchange alternatives on Highway 401 mainline operations with 8-lane cross-section in 2044 for the AM, PM, and Sunday peak period.

3.3.3.1 2044 AM Peak Period

Figure 62 and Figure 63 compare the impact on mainline density and speed of interchange configurations at Stewart Boulevard and North Augusta on the eastbound direction of Highway 401 during the 2044 AM peak hour. The Minor Improvements, Parclo A4, Diverging Diamond, and SPUI were modelled for both Stewart Boulevard and North Augusta Road interchanges, whereas Diamond, Diamond with Roundabouts, and Parclo A2 with Diamond were only modelled for North Augusta Road interchanges. As noticeable, Highway 401 EB (with 8-lane cross-section) mainline is expected to perform at LOS A during the AM Peak, with an average speed exceeding 100 km/h, during the 2044 AM peak hour, throughout the study area.

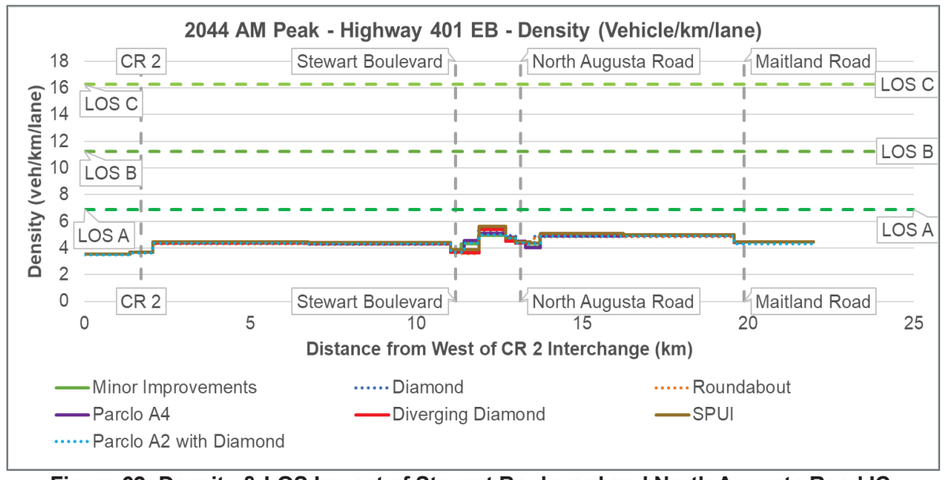


Figure 62: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 AM Peak Hour

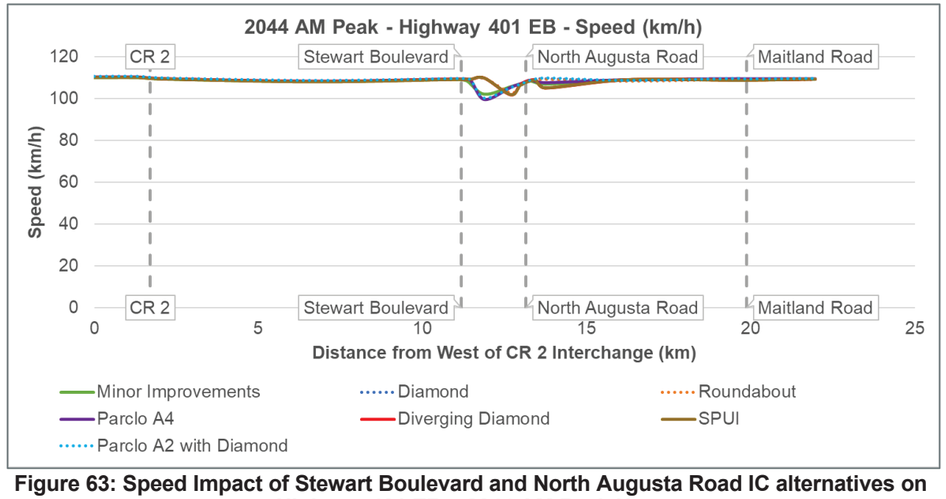


Figure 63: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 AM Peak Hour

Figure 64 and Figure 65 compare the impact on mainline density and speed of alternative interchange configurations at Stewart Boulevard and North Augusta on the eastbound direction of Highway 401 during the AM peak hour. As noticeable, Highway 401 WB (with 8-lane cross-section) mainline is expected to perform at LOS A, with an average speed exceeding 100 km/h, during the 2044 AM peak hour throughout the study area. The 2044 AM Pre-Peak and Post-Peak hour analysis shows similar traffic operations to the peak hour along the highway mainline, as shown in Exhibit K-1 to Exhibit K-8 in Appendix K.

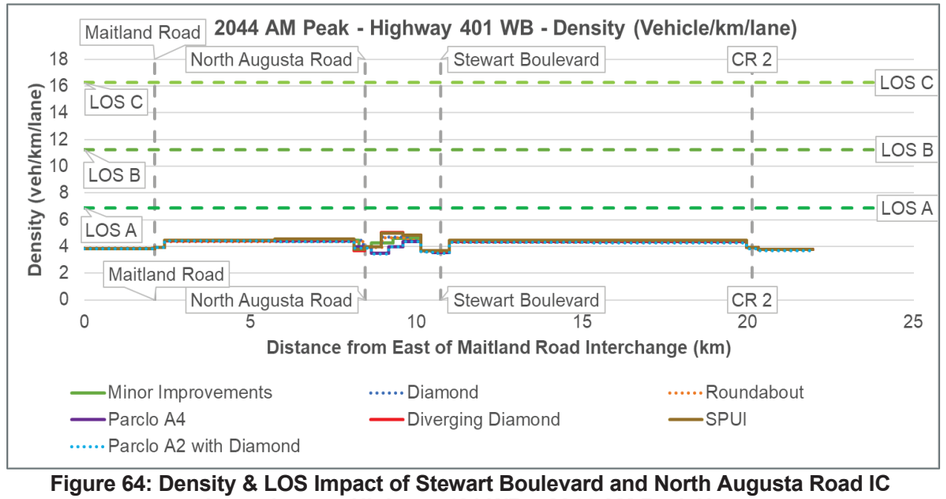


Figure 64: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 AM Peak Hour

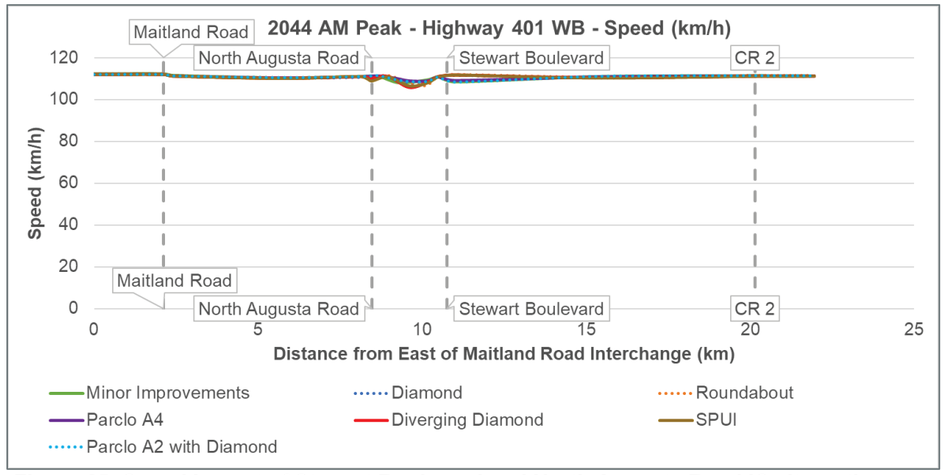


Figure 65: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 AM Peak Hour

3.3.3.2 2044 PM Peak Period

Figure 66 and Figure 67 compare the impact on mainline density and speed of interchange configurations at Stewart Boulevard and North Augusta on the eastbound direction of Highway 401 during the 2044 PM peak hour. The Minor Improvements, Parclo A4, Diverging Diamond, and SPUI were modelled for both Stewart Boulevard and North Augusta Road interchanges, whereas Diamond, Diamond with Roundabouts, and Parclo A2 with Diamond were only modelled for North Augusta Road interchanges. As noticeable, Highway 401 EB (with 8-lane cross-section) mainline is expected to perform at LOS C or better, with an average operating speed exceeding 95 km/h, during the 2044 PM peak hour, throughout the study area.

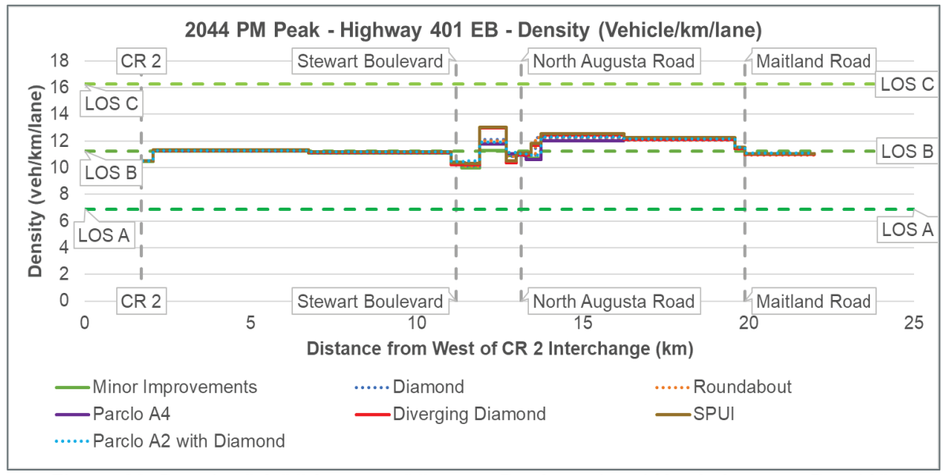


Figure 66: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 PM Peak Hour

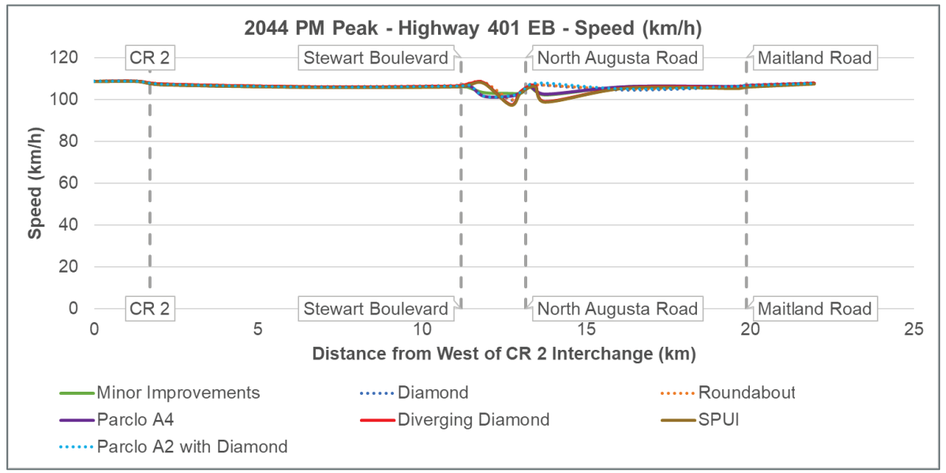


Figure 67: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 PM Peak Hour

Figure 68 and Figure 69 compare the impact on mainline density and speed of interchange configurations at Stewart Boulevard and North Augusta on the westbound direction of Highway 401 during the 2044 PM peak hour. As noticeable, Highway 401 (with 8-lane cross-section) mainline is expected to perform at LOS B or better, with an average speed exceeding 100 km/h, during the 2044 PM peak hour, throughout the study area. The 2044 PM Pre-Peak and Post-Peak hour analysis shows slightly better traffic operations when compared to the peak hour along the highway mainline, as shown in Exhibit K-9 to Exhibit K-16 in Appendix K.

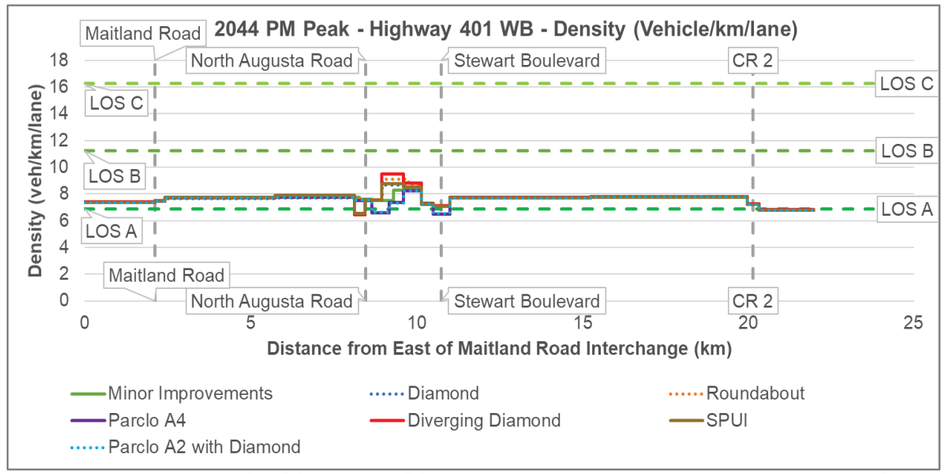


Figure 68: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 PM Peak Hour

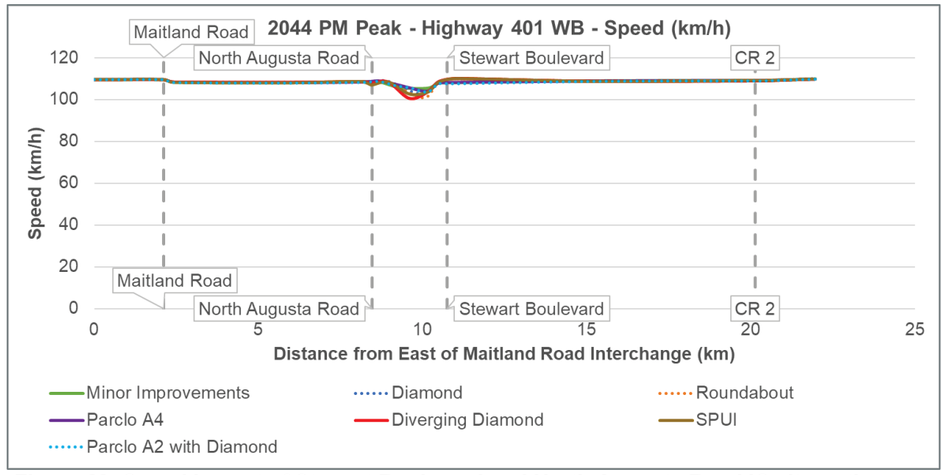


Figure 69: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 PM Peak Hour

3.3.3.3 2044 Sunday Peak Period

Figure 70 and Figure 71 compare the impact on mainline density and speed of interchange configurations at Stewart Boulevard and North Augusta on the eastbound direction of Highway 401 during the 2044 Sunday peak hour. The Minor Improvements, Parclo A4, Diverging Diamond, and SPUI were modelled for both Stewart Boulevard and North Augusta Road interchanges, whereas Diamond, Diamond with Roundabouts, and Parclo A2 with Diamond were only modelled for North Augusta Road interchanges. As noticeable, Highway 401 (with 8-lane cross-section) mainline is expected to perform at LOS B, with an average speed exceeding 100 km/h, during the 2044 Sunday peak hour, throughout the study area.

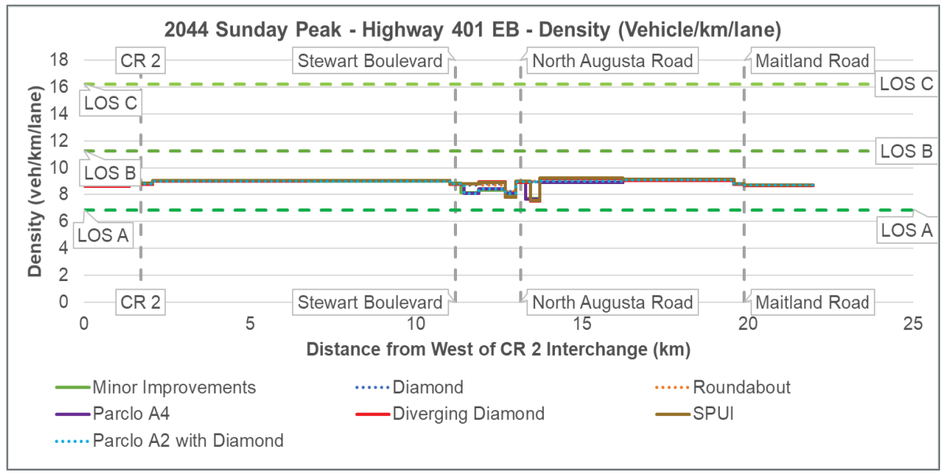


Figure 70: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 Sunday Peak Hour

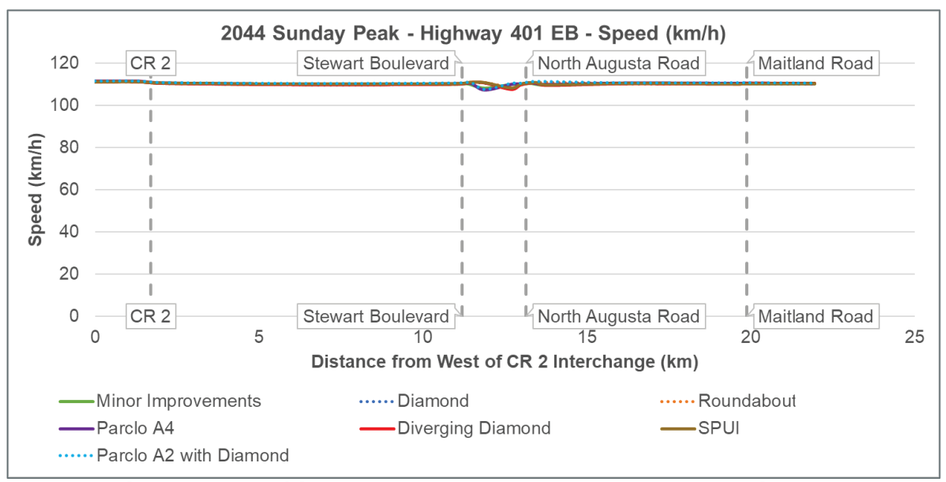
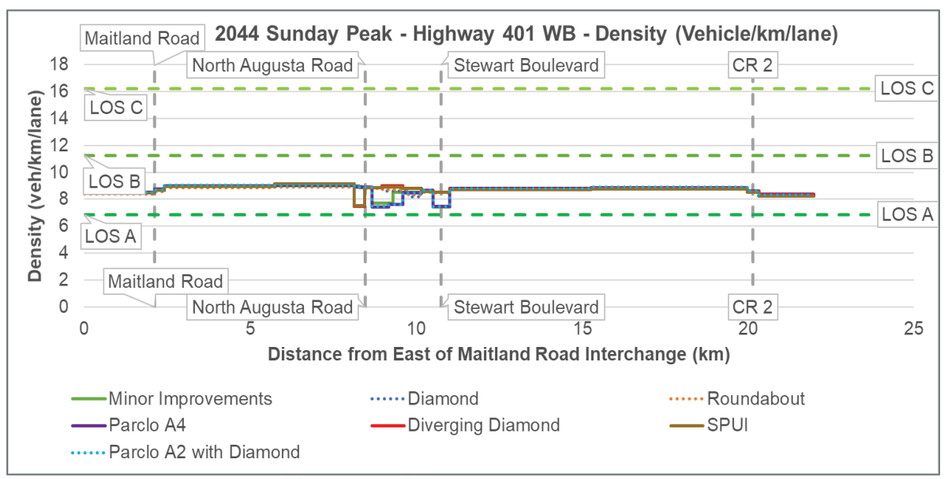


Figure 71: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 Sunday Peak Hour

Figure 72 and Figure 73 compare the impact on mainline density and speed of interchange configurations at Stewart Boulevard and North Augusta on the westbound direction of Highway 401 during the 2044 Sunday peak hour. As noticeable, Highway 401 (with 8-lane cross-section) mainline is expected to perform at LOS B or better, with an average speed exceeding 100 km/h, during the 2044 Sunday peak hour, throughout the study area. The 2044 Sunday Pre-Peak and Post-Peak hour analysis shows similar traffic operations to the peak hour along the highway mainline, as shown in Exhibit K-17 to Exhibit K-24 in Appendix K.



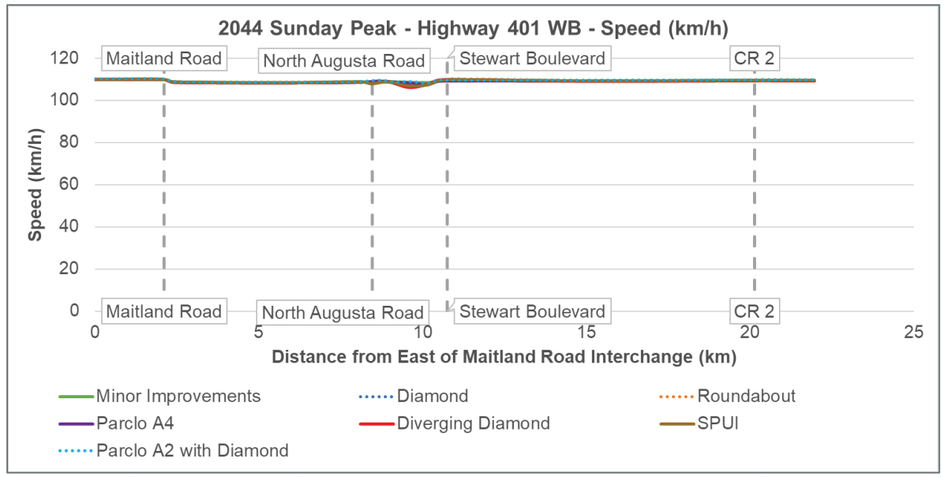


Figure 72: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 Sunday Peak Hour

Figure 73: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 Sunday Peak Hour

4. Preferred Design

The following preferred design was selected for the interchanges, SPUI configuration at Stewart Boulevard IC and Parclo A2 (North Terminal) with Diamond (South Terminal) configuration at North Augusta Road IC, is shown in Figure 74.

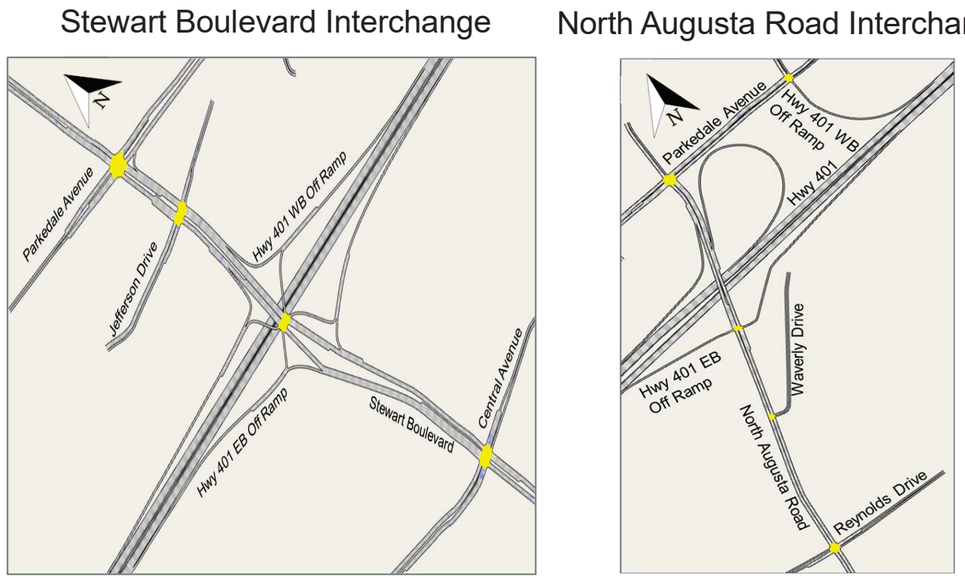


Figure 74: Stewart Boulevard and North Augusta Road Preferred Interchange Configurations

The SPUI configuration for the Stewart Boulevard IC keeps the existing configurations, with the following changes:

- Dual Eastbound Left turn lanes at Stewart Boulevard and Central Avenue intersection, due to heavy left-turn volume.
- Three southbound lanes along Stewart Boulevard between the SPUI terminal and Central Avenue.
- Optimize the Signal Timing Plans within the corridor

The SPUI configuration allows for free-flow travel for the traffic utilizing the on-ramps, resulting in minimal delays for the traffic utilizing the on-ramps. Additionally, it compresses the two typical north/south ramp terminals into one single intersection. The signalization is provided for the SPUI terminal. The signal timing plans for the SPUI ramp terminal were developed by optimizing the signals in Synchro.

The Parclo A2 (North Terminal) with Diamond (South Terminal) configuration for the North Augusta Road IC is modelled with the following changes:

- Dual Westbound Left turn lanes at North Augusta Road and Parkedale Avenue intersection.
- The Highway 401 Westbound Off-Ramp is located on Parkedale Avenue and Broome Road.
- Optimize the Signal Timing Plans within the corridor

The sections below summarize the results of the preferred design selected for the interchanges on the traffic operations at Stewart Boulevard, North Augusta Road, and Highway 401 mainline for 2034 and 2044. Two scenarios were looked at for each year, Highway 401 mainline with a 6-lane and 8-lane cross-section. The detailed diagrams that showcase LOS and queueing information at key intersections for the peak hour and mainline traffic operations for the pre-peak and post-peak hours can be found in Appendix L and Appendix M.

In order to evaluate the preferred design for different Highway 401 lane cross-sections, the LOS and queue lengths were analyzed at ramp terminals and significantly impacted intersections for the AM, PM, and Sunday peak hours. In addition, the impact of the preferred design on Highway 401 mainline operations was evaluated by comparing the average travel speed and vehicle density on segments adjacent to the interchanges (including the weaving sections) for the pre-peak, peak, and post-peak hours.

4.1 Horizon Year 2034

This subsection summarizes the traffic operations analysis results for Horizon Year 2034 on the Stewart Boulevard and North Augusta Road ICs. In addition to the expected traffic operation performance at key intersections, this subsection also summarizes the expected impact of the preferred design on Highway 401 mainline operations in 2034 for different lane cross-sections (6-lane vs 8-lane).

4.1.1 6-Lane Cross-Section

The analysis results of ramp terminals traffic operations of the preferred design at the Stewart Boulevard and North Augusta Road ICs with a 6-lane cross-section for Highway 401 mainline are summarized here after. The ramp terminal operations were evaluated based on the LOS, average, and maximum queue length per the direction of movement, for the 2034 AM, PM, and Sunday peak periods.

4.1.1.1 2034 Preferred Design – Stewart Boulevard Interchange

The 2034 peak hour traffic operation results of the preferred design at the Stewart Boulevard IC for Highway 401 mainline with a 6-lane cross-section are shown in Exhibit L-1 in Appendix L. The following observations can be made:

- All of the approaches at the SPUI ramp terminal are expected to perform at LOS C or better in the AM and PM peak hours and are expected to perform at LOS B or better during the Sunday peak hour. The maximum queue for the southbound left-turn movement may occasionally exceed the assumed storage length of 80m. However, the queue is not expected to spill back to the adjacent major intersection and does not have major impact on the through traffic.

- At Stewart Boulevard and Central Avenue, all approaches are expected to perform at LOS D or better in the AM and PM and are expected to perform at LOS C or better during the Sunday peak hour. Additionally, during the PM peak hour, the maximum queues for the eastbound and westbound left-turn movements may slightly exceed the available storage. The queues are not expected to spill back to the adjacent major intersection and do not impact the through traffic.
- At Stewart Boulevard and Jefferson Drive, all approaches are expected to perform at LOS B or better in the AM peak hour, with the exception of the westbound left-turn, which is expected to perform at LOS D. In the PM peak hour, all approaches are expected to perform at LOS C or better, with the exception of the eastbound through-left and westbound through-right shared movements, which are expected to perform at LOS D. Additionally, during the AM peak hour, the maximum queue for the westbound left-turn movement may exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At Stewart Boulevard and Parkedale Avenue, all of the approaches are expected to perform at LOS D or better in the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS C or better.

4.1.1.2 2034 Preferred Design – North Augusta Road Interchange

The 2034 peak hour traffic operation results of the preferred design at the North Augusta Road IC Highway 401 mainline with a 6-lane cross-section are shown in Exhibit L-2 in Appendix L. The following observations can be made:

- All of the approaches on the ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM and Sunday peak hours. During the PM peak hour, all of the approaches are expected to perform at LOS C or better. Additionally, during the PM peak hour, the maximum queue for the southbound left-turn movement may exceed the available storage but is not expected to spill back to the North Augusta and Parkedale intersection and cause any significant interference to the through traffic.
- All of the approaches on the ramp terminal on Parkedale Avenue are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS C or better during the PM and Sunday peak hours. During the AM peak hour, the ramp terminal is expected to perform at LOS D or better.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

4.1.2 8-Lane Cross-Section

The analysis results of ramp terminals traffic operations of the preferred design at the Stewart Boulevard and North Augusta Road ICs for Highway 401 mainline with an 8-lane cross-section are summarized here after. The ramp terminal operations were evaluated based on the LOS, average, and maximum queue length per the direction of movement, for the 2034 AM, PM, and Sunday peak periods.

4.1.2.1 2034 Preferred Design – Stewart Boulevard Interchange

The 2034 peak hour traffic operation results of the preferred design at the Stewart Boulevard IC for Highway 401 mainline with an 8-lane cross-section are shown in Exhibit L-3 in Appendix L. The following observations can be made:

- All of the approaches at the SPUI ramp terminal are expected to perform at LOS C or better in the AM and PM peak hours and are expected to perform at LOS B or better during the Sunday peak hour. The maximum queue for the southbound left-turn movement may occasionally exceed the assumed storage length of 80m. However, the queue is not expected to spill back to the adjacent major intersection and does not have major impact on the through traffic.
- At Stewart Boulevard and Central Avenue, all approaches are expected to perform at LOS D or better in the AM and PM and are expected to perform at LOS C or better during the Sunday peak hour. Additionally, during the PM peak hour, the maximum queues for the eastbound and westbound left-turn movements may slightly exceed the available storage. The queues are not expected to spill back to the adjacent major intersection and do not impact the through traffic.
- At Stewart Boulevard and Jefferson Drive, all approaches are expected to perform at LOS B or better in the AM peak hour, with the exception of the westbound left-turn, which is expected to perform at LOS D. In the PM peak hour, all approaches are expected to perform at LOS C or better, with the exception of the eastbound through-left and westbound through-right shared movements, which are expected to perform at LOS D. Additionally, during the AM peak hour, the maximum queue for the westbound left-turn movement may exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At Stewart Boulevard and Parkedale Avenue, all of the approaches are expected to perform at LOS D or better in the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS C or better.

4.1.2.2 2034 Preferred Design – North Augusta Road Interchange

The 2034 peak hour traffic operation results of the preferred design at the North Augusta Road IC for Highway 401 mainline with an 8-lane cross-section are shown in Exhibit L-4 in Appendix L. The following observations can be made:

- All of the approaches on the ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM and Sunday peak hours. During the PM peak hour, all of the approaches are expected to perform at LOS C or better. Additionally, during the PM peak hour, the maximum queue for the southbound left-turn movement may exceed the available storage but is not expected to spill back to the North Augusta and Parkedale intersection and cause any significant interference to the through traffic.
- All of the approaches on the ramp terminal on Parkedale Avenue are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS C or better during the PM and Sunday peak hours. During the AM peak hour, the ramp terminal is expected to perform at LOS D or better.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.

4.1.3 2034 Highway 401 Mainline Operations

This subsection summarizes the expected impact of the preferred design selected for the interchanges on Highway 401 mainline operations with a 6-lane or 8-lane cross-section in 2034 for the AM, PM, and Sunday peak period.

4.1.3.1 2034 AM Peak Period

Figure 75 and Figure 76 compare the impact on mainline density and speed of the preferred design configurations at Stewart Boulevard and North Augusta on the eastbound direction of Highway 401 with a 6-lane or 8-lane cross-section during the 2034 AM peak hour. As shown, Highway 401 EB mainline with a 6-lane or 8-lane cross-section is expected to perform at LOS A with an average speed exceeding 100 km/h, during the 2034 AM peak hour, throughout the study area.

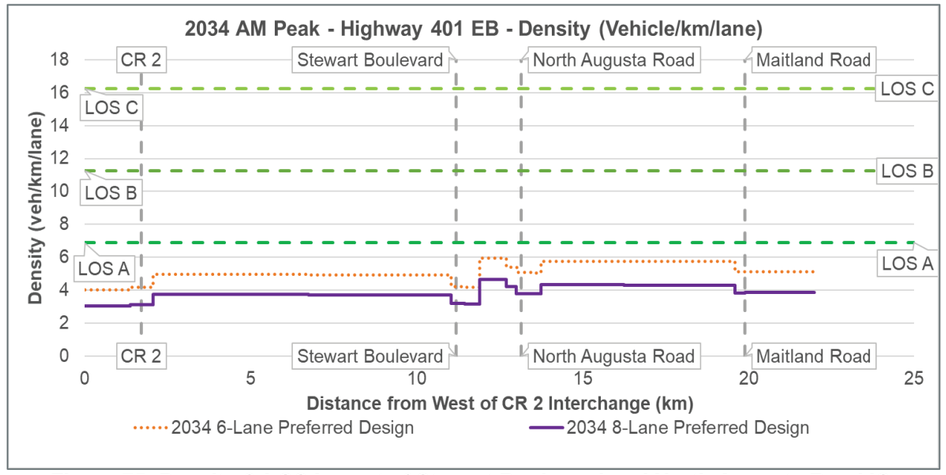


Figure 75: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 AM Peak Hour (6-lane vs 8-lane)

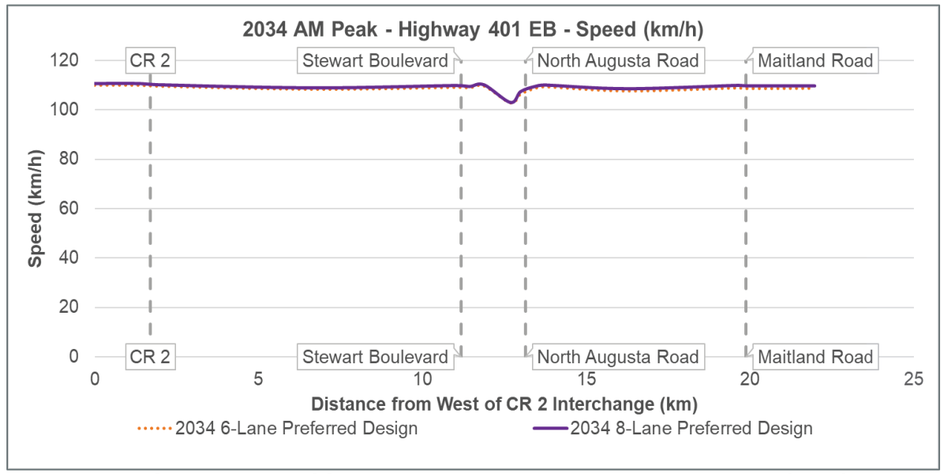


Figure 76: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 AM Peak Hour (6-lane vs 8-lane)

Figure 77 and Figure 78 compare the impact on mainline density and speed of the preferred design configurations at Stewart Boulevard and North Augusta on the westbound direction of Highway 401 with a 6-lane or 8-lane cross-section during the 2034 AM peak hour. As shown, Highway 401 WB mainline with a 6-lane or 8-lane cross-section is expected to perform at LOS A with an average speed exceeding 100 km/h, during the 2034 AM peak hour, throughout the study area. The 2034 AM Pre-Peak and Post-Peak hour analysis shows similar traffic operations to the peak hour along the highway mainline, as shown in Exhibit M-1 to Exhibit M-8 in Appendix M.

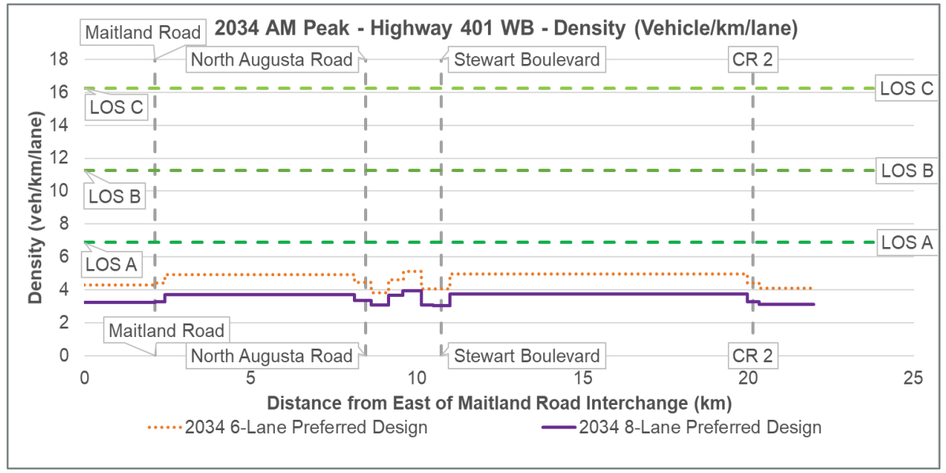


Figure 77: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Alternative on Highway 401 WB – 2034 AM Peak Hour (6-lane vs 8-lane)

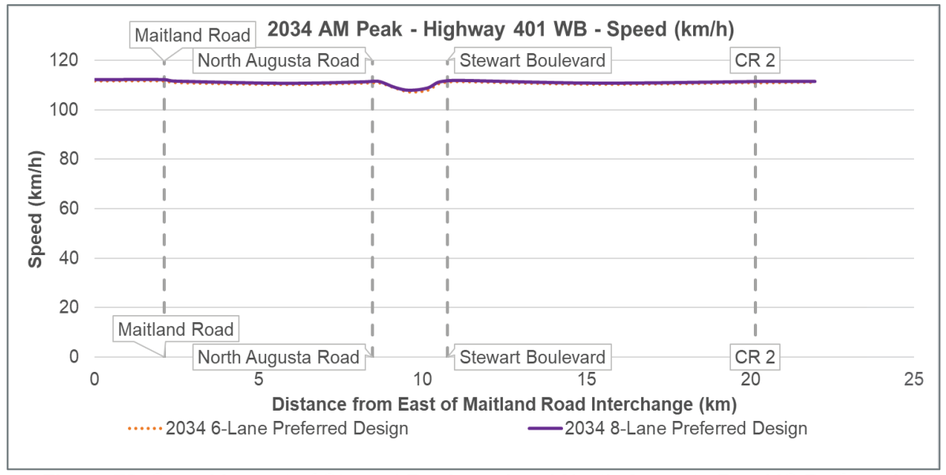


Figure 78: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Alternative on Highway 401 WB – 2034 AM Peak Hour (6-lane vs 8-lane)

4.1.3.2 2034 PM Peak Period

Figure 79 and Figure 80 compare the impact on mainline density and speed of the preferred design configurations at Stewart Boulevard and North Augusta on the eastbound direction of Highway 401 with a 6-lane or 8-lane cross-section during the 2034 PM peak hour. As shown, Highway 401 EB mainline with a 6-lane cross-section is expected to perform at LOS C with an average speed exceeding 95 km/h, during the 2034 PM peak hour, throughout the study area. On the other hand, Highway 401 EB mainline with an 8-lane cross-section is expected to perform at LOS B with an average speed exceeding 100 km/h.

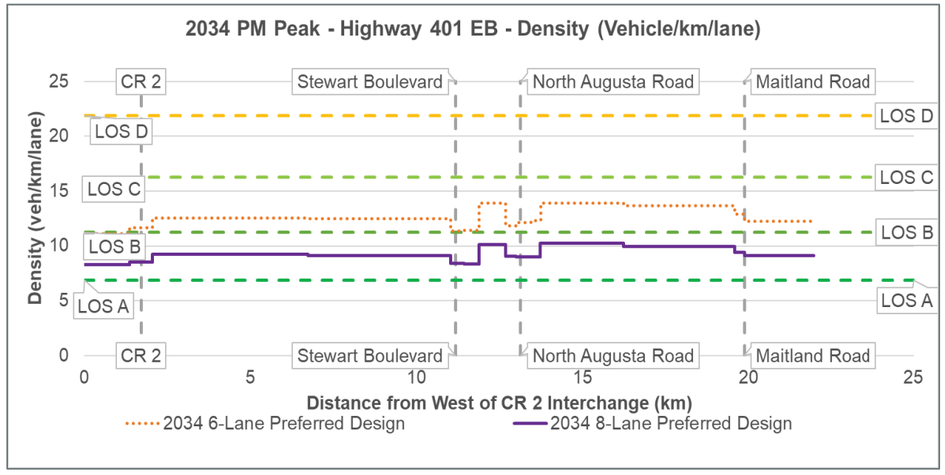


Figure 79: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 PM Peak Hour (6-lane vs 8-lane)

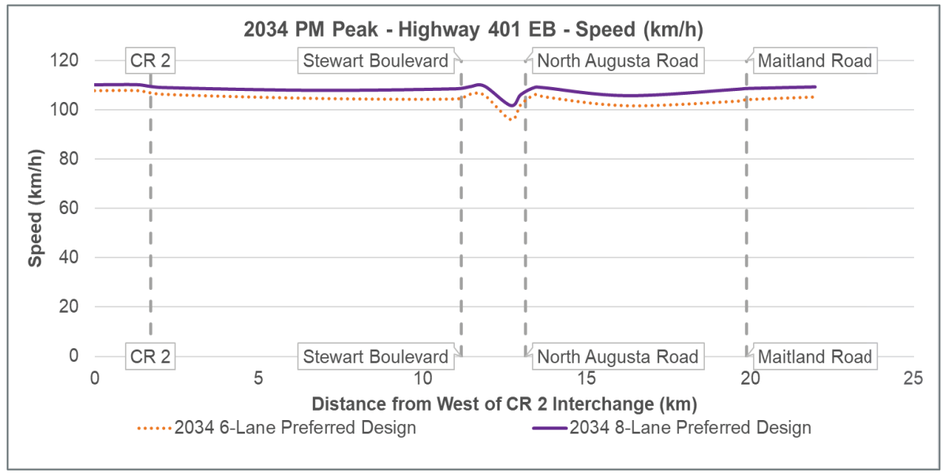


Figure 80: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 PM Peak Hour (6-lane vs 8-lane)

Figure 81 and Figure 82 compare the impact on mainline density and speed of the preferred design configurations at Stewart Boulevard and North Augusta on the westbound direction of Highway 401 with a 6-lane or 8-lane cross-section during the 2034 PM peak hour. As shown, Highway 401 WB mainline with a 6-lane cross-section is expected to perform at LOS B with an average speed exceeding 100 km/h, during the 2034 PM peak hour, throughout the study area. On the other hand, Highway 401 WB mainline with an 8-lane cross-section is expected to perform for the majority of times at LOS A with an average speed exceeding 100 km/h. The 2034 PM Post-Peak hour analysis shows similar traffic operations to the peak hour along the highway mainline while the Pre-Peak shows slightly better traffic operations, as shown in Exhibit M-9 to Exhibit M-16 in Appendix M.

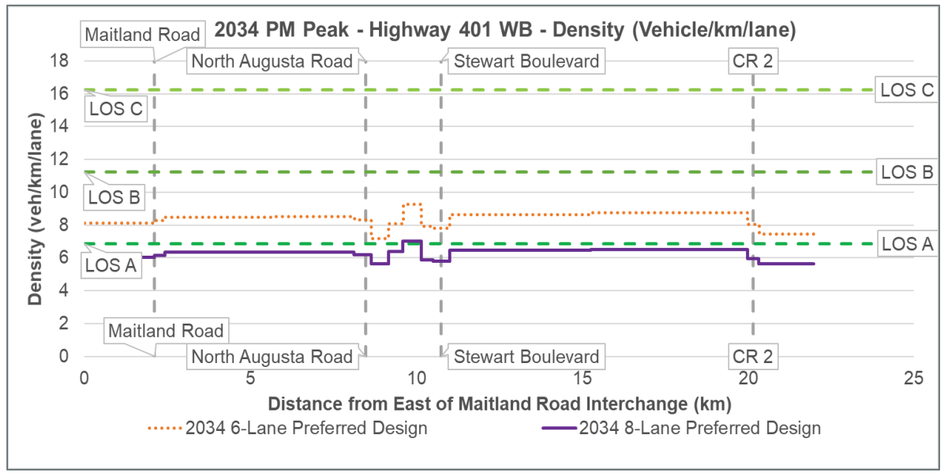


Figure 81: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2034 PM Peak Hour (6-lane vs 8-lane)

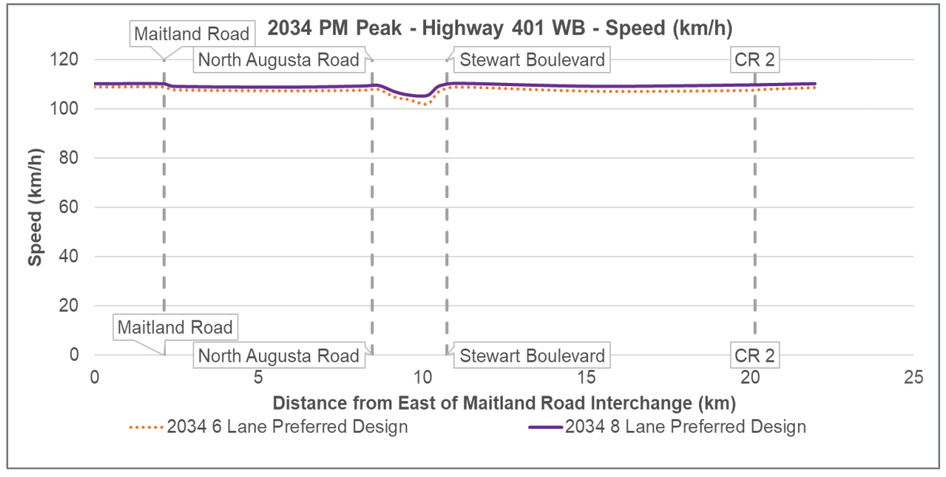


Figure 82: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2034 PM Peak Hour (6-lane vs 8-lane)

4.1.3.3 2034 Sunday Peak Period

Figure 83 and Figure 84 compare the impact on mainline density and speed of the preferred design configurations at Stewart Boulevard and North Augusta on the eastbound direction of Highway 401 with a 6-lane or 8-lane cross-section during the 2034 Sunday peak hour. As shown, Highway 401 EB mainline with a 6-lane or 8-lane cross-section is expected to perform at LOS B with an average speed exceeding 100 km/h, during the 2034 PM peak hour, throughout the study area.

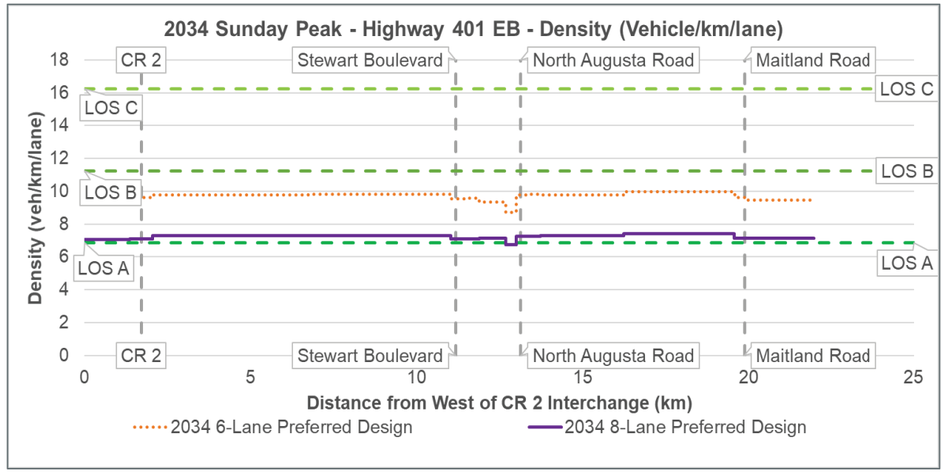


Figure 83: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 Sunday Peak Hour (6-lane vs 8-lane)

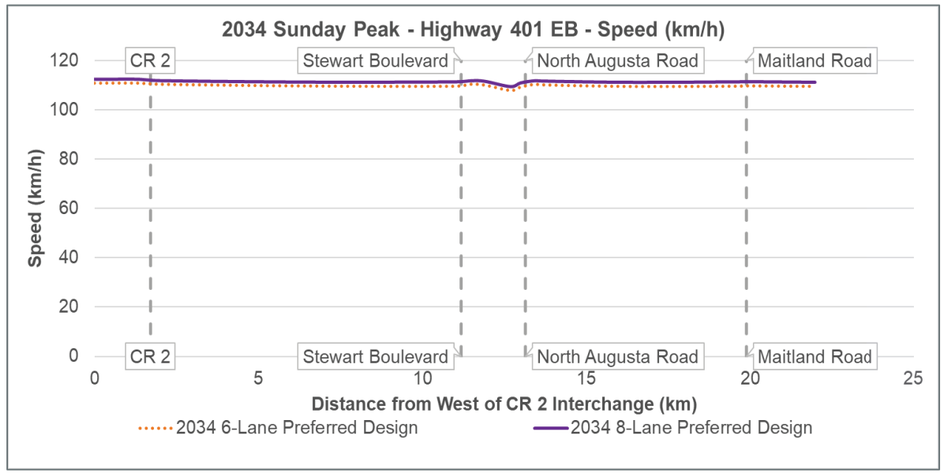


Figure 84: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 Sunday Peak Hour (6-lane vs 8-lane)

Figure 85 and Figure 86 compare the impact on mainline density and speed of the preferred design configurations at Stewart Boulevard and North Augusta on the westbound direction of Highway 401 with a 6-lane or 8-lane cross-section during the 2034 Sunday peak hour. As shown, Highway 401 WB mainline with a 6-lane is expected to perform at LOS B with an average speed exceeding 100 km/h, during the 2034 Sunday peak hour, throughout the study area. On the other hand, Highway 401 WB mainline with an 8-lane cross-section is expected to perform at LOS B or better with an average speed exceeding 100 km/h. The 2034 Sunday Pre-Peak and Post-Peak hour analysis shows slightly better traffic operations compared to the peak hour along the highway mainline, as shown in Exhibit M-17 to Exhibit M-24 in Appendix M.

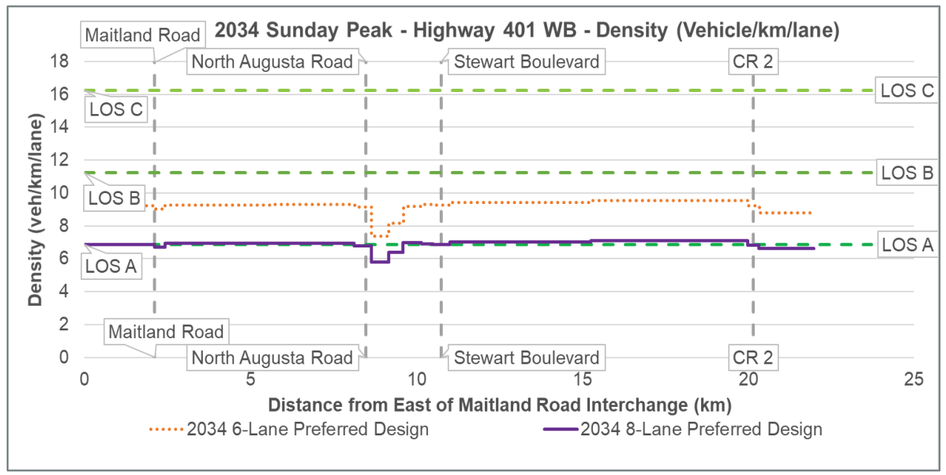


Figure 85: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB– 2034 Sunday Peak Hour (6-lane vs 8-lane)

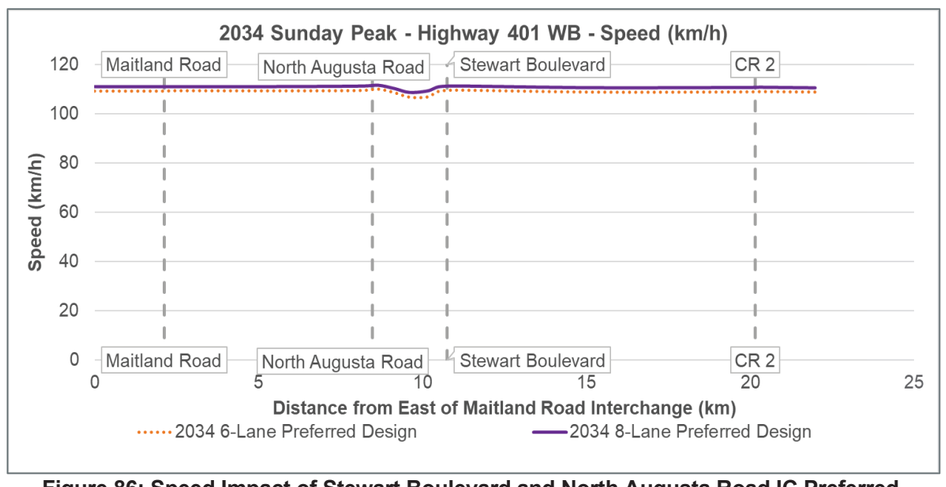


Figure 86: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2034 Sunday Peak Hour (6-lane vs 8-lane)

4.2 Horizon Year 2044

This subsection summarizes the traffic operations analysis results for Horizon Year 2044 on the Stewart Boulevard and North Augusta Road ICs. In addition to the expected traffic operation performance at key intersections, this subsection also summarizes the expected impact of the preferred design on Highway 401 mainline operations in 2044 for different lane cross-sections (6-lane vs 8-lane).

4.2.1 6-Lane Cross-Section

The analysis results of ramp terminals traffic operations of the preferred design at the Stewart Boulevard and North Augusta Road ICs with a 6-lane cross-section for Highway 401 mainline are summarized here after. The ramp terminal operations were evaluated based on the LOS, average, and maximum queue length per the direction of movement, for the 2044 AM, PM, and Sunday peak periods.

4.2.1.1 2044 Preferred Design – Stewart Boulevard Interchange

The 2044 peak hour traffic operation results of the preferred design at the Stewart Boulevard IC for Highway 401 mainline with a 6-lane cross-section are shown in Exhibit L-5 in Appendix L. The following observations can be made:

- All of the approaches at the SPUI ramp terminal are expected to perform at LOS C or better in the AM and PM peak hours and are expected to perform at LOS B or better during the Sunday peak hour. The maximum queue for the southbound left-turn movement may occasionally exceed the assumed storage length of 80m. However, the queue is not expected to spill back to the adjacent major intersection and does not have major impact on the through traffic.
- At Stewart Boulevard and Central Avenue, all approaches are expected to perform at LOS D or better in the AM, PM, and Sunday peak hours. Additionally, during the PM peak hour, the maximum queues for the eastbound and westbound left-turn movements may slightly exceed the available storage. The queues are not expected to spill back to the adjacent major intersection and do not impact the through traffic.
- At Stewart Boulevard and Jefferson Drive, all approaches are expected to perform at LOS C or better in the AM peak hour, with the exception of the westbound left-turn, which is expected to perform at LOS D. In the PM peak hour, all approaches are expected to perform at LOS C or better, with the exception of the eastbound through-left and westbound through-right shared movements, which are expected to perform at LOS D. Additionally, during the AM peak hour, the maximum queue for the westbound left-turn movement may exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At Stewart Boulevard and Parkedale Avenue, all of the approaches are expected to perform at LOS D or better in the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS C or better.

4.2.1.2 2044 Preferred Design – North Augusta Road Interchange

The 2044 peak hour traffic operation results of the preferred design at the North Augusta Road IC for Highway 401 mainline with a 6-lane cross-section are shown in Exhibit L-6 in Appendix L. The following observations can be made:

- All of the approaches on the ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM and Sunday peak hours. During the PM peak hour, all of the approaches are expected to perform at LOS C or better. Additionally, during the PM peak hour, the maximum queues for the southbound left-turn and northbound right-turn movements may exceed the available storage. The queues are not expected to spill back to the adjacent major intersection and do not impact the through traffic.
- All of the approaches on the ramp terminal on Parkedale Avenue are expected to perform at LOS C or better during the AM and Sunday peak hours. During the PM peak hour, the ramp terminal is expected to perform at LOS D or better.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS D or better during the AM and PM peak hours. During the Sunday peak hour, the ramp terminal is expected to perform at LOS C or better. Additionally, during the PM peak hour, the maximum queue for the southbound through-right shared movement may exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM and PM peak hours. During the Sunday peak hour, the ramp terminal is expected to perform at LOS B or better.

4.2.2 8-Lane Cross-Section

The analysis results of ramp terminals traffic operations of the preferred design at the Stewart Boulevard and North Augusta Road ICs for Highway 401 mainline with an 8-lane cross-section are summarized here after. The ramp terminal operations were evaluated based on the LOS, average, and maximum queue length per the direction of movement, for the 2044 AM, PM, and Sunday peak periods.

4.2.2.1 2044 Preferred Design – Stewart Boulevard Interchange

The 2044 peak hour traffic operation results of the preferred design at the Stewart Boulevard IC for Highway 401 mainline with an 8-lane cross-section are shown in Exhibit L-7 in Appendix L. The following observations can be made:

- All of the approaches at the SPUI ramp terminal are expected to perform at LOS C or better in the AM and PM peak hours and are expected to perform at LOS B or better during the Sunday peak hour. The maximum queue for the southbound left-turn movement may occasionally exceed the assumed storage length of 80m. However, the queue is not expected to spill back to the adjacent major intersection and does not have major impact on the through traffic.
- At Stewart Boulevard and Central Avenue, all approaches are expected to perform at LOS D or better in the AM, PM, and Sunday peak hours. Additionally, during the PM peak hour, the maximum queues for the eastbound and westbound left-turn movements may slightly

exceed the available storage. This also occurs for the southbound left-turn movement during the AM peak hour. The queues are not expected to spill back to the adjacent major intersection and do not impact the through traffic.

- At Stewart Boulevard and Jefferson Drive, all approaches are expected to perform at LOS B or better in the AM peak hour, with the exception of the westbound left-turn and eastbound through-left shared movements, which are expected to perform at LOS C and LOS D, respectively. In the PM peak hour, all approaches are expected to perform at LOS C or better, with the exception of the eastbound through-left shared movement, which is expected to perform at LOS D. Additionally, during the AM peak hour, the maximum queue for the westbound left-turn movement may exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At Stewart Boulevard and Parkedale Avenue, all of the approaches are expected to perform at LOS D or better in the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS C or better.

4.2.2.2 2044 Preferred Design – North Augusta Road Interchange

The 2044 peak hour traffic operation results of the preferred design at the North Augusta Road IC for Highway 401 mainline with an 8-lane cross-section are shown in Exhibit L-8 in Appendix L. The following observations can be made:

- All of the approaches on the ramp terminal on North Augusta Road are expected to perform at LOS B or better during the AM and Sunday peak hours. During the PM peak hour, all of the approaches are expected to perform at LOS C or better. Additionally, during the PM peak hour, the maximum queues for the southbound left-turn and northbound right-turn movements may exceed the available storage. The queues are not expected to spill back to the adjacent major intersection and do not impact the through traffic.
- All of the approaches on the ramp terminal on Parkedale Avenue are expected to perform at LOS C or better during the AM, PM, and Sunday peak hours.
- At North Augusta Road and Parkedale Avenue, all approaches are expected to perform at LOS D or better during the AM and PM peak hours. During the Sunday peak hour, the ramp terminal is expected to perform at LOS C or better. Additionally, during the PM peak hour, the maximum queue for the southbound through-right shared movement may exceed the available storage. The queue is not expected to spill back to the adjacent major intersection and does not impact the through traffic.
- At North Augusta Road and Reynolds Drive, all approaches are expected to perform at LOS C or better during the AM and PM peak hours. During the Sunday peak hour, all approaches are expected to perform at LOS B or better.

4.2.3 2044 Highway 401 Mainline Operations

This subsection summarizes the expected impact of the preferred design selected for the interchanges on Highway 401 mainline operations with a 6-lane or 8-lane cross-section in 2044 for the AM, PM, and Sunday peak period.

4.2.3.1 2044 AM Peak Period

Figure 87 and Figure 88 compare the impact on mainline density and speed of the preferred design configurations at Stewart Boulevard and North Augusta on the eastbound direction of Highway 401 with a 6-lane or 8-lane cross-section during the 2044 AM peak hour. As shown, Highway 401 EB mainline with a 6-lane cross-section is expected to perform for the majority of times at LOS A with an average speed exceeding 100 km/h, during the 2044 AM peak hour, throughout the study area. On the other hand, Highway 401 EB mainline with an 8-lane cross-section is expected to perform at LOS A with an average speed exceeding 100 km/h.

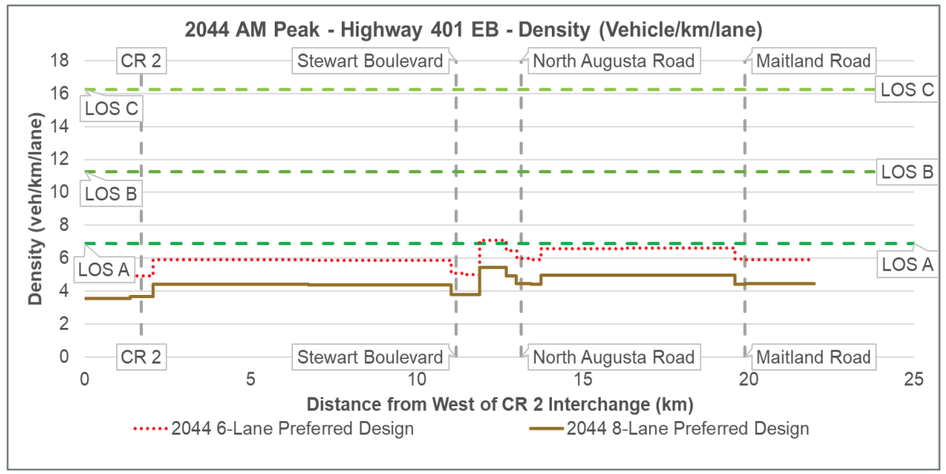


Figure 87: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 AM Peak Hour (6-lane vs 8-lane)

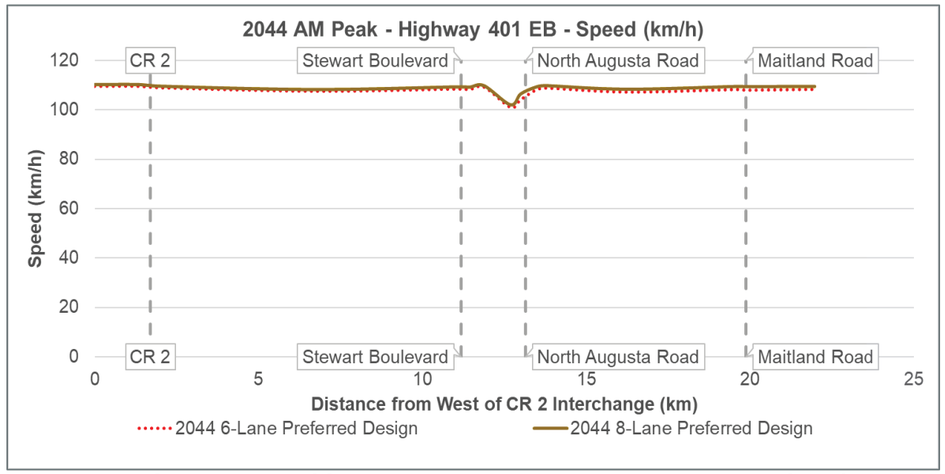


Figure 88: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 AM Peak Hour (6-lane vs 8-lane)

Figure 89 and Figure 90 compare the impact on mainline density and speed of the preferred design configurations at Stewart Boulevard and North Augusta on the westbound direction of Highway 401 with a 6-lane or 8-lane cross-section during the 2044 AM peak hour. As shown, Highway 401 WB mainline with a 6-lane or 8-lane cross-section is expected to perform at LOS A with an average speed exceeding 100 km/h, during the 2044 AM peak hour, throughout the study area. The 2044 AM Pre-Peak hour analysis shows similar traffic operations to the peak hour along the highway mainline while the Post-Peak shows slightly worse traffic operations, as shown in Exhibit M-25 to Exhibit M-32 in Appendix M.

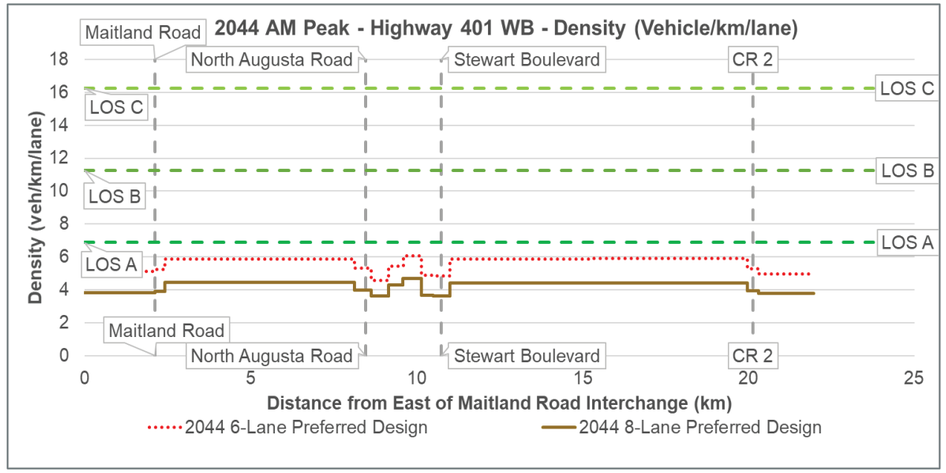


Figure 89: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Alternative on Highway 401 WB – 2044 AM Peak Hour (6-lane vs 8-lane)

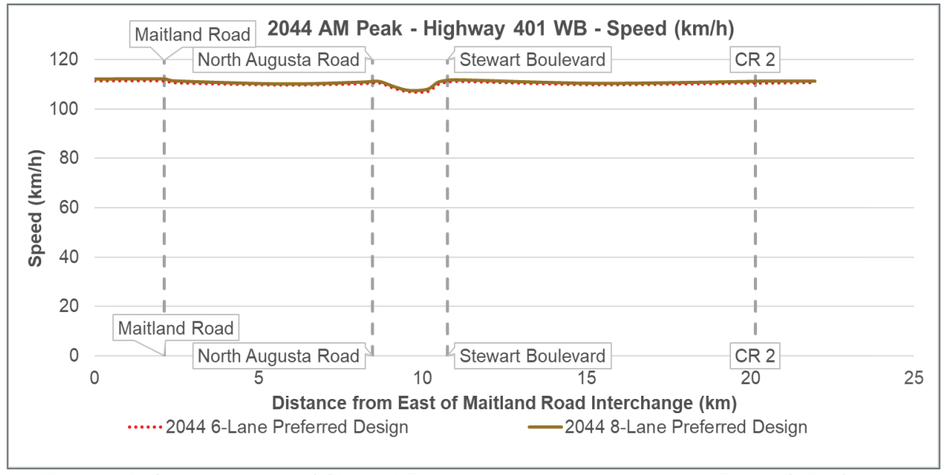


Figure 90: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Alternative on Highway 401 WB – 2044 AM Peak Hour (6-lane vs 8-lane)

4.2.3.2 2044 PM Peak Period

Figure 91 and Figure 92 compare the impact on mainline density and speed of the preferred design configurations at Stewart Boulevard and North Augusta on the eastbound direction of Highway 401 with a 6-lane or 8-lane cross-section during the 2044 PM peak hour. As shown, Highway 401 EB mainline with a 6-lane cross-section is expected to perform at LOS D or better with an average speed exceeding 85 km/h, during the 2044 PM peak hour, throughout the study area. On the other hand, Highway 401 EB mainline with an 8-lane cross-section is expected to perform at LOS C or better with an average speed exceeding 95 km/h.

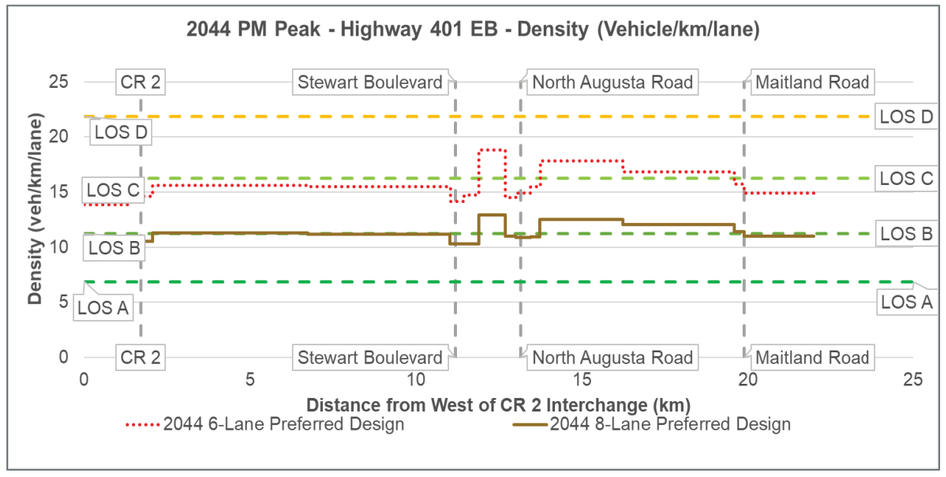


Figure 91: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 PM Peak Hour (6-lane vs 8-lane)

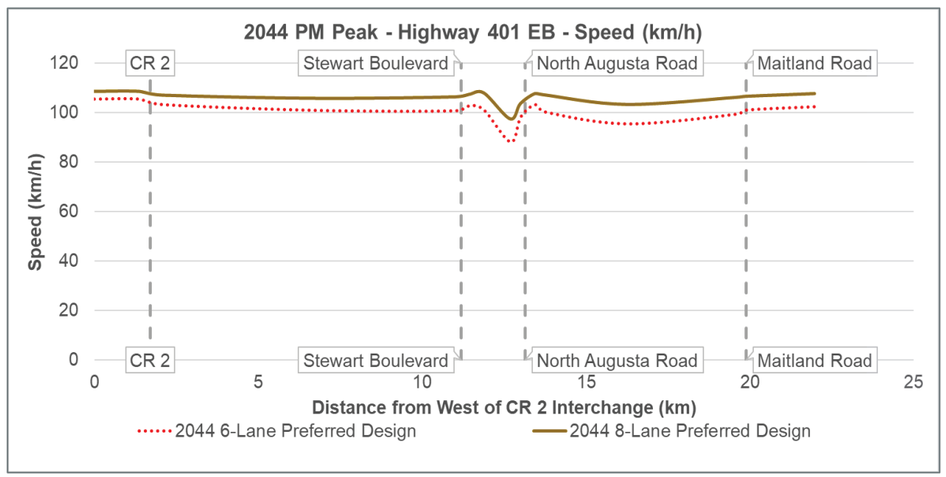


Figure 92: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 PM Peak Hour (6-lane vs 8-lane)

Figure 93 and Figure 94 compare the impact on mainline density and speed of the preferred design configurations at Stewart Boulevard and North Augusta on the westbound direction of Highway 401 with a 6-lane or 8-lane cross-section during the 2044 PM peak hour. As shown, Highway 401 WB mainline with a 6-lane cross-section is expected to perform for the majority of times at LOS B with an average speed exceeding 95 km/h, during the 2044 PM peak hour, throughout the study area. On the other hand, Highway 401 WB mainline with an 8-lane cross-section is expected to perform at LOS B with an average speed exceeding 100 km/h. The 2044 PM Pre-Peak and Post-Peak hour analysis shows better traffic operations compared to the peak hour along the highway mainline, as shown in Exhibit M-33 to Exhibit M-40 in Appendix M.

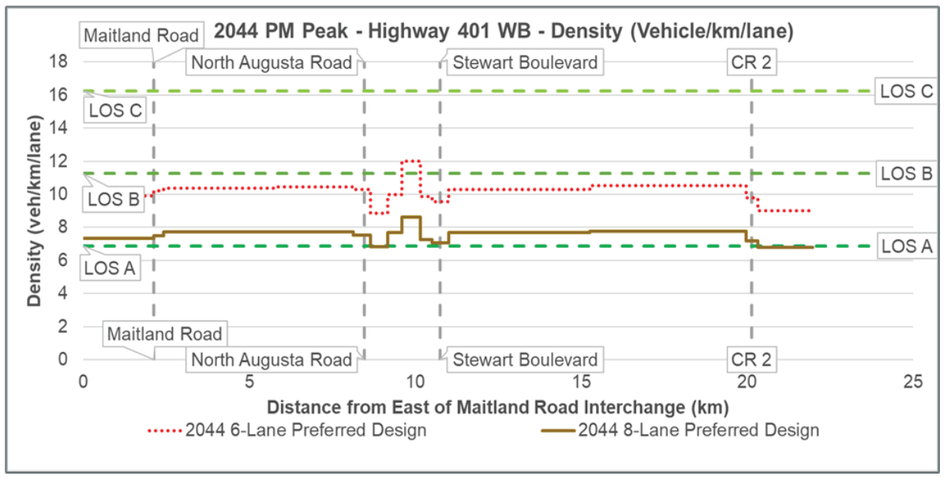


Figure 93: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2044 PM Peak Hour (6-lane vs 8-lane)

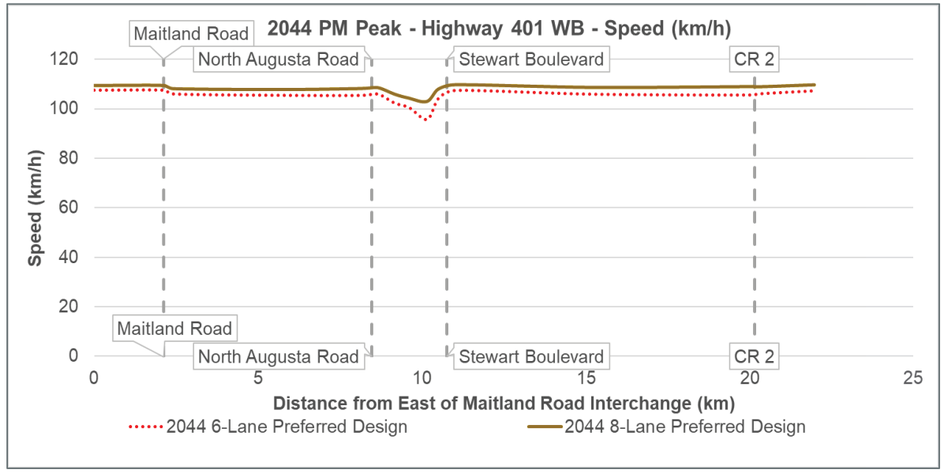


Figure 94: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2044 PM Peak Hour (6-lane vs 8-lane)

4.2.3.3 2044 Sunday Peak Period

Figure 95 and Figure 96 compare the impact on mainline density and speed of the preferred design configurations at Stewart Boulevard and North Augusta on the eastbound direction of Highway 401 with a 6-lane or 8-lane cross-section during the 2044 Sunday peak hour. As shown, Highway 401 EB mainline with a 6-lane cross-section is expected to perform for the majority of times at LOS C with an average speed exceeding 100 km/h, during the 2044 PM peak hour, throughout the study area. On the other hand, Highway 401 EB mainline with an 8-lane cross-section is expected to perform at LOS B with an average speed exceeding 100 km/h.

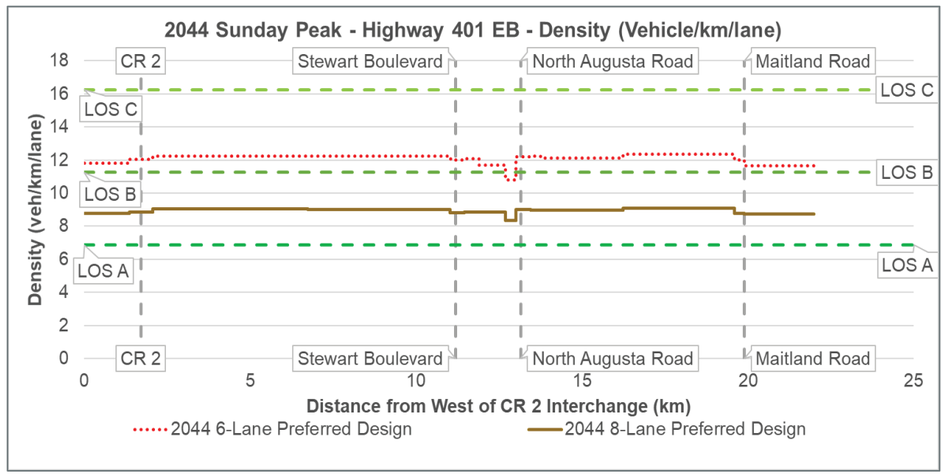


Figure 95: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 Sunday Peak Hour (6-lane vs 8-lane)

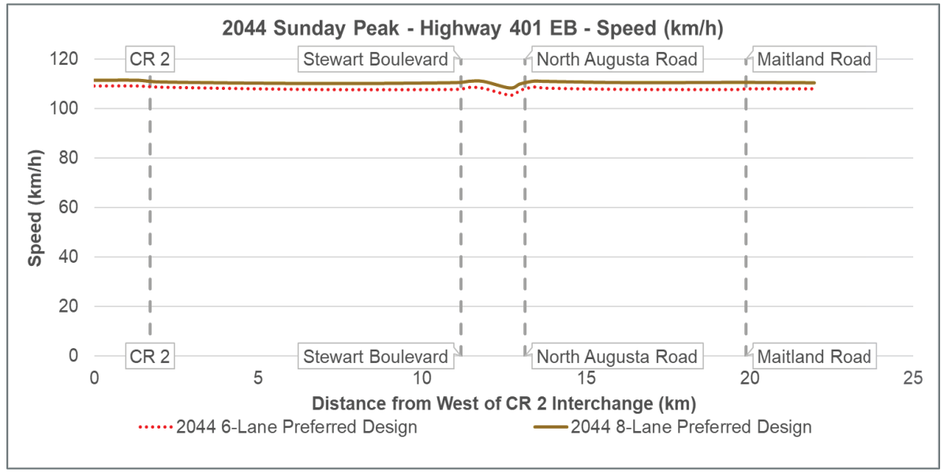


Figure 96: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 Sunday Peak Hour (6-lane vs 8-lane)

Figure 97 and Figure 98 compare the impact on mainline density and speed of the preferred design configurations at Stewart Boulevard and North Augusta on the westbound direction of Highway 401 with a 6-lane or 8-lane cross-section during the 2044 Sunday peak hour. As shown, Highway 401 WB mainline with a 6-lane cross-section is expected to perform for the majority of times at LOS C with an average speed exceeding 100 km/h, during the 2044 PM peak hour, throughout the study area. On the other hand, Highway 401 WB mainline with an 8-lane cross-section is expected to perform at LOS B with an average speed exceeding 100 km/h. The 2034 Sunday Pre-Peak and Post-Peak hour analysis shows slightly better traffic operations compared to the peak hour along the highway mainline, as shown in Exhibit M-41 to Exhibit M-48 in Appendix M.

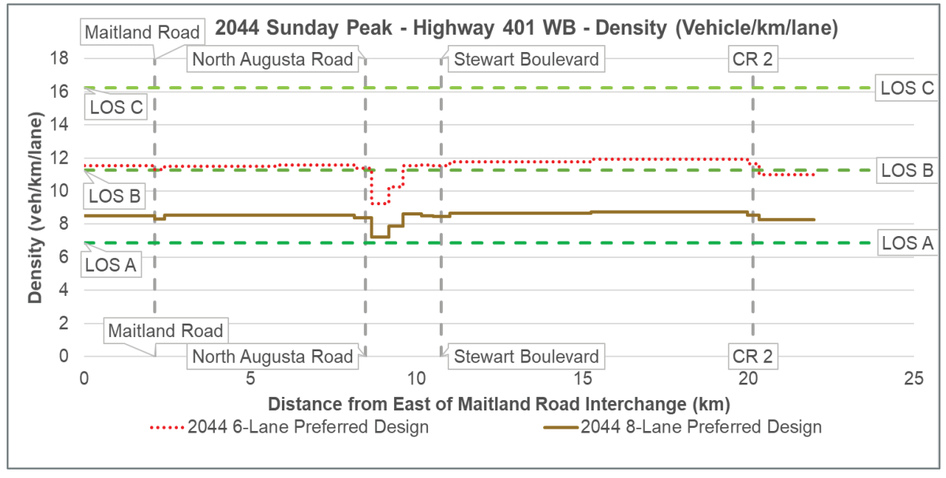


Figure 97: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB– 2044 Sunday Peak Hour (6-lane vs 8-lane)

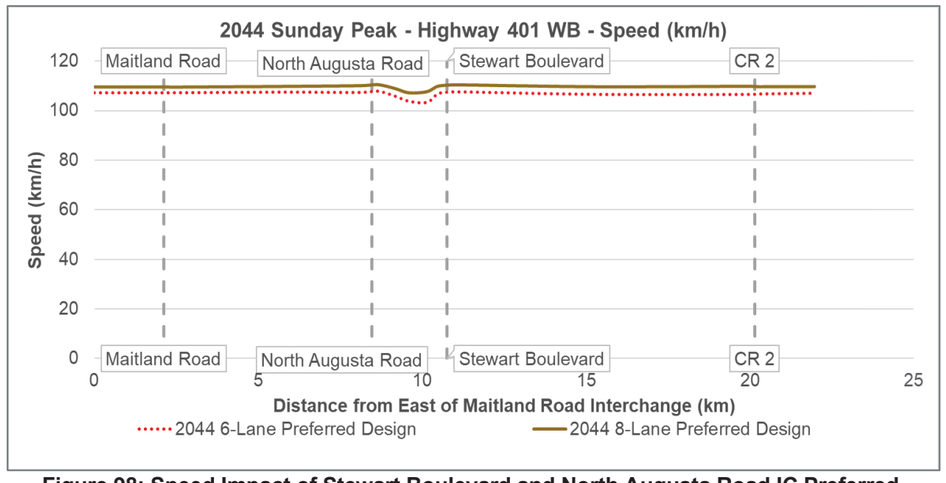


Figure 98: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2044 Sunday Peak Hour (6-lane vs 8-lane)

5. Sensitivity Analysis – 2034 4-Lane Scenario

In addition to the evaluation of mainline operations for the 6- and 8-lane scenario, CIMA+ evaluated the 4-lane configuration for the 2034 horizon year. This was to address a potential scenario where Highway 401 remains at a 4-lane configuration after the reconstruction of the Stewart Boulevard SPUI interchange until the remaining bridges (Buells Creek, VIA Rail, Ormond Street, and North Augusta Road) are updated.

This sensitivity analysis was completed by using the 2034 *Minor Improvements* scenario model and reducing the number of lanes on Highway 401 to 2 lanes in each direction. This will have the N Augusta existing configuration, but not the SPUI at Stewart Blvd. Given that the purpose of sensitivity analysis is to account for weaving along the section of highway between North Augusta and Stewart interchanges, and the distance between the off-ramp and on-ramps is more or less the same between the existing configuration at Stewart interchange and the SPUI, the results are expected to be close.

In addition to the lane reduction along Highway 401, the south terminal at the North Augusta Road interchange (currently unsignalized) was signalized to prioritize the off-ramp traffic. The 2034 PM peak scenario was analyzed for this sensitivity analysis as it represented the critical scenario with the highest highway volumes.

The speed and density plots for Highway 401 EB and WB, which compare the mainline speed, density, and LOS along Highway 401 for the 4-, 6-, and 8-lane scenarios are shown in Figure 99 to Figure 102. The following observations can be made:

- As expected, the EB and WB travel speeds are reduced in the 4-lane scenario, compared to the 6- and 8-lane scenarios.
- The EB direction in the 4-lane scenario is expected to experience LOS D (approaching LOS E) with average travel speeds of 80 km/h during the 2034 PM peak period
- The WB direction is expected to perform better than the EB direction, with higher speeds and better LOS
- The highway capacity analysis, based on the Highway Capacity Manual (HCM) methodology was conducted in October 2020, which estimated that the Highway 401 mainline is expected to operate at LOS E by 2036.[5] As noticeable, the results from the microsimulation analysis show that the mainline operations are LOS D (approaching LOS E) in 2034, which is in line with the previously completed HCM analysis.

[5] *Highway 401 Brockville – Preliminary Design and EA (GWP 4003-19-00) – Highway Capacity Analysis, CIMA+, October 2020*

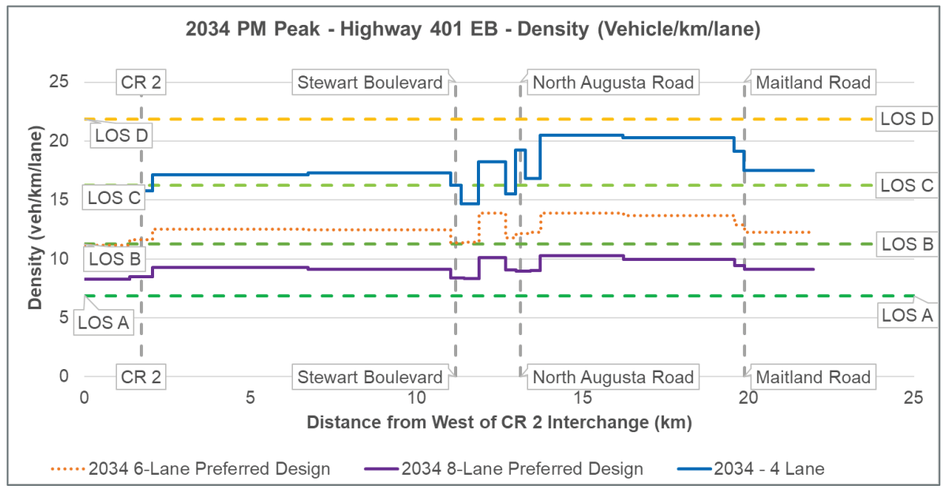


Figure 99: Density & LOS Impact of 4-lane cross section on Highway 401 Mainline EB – 2034 PM Peak Hour

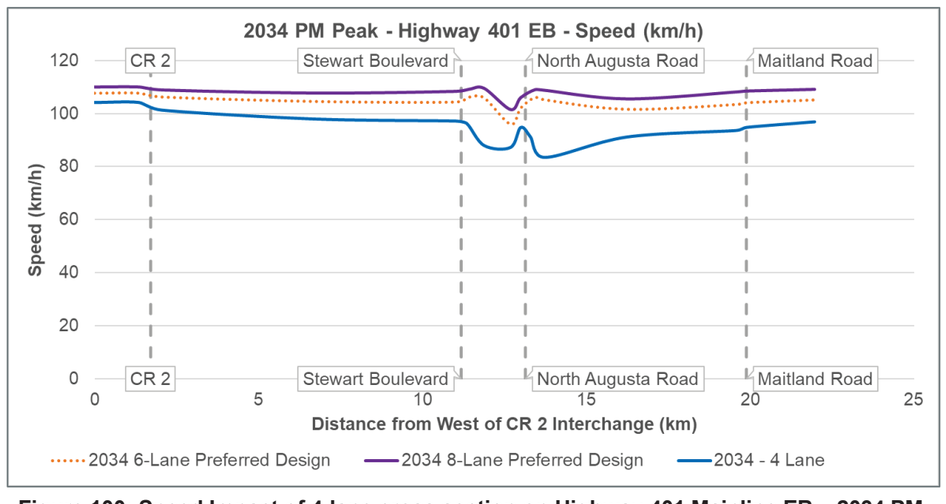


Figure 100: Speed Impact of 4-lane cross section on Highway 401 Mainline EB – 2034 PM Peak Hour

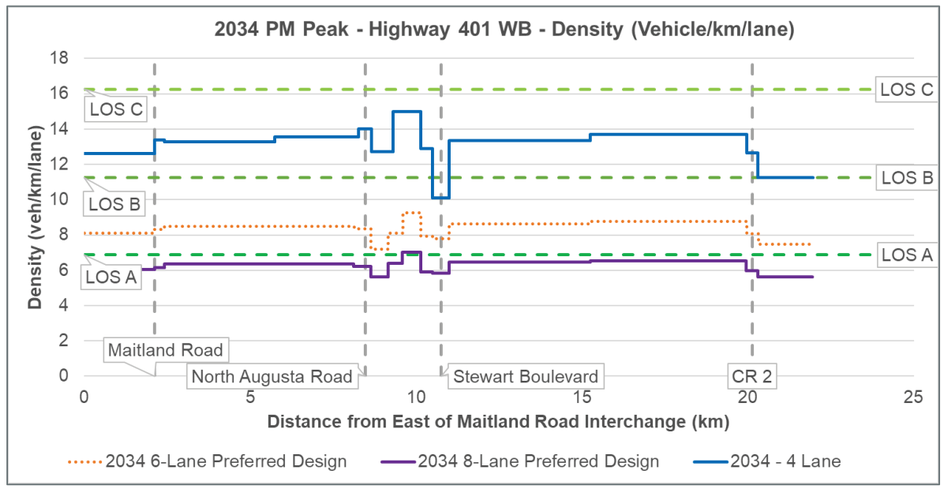


Figure 101: Density & LOS Impact of 4-lane cross section on Highway 401 Mainline WB – 2034 PM Peak Hour

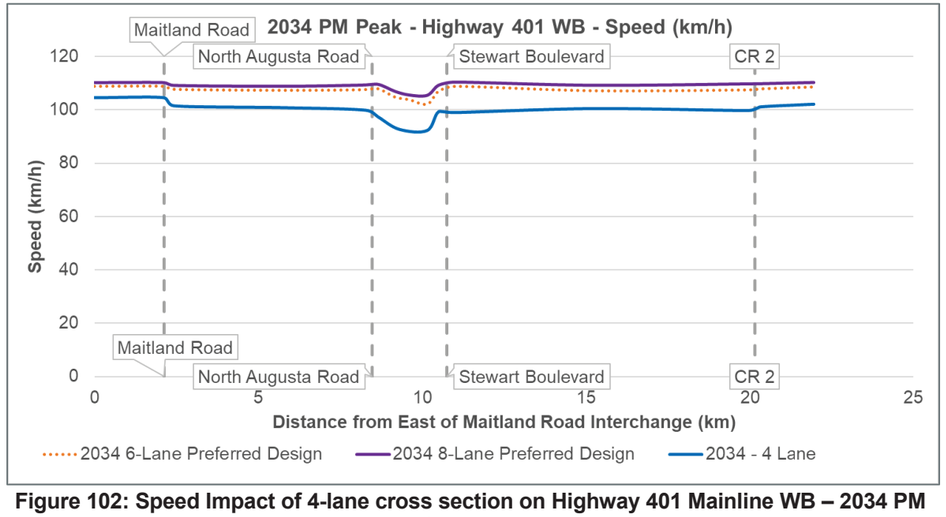


Figure 102: Speed Impact of 4-lane cross section on Highway 401 Mainline WB – 2034 PM Peak Hour

6. Safety Review

The following subsections summarize the results of the safety review of the interchange alternatives that were conducted based on MTO's Safety Performance Functions (SPFs) at Stewart Boulevard and North Augusta Road ICs. Appendix B provides the equations and parameters from MTO's SafetyAnalyst tool that were utilized for the analysis. The analysis provides a predicted number of collisions at the ramp, the ramp terminal and along the highway mainline segment within 1 km in either direction of the ramp terminal. The total collisions refer to total predicted collisions over a 20-year period and the average collisions refer to the average number of predicted collisions per year. For Diverging Diamond and Diamond with Roundabout configuration, CMFs were applied to the SPF predicted collisions at the ramp terminals. Due to the lack of collision data available for SPUIs, no SPFs or CMFs are available for this configuration. Hence, based on the literature review, the predicted collisions at the SPUI ramp terminal were modelled as a diamond interchange with a split on/off-ramp[6].

It should be noted that when comparing the safety performance of the interchange alternatives, the focus should be based on a comparative approach, rather than the absolute number of predicted collisions.

6.1.1 Stewart Boulevard Interchange

At the Stewart Boulevard interchange, all interchange alternatives are expected to have a similar number of predicted collisions on the ramps. A similar number of predicted collisions on the ramp terminal intersections is expected for all interchange alternatives. The Diverging Diamond and SPUI configurations are expected to result in lower predicted collisions than Minor Improvements and Parclo A4, along the Highway 401 mainline segment. This is mainly due to the number of ramps interacting with the mainline; For Diverging Diamond and SPUI, there are 4 ramps connected to the mainline, whereas for the Minor Improvements and Parclo A4, there are 6 ramps connected to the mainline, which results in higher conflict points. Overall, the Diverging Diamond and SPUI configuration are expected to have the least amount of total predicted collisions. Table 14 summarizes the safety review results at Stewart Boulevard IC.

[6] *Safety Prediction Methodology and Analysis Tool for Freeways and Interchanges, National Cooperative Highway Research Program Transportation Research Board of The National Academies, May 2012, http://onlinepubs.trb.org/onlinepubs/nchrp/docs/nchrp17-45_fr.pdf*

Table 14: Safety Analysis (SPFs) – Stewart Boulevard IC

Scenario	Stewart Boulevard Interchange			
	Total Ramp Predicted Collisions	**Total Ramp Predicted Severe Collisions**	**Average Ramp Predicted Collisions per year**	**Average Ramp Predicted Severe Collisions per year**
Minor Improvements	25	<5	<2	<1
Parclo A4	26	<5	<2	<1
Diverging Diamond	22	<5	<2	<1
SPUI	23	<5	<2	<1
	Total Ramp Terminal Predicted Collisions	**Total Ramp Terminal Predicted Severe Collisions**	**Average Ramp Terminal Predicted Collisions per year**	**Average Ramp Terminal Predicted Severe Collisions per year**
Minor Improvements	5	<5	<1	<1
Parclo A4	5	<5	<1	<1
Diverging Diamond[7]	<5	<5	<1	<1
SPUI[8]	<5	<5	<1	<1
	Total Segment Predicted Collisions	**Total Segment Predicted Severe Collisions**	**Average Mainline Predicted Collisions per year**	**Average Mainline Predicted Severe Collisions per year**
Minor Improvements	537	81	27	4
Parclo A4	537	81	27	4
Diverging Diamond	412	69	21	3
SPUI	412	69	21	3
	Total Predicted Collisions	**Total Predicted Severe Collisions**	**Average Predicted Collisions per year**	**Average Predicted Severe Collisions per year**
Minor Improvements	567	86	28	4
Parclo A4	568	86	28	4
Diverging Diamond	436	72	22	4
SPUI	437	72	22	4

6.1.2 North Augusta Road Interchange

At the North Augusta Road interchange, the Diverging Diamond, SPUI, Diamond, and Diamond with Roundabouts interchange alternatives are expected to have slightly lower predicted collisions on the ramps than Minor Improvements, Parclo A4, and Parclo A2 with Diamond configurations. SPUI and Diverging Diamond configurations are expected to have the least amount of predicted collisions on the ramp terminal intersections, compared to the other interchange alternatives. The Diverging Diamond, SPUI, Diamond, and Diamond with Roundabout configurations are expected to result in lower predicted collisions than Minor Improvements, Parclo A4, and Parclo A2 with Diamond configurations along the Highway 401 mainline segment. This is mainly due to the number of ramps interacting with the mainline; For Diverging Diamond, SPUI, Diamond, and Diamond with Roundabout configurations there are 4 ramps connected to the mainline, whereas for the Minor Improvements, Parclo A4, and Parclo A2 with Diamond configurations there are 5-6 ramps connected to the mainline, which results in higher conflict points. Overall, the Diverging Diamond and SPUI configuration are expected to have the least amount of total predicted collisions. Table 15 summarizes the safety review results at North Augusta Road IC.

[7] *Convert Diamond Interchange to Diverging Diamond Interchange (CMF ID: 9105 and 9107), January 2018, http://www.cmfclearinghouse.org/detail.cfm?facid=9105*

[8] *For the Ramp Terminal SPF analysis, SPUI is modelled as a diamond interchange with split on/off ramps.*

Table 15: Safety Analysis (SPFs) – North Augusta Road IC

Scenario	North Augusta Interchange			
	Total Ramp Predicted Collisions	**Total Ramp Predicted Severe Collisions**	**Average Ramp Predicted Collisions per year**	**Average Ramp Predicted Severe Collisions per year**
Minor Improvements	24	<5	<2	<1
Parclo A4	27	<5	<2	<1
Diverging Diamond	19	<5	<1	<1
SPUI	17	<5	<1	<1
Diamond	17	<5	<1	<1
Diamond with RB	17	<5	<1	<1
Parclo A2 with Diamond	25	<5	<2	<1
	Total Ramp Terminal Predicted Collisions	**Total Ramp Terminal Predicted Severe Collisions**	**Average Ramp Terminal Predicted Collisions per year**	**Average Ramp Terminal Predicted Severe Collisions per year**
Minor Improvements	15	<5	<1	<1
Parclo A4	16	<5	<1	<1
Diverging Diamond[9]	3	<5	<1	<1
SPUI[10]	3	<5	<1	<1
Diamond	23	<5	<2	<1
Diamond with RB[11]	39	10	<2	<1
Parclo A2 with Diamond	15	<5	<1	<1
	Total Segment Predicted Collisions	**Total Segment Predicted Severe Collisions**	**Average Mainline Predicted Collisions per year**	**Average Mainline Predicted Severe Collisions per year**
Minor Improvements	488	73	24	4
Parclo A4	488	73	24	4
Diverging Diamond	380	63	19	3
SPUI	380	63	19	3
Diamond	380	63	19	3
Diamond with RB	380	63	19	3
Parclo A2 with Diamond	433	67	22	3
	Total Predicted Collisions	**Total Predicted Severe Collisions**	**Average Predicted Collisions per year**	**Average Predicted Severe Collisions per year**
Minor Improvements	527	79	26	4
Parclo A4	531	79	27	4
Diverging Diamond	402	66	20	3
SPUI	400	66	20	3
Diamond	420	69	21	3
Diamond with RB	436	76	22	4
Parclo A2 with Diamond	473	73	24	4

[9] *Convert Diamond Interchange to Diverging Diamond Interchange (CMF ID: 9105 and 9107), January 2018, http://www.cmfclearinghouse.org/detail.cfm?facid=9105*
[10] *For the Ramp Terminal SPF analysis, SPUI is modelled as a diamond interchange with split on/off ramps.*
[11] *Convert unsignalized ramp terminals to a 2-lane roundabout (CMF ID: 9440 and 9437), October 2018, http://www.cmfclearinghouse.org/detail.cfm?facid=9440*

7. Conclusions

Traffic analyses presented in this report are completed in support of the Preliminary Design and Environmental Assessment Study for replacement/rehabilitation of structures along Highway 401 within the City of Brockville. The following section summarizes the findings of traffic operations and safety analysis for the interchanges' alternatives and the preferred design.

7.1 Interchange Alternatives Analysis

The interchanges' alternatives analyses were conducted using the calibrated Aimsun model of the study area for the AM, PM, and Sunday peak hours and under future 2029, 2034, and 2044 conditions. The horizon years represent 5-, 10-, and 20-year periods beyond the planned construction year (2024). In addition, a safety review of the design alternatives was conducted based on predicted collisions for each interchange configuration. In total four and six interchange configurations were evaluated at the Stewart Boulevard and North Augusta interchanges, respectively. The findings of traffic operations and safety analysis for the interchanges' alternatives are presented below.

Stewart Boulevard IC:
Comparing the Minor Improvement, Parclo A4, Diverging Diamond, and SPUI interchange alternatives, the following observations are made:

- The approaches at the north and south ramp terminals are expected to perform at LOS C or better in all the alternatives and peak periods by 2044.
- The traffic operations at adjacent intersections to the ramp terminals (i.e. Stewart Boulevard & Central Avenue, Stewart Boulevard & Jefferson Drive, and Stewart Boulevard & Parkedale Avenue) are not expected to be adversely impacted by either of the interchange alternatives and are expected to perform at an overall LOS D or better in each alternative for all peak periods by 2044.
- Highway 401, with an 8-lane cross-section, is expected to perform at LOS B or better during the AM and Sunday peak period and is expected to perform at LOS C or better during the PM peak period by 2044, in the evaluated alternatives.
- Based on the Safety Review, the Diverging Diamond and SPUI configuration are expected to have a lower number of predicted collisions than Minor Improvements and Parclo A4. This is mainly due to the number of ramps interacting with the Highway 401 mainline; For Diverging Diamond and SPUI, there are 4 ramps to/from the mainline, whereas for the Minor Improvements and Parclo A4, there are 6 ramps to/from the mainline, which result in higher conflict points.

North Augusta IC:
Comparing the Minor Improvement, Parclo A4, Diverging Diamond, SPUI, Diamond, Diamond with Roundabouts, and Parclo A2 with Diamond interchange alternatives, the following observations are made:

- The approaches at the north ramp terminal are expected to perform at LOS C or better in all the alternatives and peak periods by 2044, with the exception of the eastbound approach in the Minor Improvements configuration, which is expected to perform at acceptable LOS D during the PM peak hour.

- The approaches at the south ramp terminal are expected to perform at LOS C or better in all the alternatives and peak periods by 2044, with the exception of the eastbound approach in the Minor Improvements configuration, which is expected to perform at acceptable LOS D during the PM peak hour[12].
- For the Diamond configuration, it is recommended that the distance between the north and south ramp terminals be at least 150 m, to accommodate the storage for vehicles utilizing the back-to-back northbound left-turn at the north ramp terminal and the southbound left-turn at the south ramp terminal along North Augusta Road.
- The traffic operations at adjacent intersections to the ramp terminals (i.e. North Augusta Road & Parkedale Avenue and North Augusta & Reynolds Drive) are not expected to be adversely impacted by either of the interchange alternatives and are expected to perform at overall LOS C or better in each alternative for all peak periods by 2044.
- Highway 401, with an 8-lane cross-section, is expected to perform at LOS B or better during the AM and Sunday peak period and is expected to perform at LOS C or better during the PM peak period by 2044, in the evaluated alternatives.
- Based on the Safety Review, the Diverging Diamond and SPUI configuration are expected to have a lower number of predicted collisions than Minor Improvements, Parclo A4, Diamond, Diamond with Roundabouts, and Parclo A2 with Diamond configuration. This is mainly due to the number of ramps interacting with the Highway 401 mainline; For Diverging Diamond and SPUI, there are 4 ramps to/from the mainline, whereas for the other alternatives, there are 5-6 ramps to/from the mainline, which results in higher conflict points.

7.2 Preferred Design Analysis

The following preferred design was approved by the Ministry for the study interchanges: SPUI configuration at Stewart Boulevard interchange and Parclo A2 (North Terminal) with Diamond (South Terminal) configuration at North Augusta Road interchange. Similar to the alternatives analyses, the analysis of the preferred design was conducted using the calibrated Aimsun model of the study area for the AM, PM, and Sunday peak hours and under future 2034 and 2044 conditions. The horizon years represent 10-, and 20-year periods beyond the planned construction year (2024). In addition, two scenarios were looked at for each horizon year, Highway 401 mainline with a 6-lane and 8-lane cross-section. The findings of traffic operations for the preferred design are presented below.

Stewart Boulevard IC:

- All approaches at the north and south ramp terminals are expected to perform at LOS C or better in all the peak periods by 2044 for both 6-lane and 8-lane configuration of Highway 401 mainline.
- The traffic operations at adjacent intersections to the ramp terminals (i.e. Stewart Boulevard & Central Avenue, Stewart Boulevard & Jefferson Drive, and Stewart Boulevard & Parkedale Avenue) are not expected to be adversely impacted by the preferred design selected and are expected to perform at an overall LOS D or better in each of the different Highway 401 mainline lane configuration scenarios for all peak periods by 2044.

[12] *The South Ramp Terminal is unsignalized in the Minor Improvements configuration and Signalized for all other alternatives*

North Augusta IC:

- All approaches at the north and south ramp terminals are expected to perform at LOS C or better in all the peak periods by 2044 for both 6-lane and 8-lane configuration of Highway 401 mainline.
- For the Diamond configuration, it is recommended that the distance between the north and south ramp terminals be at least 150 m, to accommodate the storage for vehicles utilizing the back-to-back northbound left-turn at the north ramp terminal and the southbound left-turn at the south ramp terminal along North Augusta Road.
- The traffic operations at adjacent intersections to the ramp terminals (i.e. North Augusta Road & Parkedale Avenue and North Augusta & Reynolds Drive) are not expected to be adversely impacted by the preferred design selected and are expected to perform at an overall LOS D or better in each of the different Highway 401 mainline lane configuration scenarios for all peak periods by 2044.

Highway 401 Mainline Operations:

- Highway 401, with a 6-lane cross-section, is expected to perform at LOS B better during the AM peak period, at LOS C or better during the Sunday peak period, and at LOS D or better during the PM peak period by 2044, in the evaluated preferred design.
- Highway 401, with an 8-lane cross-section, is expected to perform at LOS A during the AM peak period, at LOS B or better during the Sunday peak period, and at LOS C or better during the PM peak period by 2044, in the evaluated preferred design.

7.3 Sensitivity Analysis – 2034 4-Lane Cross-Section

CIMA+ evaluated the 4-lane configuration for the 2034 horizon year as part of sensitivity analysis to address a potential scenario where Highway 401 remains at a 4-lane configuration after the reconstruction of the Stewart Boulevard interchange until the remaining bridges are updated.

This sensitivity analysis was completed for the PM peak as it represents the critical scenario with the highest highway volume. In addition, the south terminal at the North Augusta Road interchange (currently unsignalized) was signalized to prioritize the off-ramp traffic.

The following observations can be made from the mainline operations analysis:

- The EB direction in the 4-lane scenario is expected to experience LOS D (approaching LOS E) with average travel speeds of 80 km/h during the 2034 PM peak period
- The WB direction is expected to perform better than the EB direction, with higher speeds and better LOS
- The results from the microsimulation analysis show that the mainline operations are LOS D (approaching LOS E) in 2034, which is in line with the previously completed HCM analysis

Appendix A: Future Horizon Traffic Volume

CIMA+

Appendix A:Future Horizon Traffic Volume
Interchange Design Alternative Analysis Report
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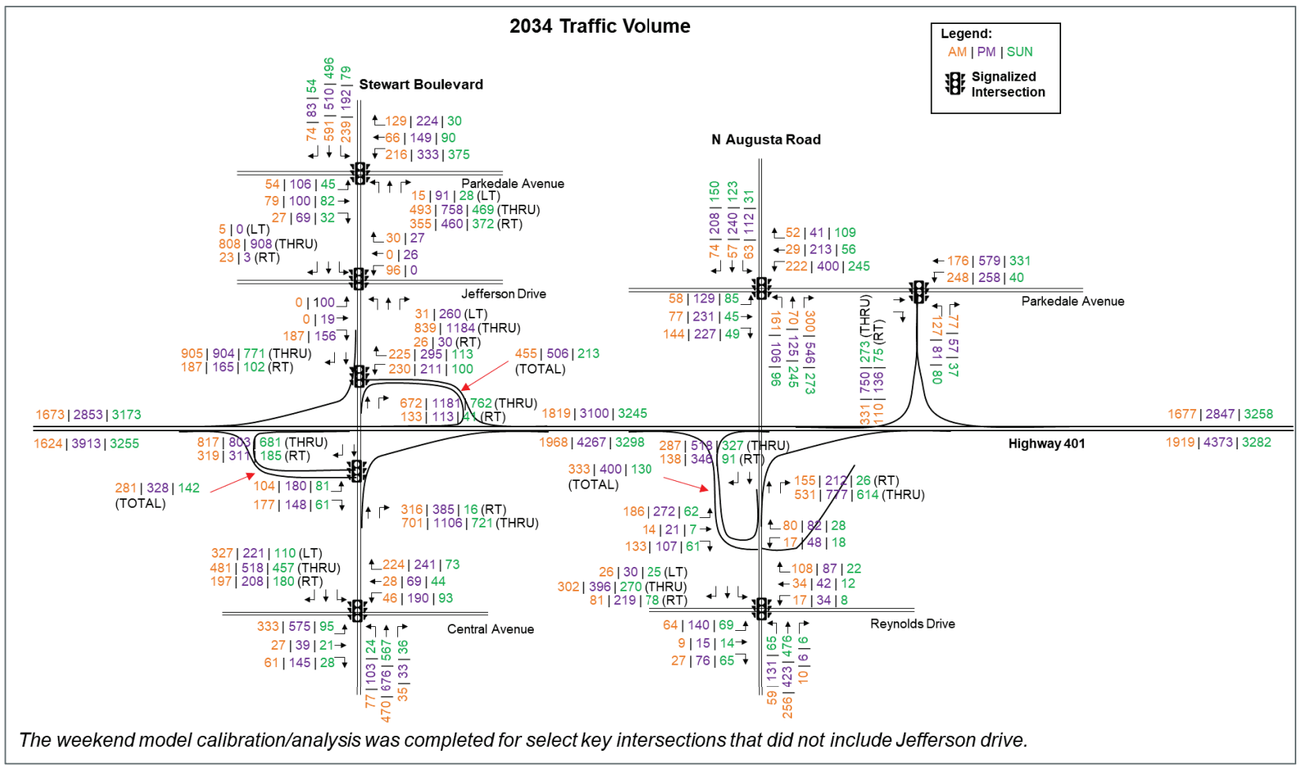
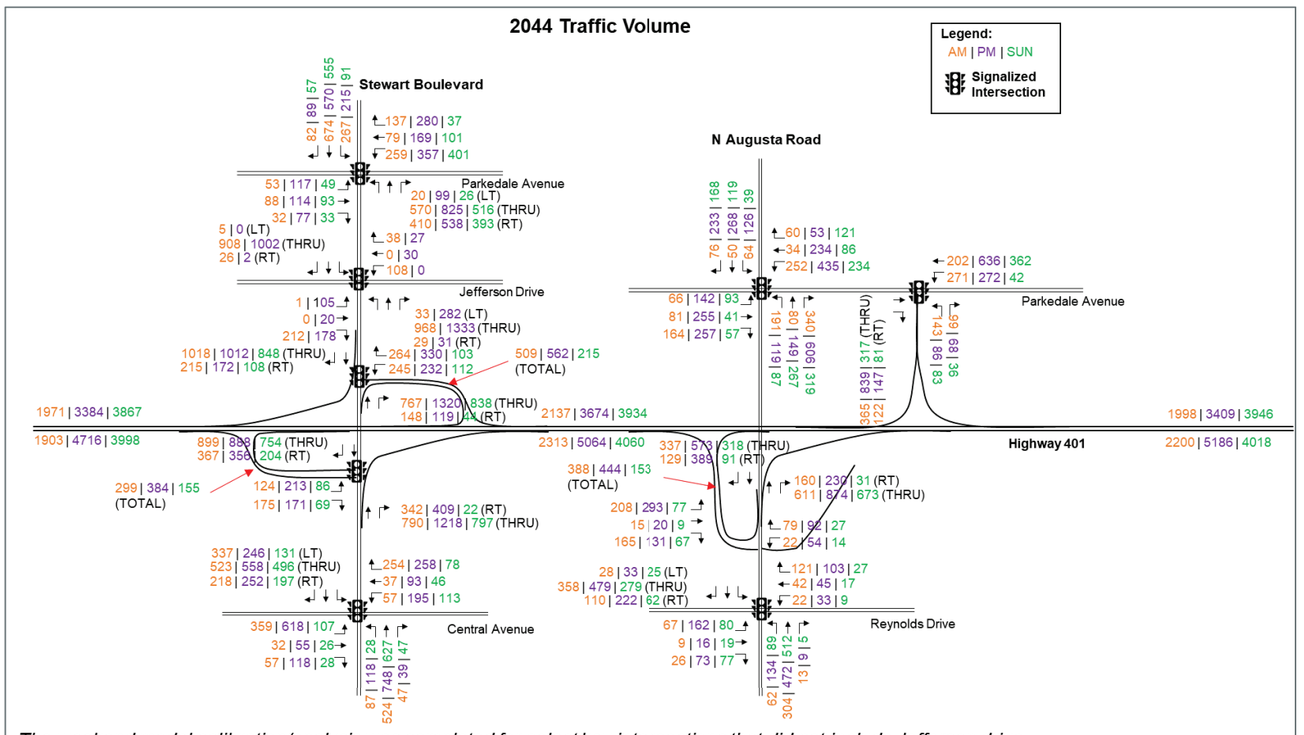
CIMA+



The weekend model calibration/analysis was completed for select key intersections that did not include Jefferson drive.



The weekend model calibration/analysis was completed for select key intersections that did not include Jefferson drive.

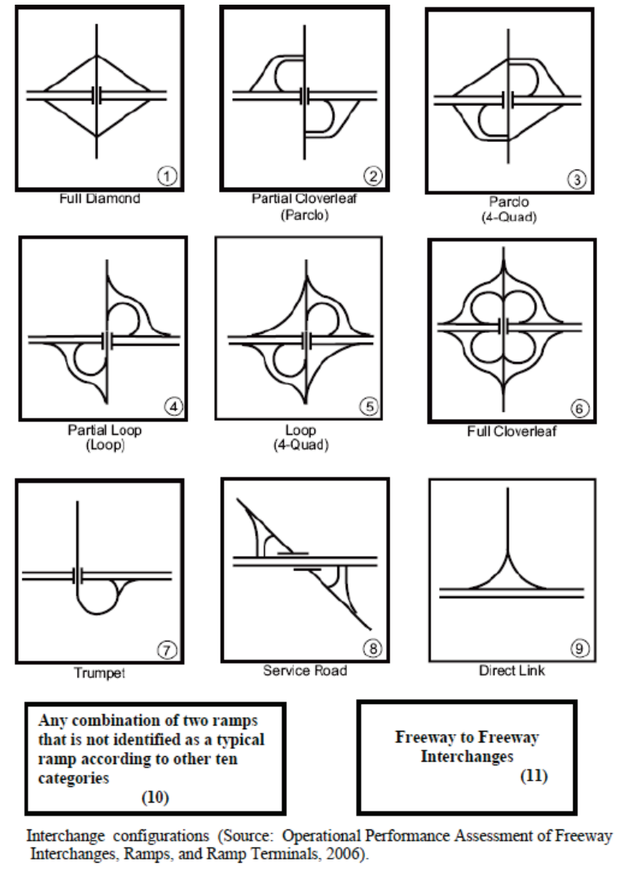
Appendix B: Safety Performance Factors Analysis

Appendix B:Safety Performance Factors Analysis
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

Mainline Interchange SPF Parameters

Mainline Interchange Segments	SPF Coefficients (Total)		SPF Coefficients (Severe)	
	B_0	B_1	B_0	B_1
Group 1 - Interchange types 1, 2, 4, and 8	-8.5731	1.0050	-11.2196	1.0836
Group 2 - Interchange types 3, 5, and 6	-10.1445	1.1741	-12.6670	1.2318
Group 3 - Interchange types 7, 9, 10, and 11	-10.3381	1.1810	-12.5678	1.2147

Collisions = (Years)L x $\exp(B_0)$ x $AADT^{B1}$



Interchange configurations (Source: Operational Performance Assessment of Freeway Interchanges, Ramps, and Ramp Terminals, 2006).

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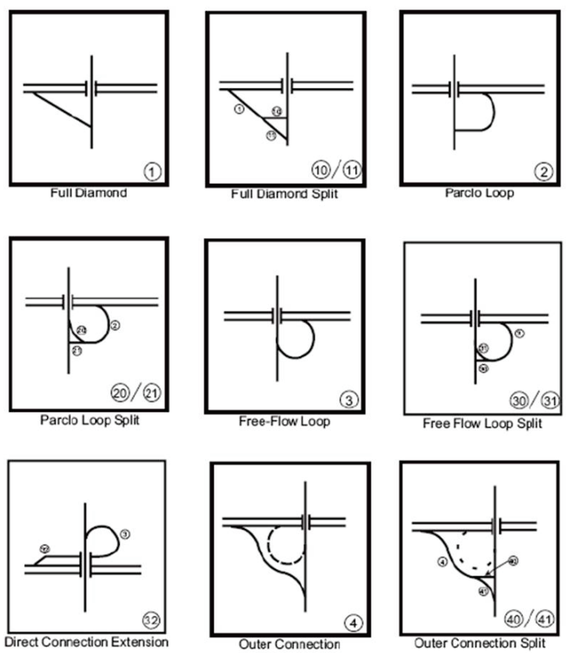
Ramps SPF Parameters

Ramps	SPF Coefficients (Total)		SPF Coefficients (Severe)	
	B_0	B_1	B_0	B_1
Group 1 - Flared On Ramps	-7.6305	0.8931	-9.1526	0.8210
Group 2 - Flared Off Ramps	-5.4205	0.6776	-6.3313	0.5699
Group 3 - Loop On Ramps	-6.5511	0.7696	-8.1687	0.7264
Group 4 - Loop Off Ramps	-5.9025	0.7995	-7.0709	0.6764
Group 5 - Freeway to Freeway Ramps	-4.9653	0.6229	-7.6350	0.7166
Group 6 - Other On Ramps	-1.7462	0.2626	Use factor of 0.17 applied to Total collision model	
Group 7 - Other Off Ramps	-6.9399	0.7533	Use factor of 0.19 applied to Total collision model	

Collisions = (Years)L x exp(B_0) x $AADT^{B1}$



B-1 Ramp configurations page 1 of 2 (Operational Performance Assessment of Freeway Interchanges, Ramps, and Ramp Terminals, 2006).

Appendix B:Safety Performance Factors Analysis
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

Ramp Terminals SPF Parameters

Ramp Terminals	SPF Coefficients (Total)					SPF Coefficients (Severe)				
	B_0	B_1	B_2	B_3	B_4	B_0	B_1	B_2	B_3	B_4
Group 1 - 3-legged Signalized	-11.9128	0.2122	1.0734	-0.3755		-12.8802	0.3658	0.7851	-0.4739	
Group 2 - 3-legged Stop-Controlled	-7.2005	0.1045	0.6024	-0.9401		-8.9365	0.3086	0.3661	-0.6830	
Group 3 - 4-legged Signalized	-13.4021	0.7437	0.6231	-1.5946	0.5805	-14.5449	0.7583	0.4946	-1.6512	0.7859
Group 4 - 4-legged Stop-Controlled	-13.7027	0.2990	1.1955	-2.5506	0.7780	Multiplier of total: 0.2317				

Collisions = (Years)exp(B_0) x $MAJAADT^{B1}$ x $MINAADT^{B2}$ x exp(B_3 x SPLIT + B_4 x ONRAMP)
Where,
Years is the number of years the model is predicting for,
MAJAADT is the major road AADT, i.e. the approach with the higher AADT
MINAADT is the minor road AADT, i.e. the approach with the lower AADT
SPLIT = 1 if a split right-turn; 0 otherwise,
ONRAMP = 1 if 4th leg of terminal is an on-ramp; 0 otherwise, and
k , the overdispersion parameter, is estimated as a constant.

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Appendix C: 2029 Stewart Boulevard – Intersection Operations

Appendix C:2029 Stewart Boulevard – Intersection Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

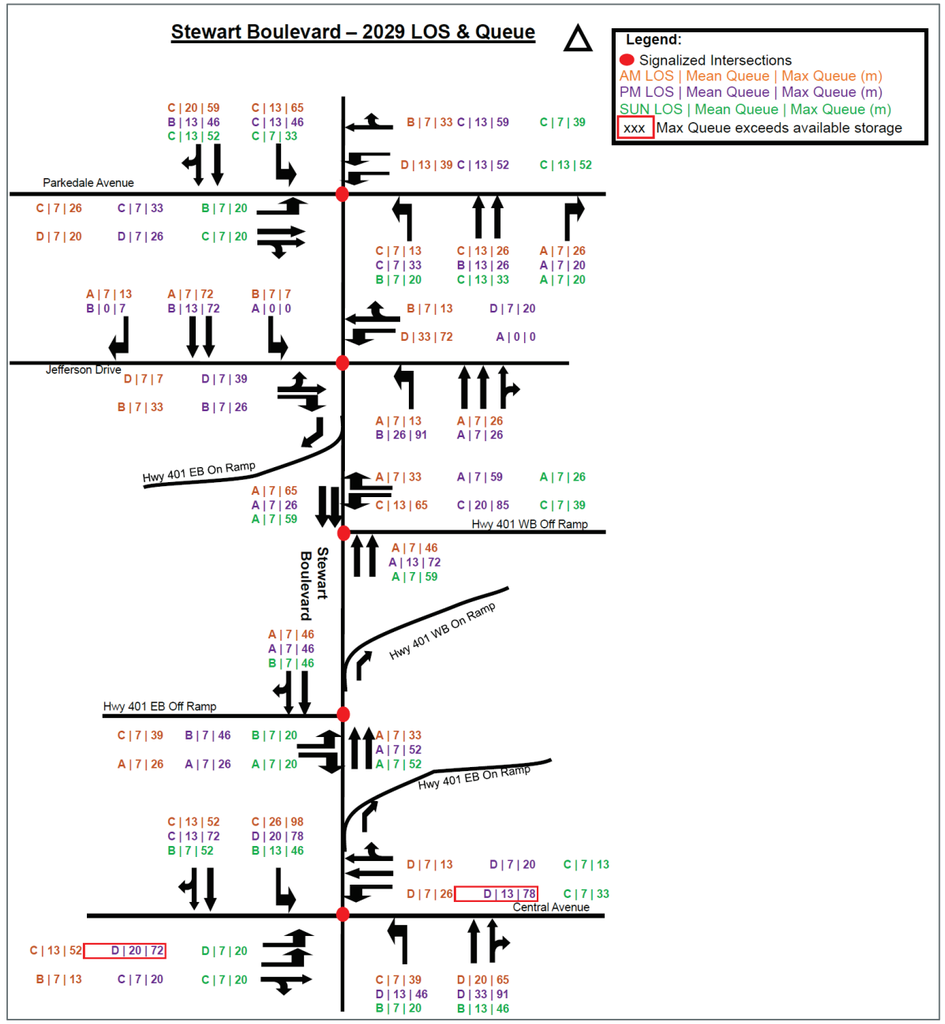

Exhibit C-1: 2029 – Stewart Boulevard Minor Improvement Interchange - Intersection Operations

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

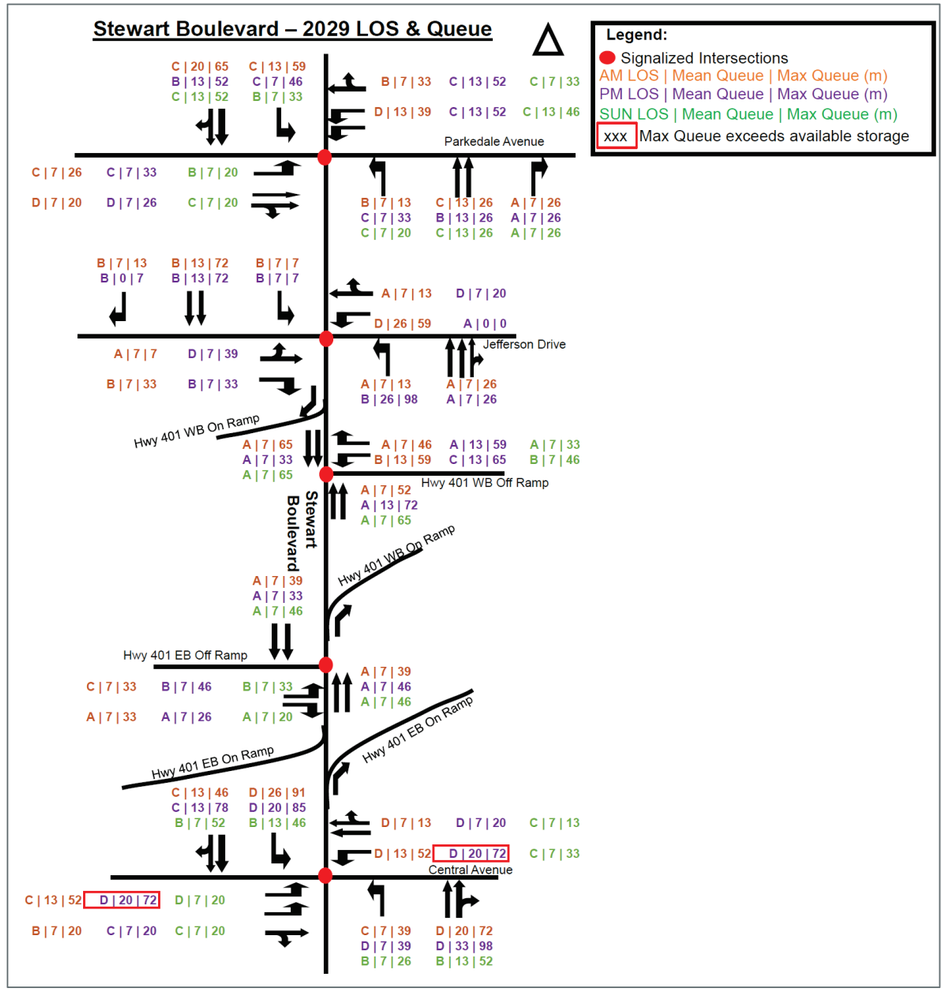

Exhibit C-2: 2029 – Stewart Boulevard Parclo A4 Interchange - Intersection Operations

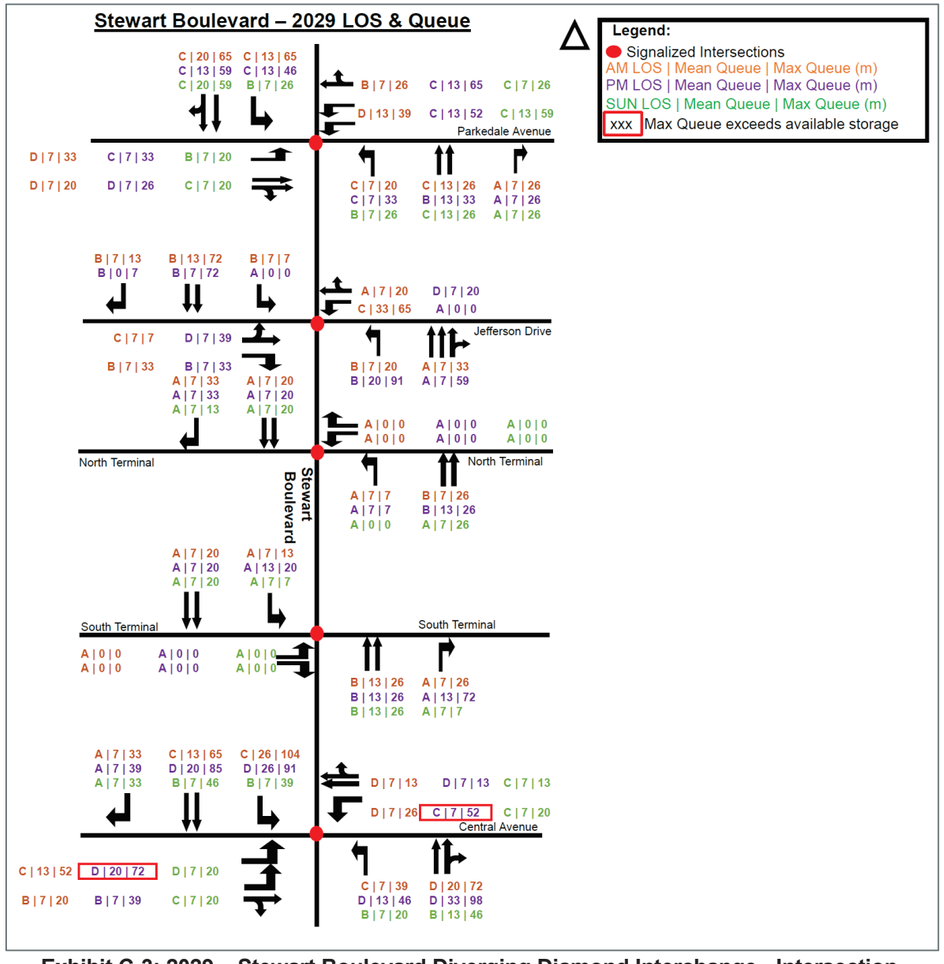

Exhibit C-3: 2029 – Stewart Boulevard Diverging Diamond Interchange - Intersection Operations

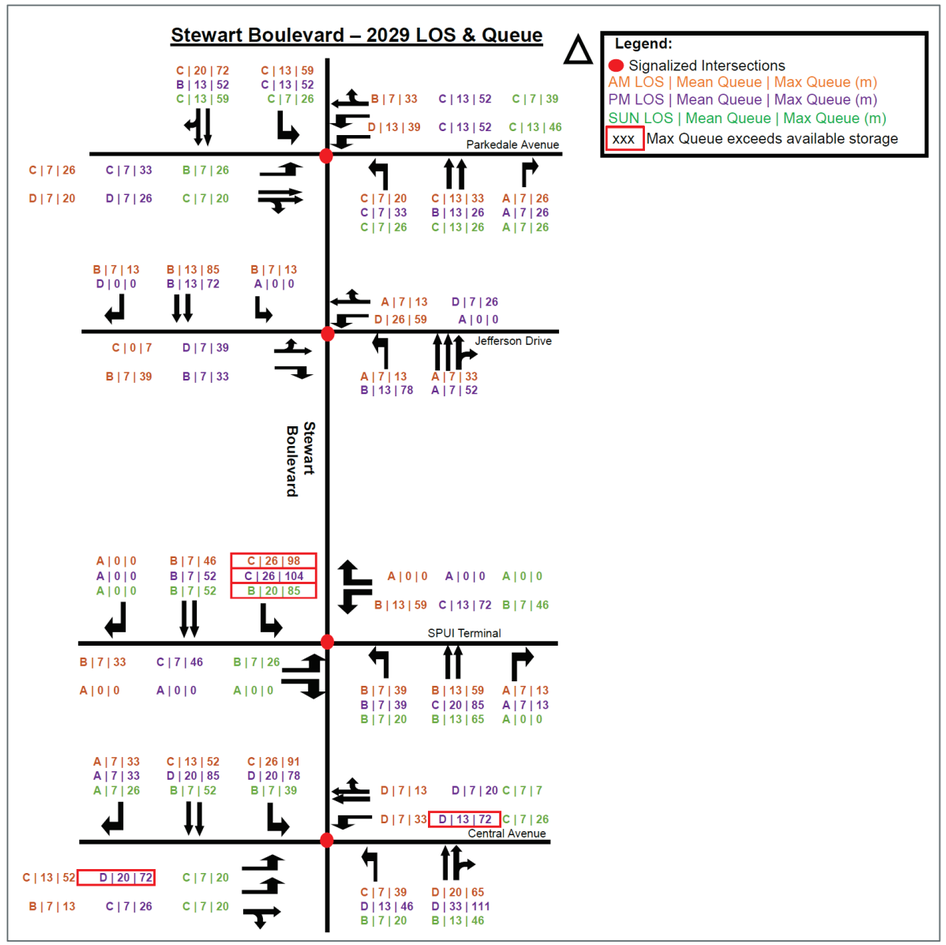

Exhibit C-4: 2029 – Stewart Boulevard SPUI - Intersection Operations

Appendix D: 2029 North Augusta Road – Intersection Operations

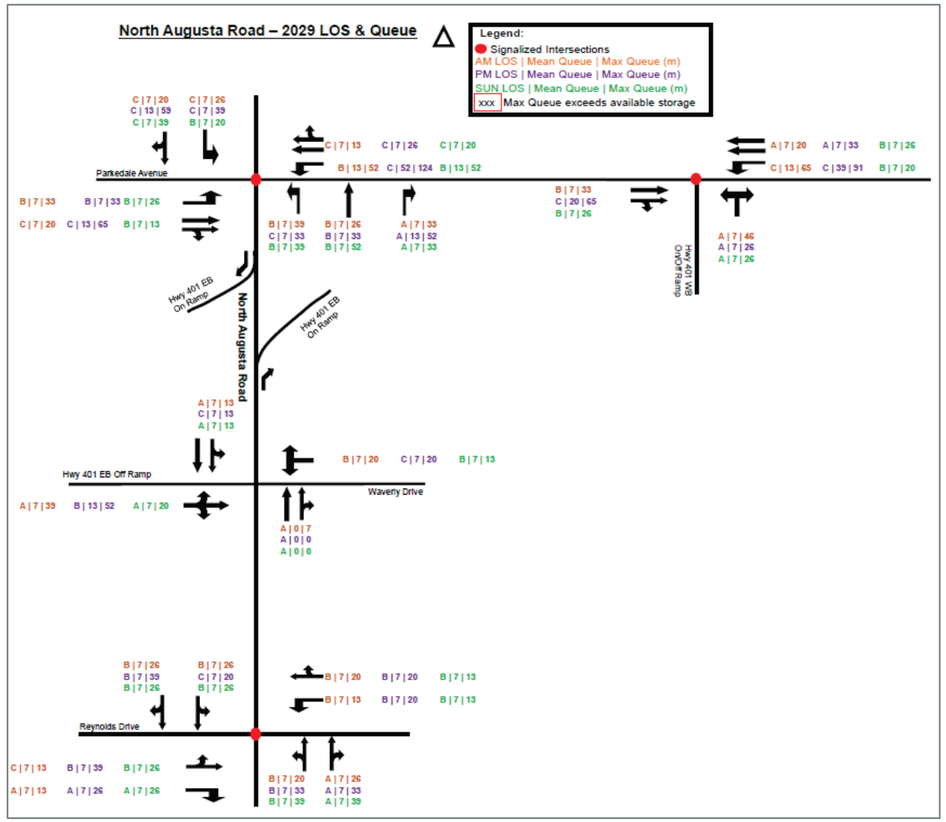

Exhibit D-1: 2029 – North Augusta Road Minor Improvement Interchange - Intersection Operations

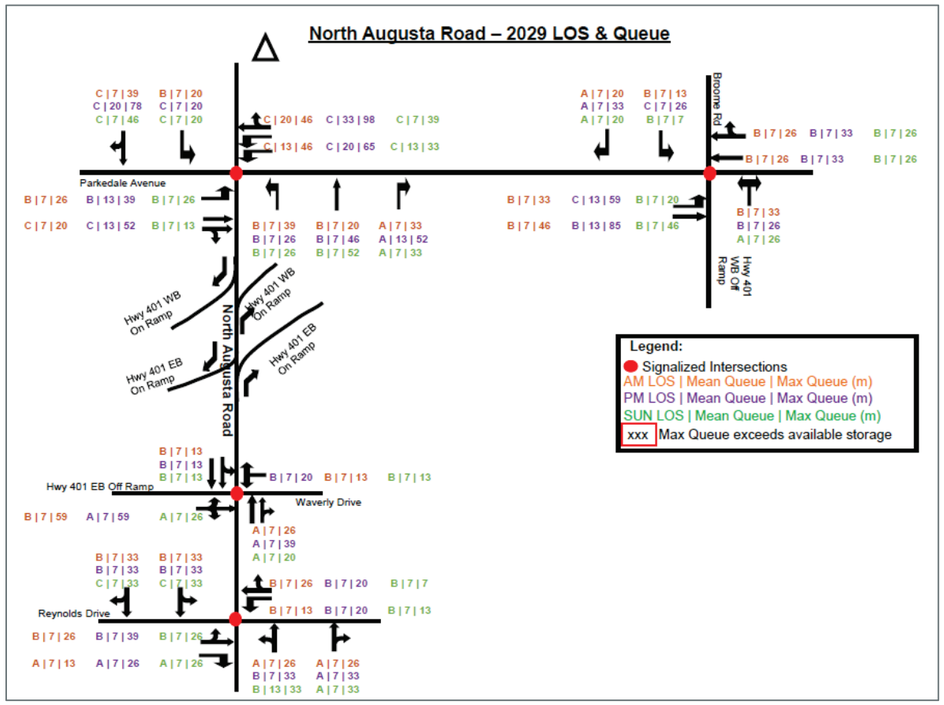

Exhibit D-2: 2029 – North Augusta Road Parclo A4 Interchange - Intersection Operations

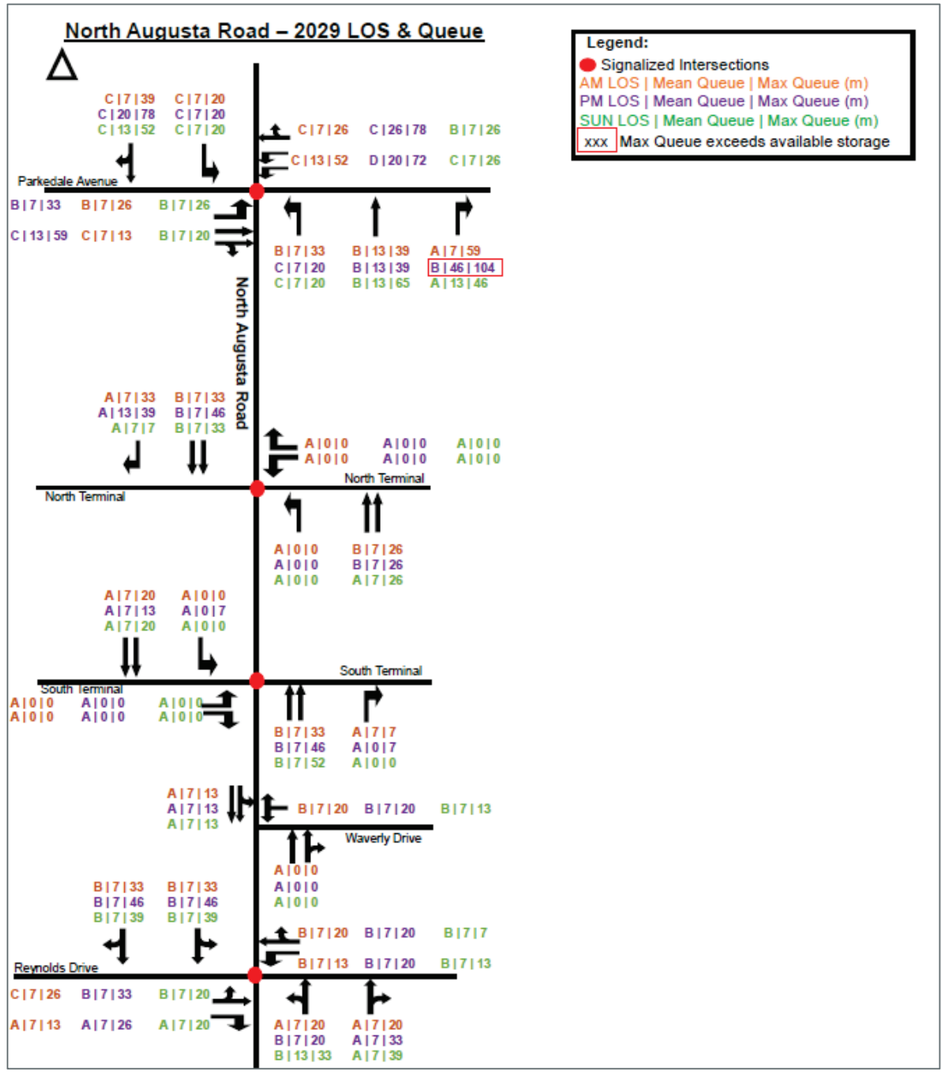

Exhibit D-3: 2029 - North Augusta Road Diverging Diamond Interchange - Intersection Operations

Appendix D:2029 North Augusta Road – Intersection Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

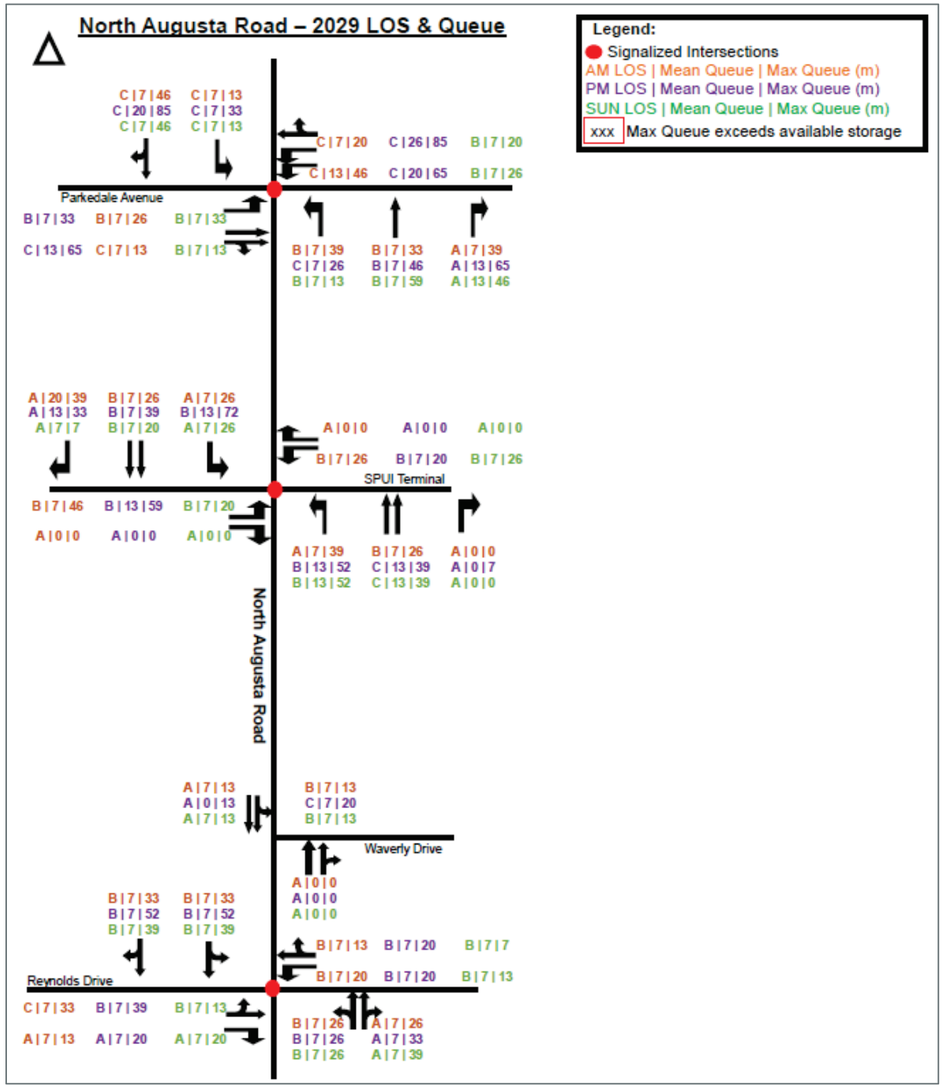

Exhibit D-4: 2029 - North Augusta Road SPUI - Intersection Operations

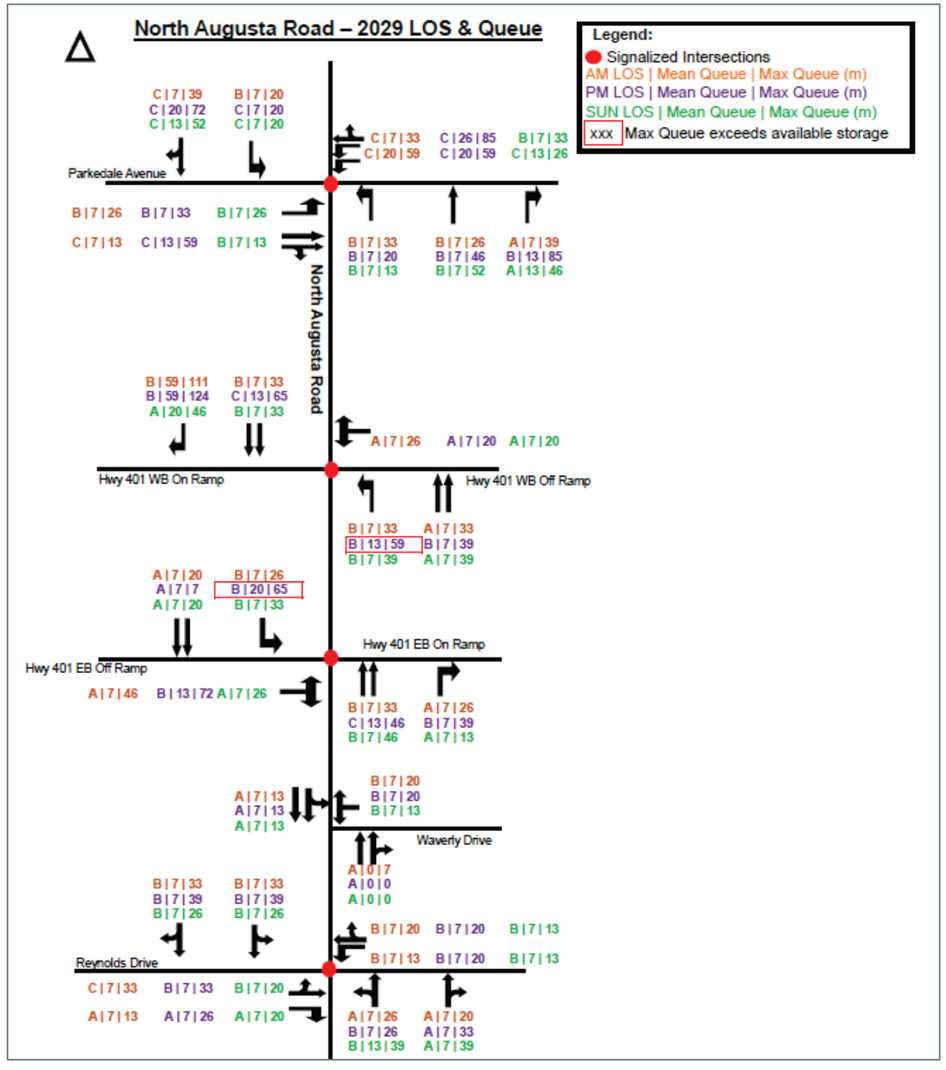

Exhibit D-5: 2029 - North Augusta Road Diamond Interchange - Intersection Operations

Appendix D:2029 North Augusta Road – Intersection Operations
Interchange Design Alternative Analysis Report
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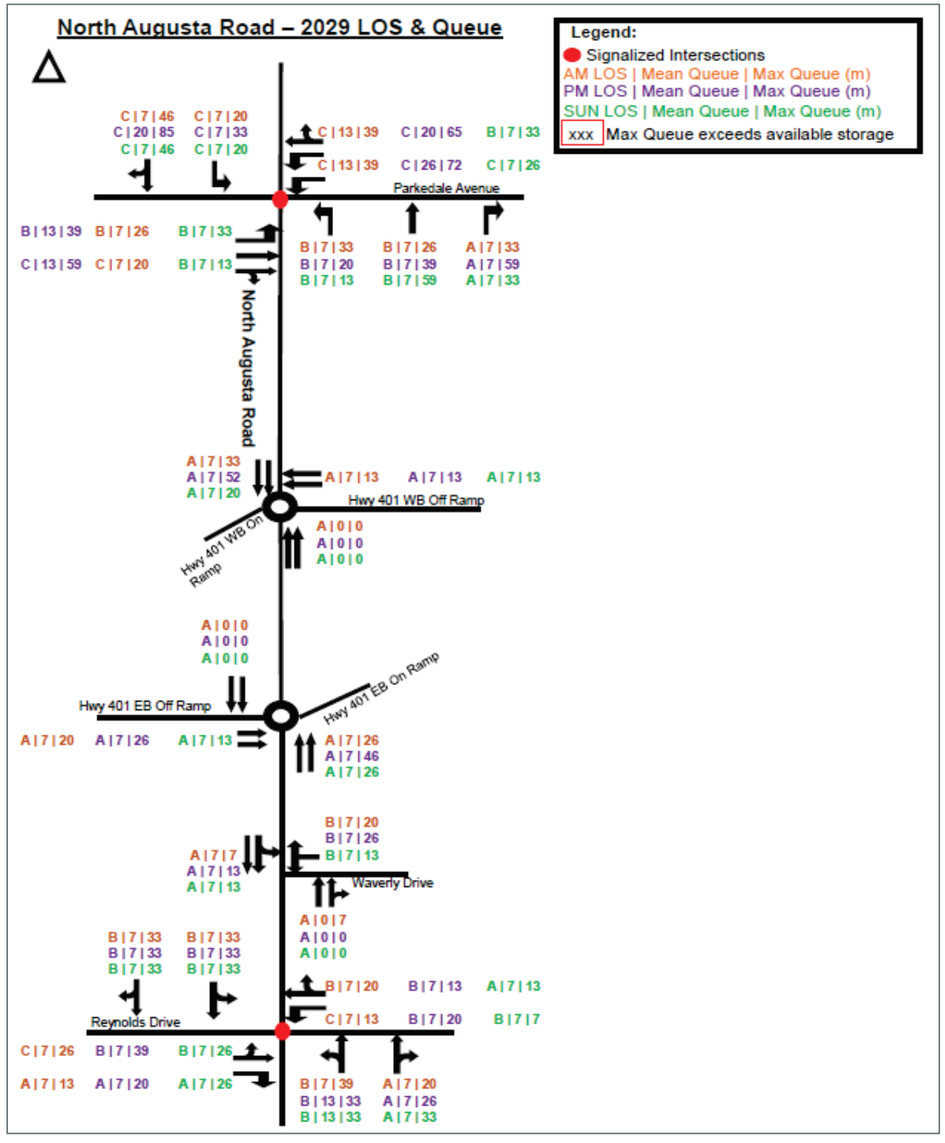

Exhibit D-6: 2029 - North Augusta Road Diamond with Roundabout Interchange - Intersection Operations

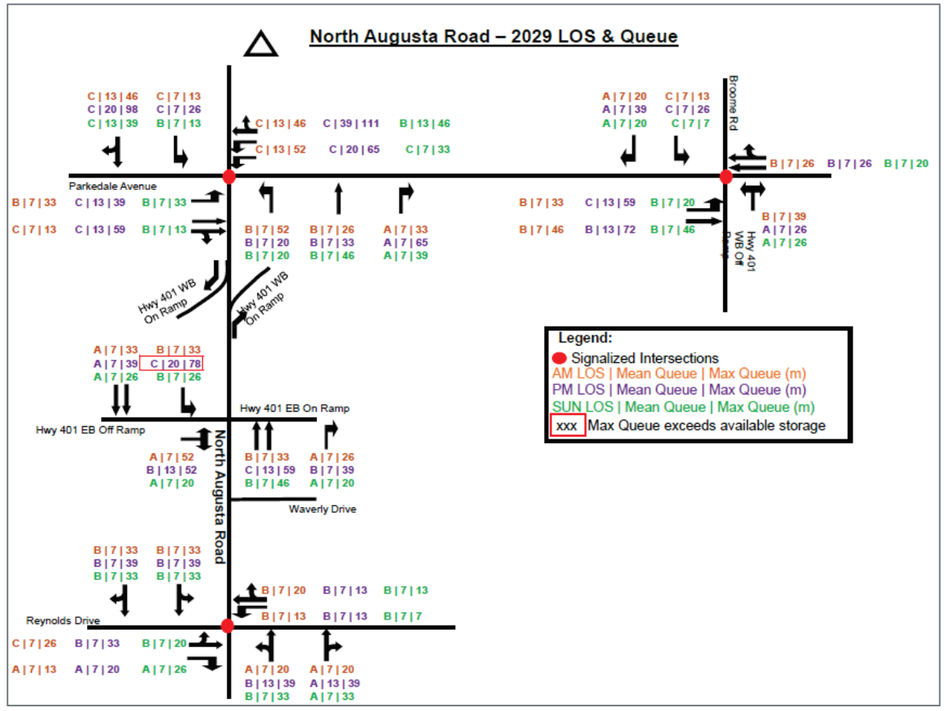

Exhibit D-7: 2029 - North Augusta Road Parclo A2 with Diamond Interchange - Intersection Operations

Appendix E: 2029 Highway Mainline Operations

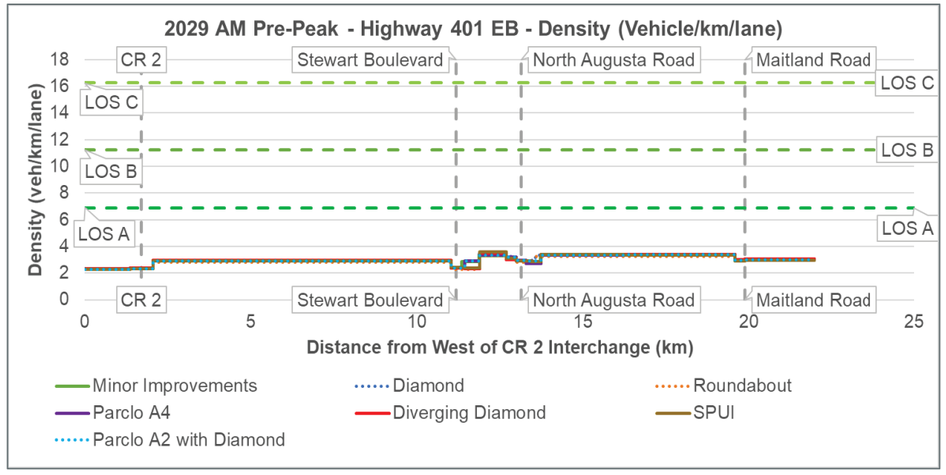

Exhibit E-1: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 AM Pre-Peak Hour

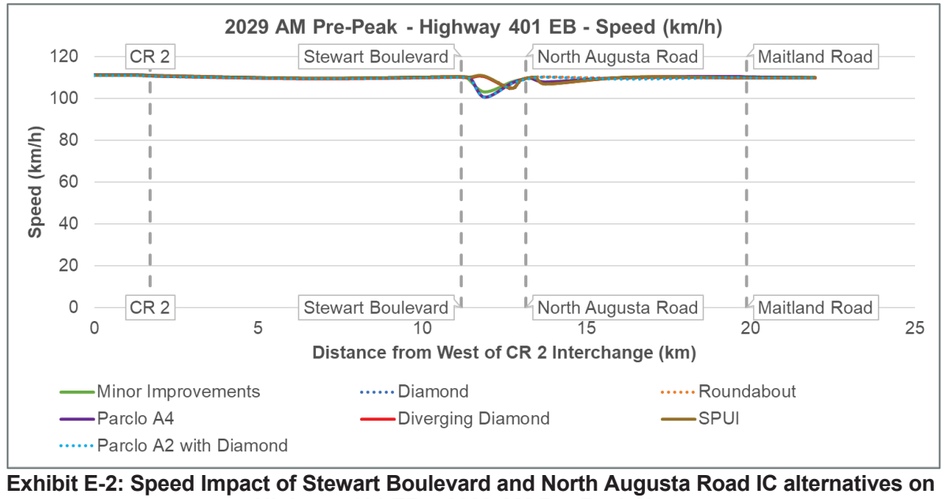

Exhibit E-2: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 AM Pre-Peak Hour

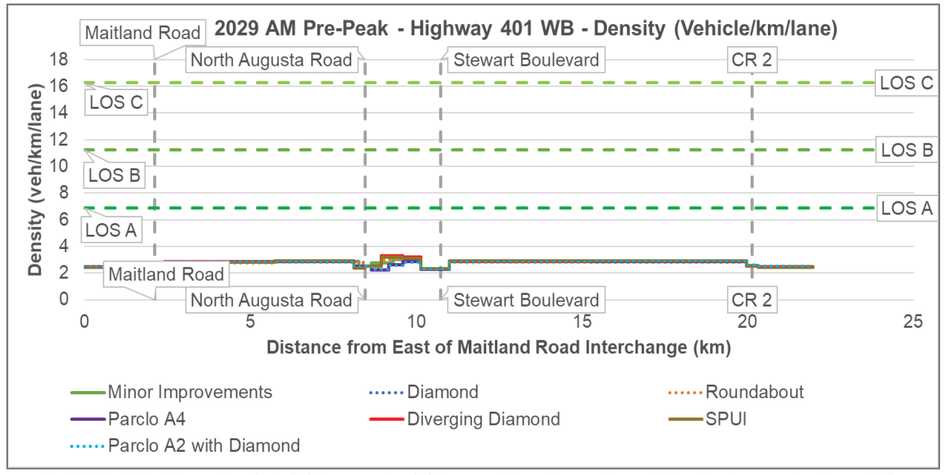

Exhibit E-3: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 AM Pre-Peak Hour

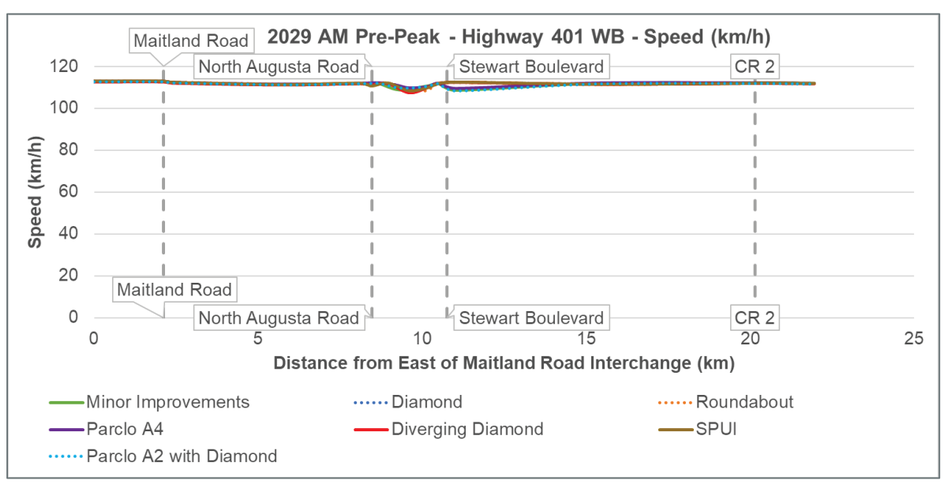

Exhibit E-4: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 AM Pre-Peak Hour

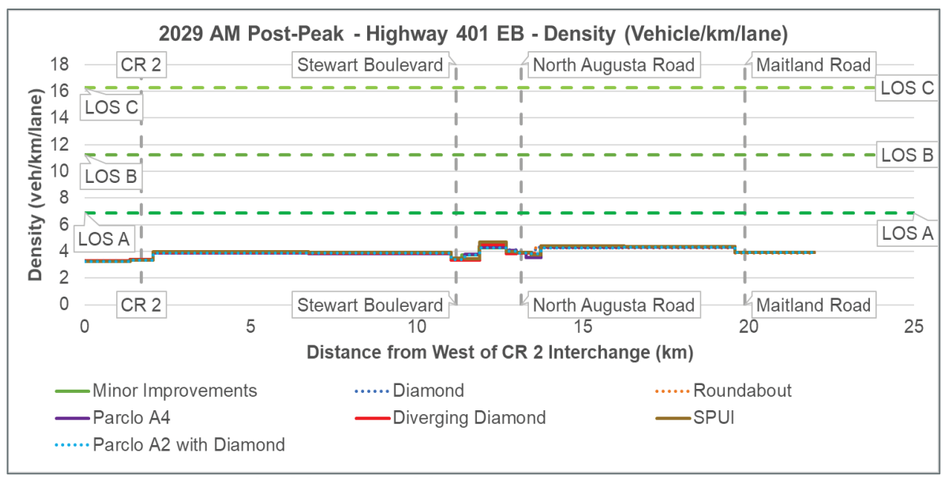

Exhibit E-5: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 AM Post-Peak Hour

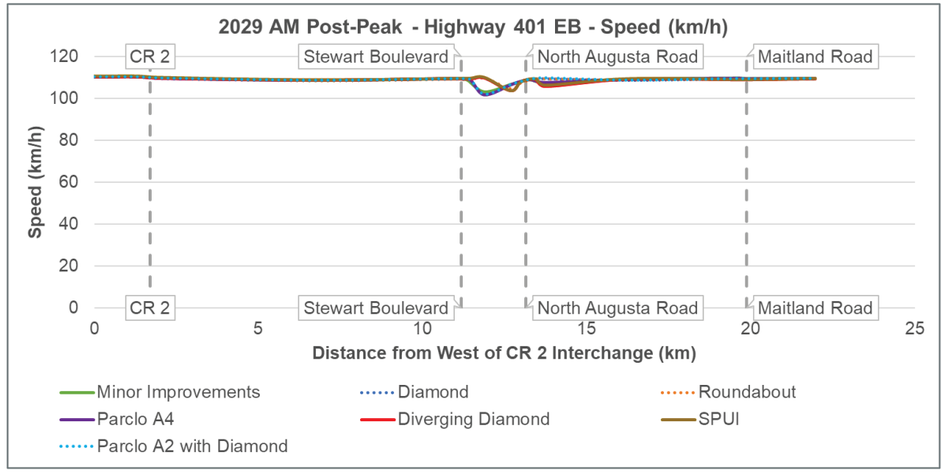

Exhibit E-6: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 AM Post-Peak Hour

Appendix E:2029 Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

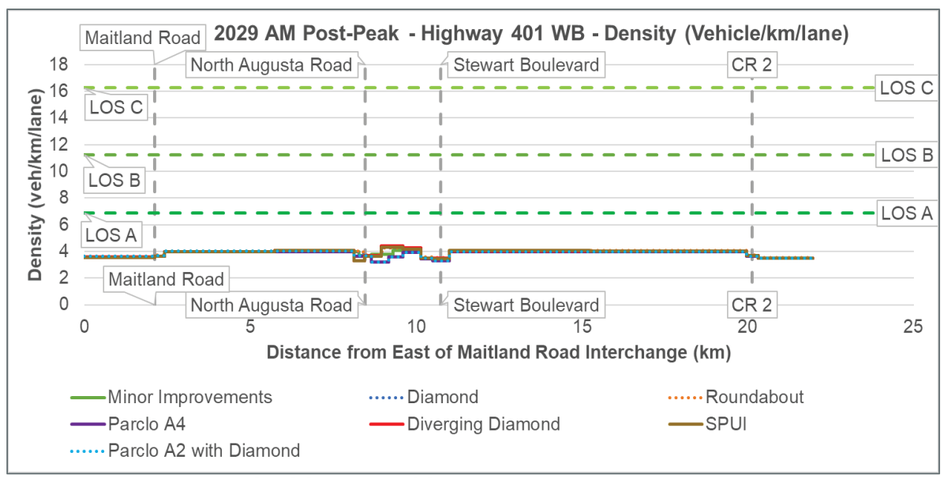

Exhibit E-7: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 AM Post-Peak Hour

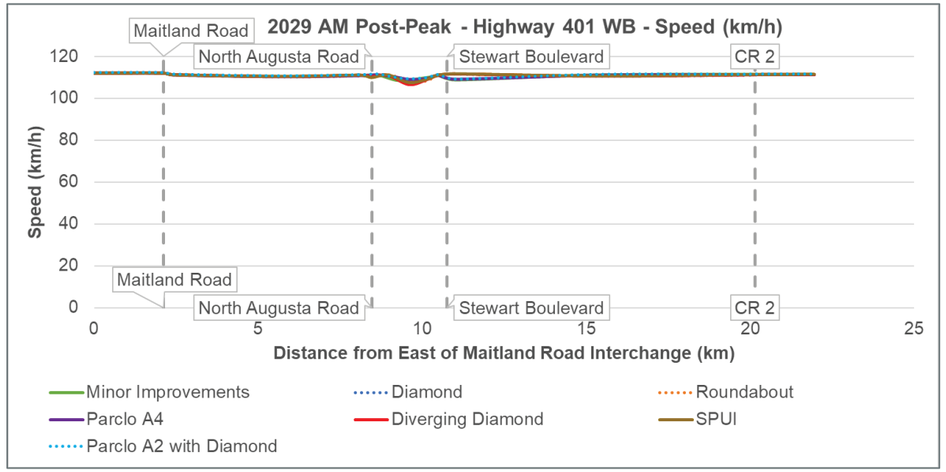

Exhibit E-8: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 AM Post-Peak Hour

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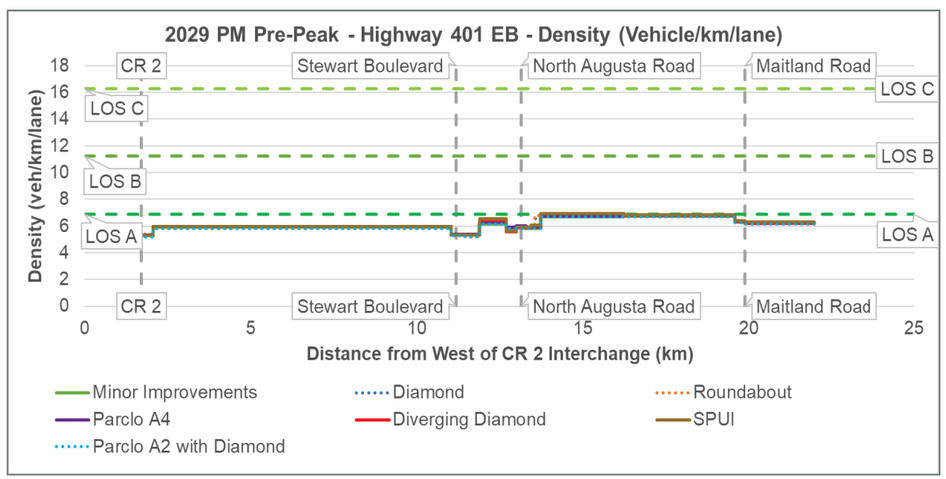

Exhibit E-9: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 PM Pre-Peak Hour

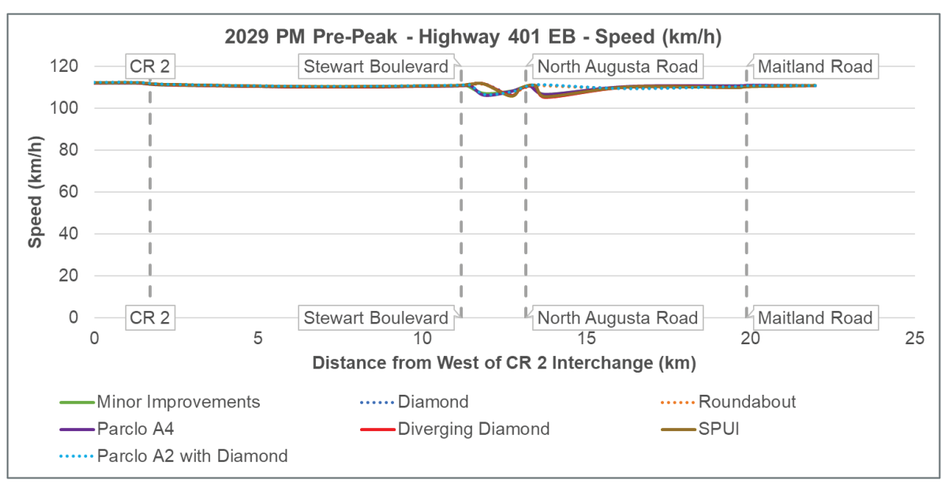

Exhibit E-10: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 PM Pre-Peak Hour

Appendix E:2029 Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

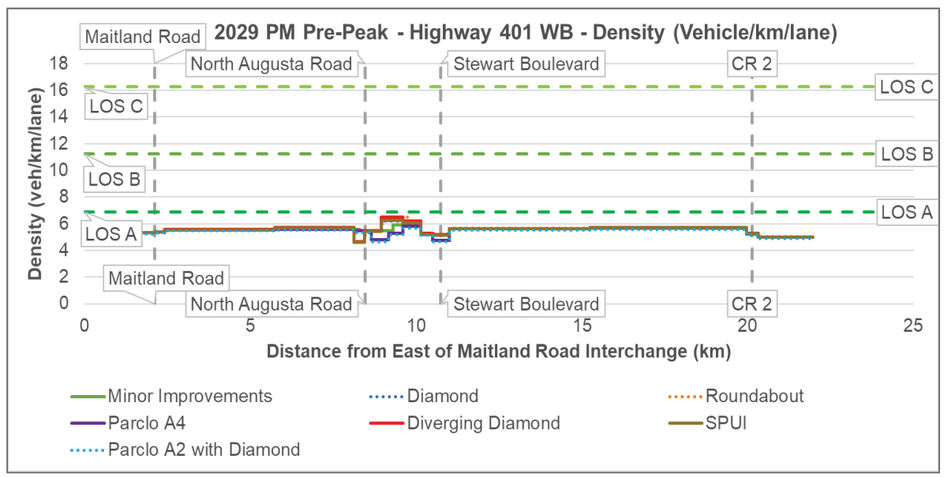

Exhibit E-11: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 PM Pre-Peak Hour

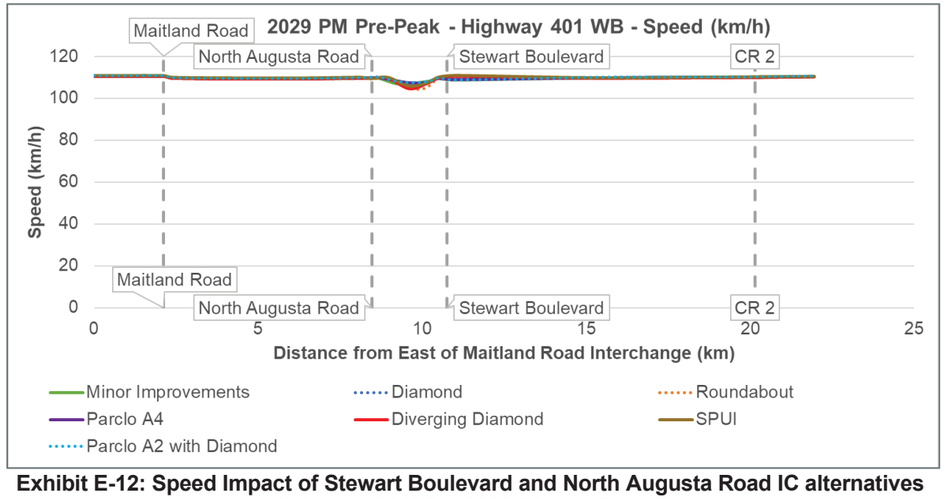

Exhibit E-12: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 PM Pre-Peak Hour

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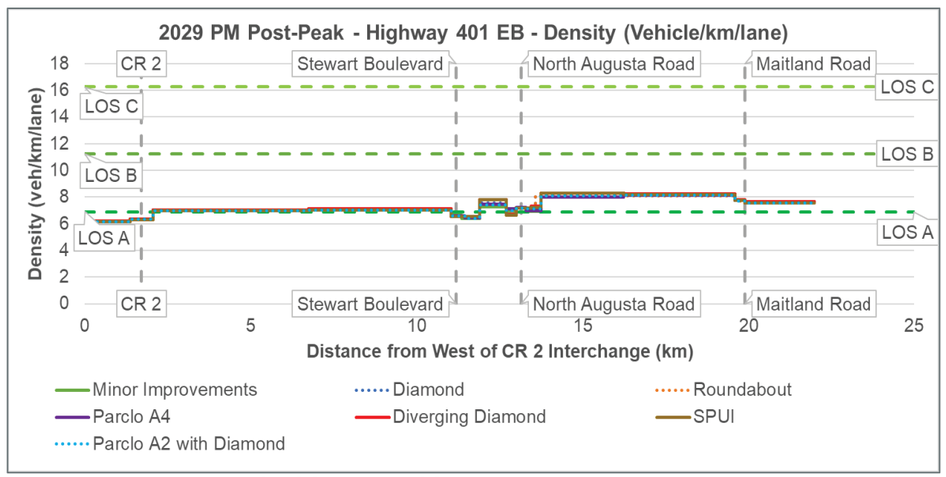

Exhibit E-13: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 PM Post-Peak Hour

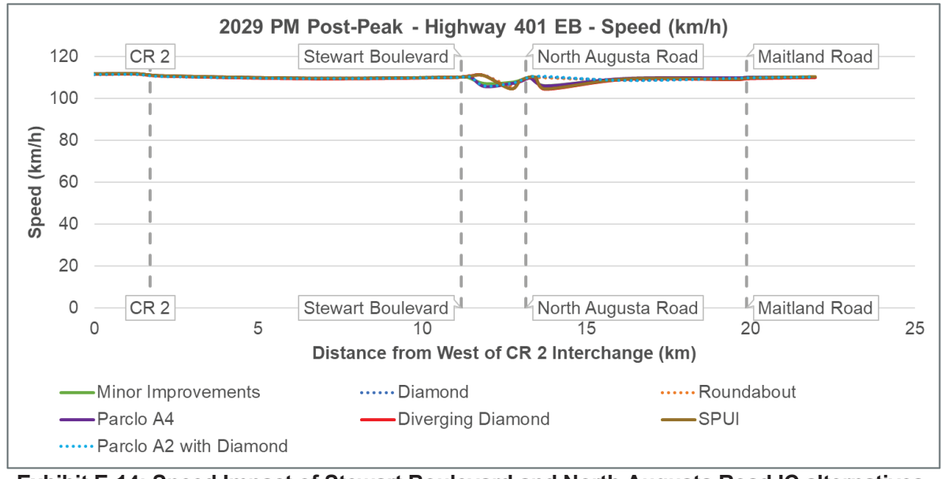

Exhibit E-14: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 PM Post-Peak Hour

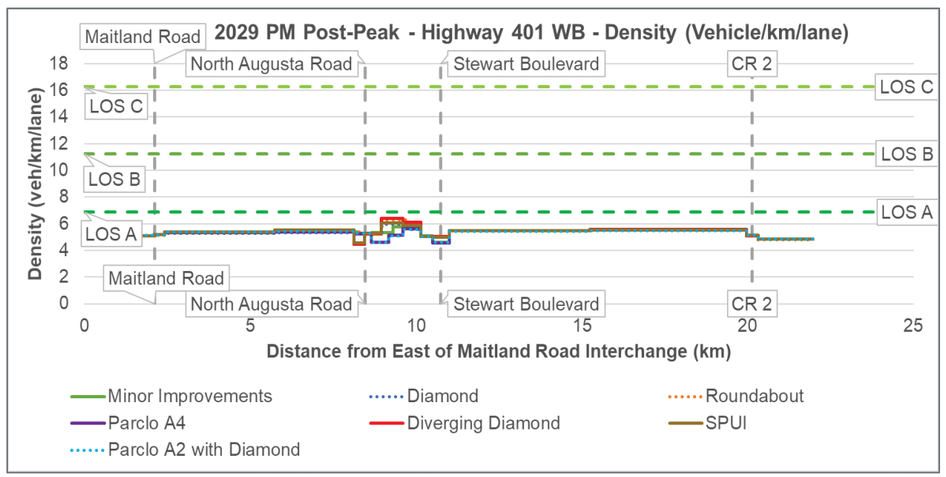

Exhibit E-15: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 PM Post-Peak Hour

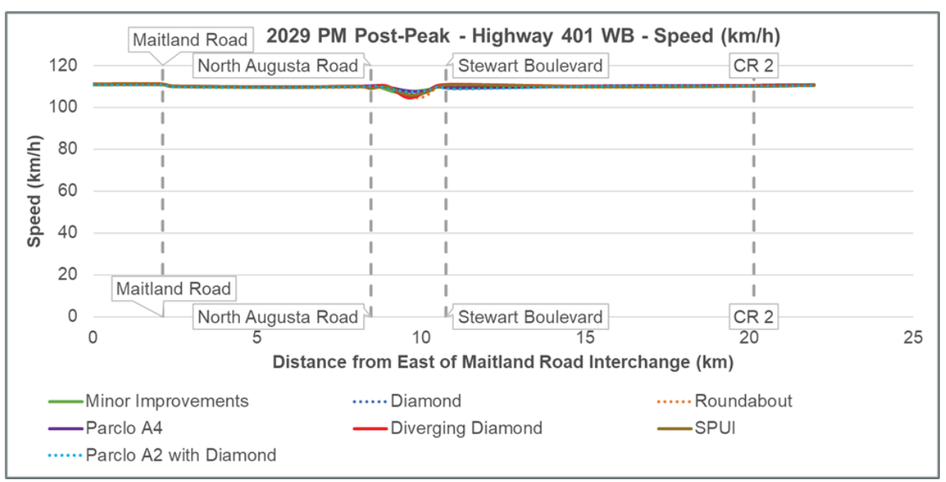

Exhibit E-16: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 PM Post-Peak Hour

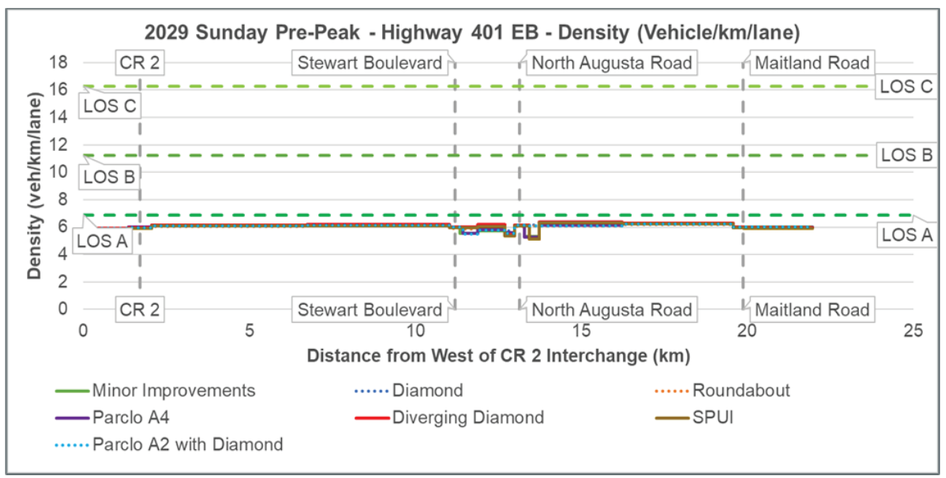

Exhibit E-17: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 Sunday Pre-Peak Hour

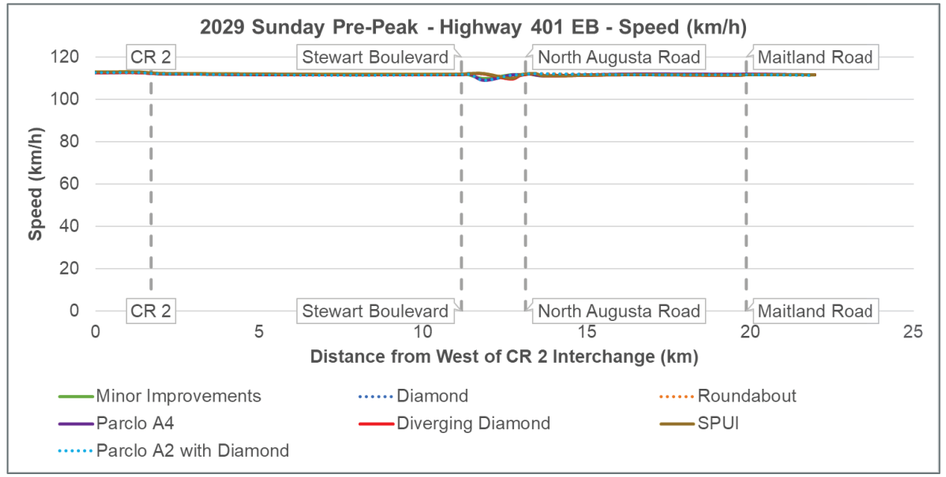

Exhibit E-18: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 Sunday Pre-Peak Hour

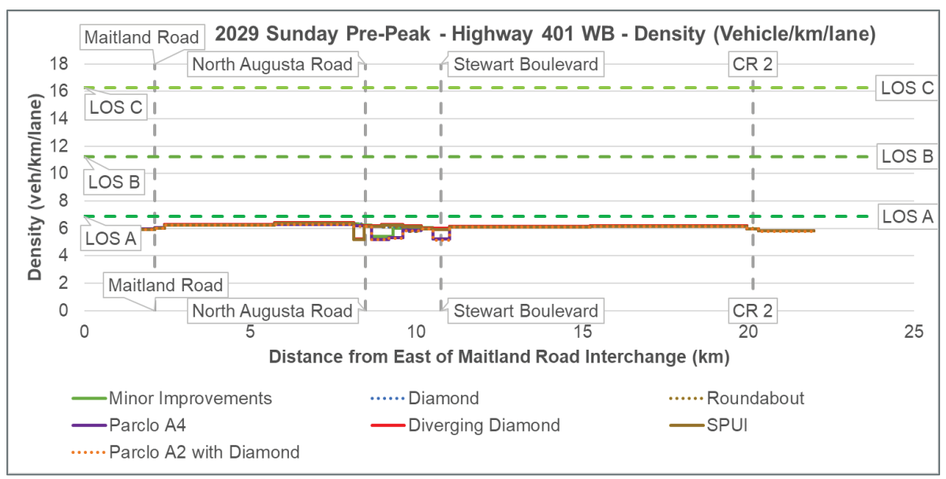

Exhibit E-19: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 Sunday Pre-Peak Hour

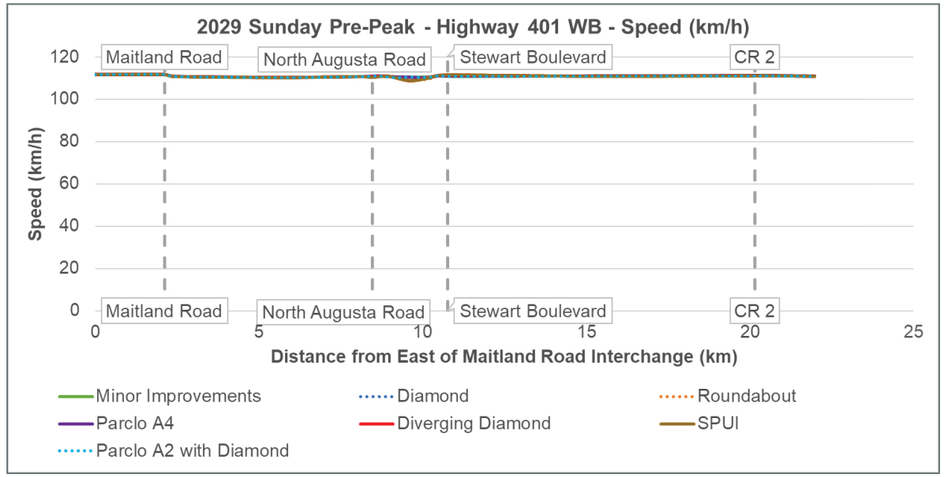

Exhibit E-20: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 Sunday Pre-Peak Hour

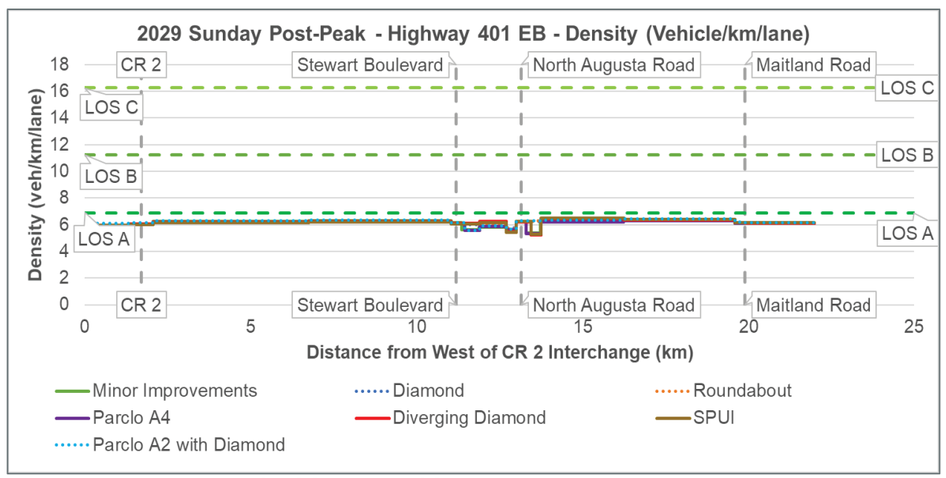

Exhibit E-21: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 Sunday Post-Peak Hour

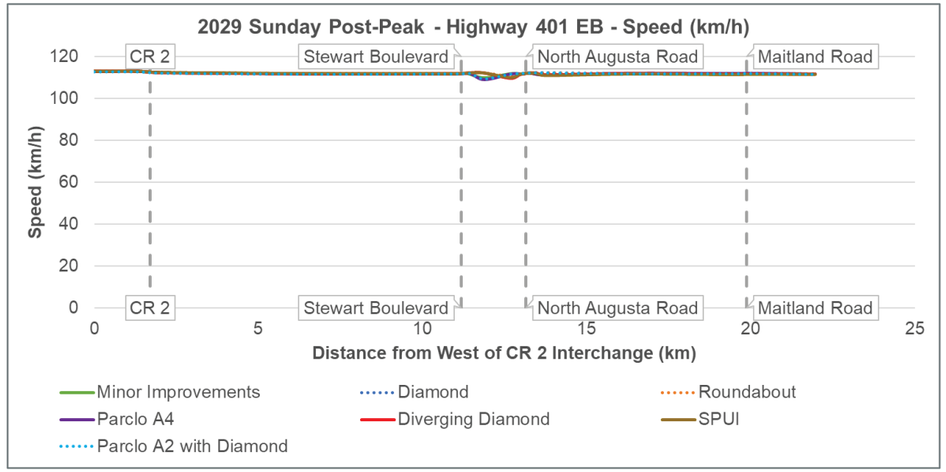

Exhibit E-22: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2029 Sunday Post-Peak Hour

Appendix E:2029 Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

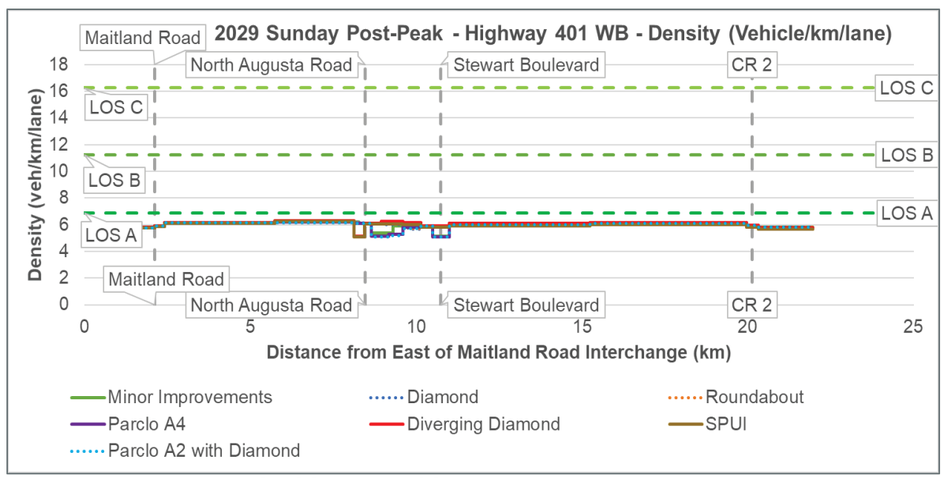

Exhibit E-23: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 Sunday Post-Peak Hour

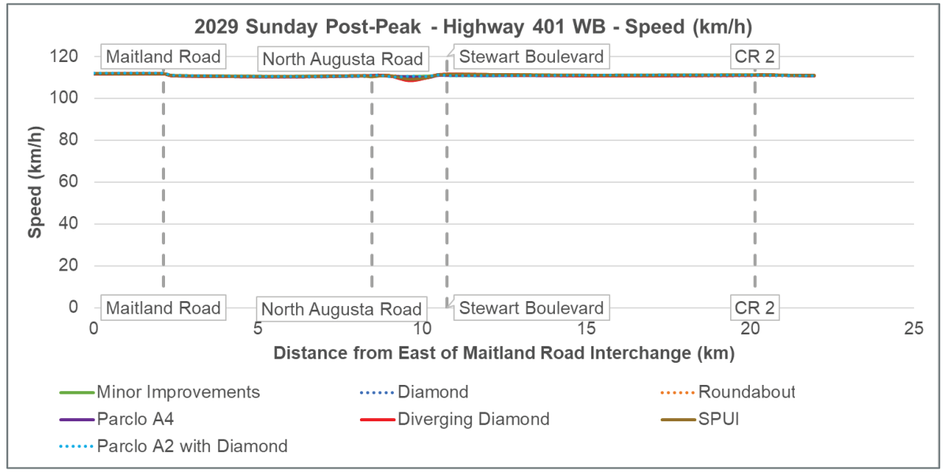

Exhibit E-24: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2029 Sunday Post-Peak Hour

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

Appendix F: 2034 Stewart Boulevard – Intersection Operations

Appendix F:2034 Stewart Boulevard – Intersection Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

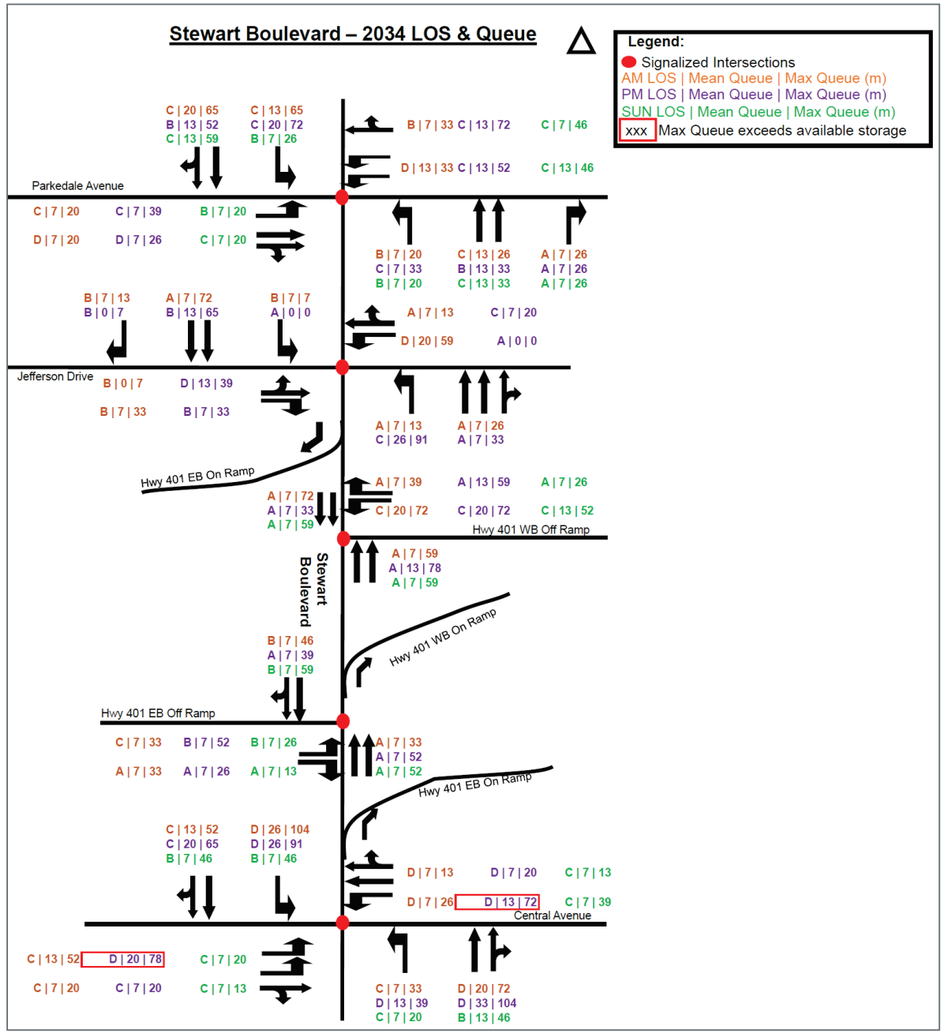

Exhibit F-1: 2034 – Stewart Boulevard Minor Improvement Interchange - Intersection Operations

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

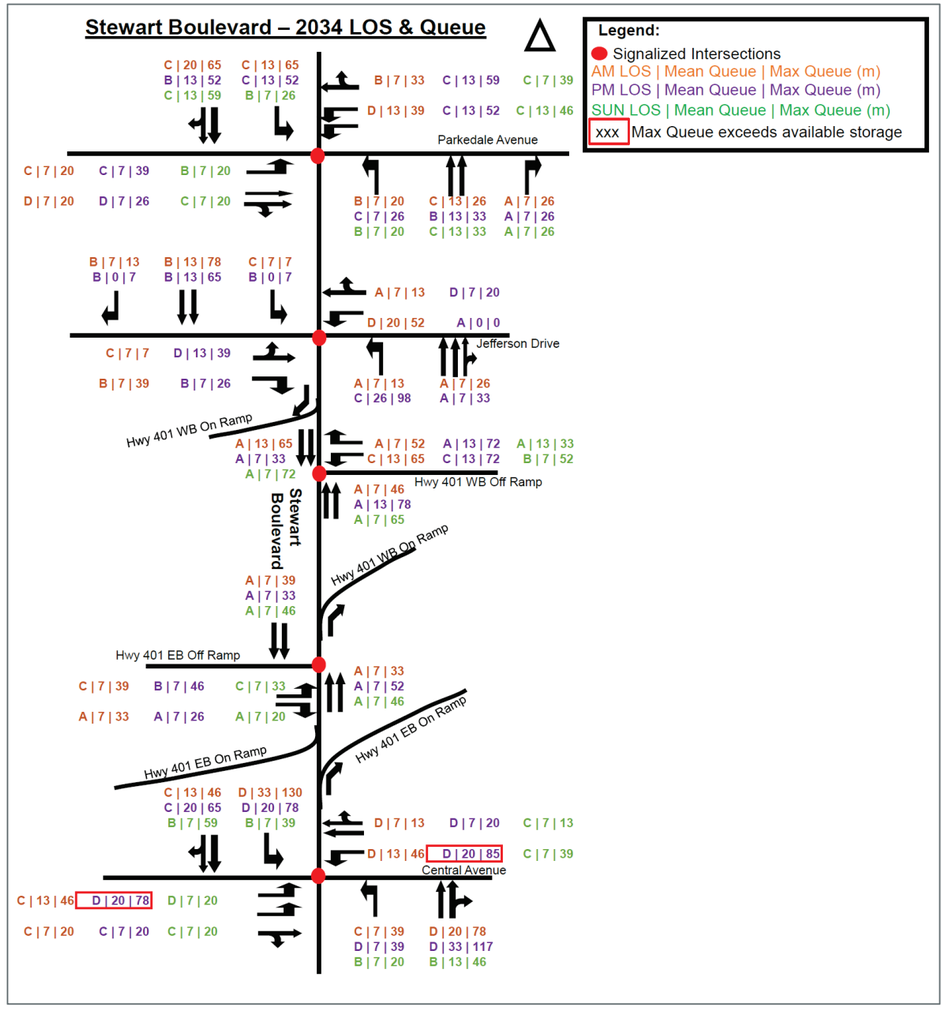

Exhibit F-2: 2034 – Stewart Boulevard Parclo A4 Interchange - Intersection Operations

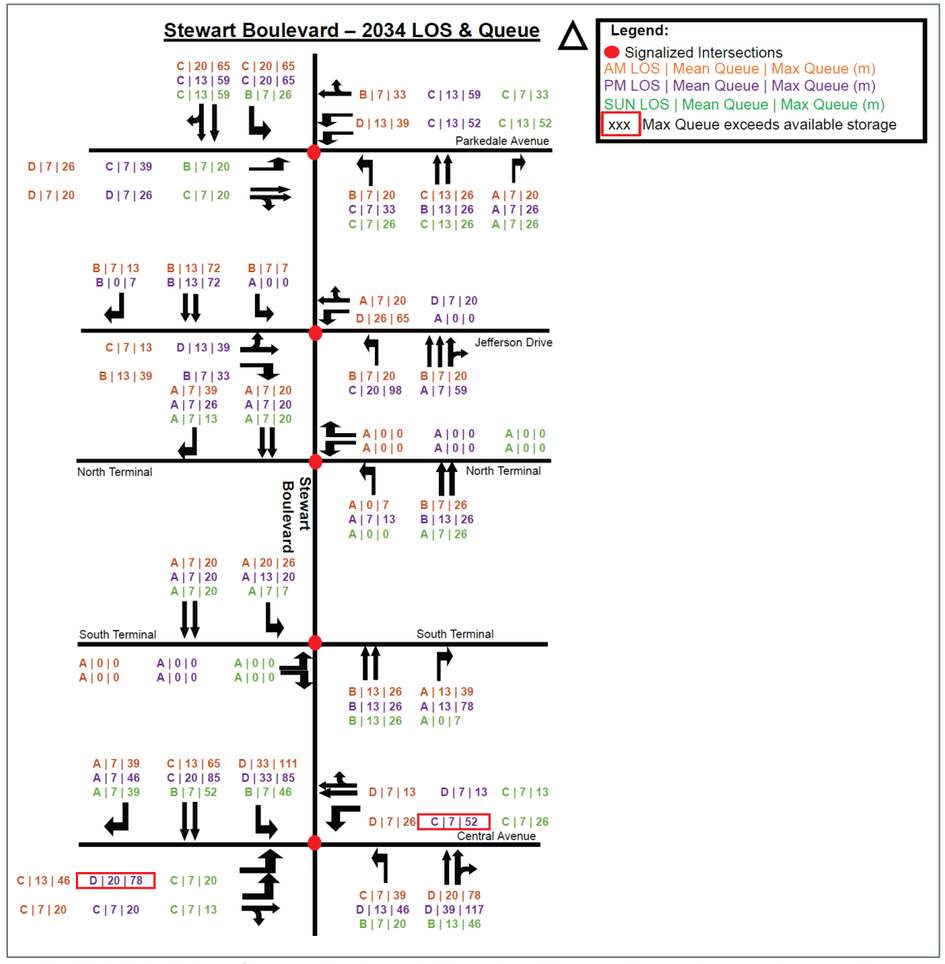

Exhibit F-3: 2034 – Stewart Boulevard Diverging Diamond Interchange - Intersection Operations

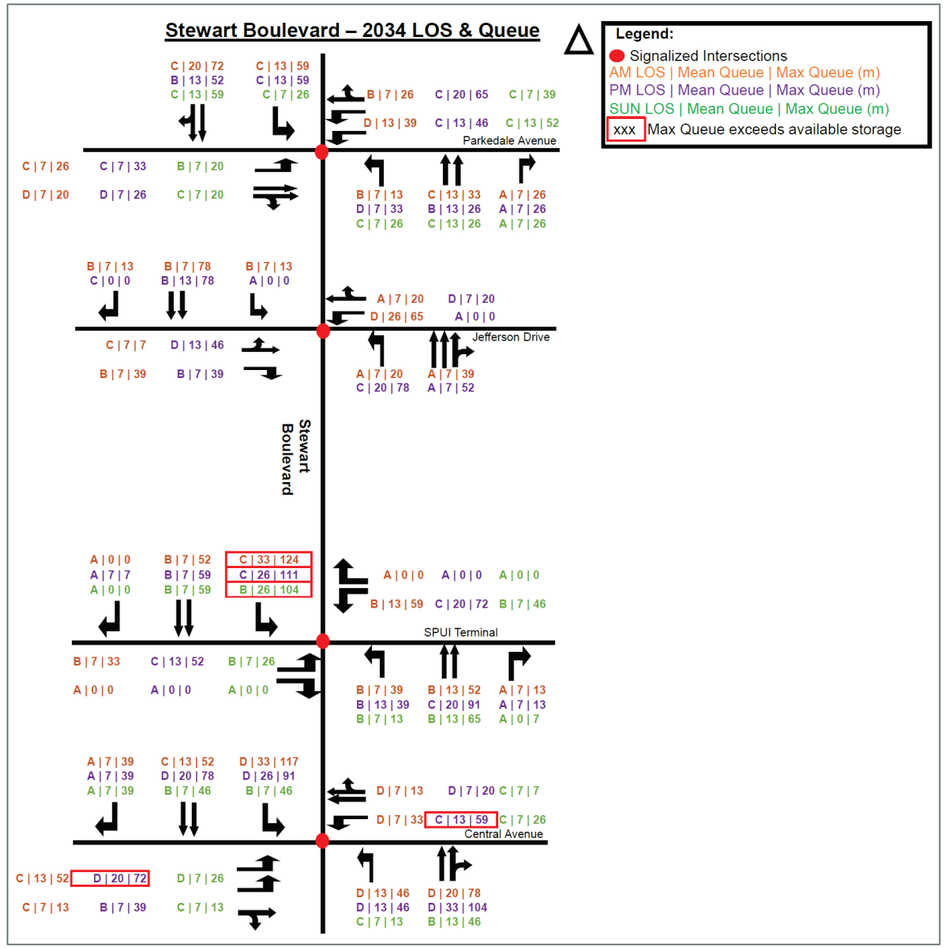

Exhibit F-4: 2034 – Stewart Boulevard SPUI - Intersection Operations

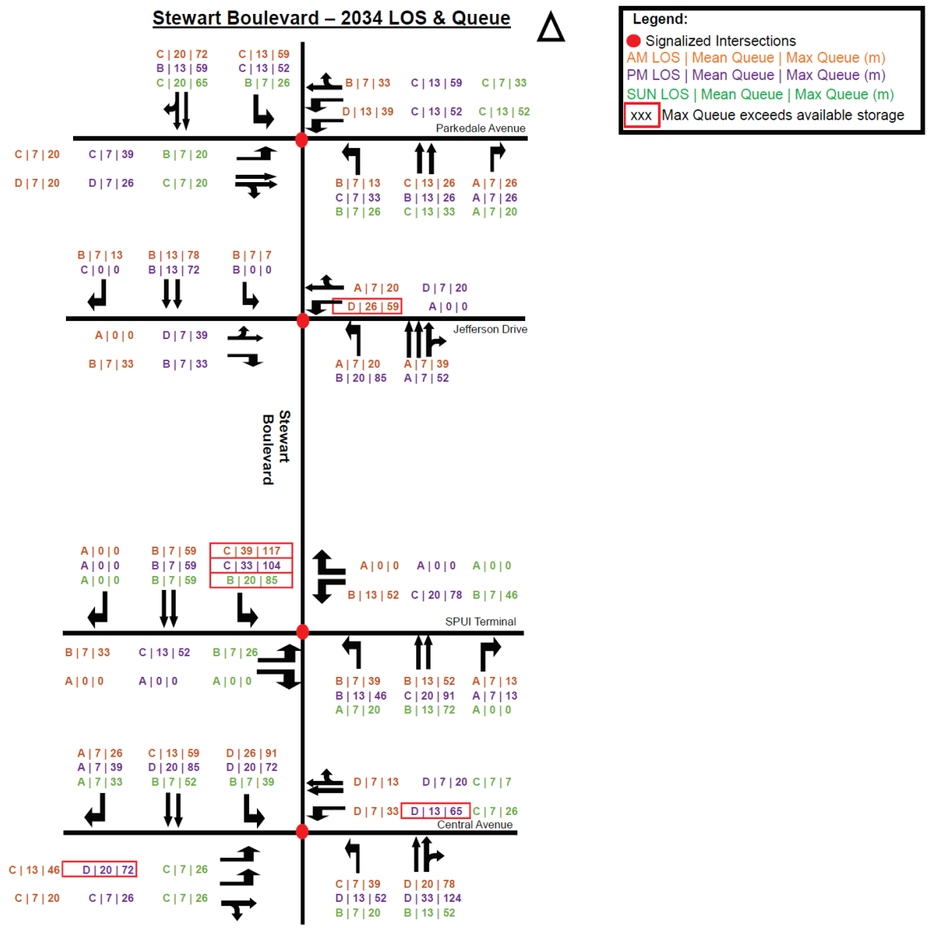

Exhibit F-5: 2034 – Stewart Boulevard Preferred Design (SPUI) – Highway 401 with 6-Lane Cross-Section - Intersection Operations

Appendix G: 2034 North Augusta Road – Intersection Operations

Appendix G:2034 North Augusta Road – Intersection Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

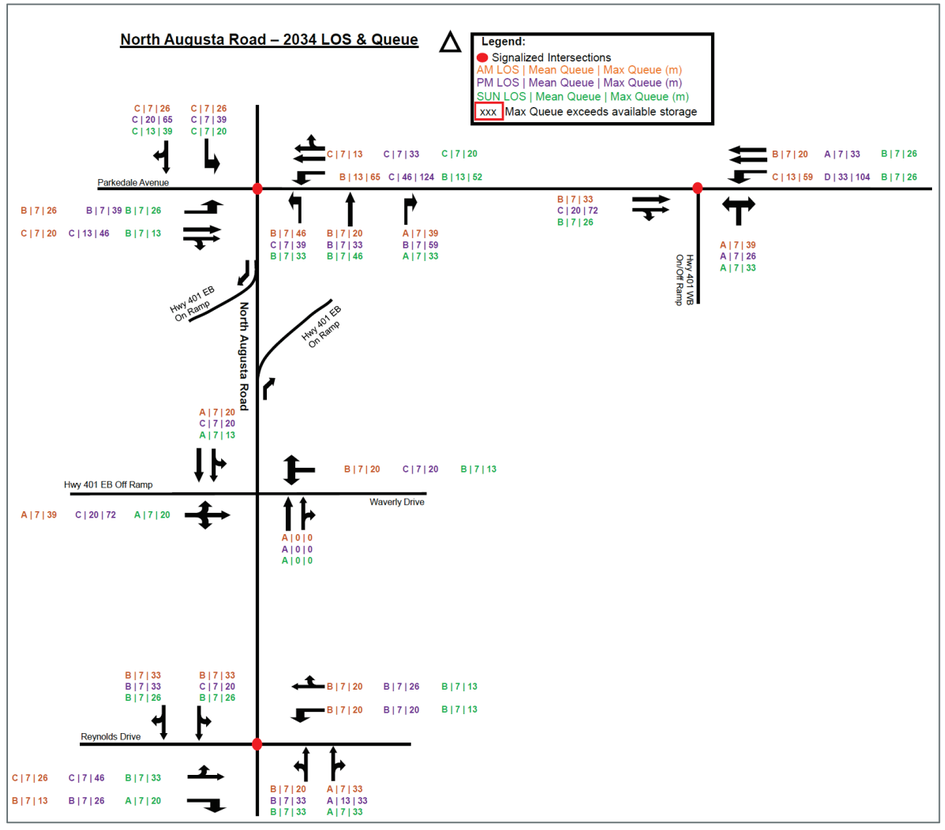

Exhibit G-1: 2034 – North Augusta Road Minor Improvement Interchange - Intersection Operations

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

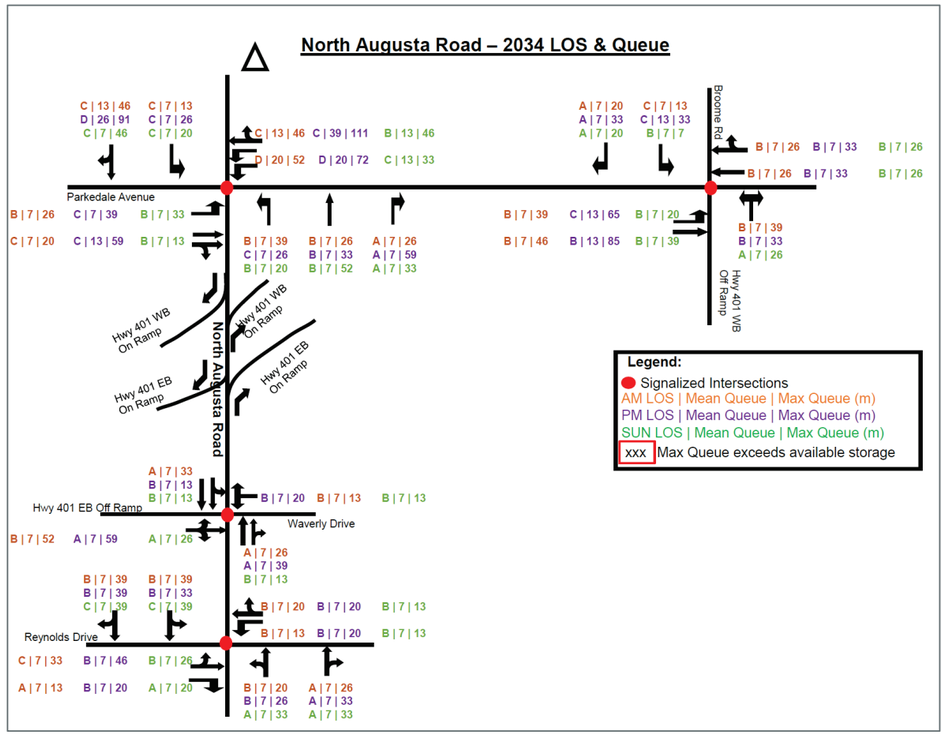

Exhibit G-2: 2034 – North Augusta Road Parclo A4 Interchange - Intersection Operations

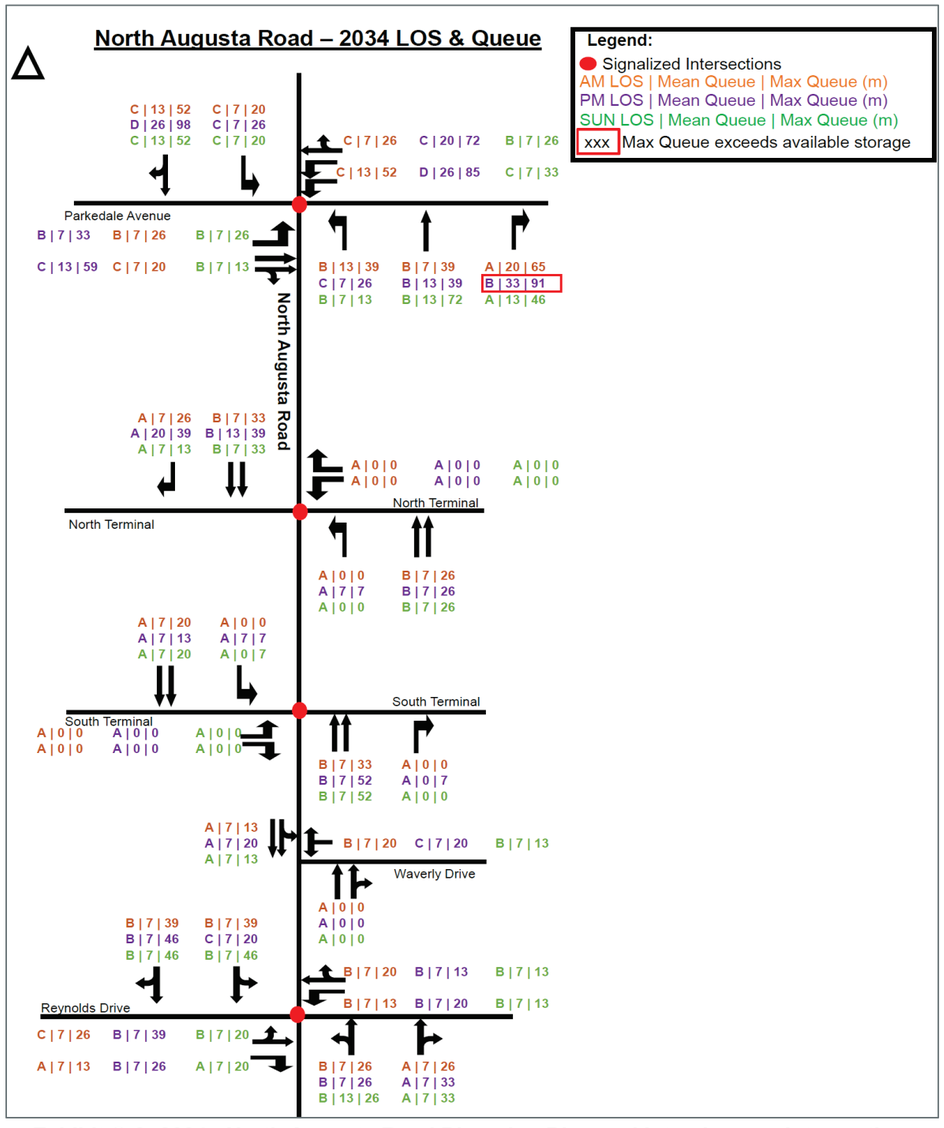

Exhibit G-3: 2034 - North Augusta Road Diverging Diamond Interchange - Intersection Operations

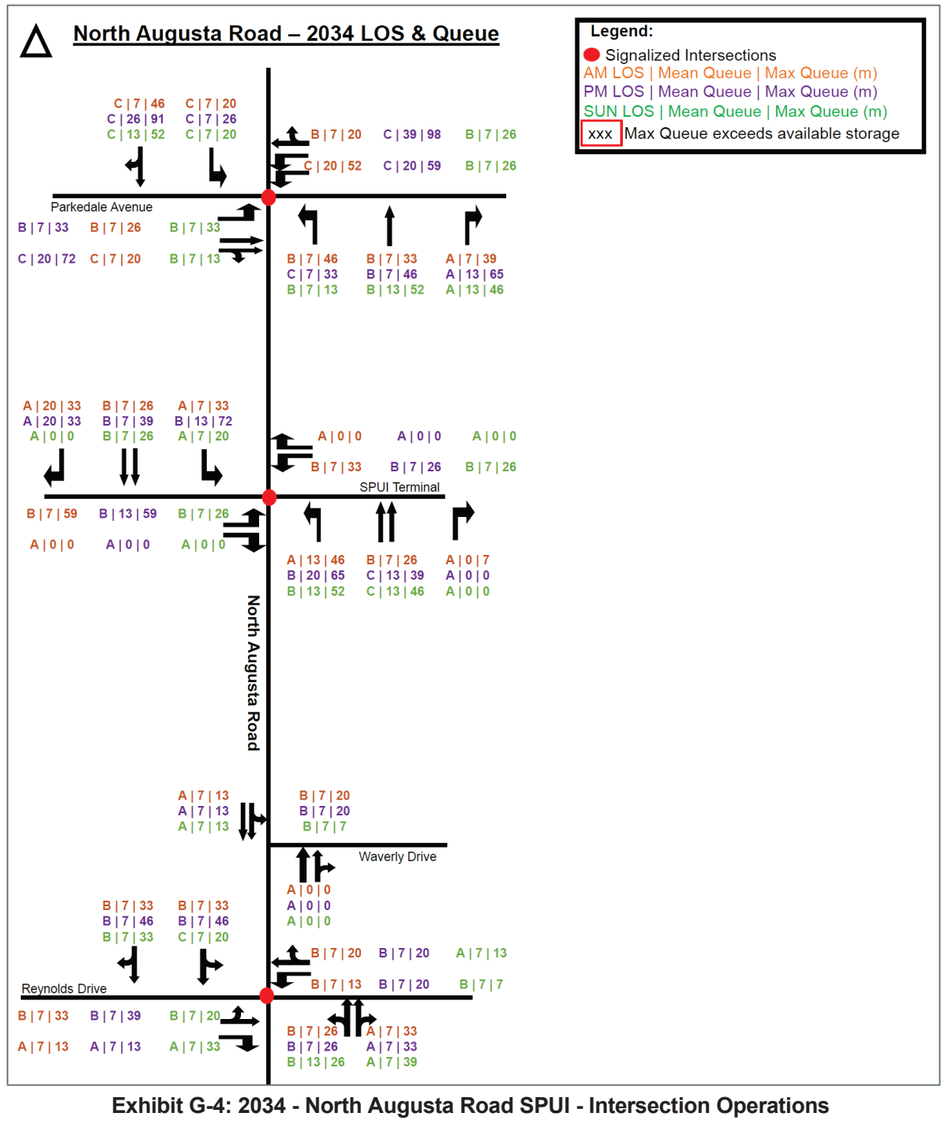

Exhibit G-4: 2034 - North Augusta Road SPUI - Intersection Operations

Appendix G:2034 North Augusta Road – Intersection Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

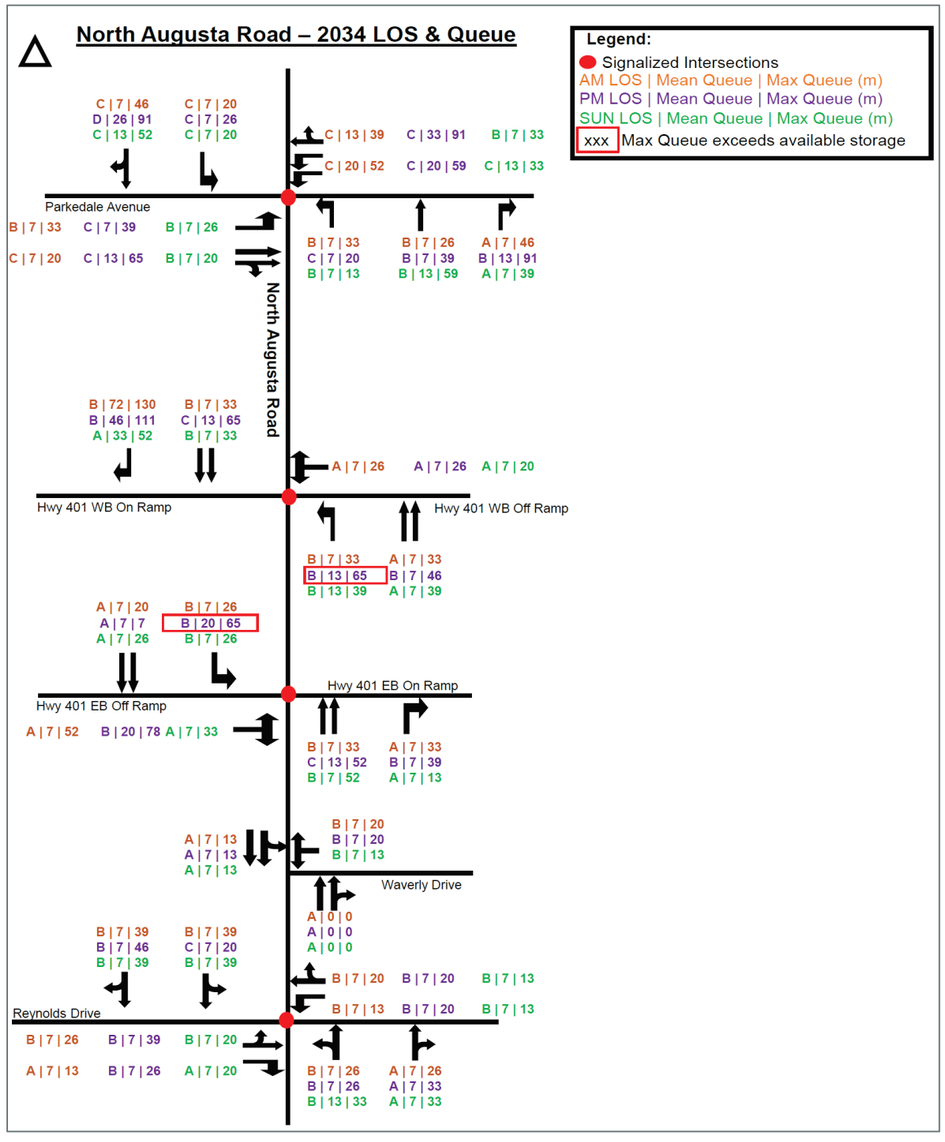

Exhibit G-5: 2034 - North Augusta Road Diamond Interchange - Intersection Operations

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

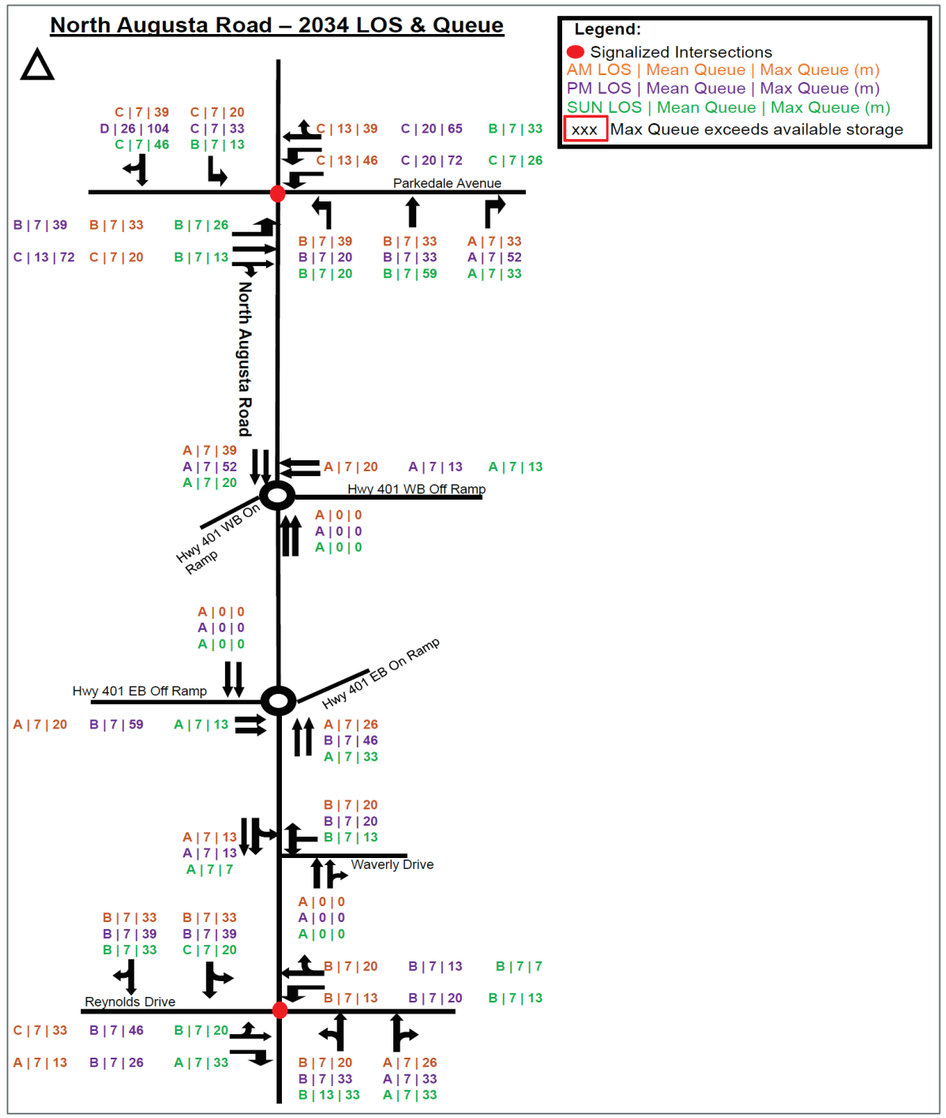

Exhibit G-6: 2034 - North Augusta Road Diamond with Roundabout Interchange - Intersection Operations

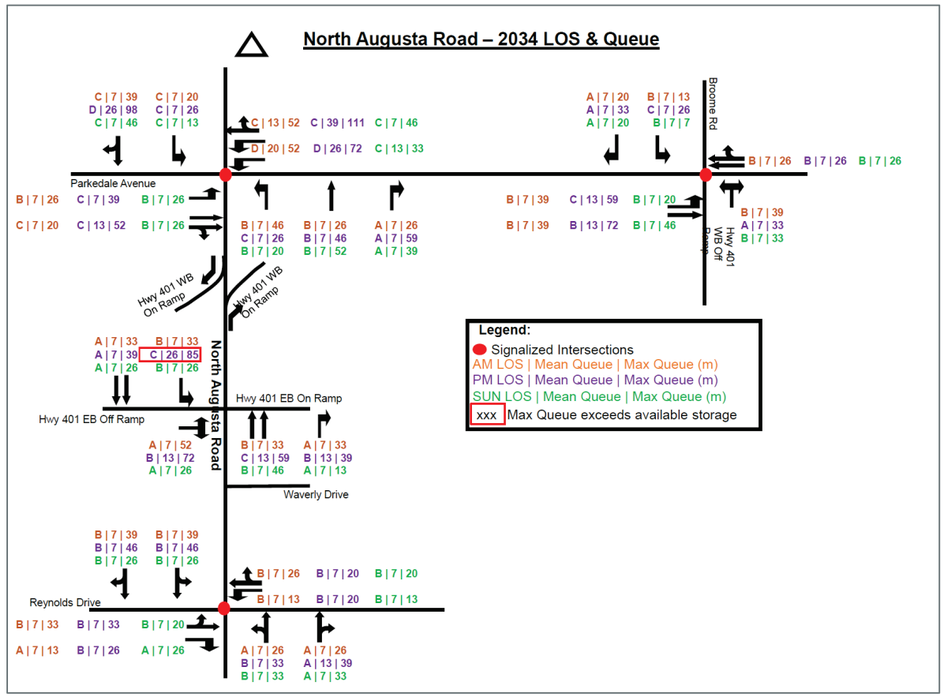

Exhibit G-7: 2034 - North Augusta Road Parclo A2 with Diamond Interchange - Intersection Operations

Appendix H: 2034 Highway Mainline Operations

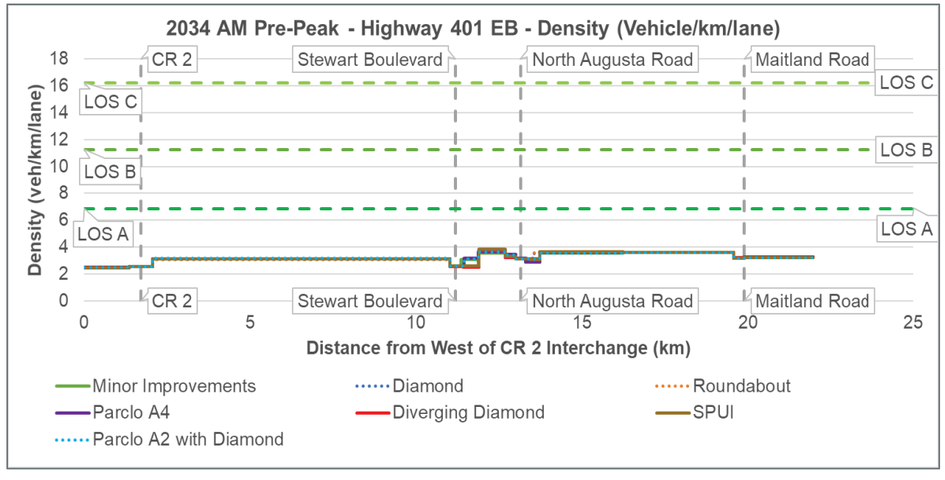

Exhibit H-1: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 AM Pre-Peak Hour

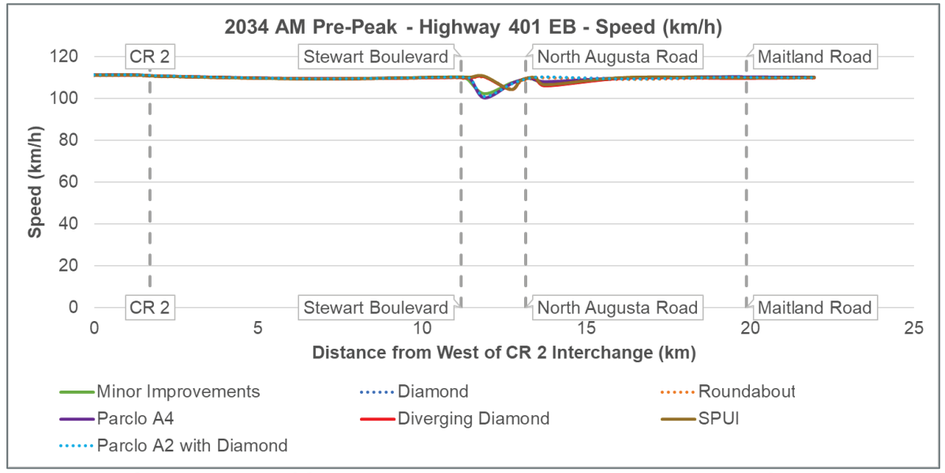

Exhibit H-2: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 AM Pre-Peak Hour

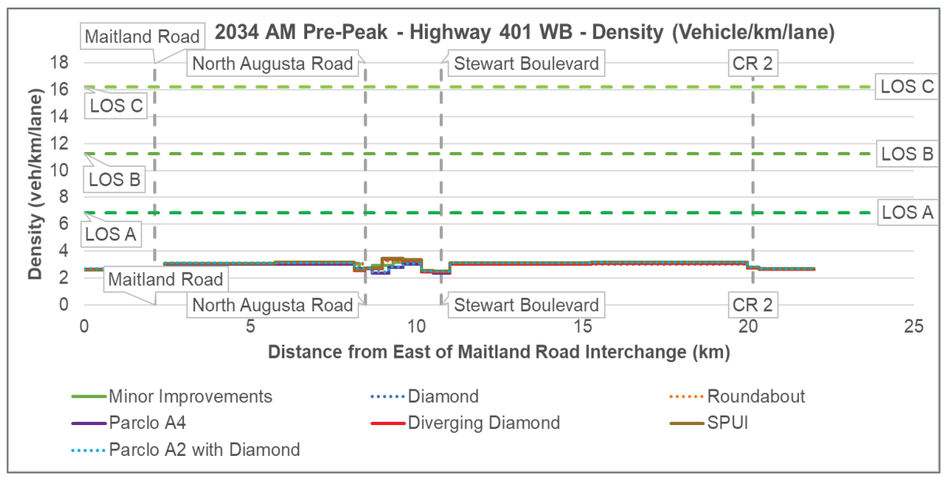

Exhibit H-3: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 AM Pre-Peak Hour

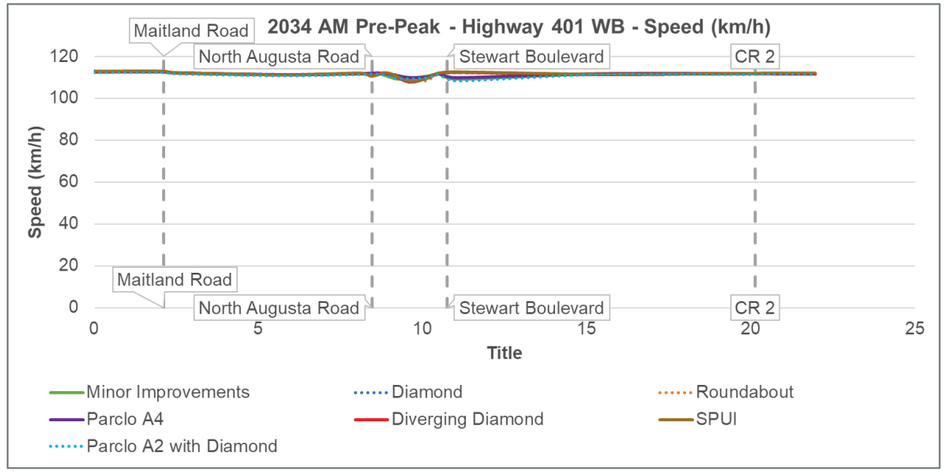

Exhibit H-4: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 AM Pre-Peak Hour

Appendix H:2034 Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

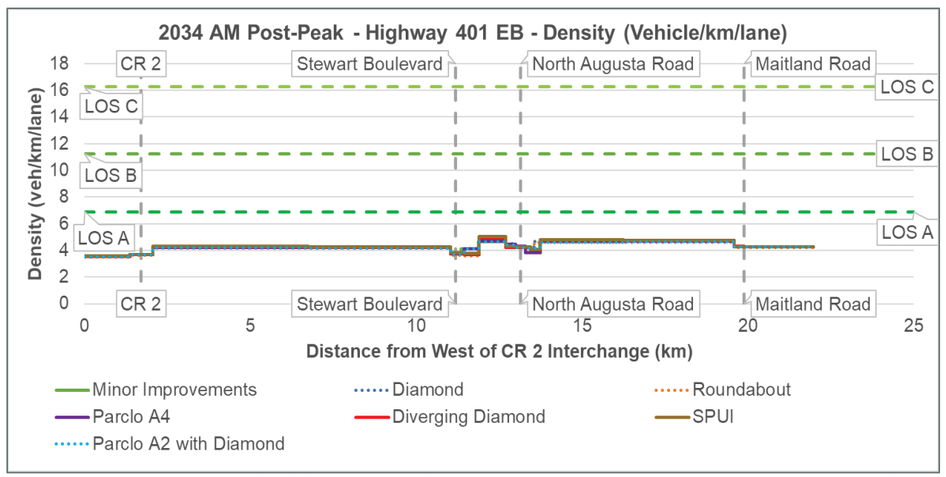

Exhibit H-5: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 AM Post-Peak Hour

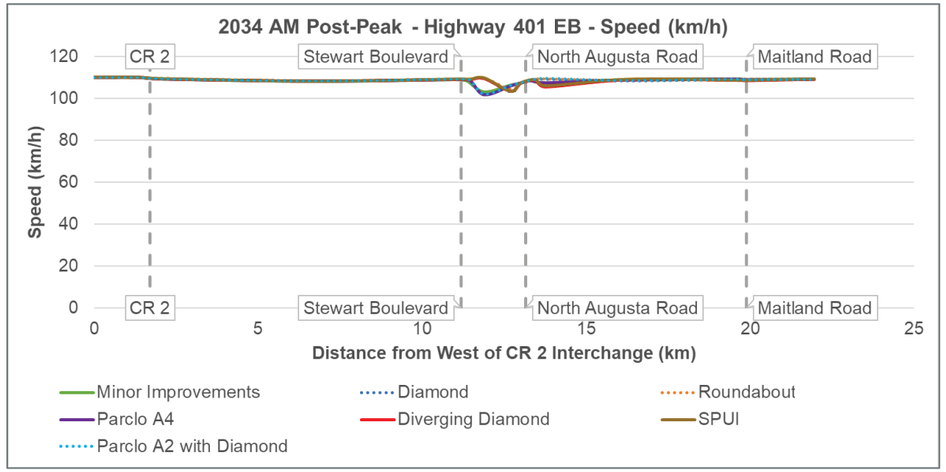

Exhibit H-6: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 AM Post-Peak Hour

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

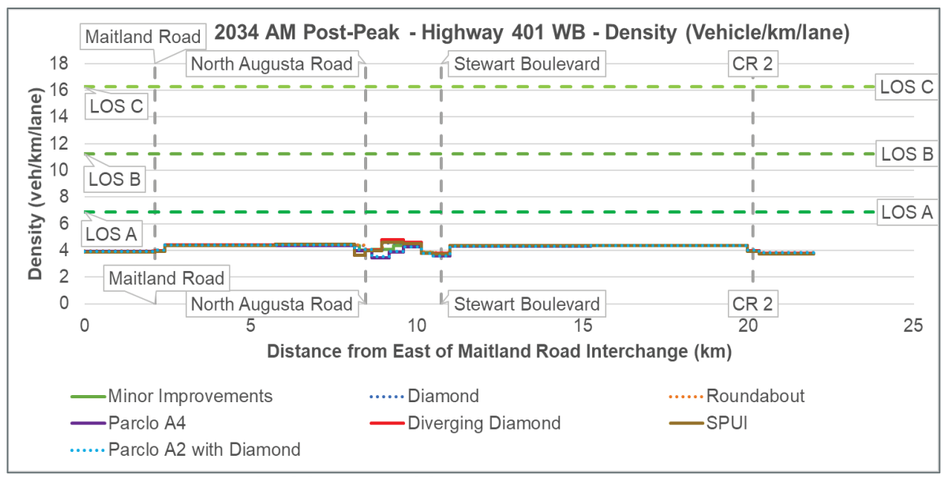

Exhibit H-7: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 AM Post-Peak Hour

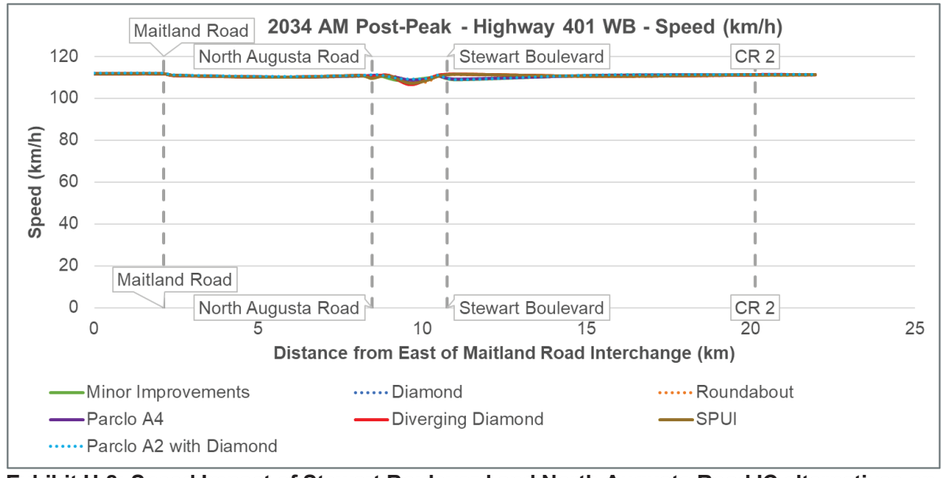

Exhibit H-8: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 AM Post-Peak Hour

Appendix H:2034 Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

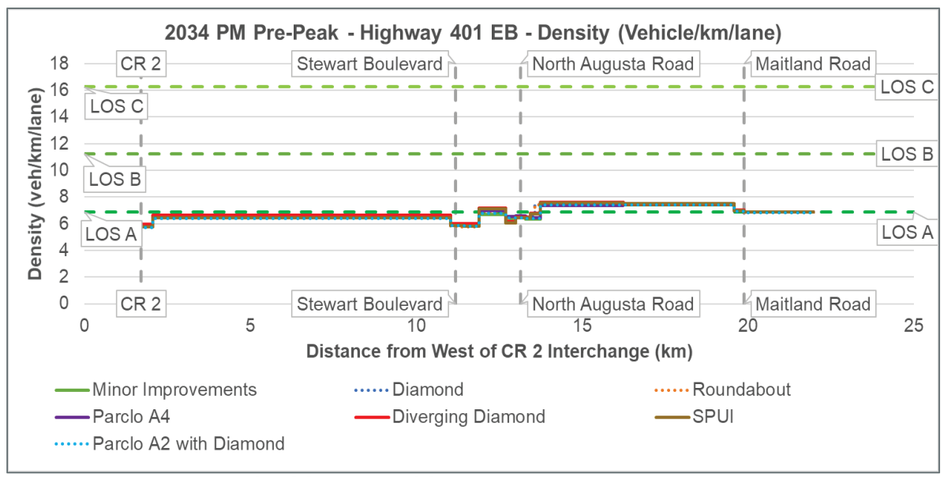

Exhibit H-9: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 PM Pre-Peak Hour

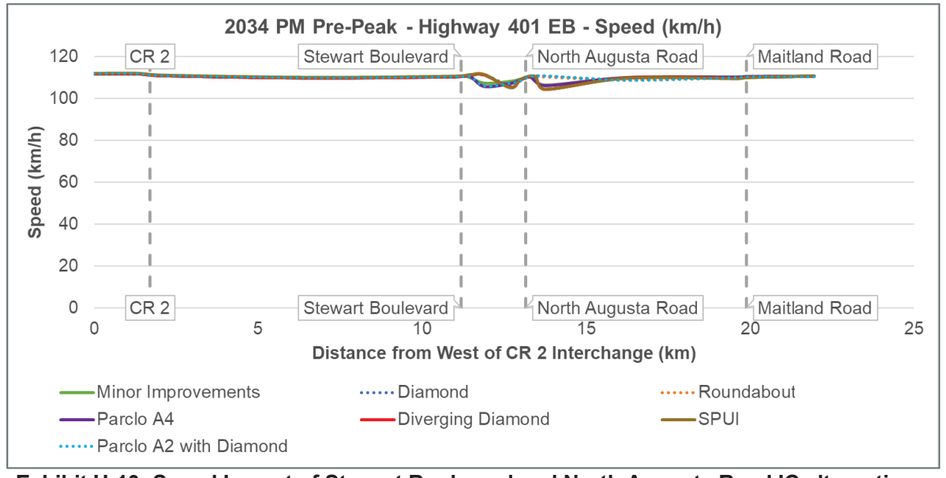

Exhibit H-10: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 PM Pre-Peak Hour

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

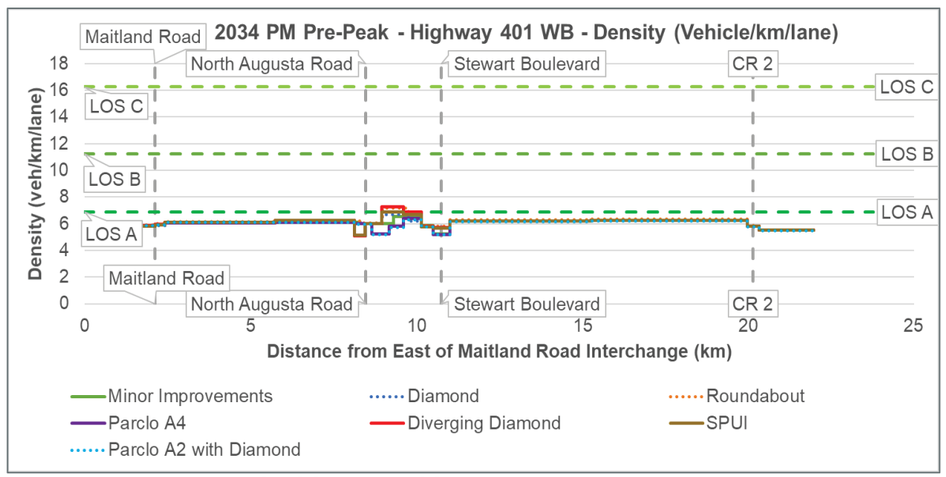

Exhibit H-11: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 PM Pre-Peak Hour

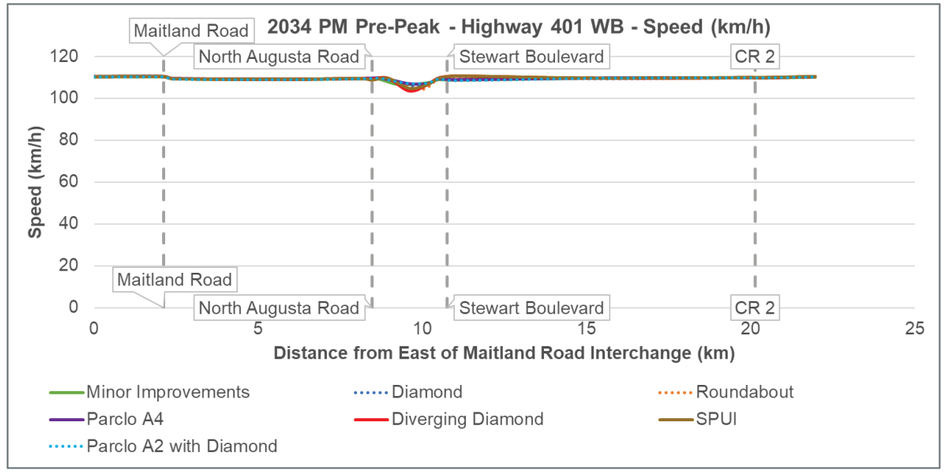

Exhibit H-12: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 PM Pre-Peak Hour

Appendix H:2034 Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

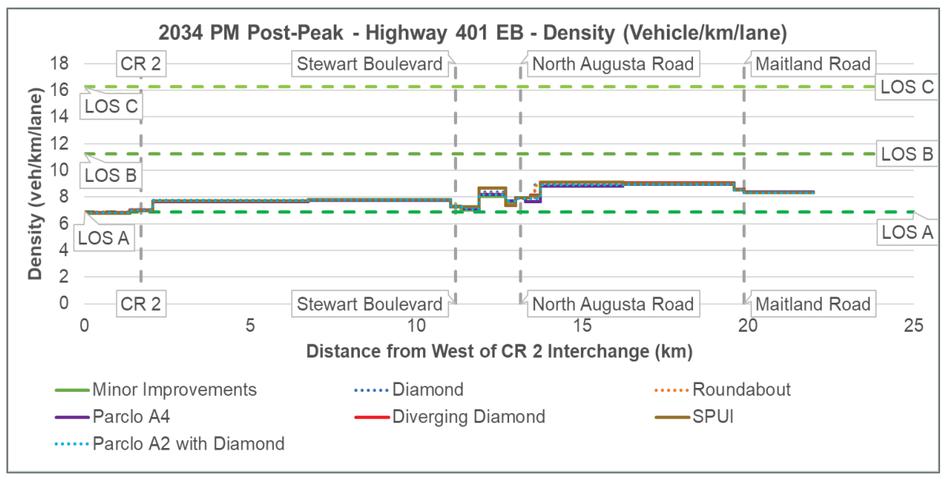

Exhibit H-13: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 PM Post-Peak Hour

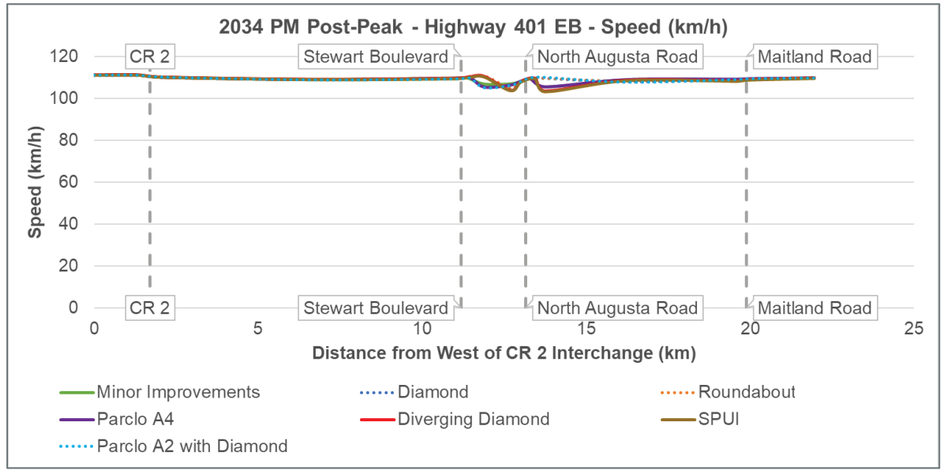

Exhibit H-14: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 PM Post-Peak Hour

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

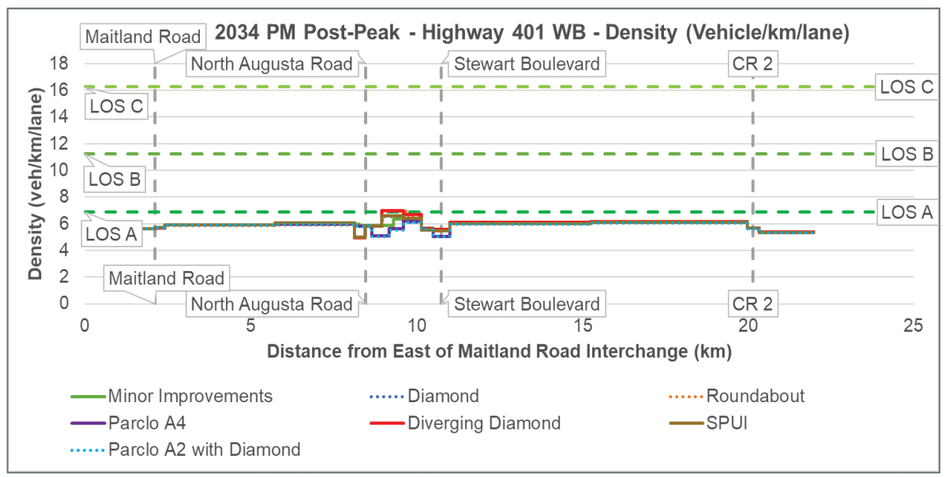

Exhibit H-15: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 PM Post-Peak Hour

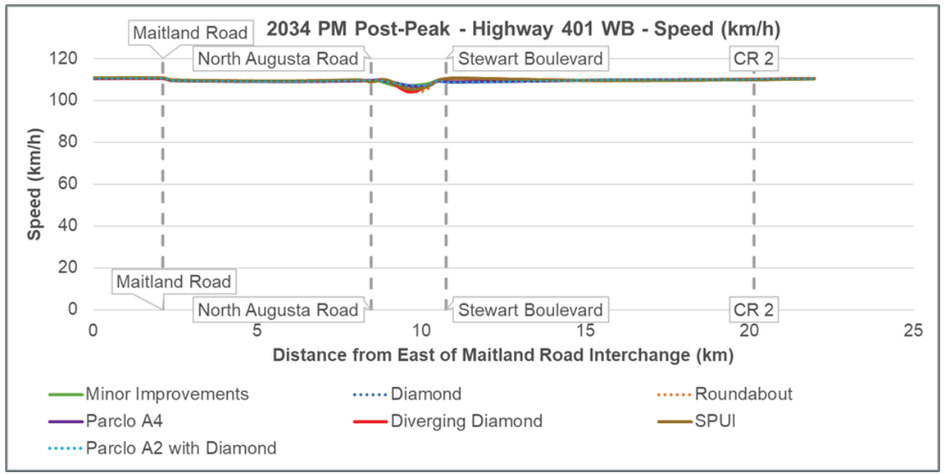

Exhibit H-16: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 PM Post-Peak Hour

Appendix H:2034 Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

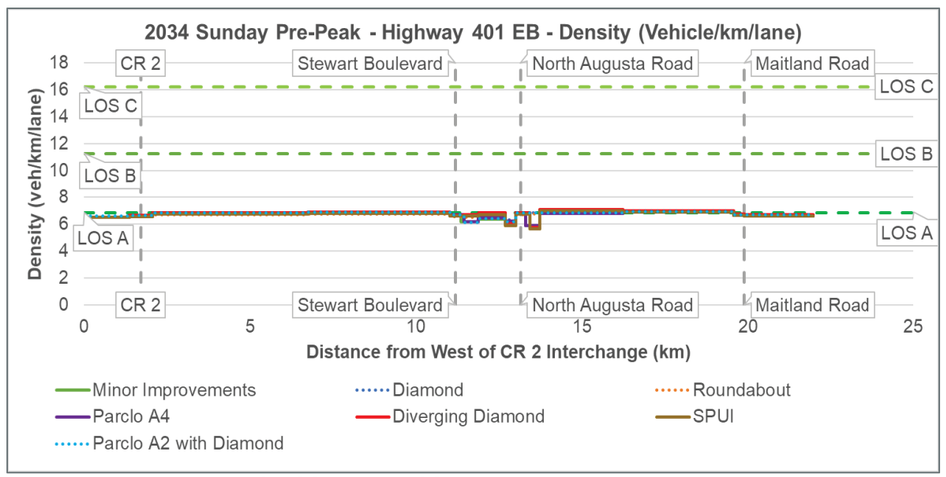

Exhibit H-17: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 Sunday Pre-Peak Hour

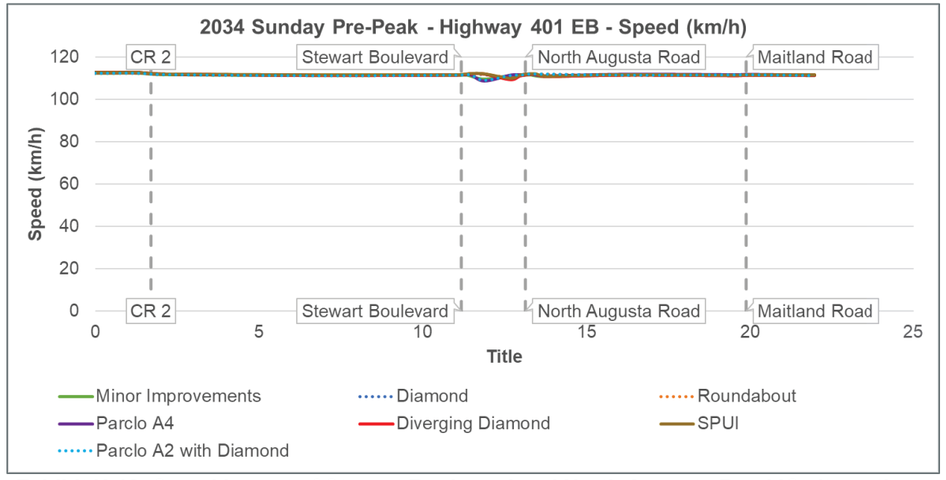

Exhibit H-18: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 Sunday Pre-Peak Hour

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

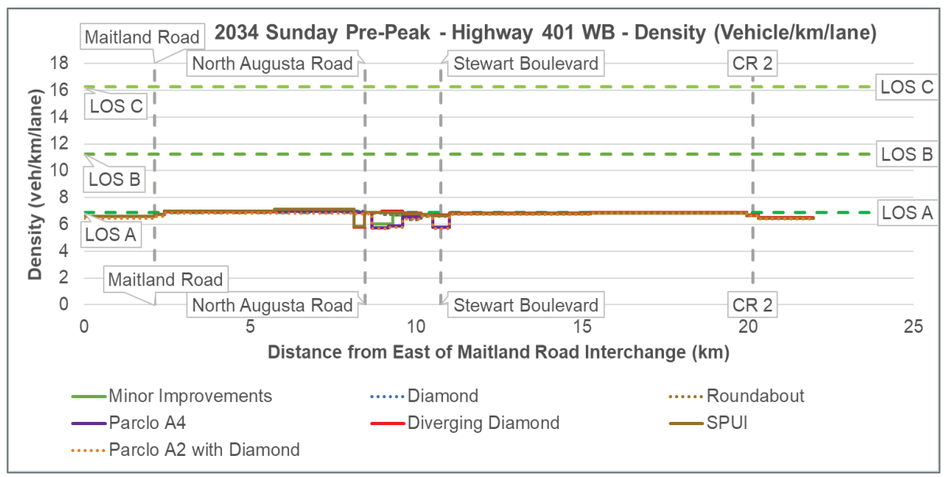

Exhibit H-19: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 Sunday Pre-Peak Hour

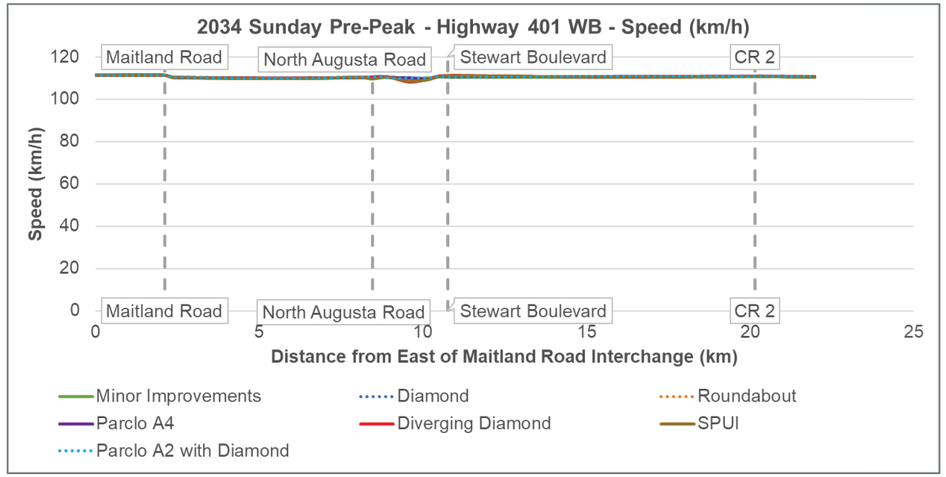

Exhibit H-20: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 Sunday Pre-Peak Hour

Appendix H:2034 Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

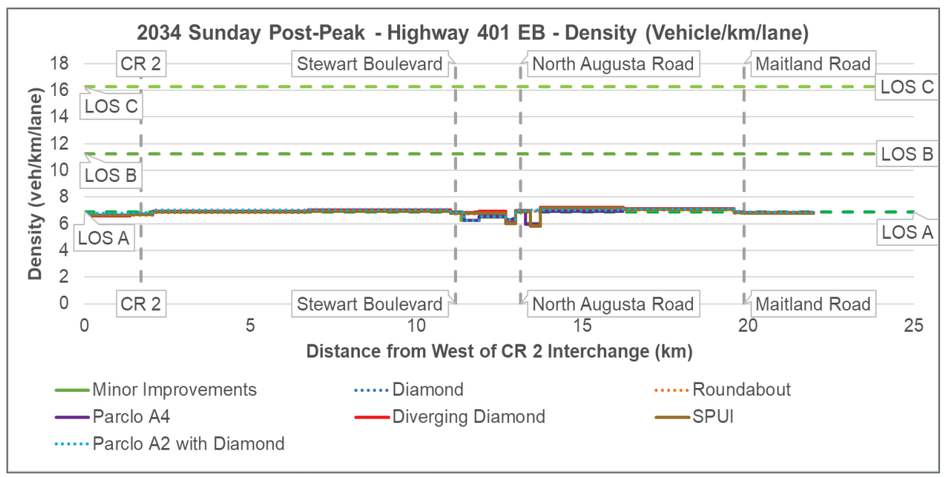

Exhibit H-21: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 Sunday Post-Peak Hour

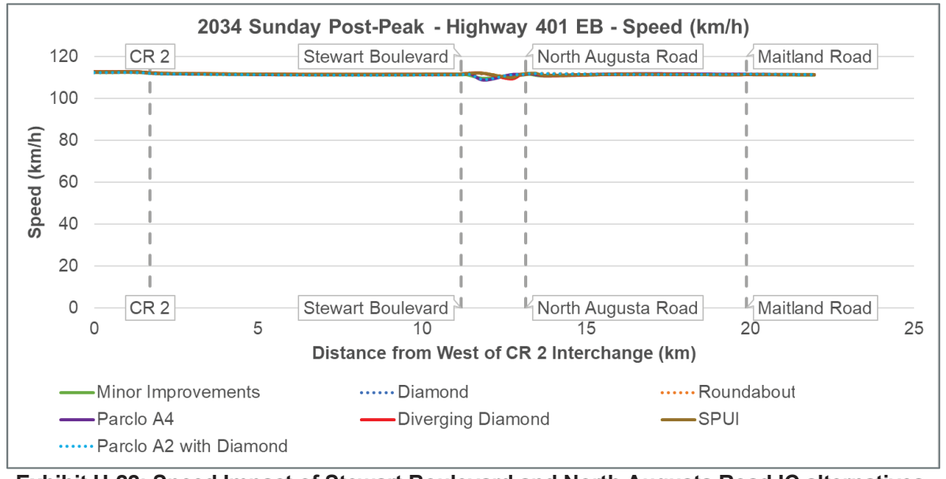

Exhibit H-22: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2034 Sunday Post-Peak Hour

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

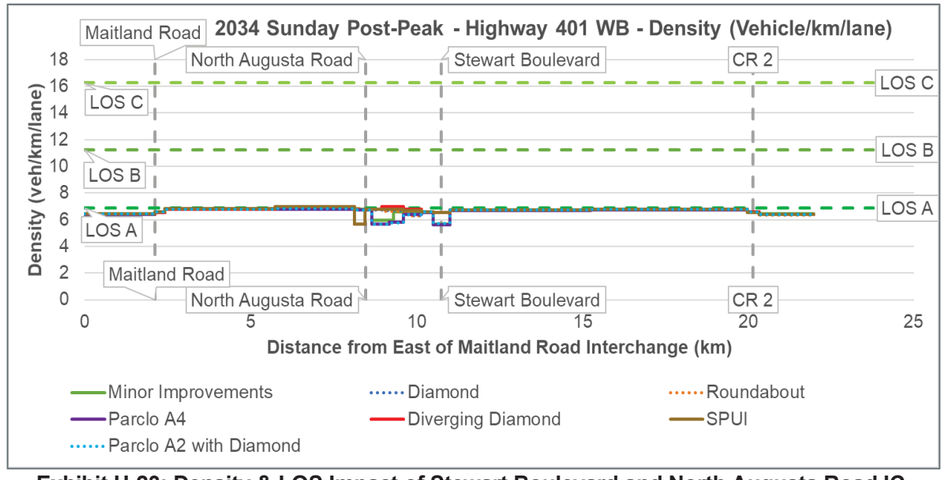

Exhibit H-23: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 Sunday Post-Peak Hour

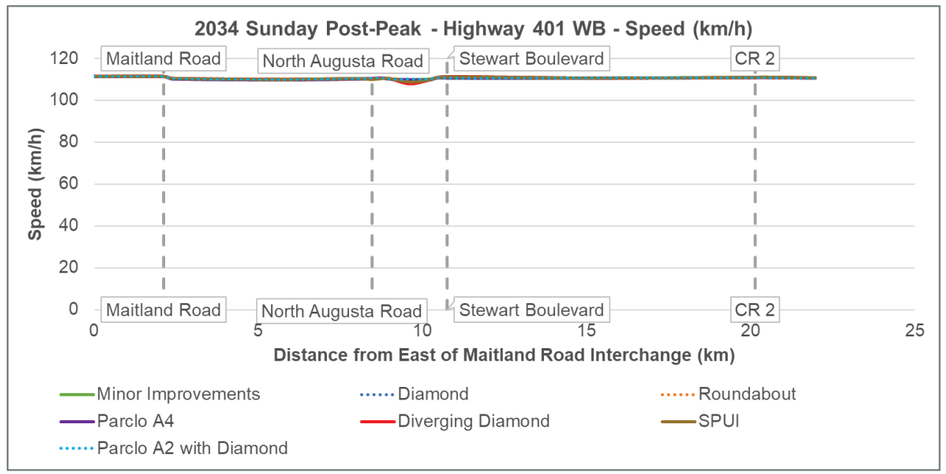

Exhibit H-24: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2034 Sunday Post-Peak Hour

Appendix I: 2044 Stewart Boulevard – Intersection Operations

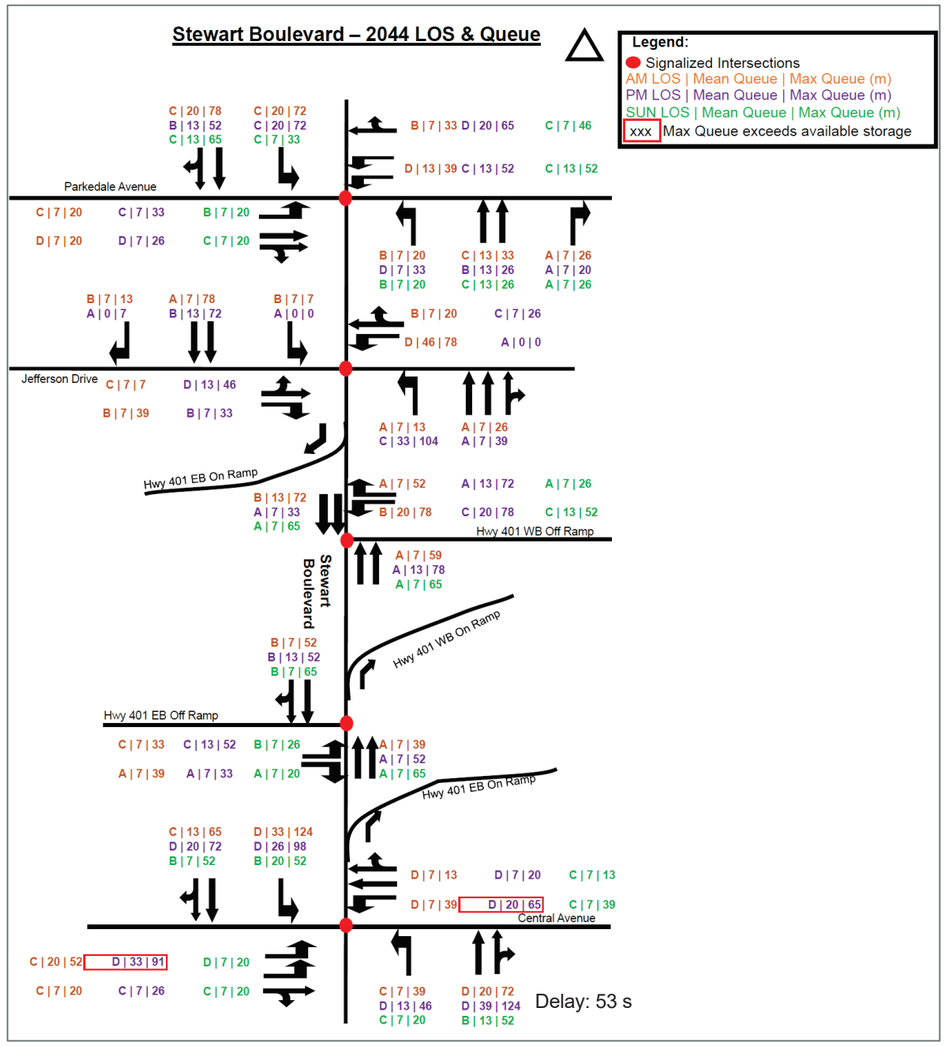

Exhibit I-1: 2044 – Stewart Boulevard Minor Improvement Interchange - Intersection Operations

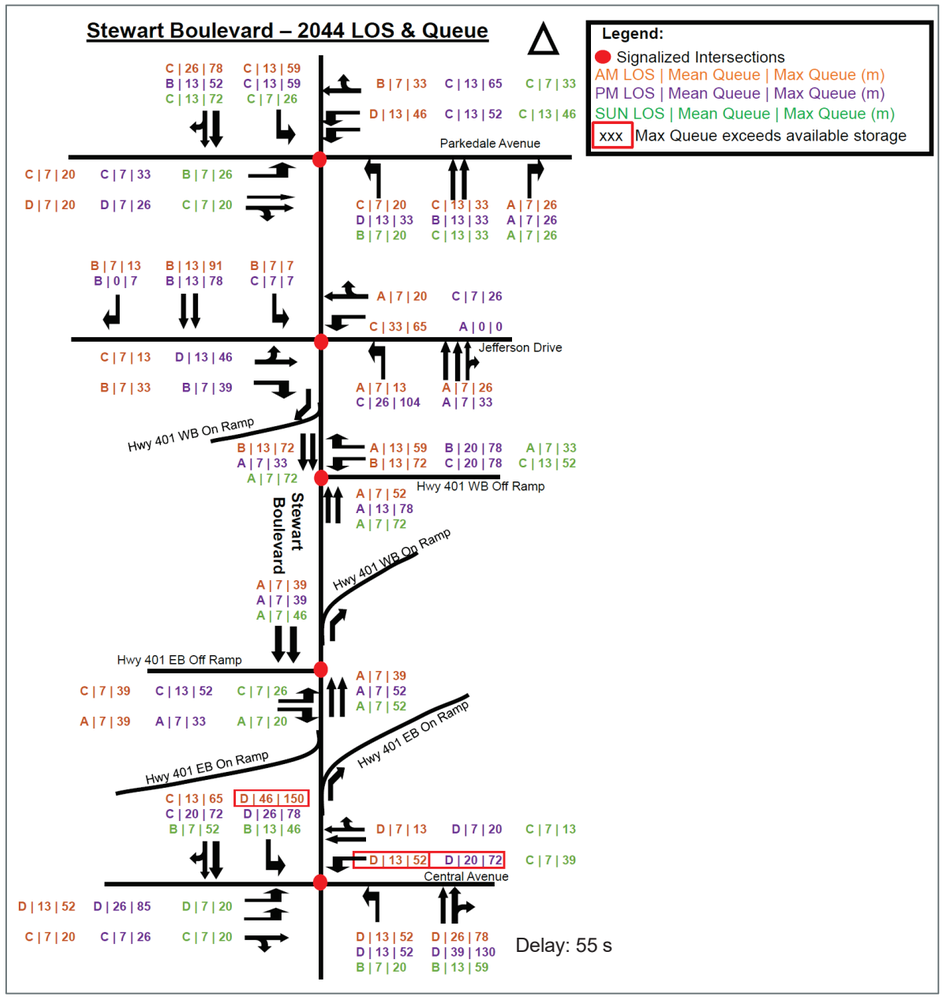

Exhibit I-2: 2044 – Stewart Boulevard Parclo A4 Interchange - Intersection Operations

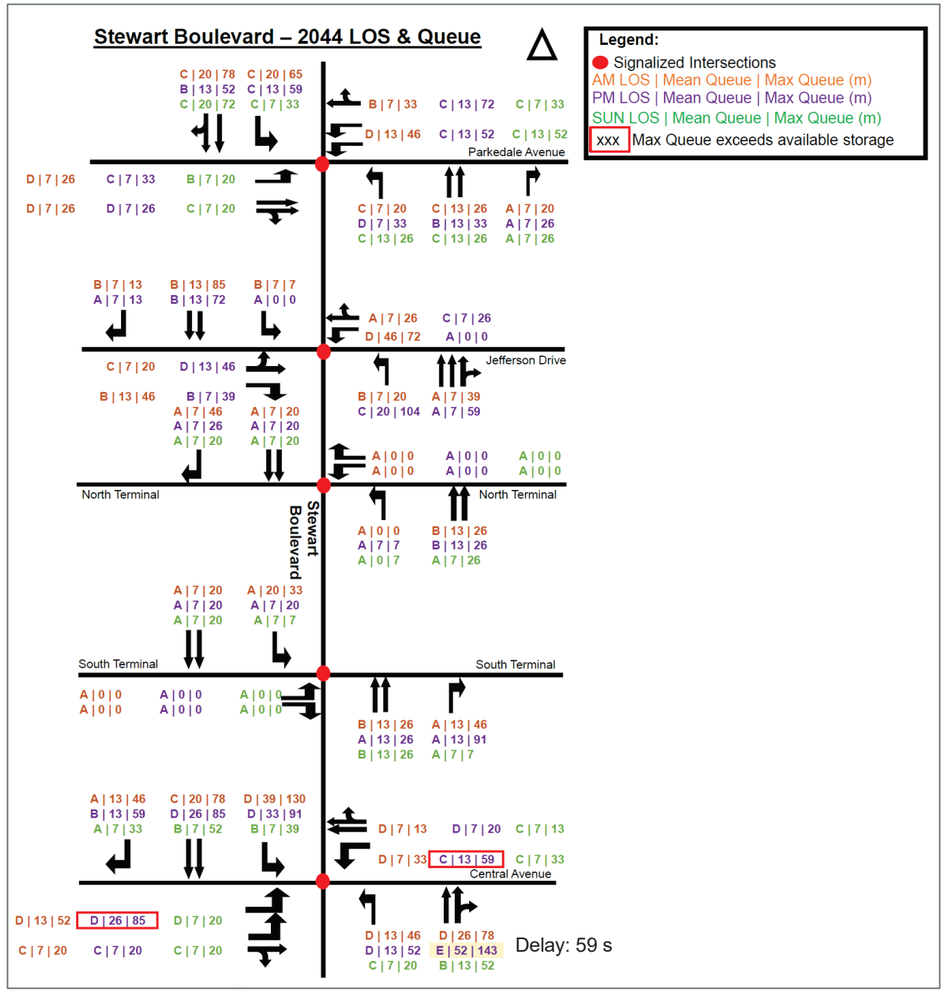

Exhibit I-3: 2044 – Stewart Boulevard Diverging Diamond Interchange - Intersection Operations

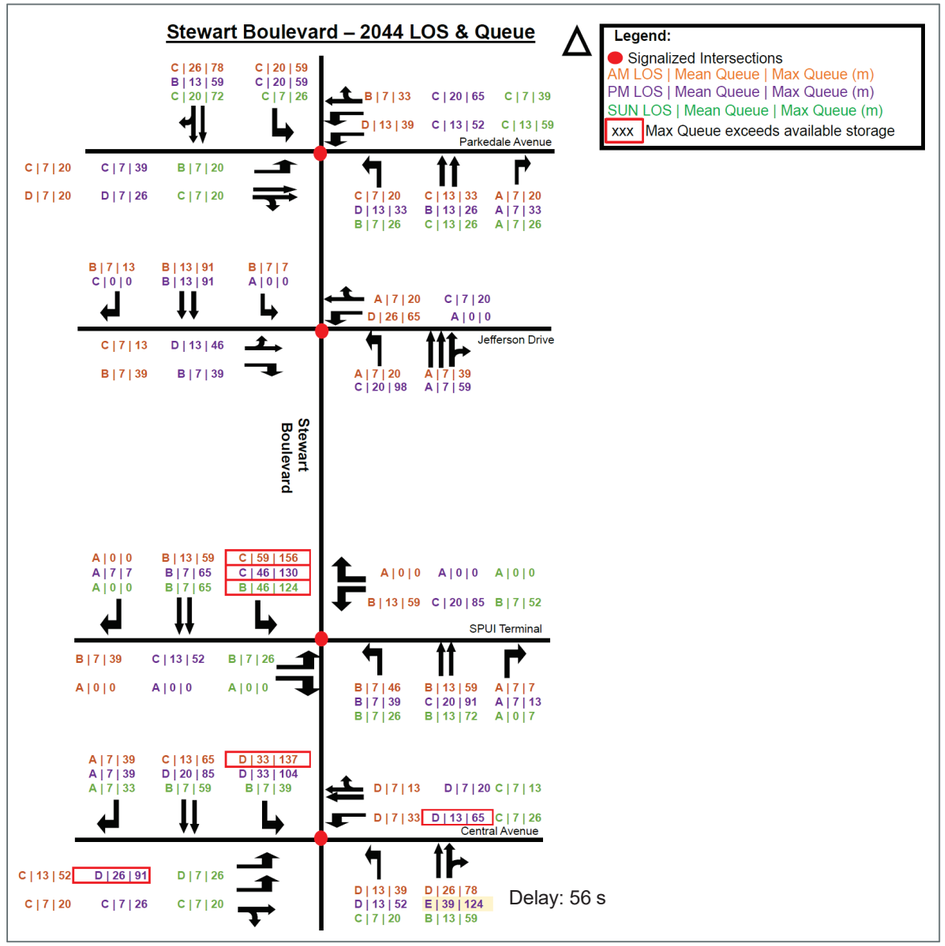

Exhibit I-4: 2044 – Stewart Boulevard SPUI - Intersection Operations

Appendix J: 2044 North Augusta Road – Intersection Operations

Appendix J:2044 North Augusta Road – Intersection Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

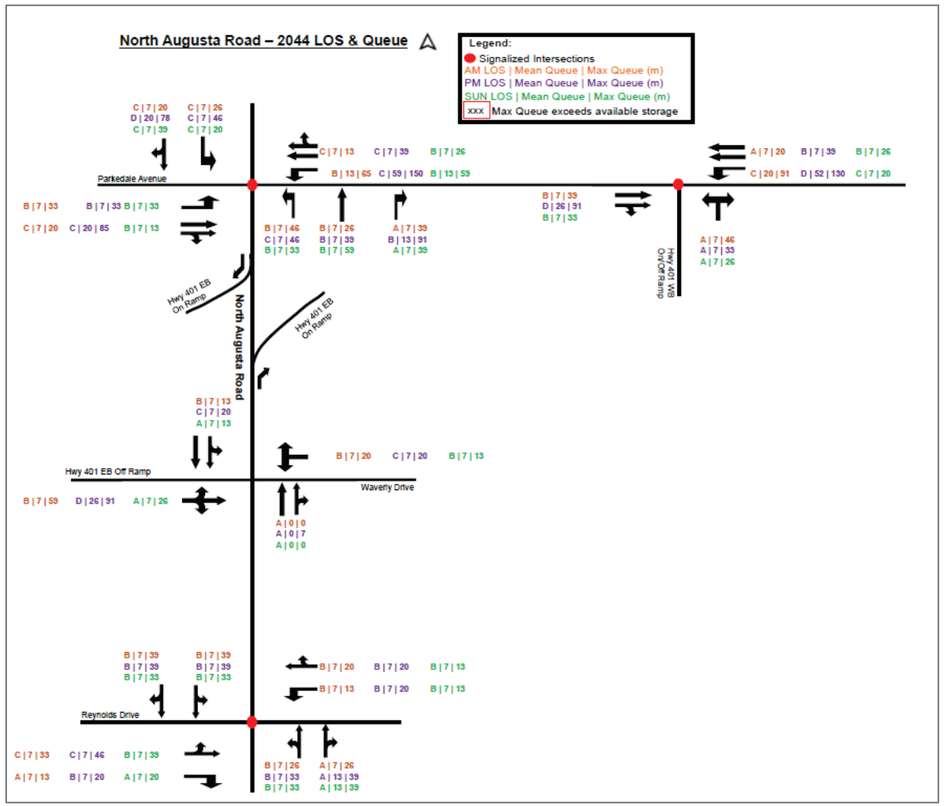

Exhibit J-1: 2044 – North Augusta Road Minor Improvement Interchange - Intersection Operations

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

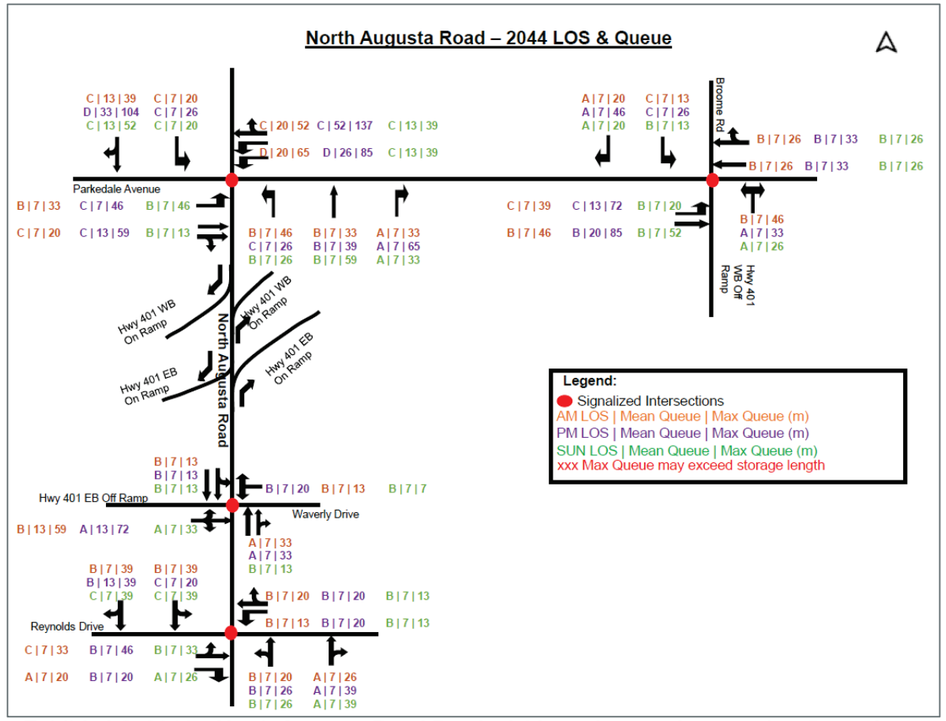

Exhibit J-2: 2044 – North Augusta Road Parclo A4 Interchange - Intersection Operations

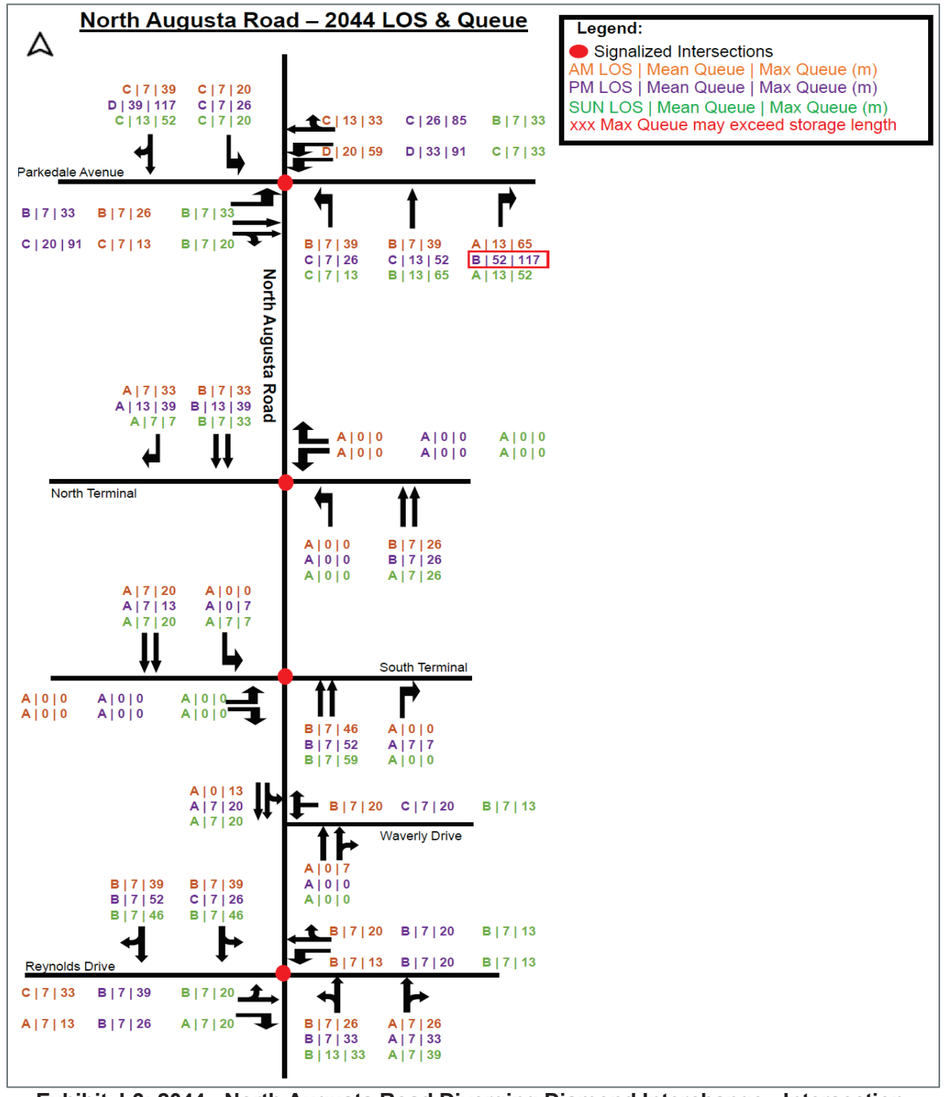

Exhibit J-3: 2044 - North Augusta Road Diverging Diamond Interchange - Intersection Operations

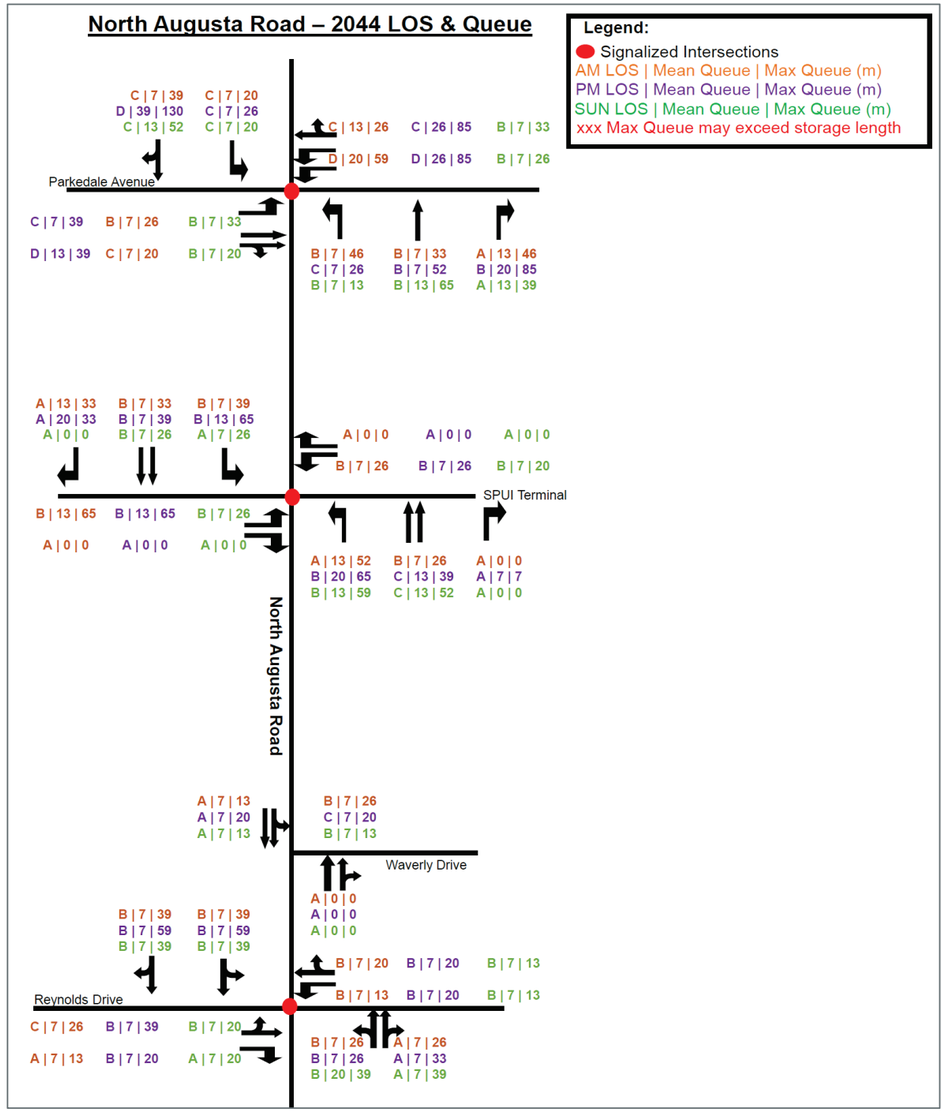

Exhibit J-4: 2044 - North Augusta Road SPUI - Intersection Operations

Appendix J:2044 North Augusta Road – Intersection Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

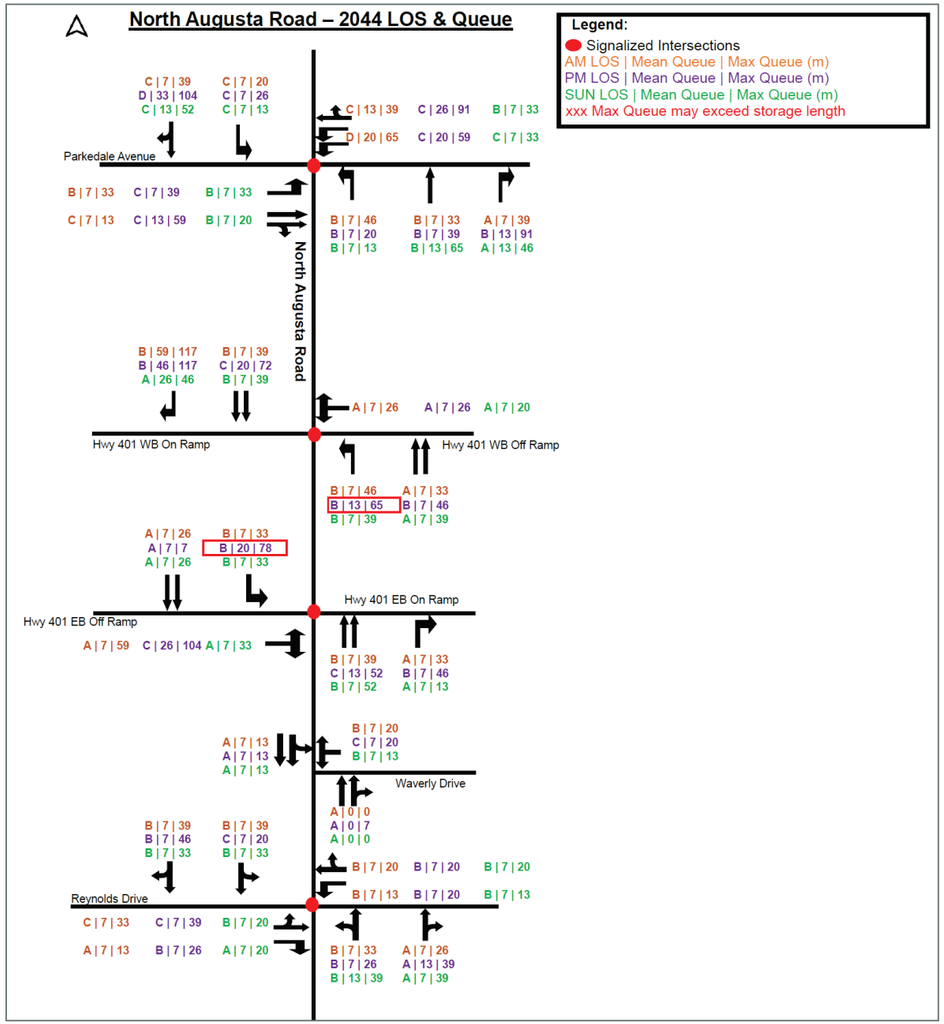

Exhibit J-5: 2044 - North Augusta Road Diamond Interchange - Intersection Operations

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

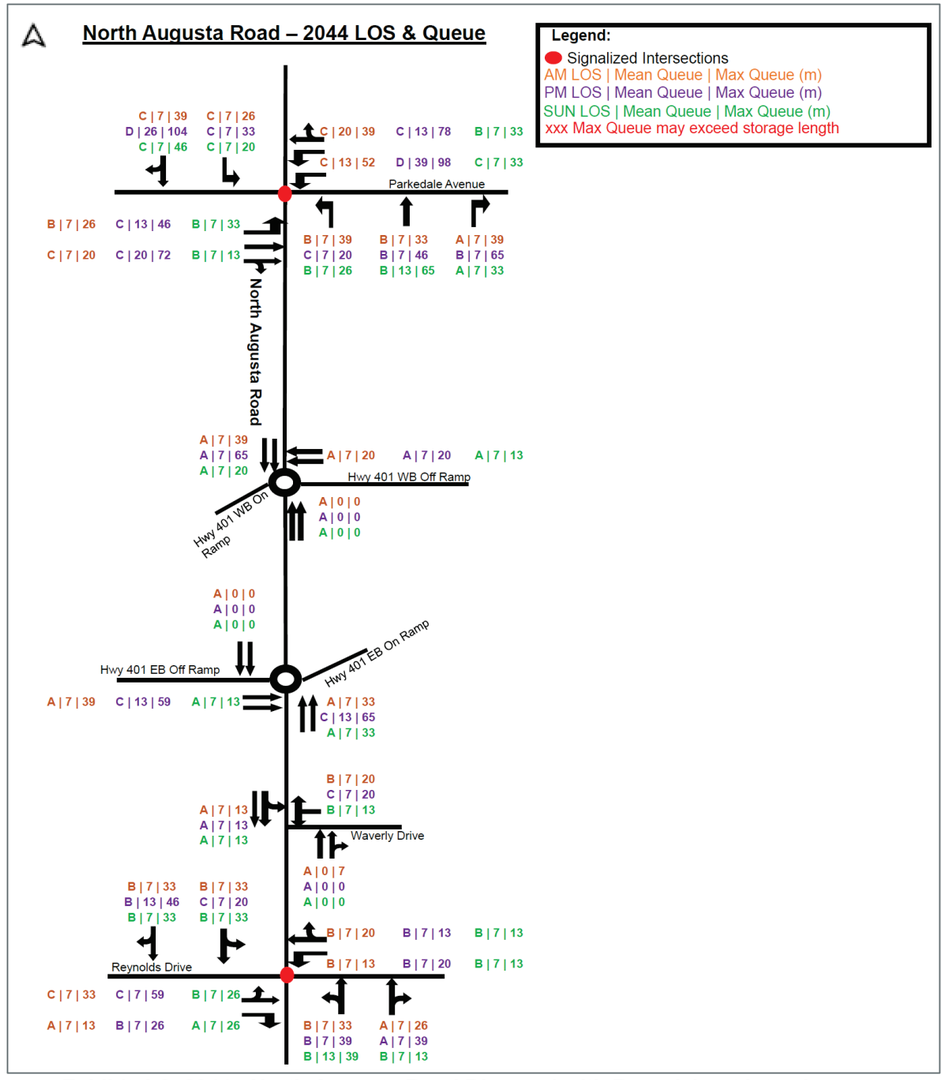

Exhibit J-6: 2044 - North Augusta Road Diamond with Roundabout Interchange - Intersection Operations

Appendix J:2044 North Augusta Road – Intersection Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

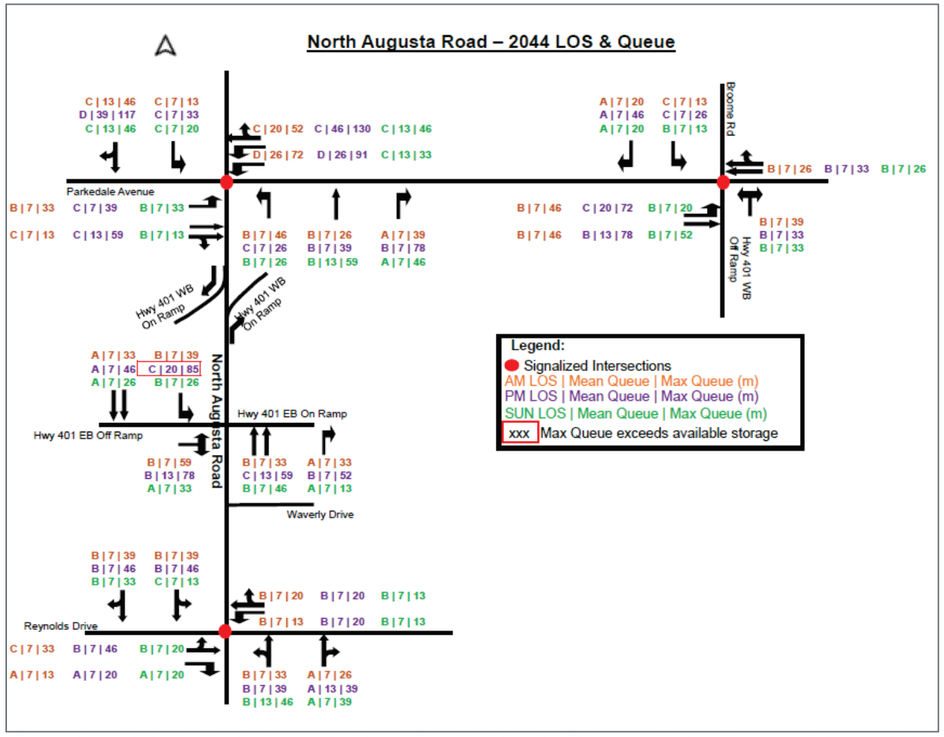

Exhibit J-7: 2044 - North Augusta Road Parclo A2 with Diamond Interchange - Intersection Operations

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

Appendix K: 2044 Highway Mainline Operations

Appendix K:2044 Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

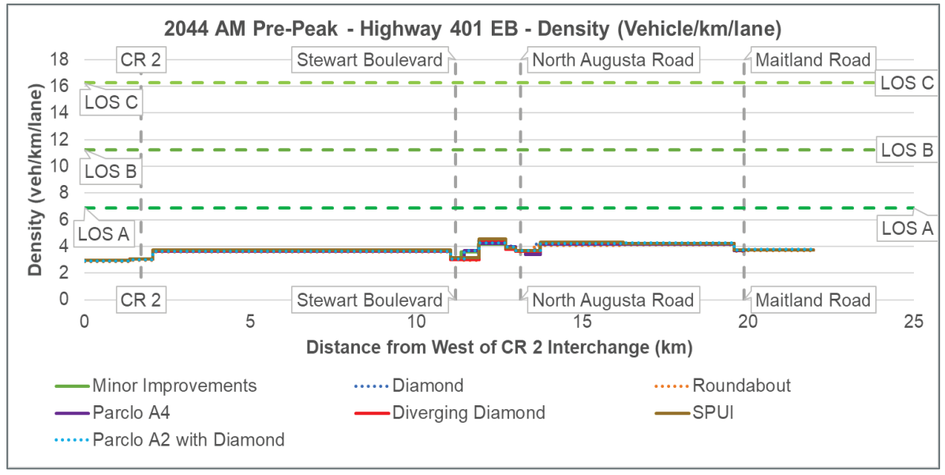

Exhibit K-1: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 AM Pre-Peak Hour

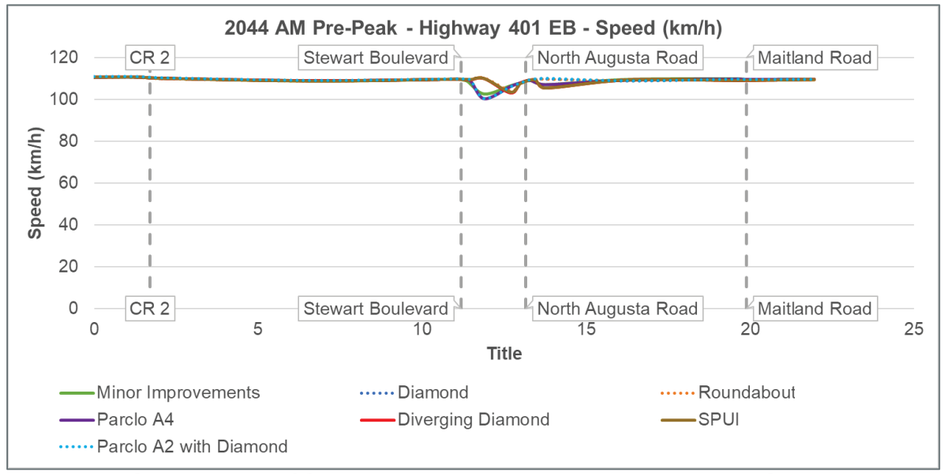

Exhibit K-2: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 AM Pre-Peak Hour

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

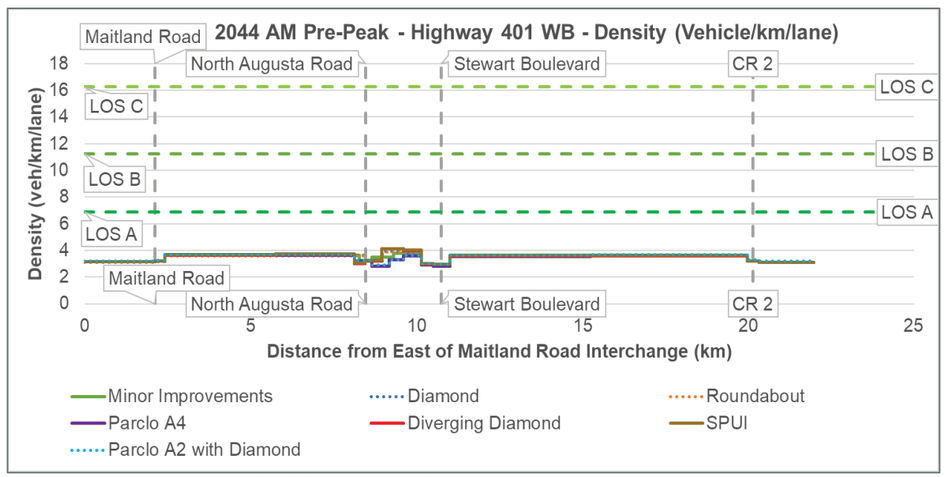

Exhibit K-3: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 AM Pre-Peak Hour

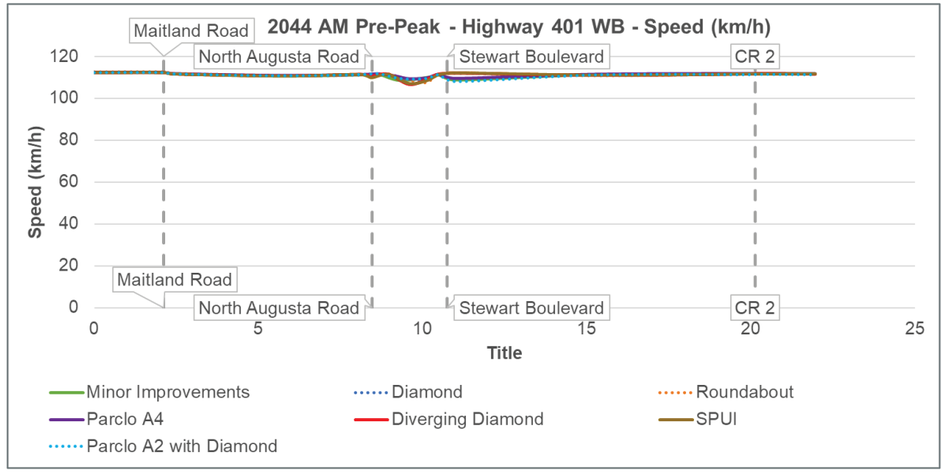

Exhibit K-4: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 AM Pre-Peak Hour

Appendix K:2044 Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

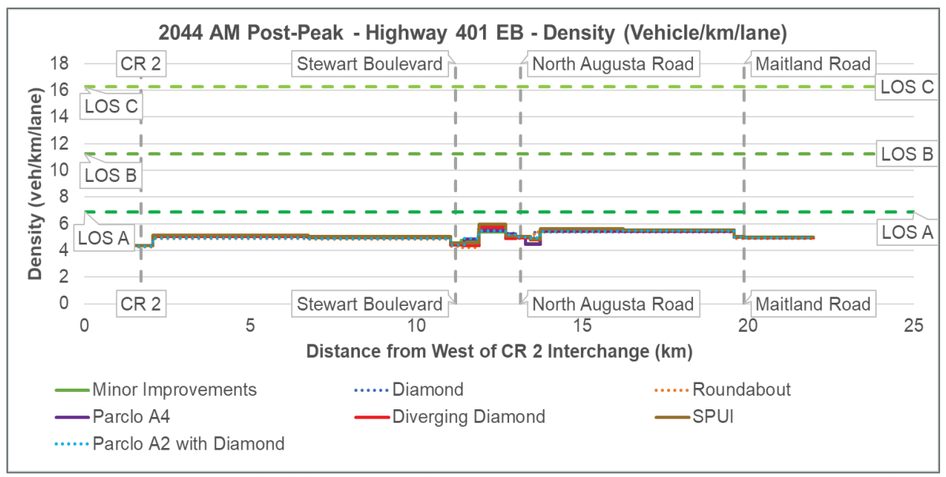

Exhibit K-5: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 AM Post-Peak Hour

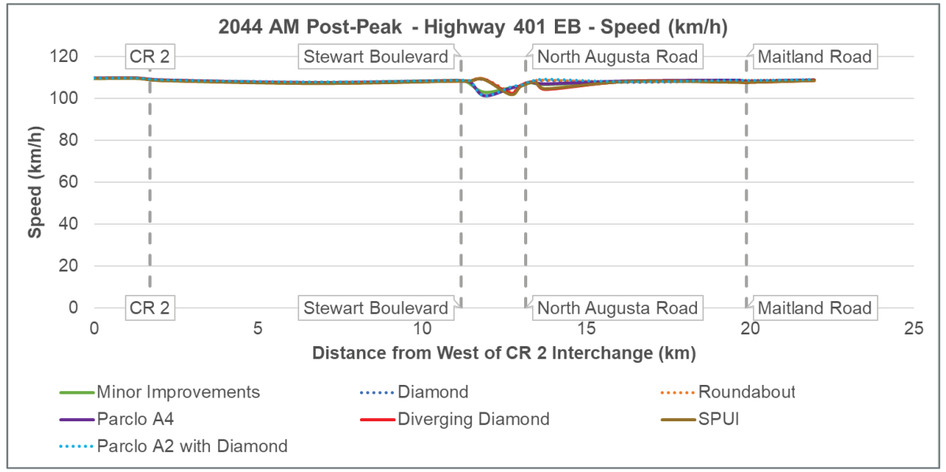

Exhibit K-6: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 AM Post-Peak Hour

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

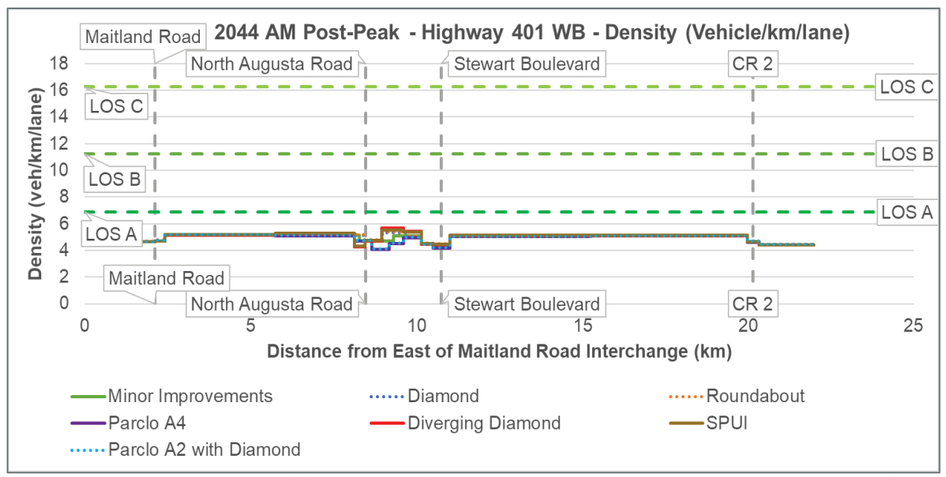

Exhibit K-7: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 AM Post-Peak Hour

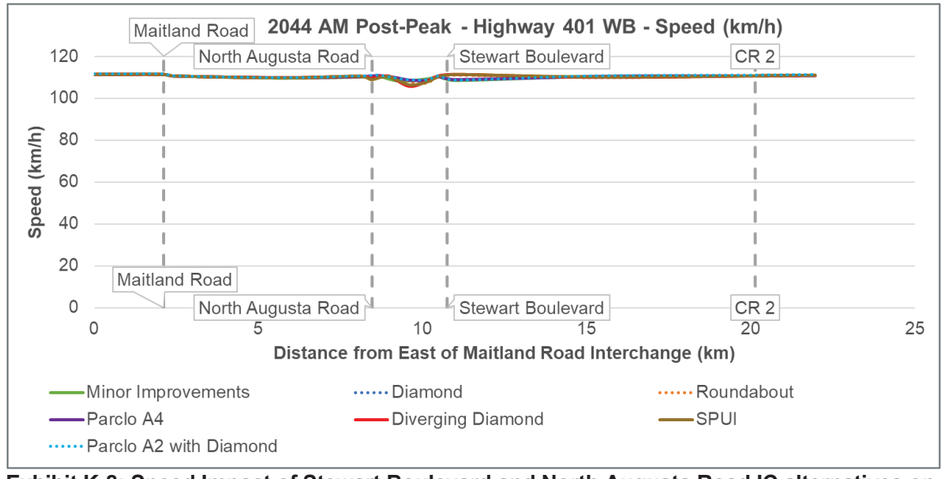

Exhibit K-8: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 AM Post-Peak Hour

Appendix K:2044 Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

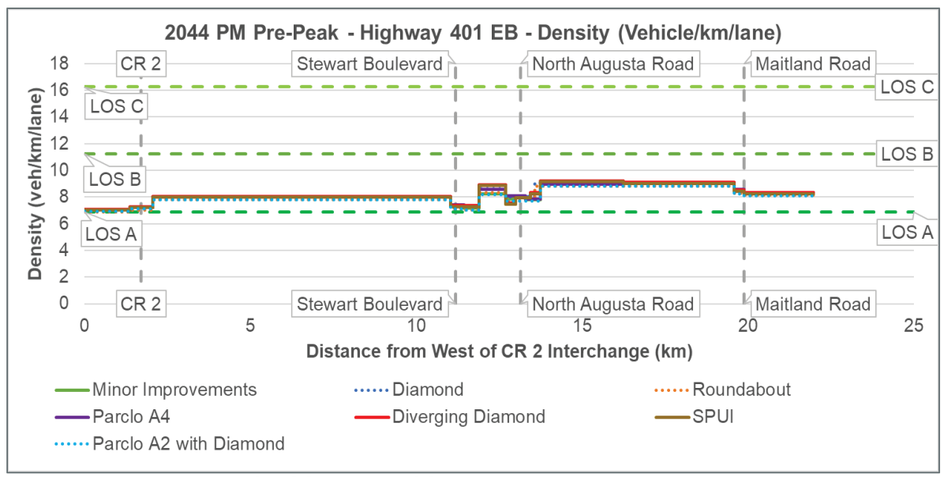

Exhibit K-9: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 PM Pre-Peak Hour

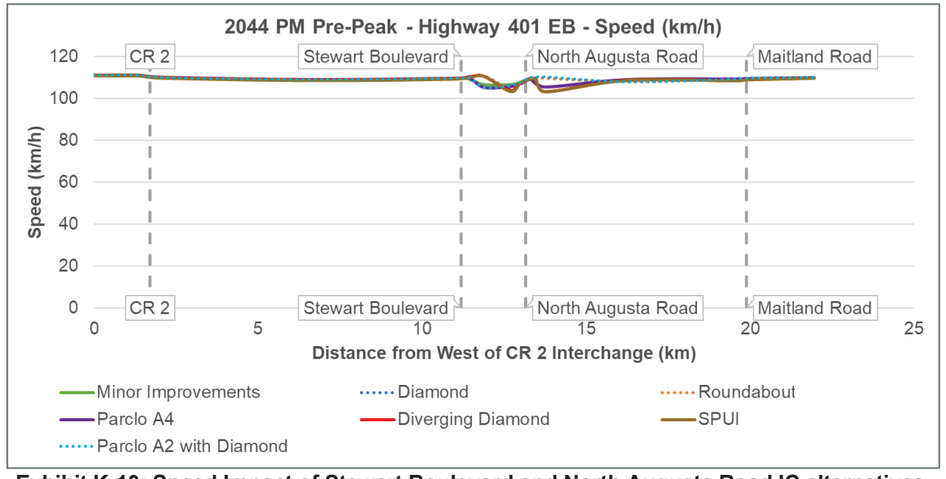

Exhibit K-10: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 PM Pre-Peak Hour

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

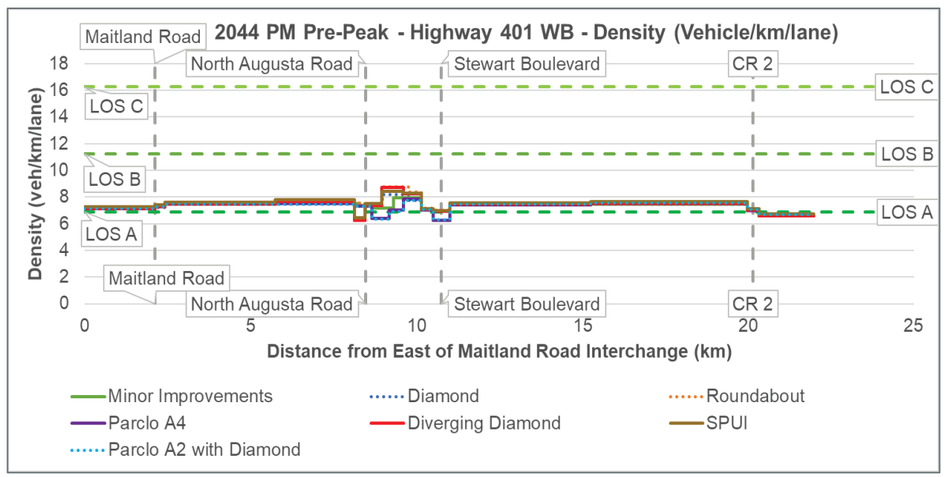

Exhibit K-11: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 PM Pre-Peak Hour

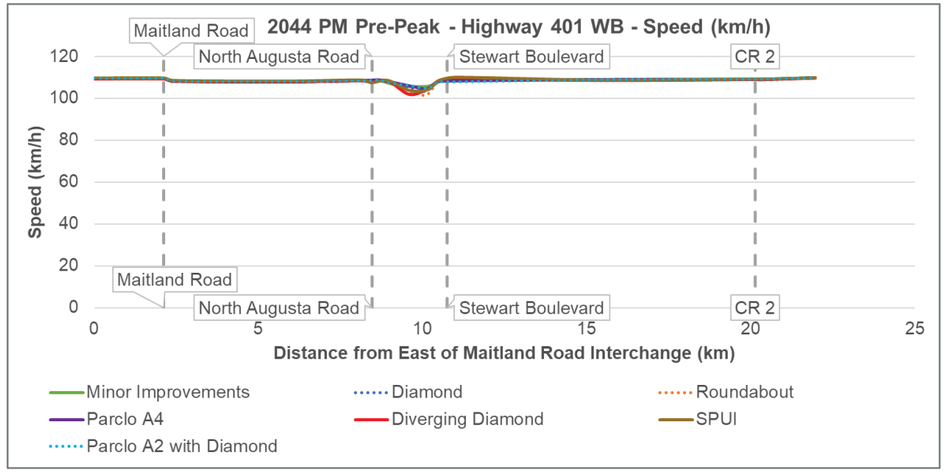

Exhibit K-12: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 PM Pre-Peak Hour

Appendix K:2044 Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

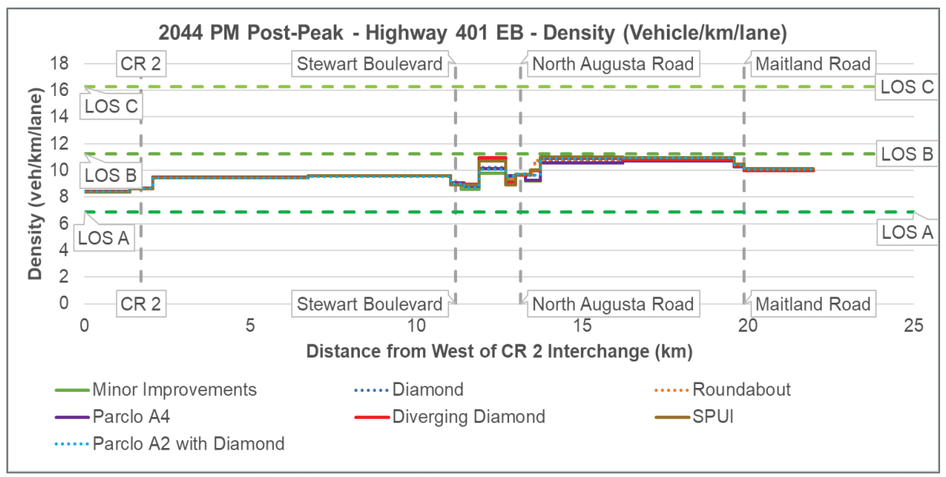

Exhibit K-13: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 PM Post-Peak Hour

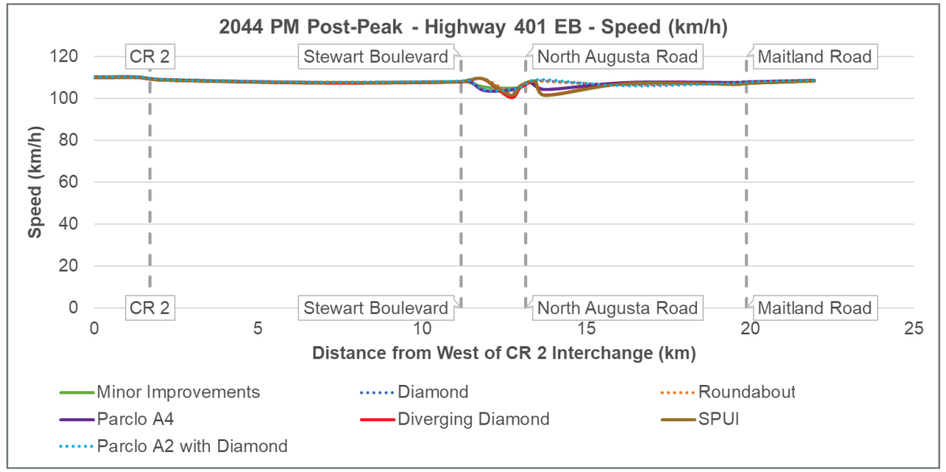

Exhibit K-14: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 PM Post-Peak Hour

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

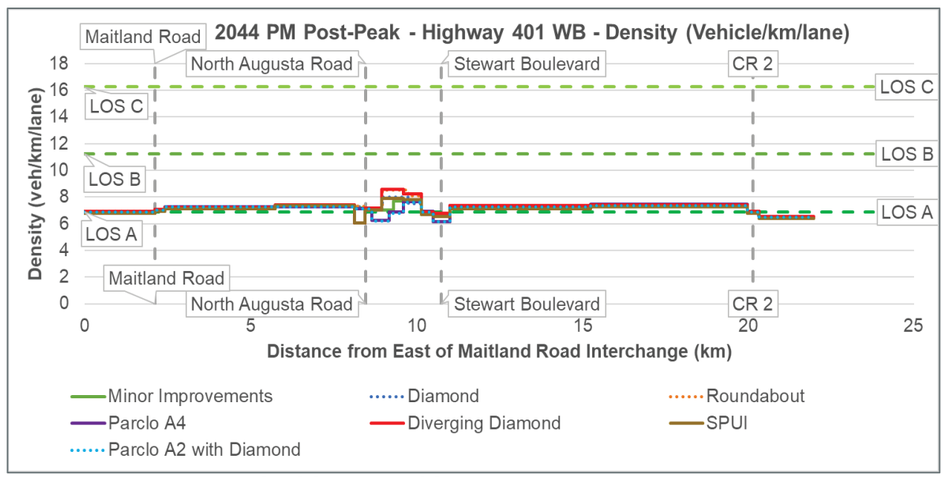

Exhibit K-15: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 PM Post-Peak Hour

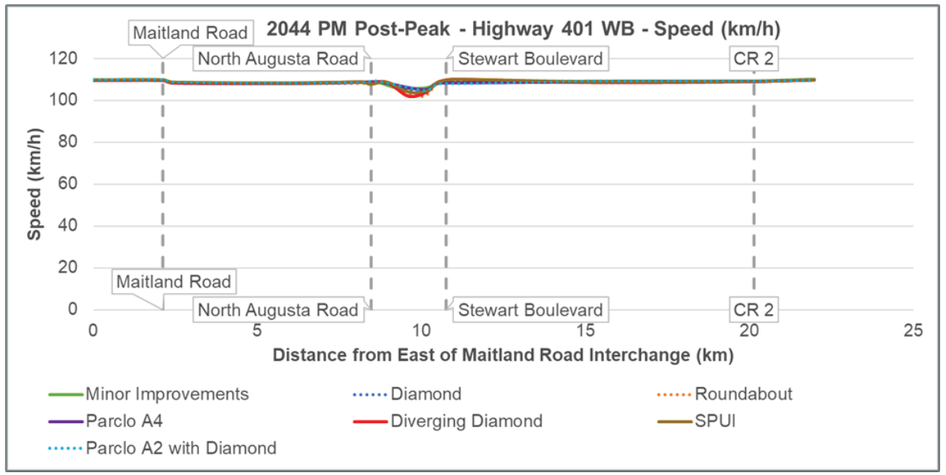

Exhibit K-16: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 PM Post-Peak Hour

Appendix K:2044 Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

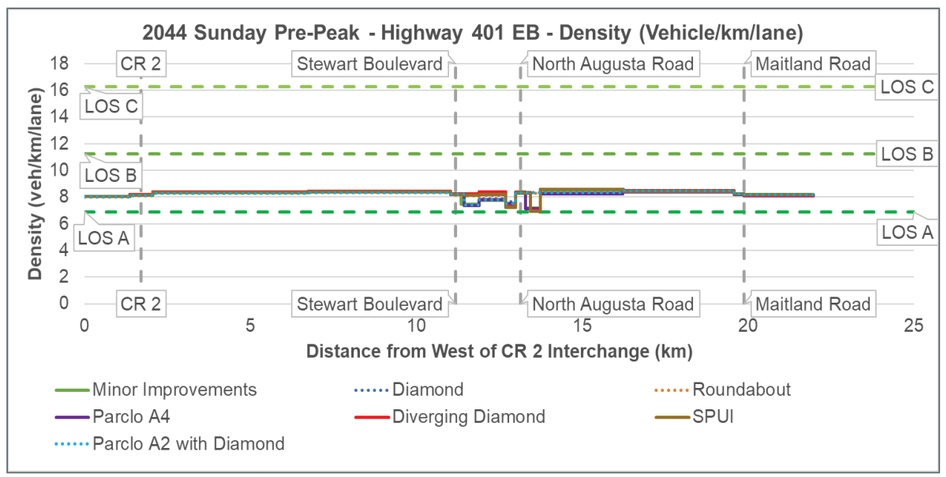

Exhibit K-17: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 Sunday Pre-Peak Hour

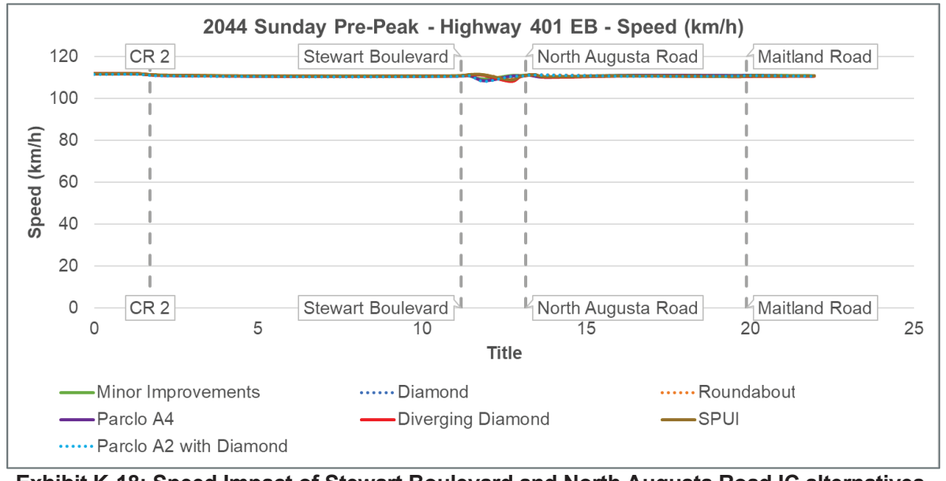

Exhibit K-18: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 Sunday Pre-Peak Hour

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

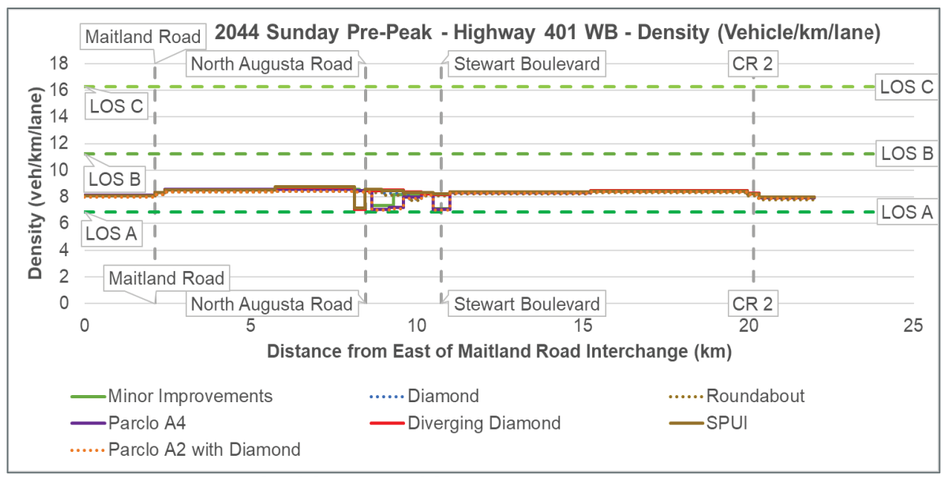

Exhibit K-19: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 Sunday Pre-Peak Hour

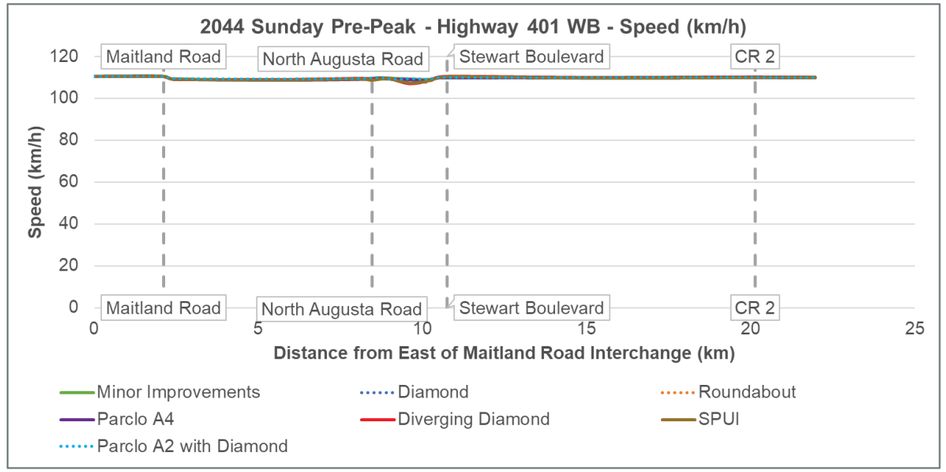

Exhibit K-20: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 Sunday Pre-Peak Hour

Appendix K:2044 Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

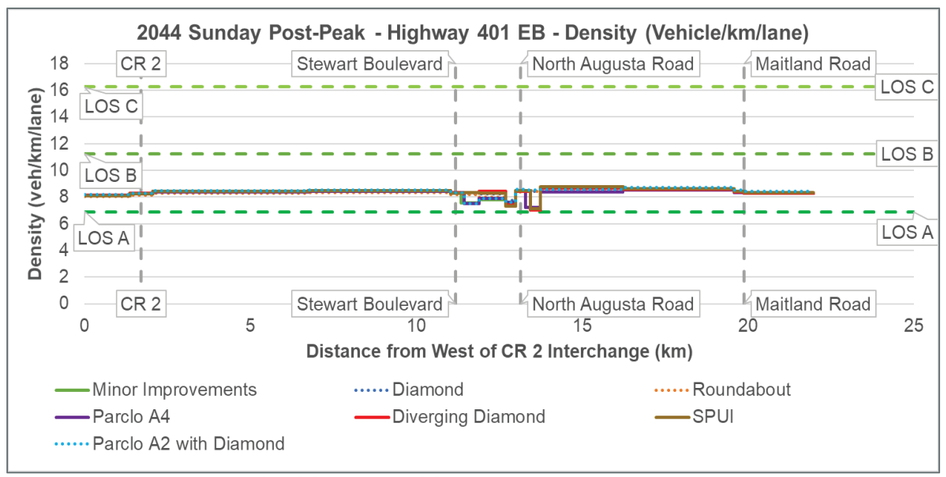

Exhibit K-21: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 Sunday Post-Peak Hour

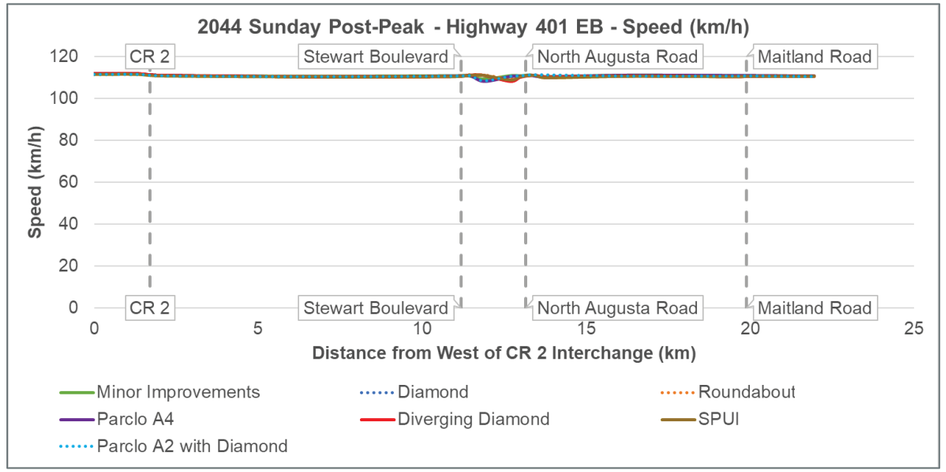

Exhibit K-22: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 EB – 2044 Sunday Post-Peak Hour

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

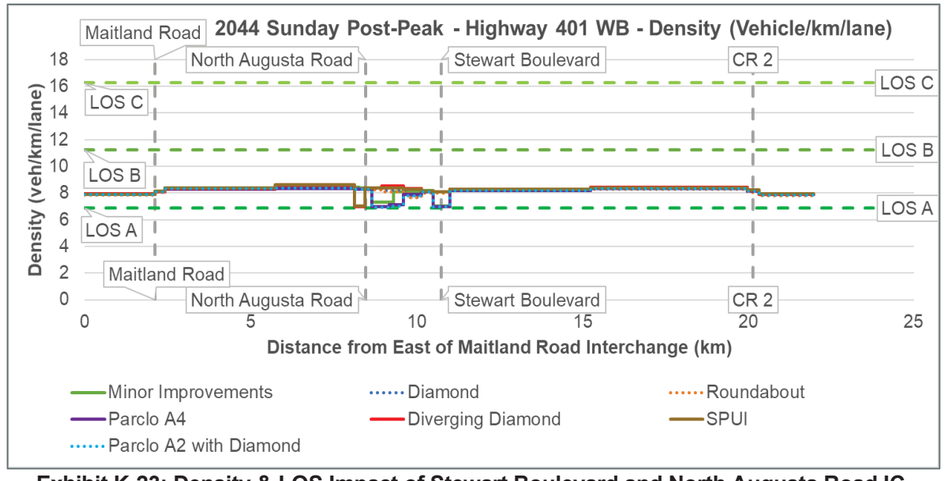

Exhibit K-23: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 Sunday Post-Peak Hour

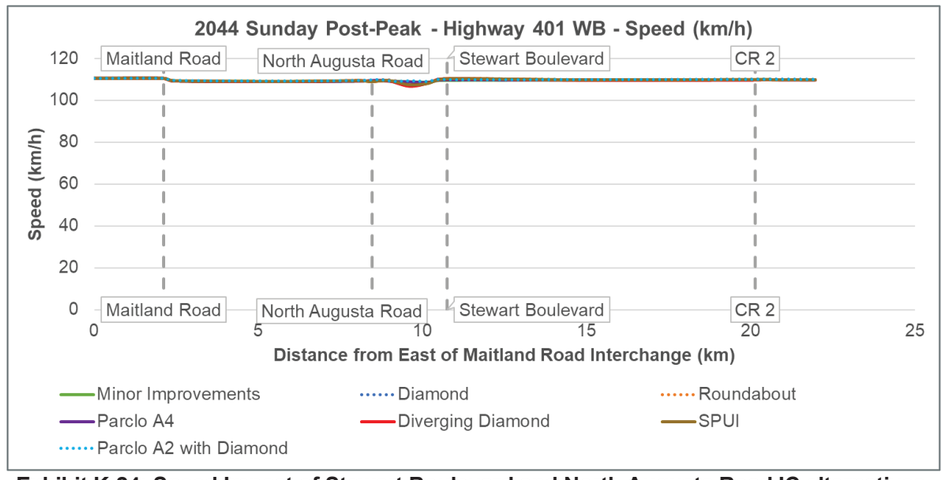

Exhibit K-24: Speed Impact of Stewart Boulevard and North Augusta Road IC alternatives on Highway 401 WB – 2044 Sunday Post-Peak Hour

Appendix L: Preferred Design – Intersection Operations

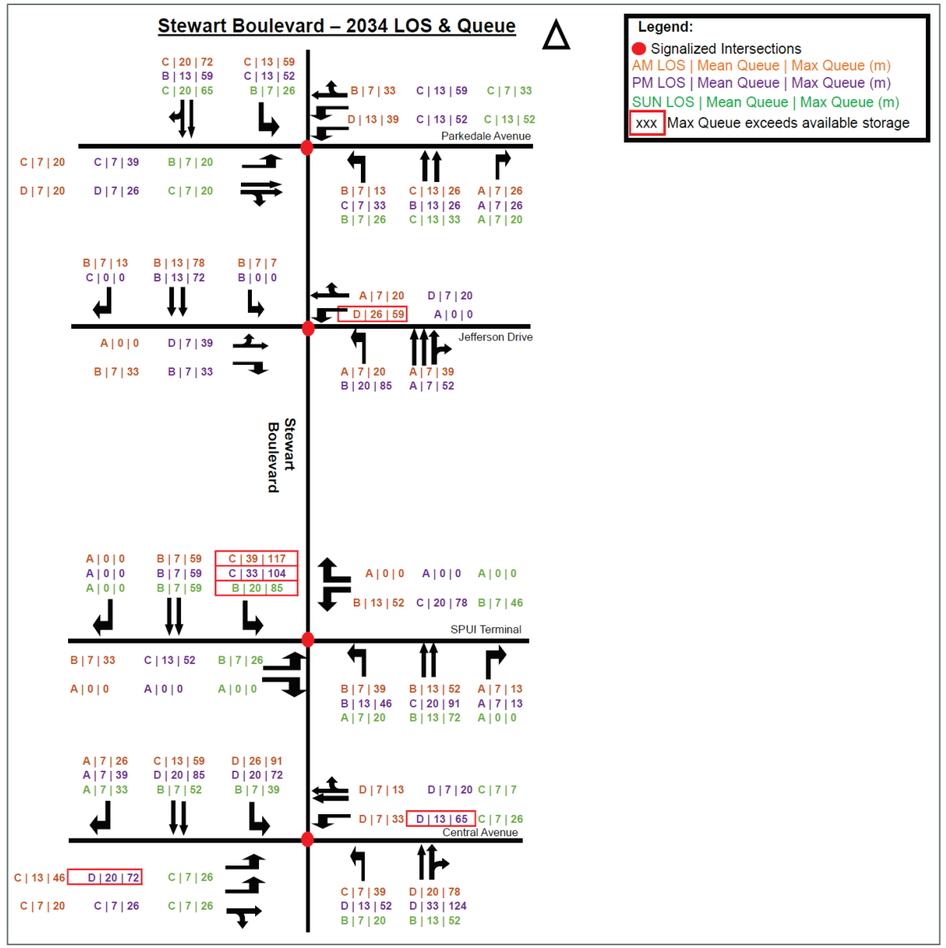

Exhibit L-1: 2034 – Stewart Boulevard Preferred Design (SPUI) – Highway 401 with 6-Lane Cross-Section - Intersection Operations

Appendix L:Preferred Design – Intersection Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

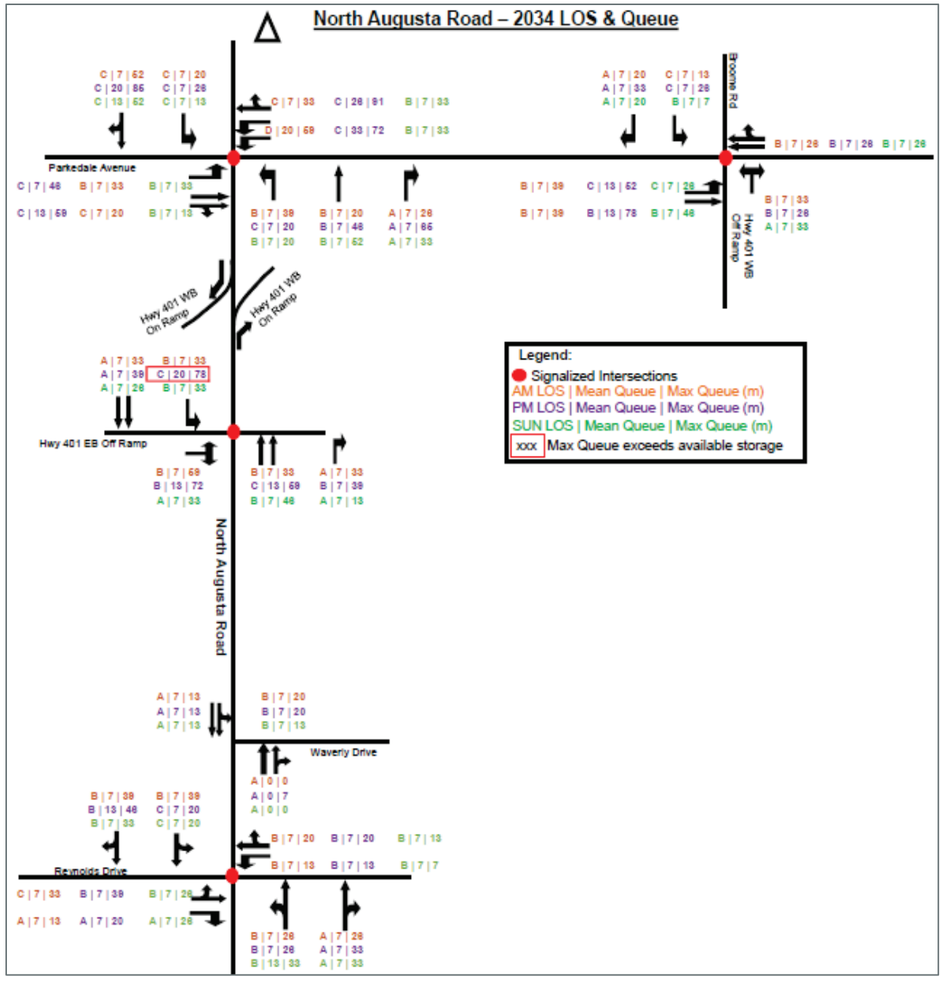

Exhibit L-2: 2034 – North Augusta Road Preferred Design (Parclo A2 with Diamond) – Highway 401 with 6-Lane Cross-Section - Intersection Operations

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

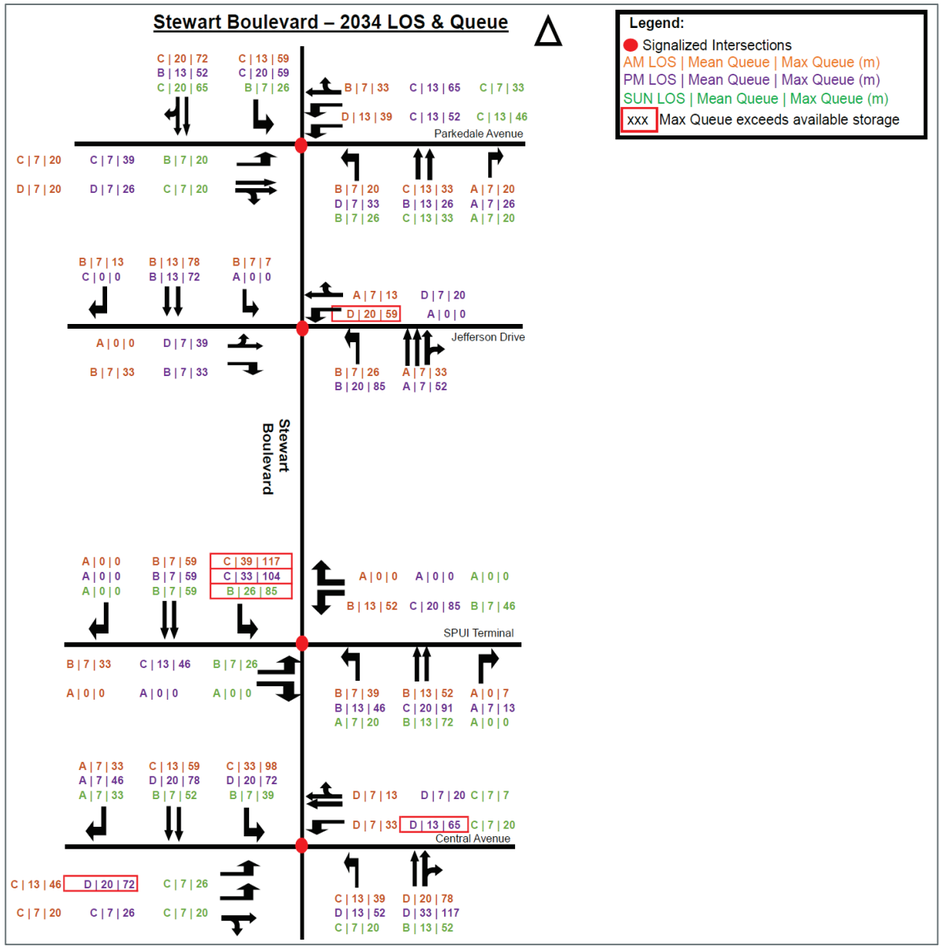

Exhibit L-3: 2034 – Stewart Boulevard Preferred Design (SPUI) – Highway 401 with 8-Lane Cross-Section - Intersection Operations

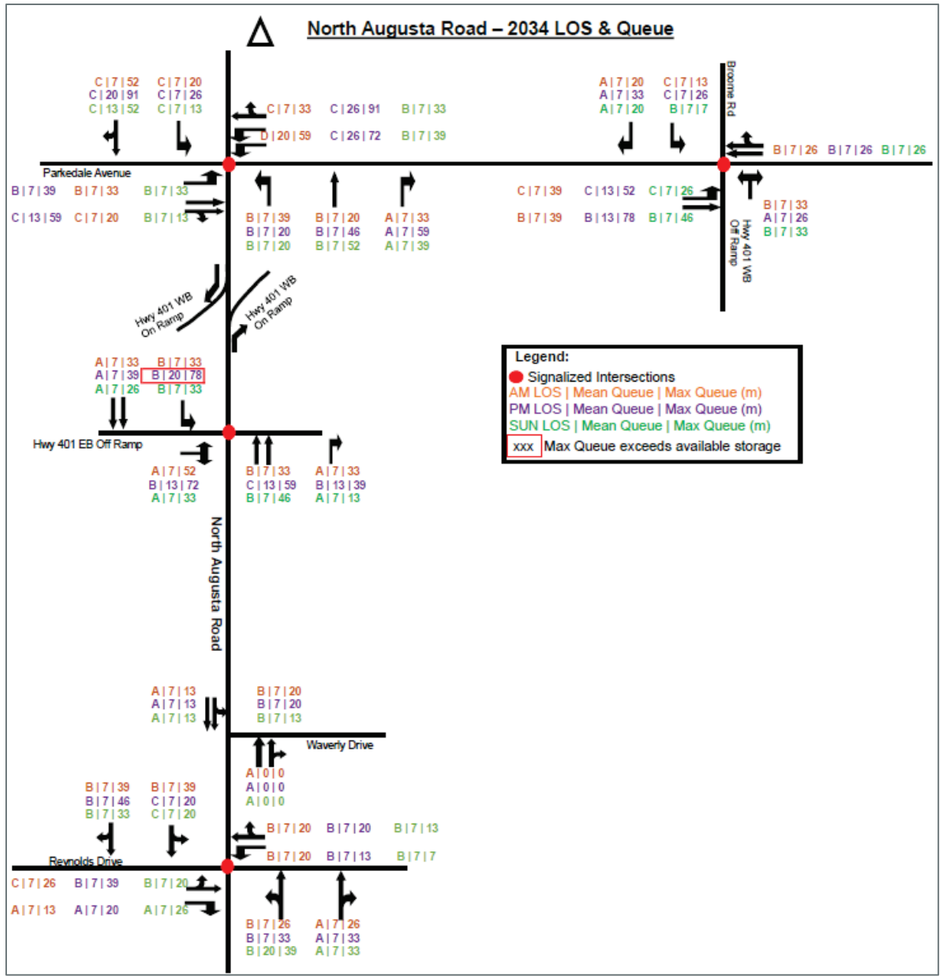

Exhibit L-4: 2034 – North Augusta Road Preferred Design (Parclo A2 with Diamond) – Highway 401 with 8-Lane Cross-Section - Intersection Operations

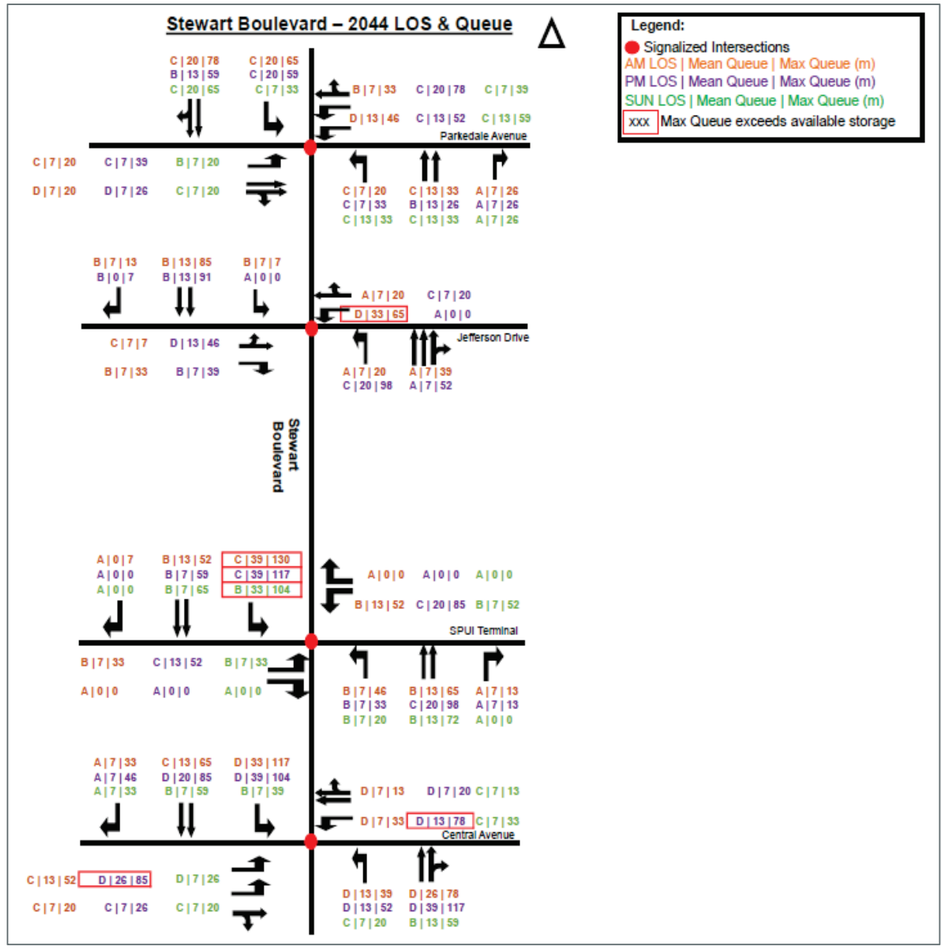

Exhibit L-5: 2044 – Stewart Boulevard Preferred Design (SPUI) – Highway 401 with 6-Lane Cross-Section - Intersection Operations

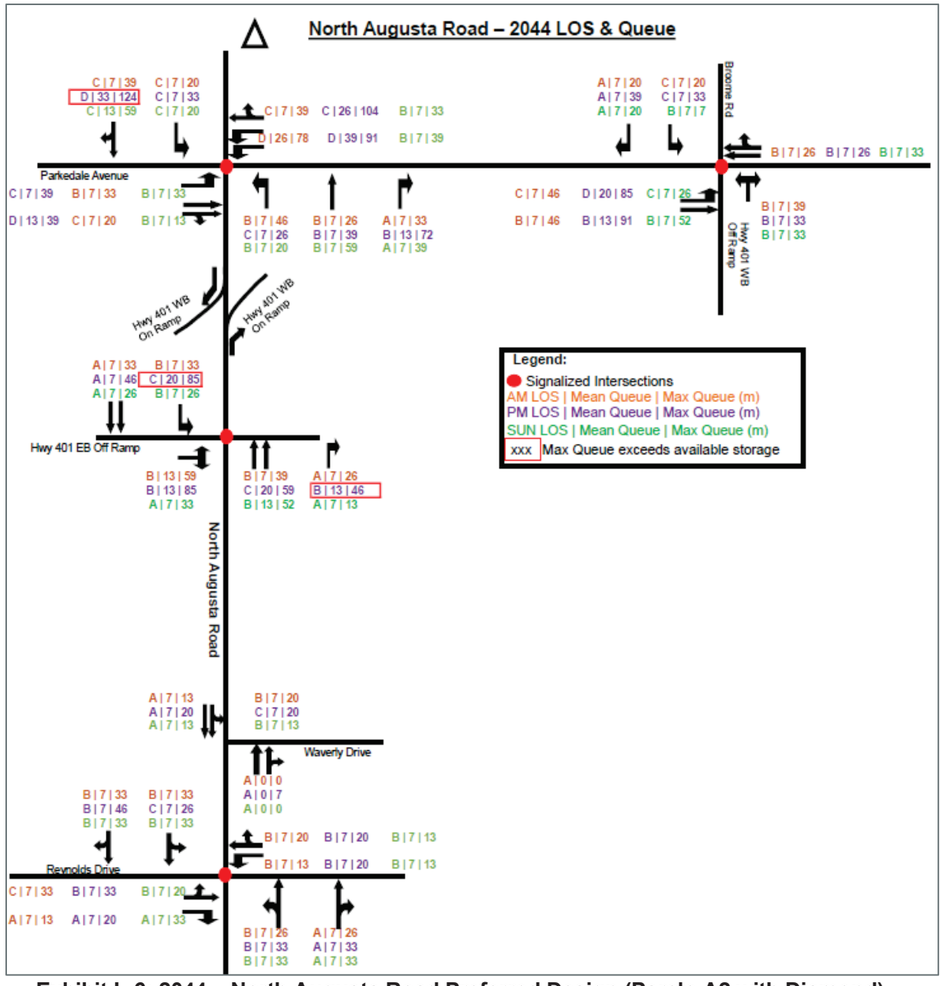

Exhibit L-6: 2044 – North Augusta Road Preferred Design (Parclo A2 with Diamond) – Highway 401 with 6-Lane Cross-Section - Intersection Operations

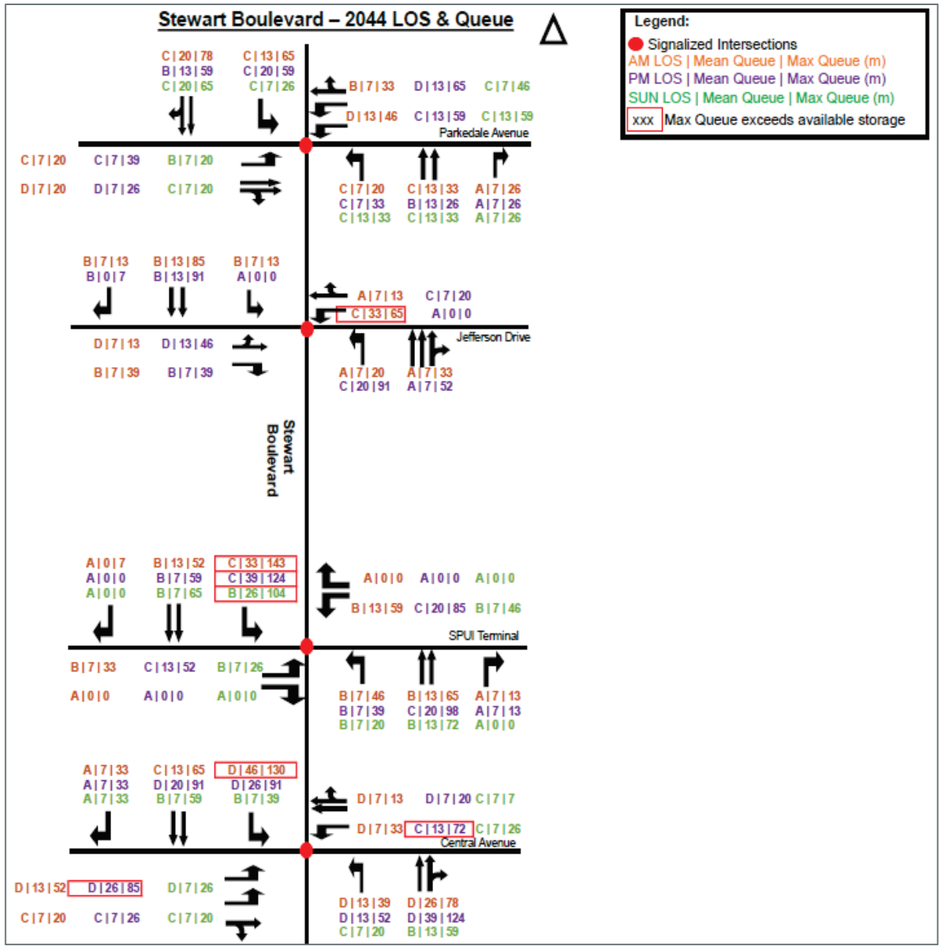

Exhibit L-7: 2044 – Stewart Boulevard Preferred Design (SPUI) – Highway 401 with 8-Lane Cross-Section - Intersection Operations

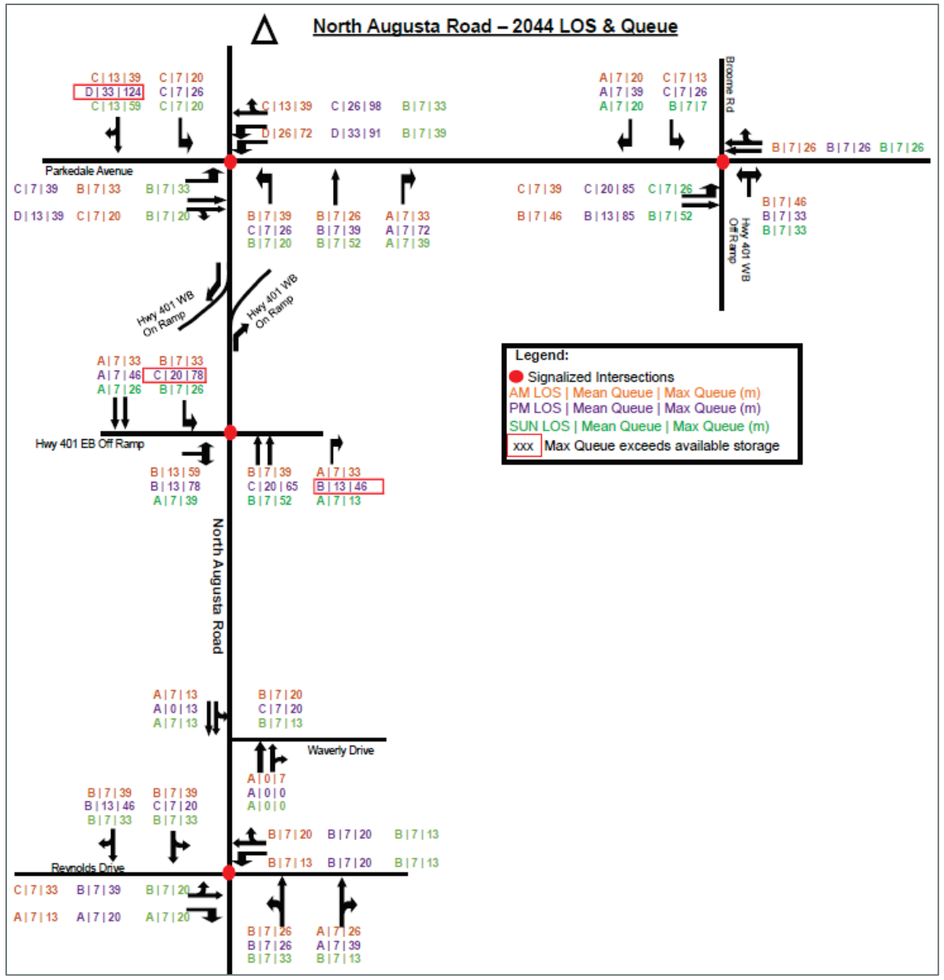

Exhibit L-8: 2044 – North Augusta Road Preferred Design (Parclo A2 with Diamond) – Highway 401 with 8-Lane Cross-Section - Intersection Operations

Appendix M: Preferred Design –Highway Mainline Operations

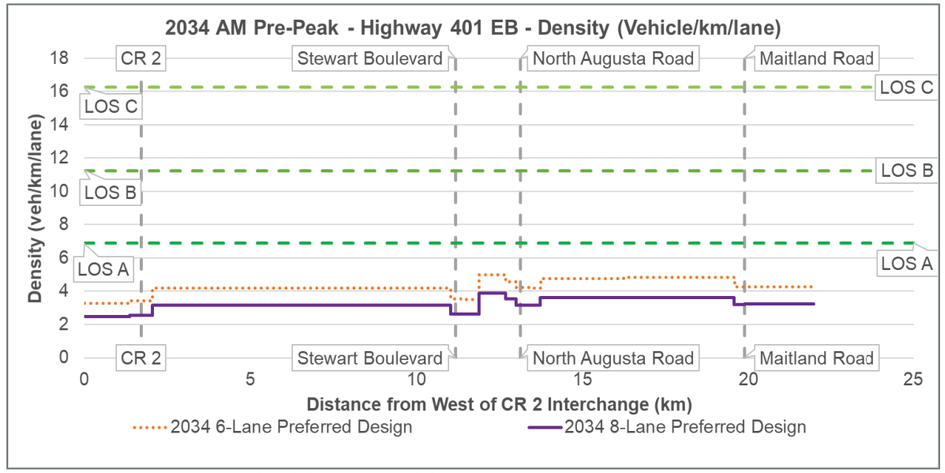

Exhibit M-1: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 AM Pre-Peak Hour (6-lane vs 8-lane)

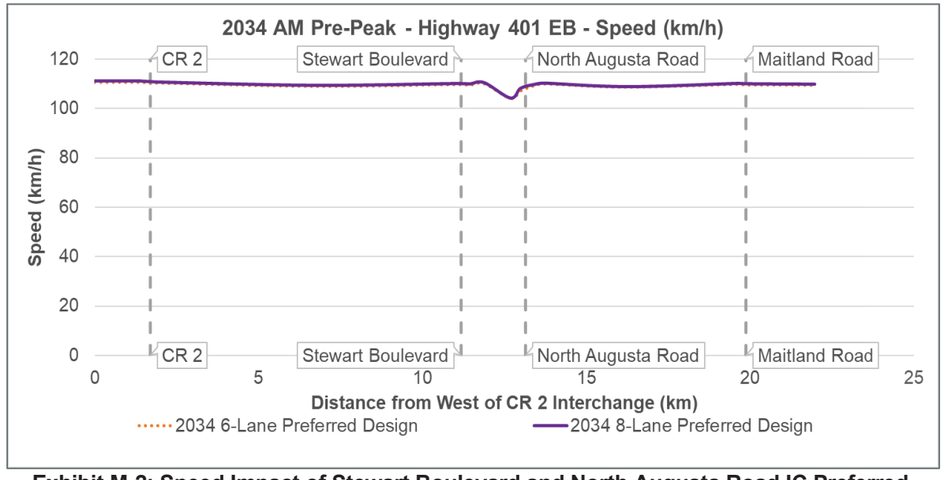

Exhibit M-2: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 AM Pre-Peak Hour (6-lane vs 8-lane)

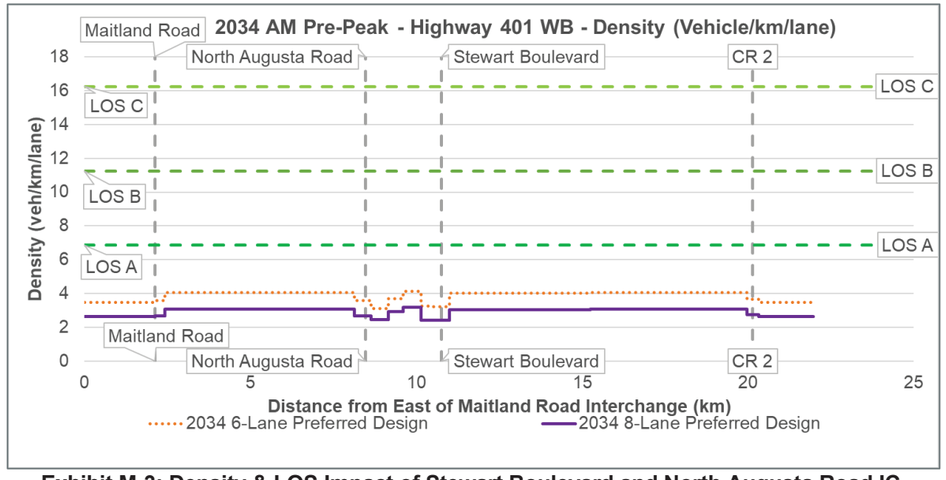

Exhibit M-3: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2034 AM Pre-Peak Hour (6-lane vs 8-lane)

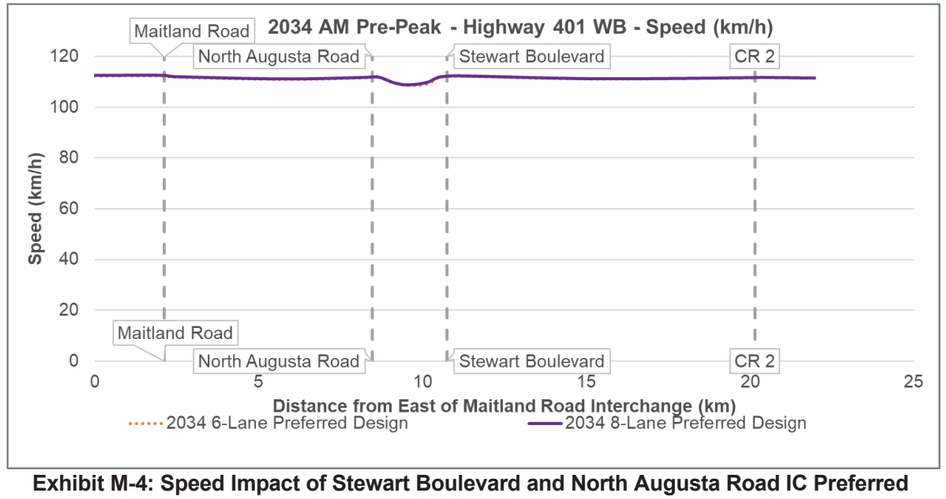

Exhibit M-4: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2034 AM Pre-Peak Hour (6-lane vs 8-lane)

Appendix M:Preferred Design –Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

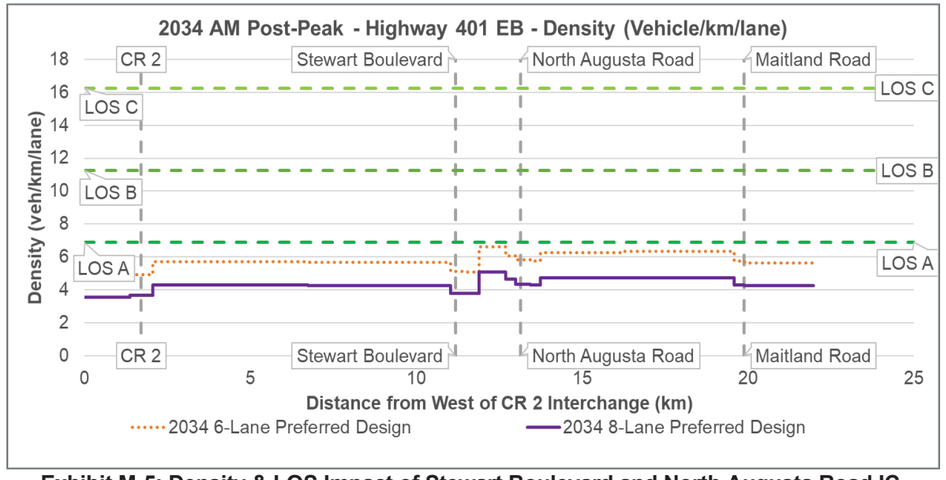

Exhibit M-5: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 AM Post-Peak Hour (6-lane vs 8-lane)

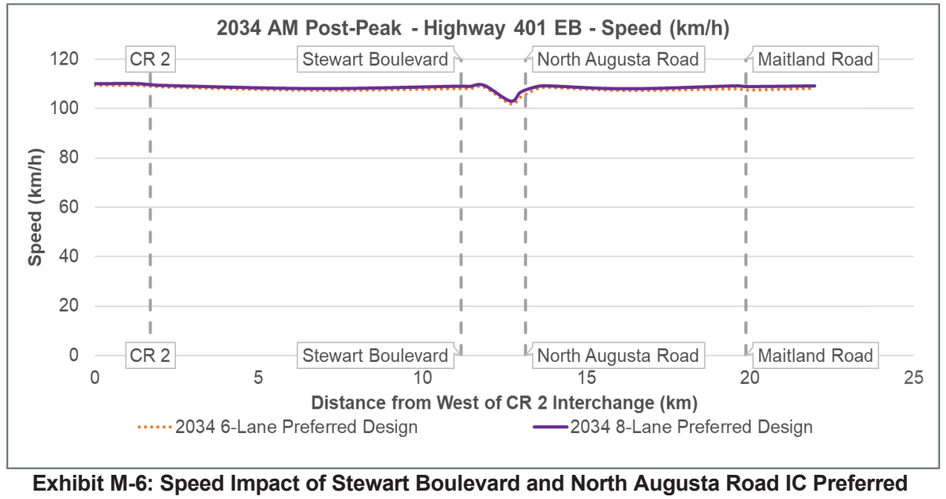

Exhibit M-6: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 AM Post-Peak Hour (6-lane vs 8-lane)

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

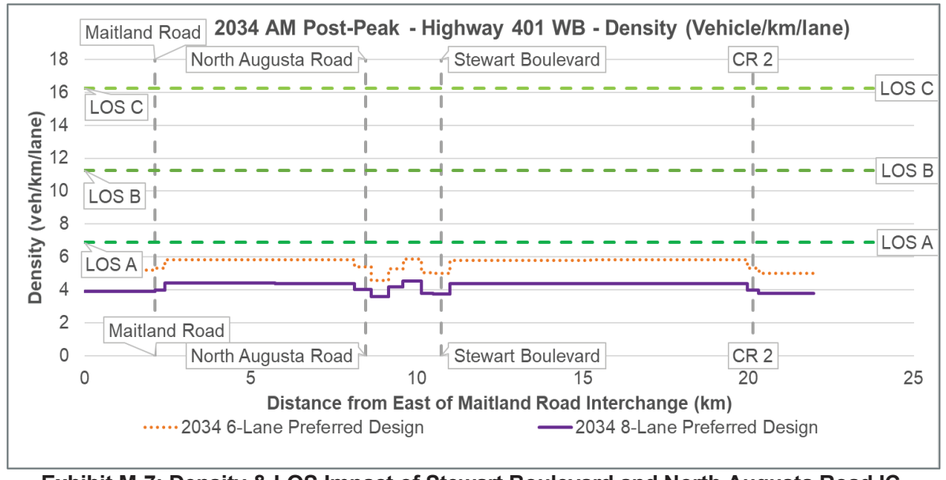

Exhibit M-7: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2034 AM Post-Peak Hour (6-lane vs 8-lane)

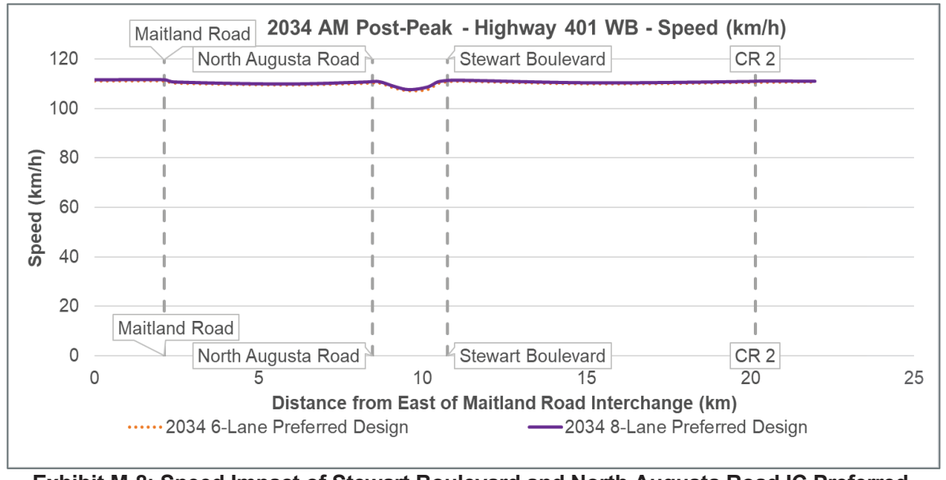

Exhibit M-8: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2034 AM Post-Peak Hour (6-lane vs 8-lane)

Appendix M:Preferred Design –Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

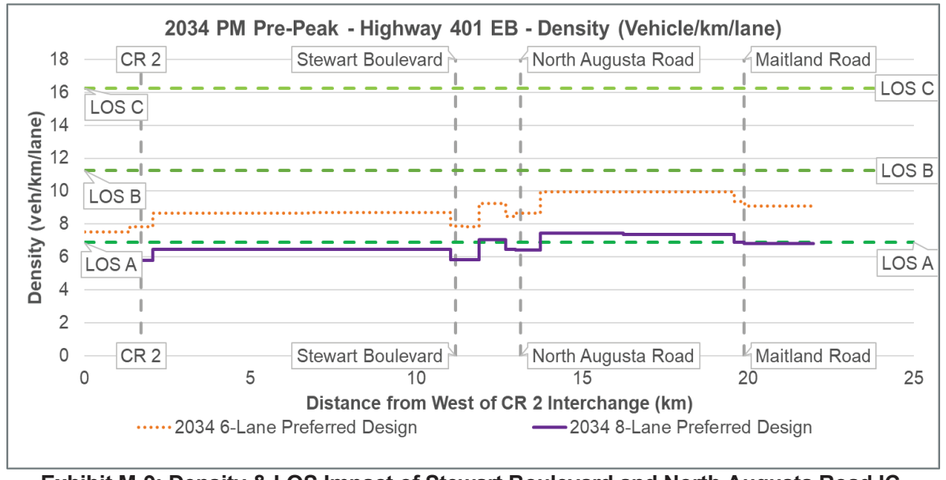

Exhibit M-9: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 PM Pre-Peak Hour (6-lane vs 8-lane)

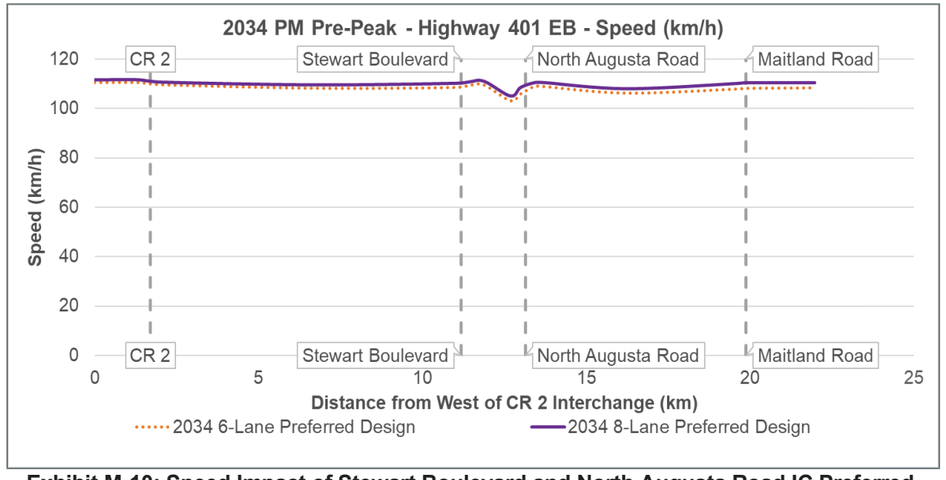

Exhibit M-10: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 PM Pre-Peak Hour (6-lane vs 8-lane)

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

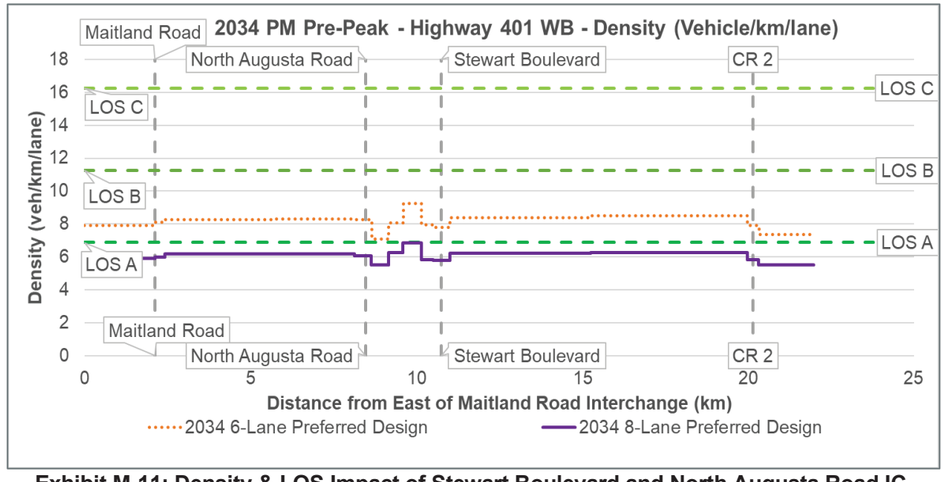

Exhibit M-11: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2034 PM Pre-Peak Hour (6-lane vs 8-lane)

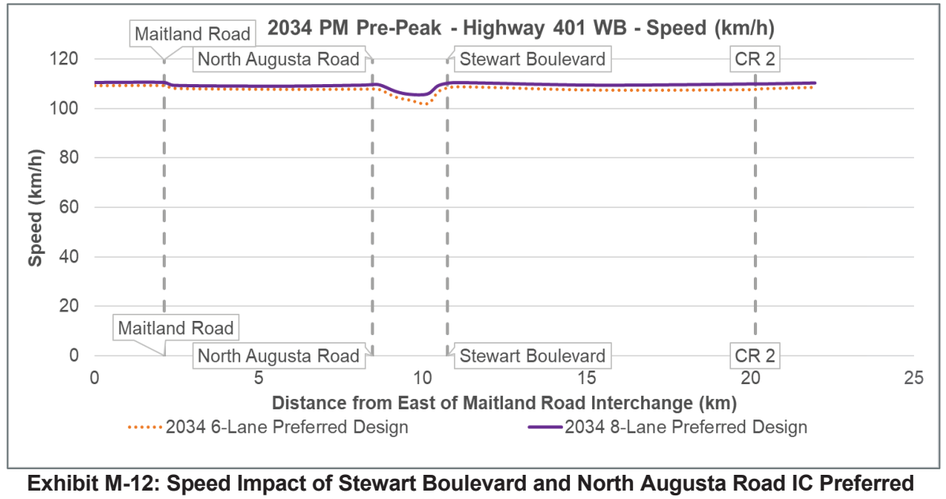

Exhibit M-12: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2034 PM Pre-Peak Hour (6-lane vs 8-lane)

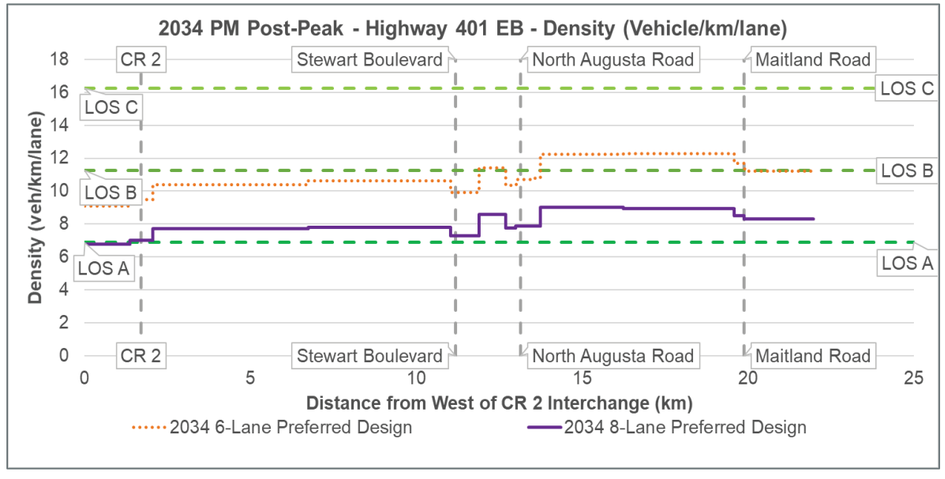

Exhibit M-13: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 PM Post-Peak Hour (6-lane vs 8-lane)

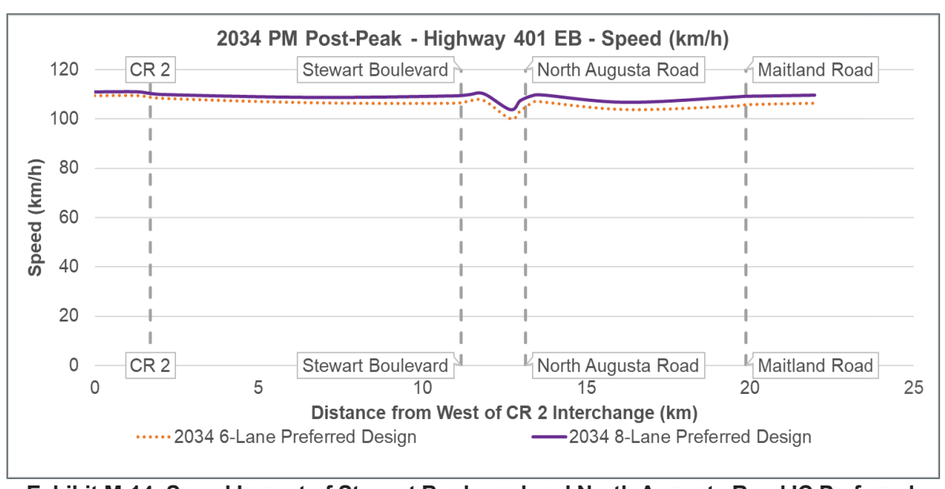

Exhibit M-14: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 PM Post-Peak Hour (6-lane vs 8-lane)

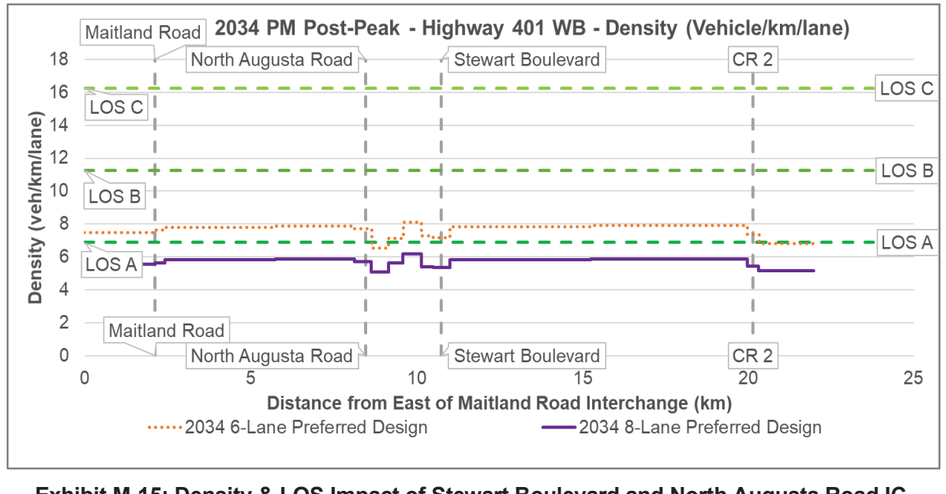

Exhibit M-15: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2034 PM Post-Peak Hour (6-lane vs 8-lane)

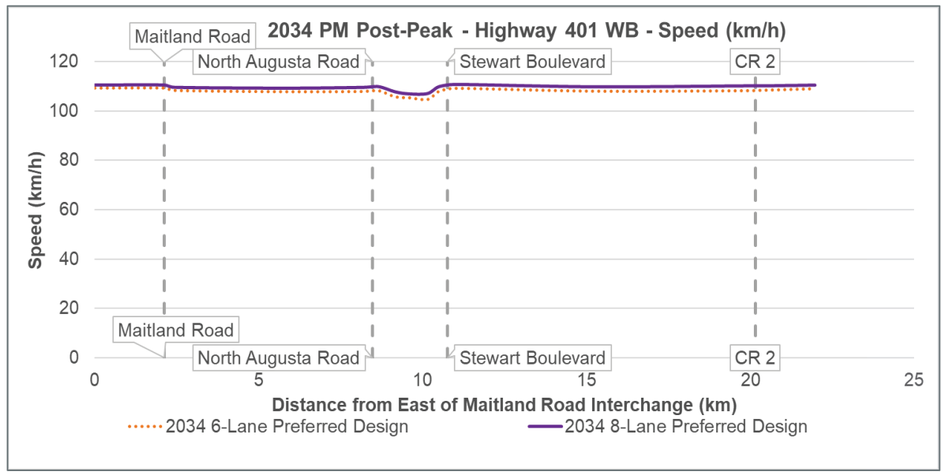

Exhibit M-16: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2034 PM Post-Peak Hour (6-lane vs 8-lane)

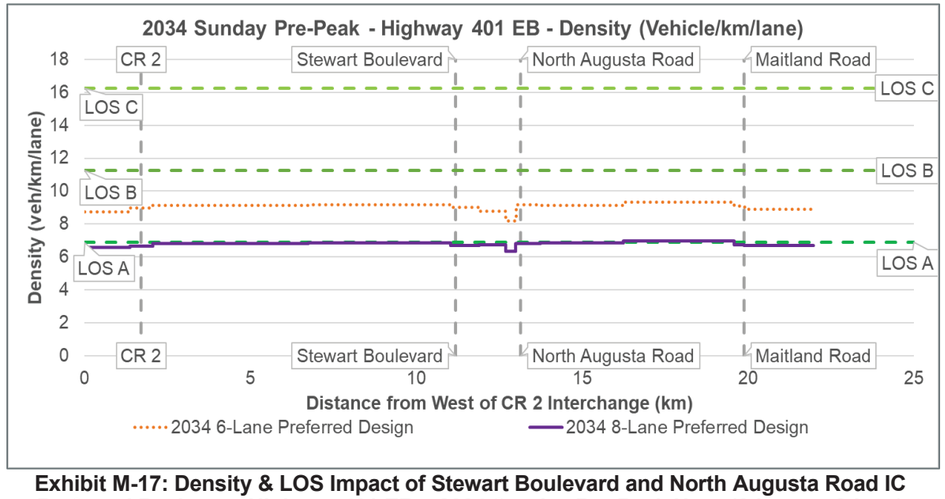

Exhibit M-17: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 Sunday Pre-Peak Hour (6-lane vs 8-lane)

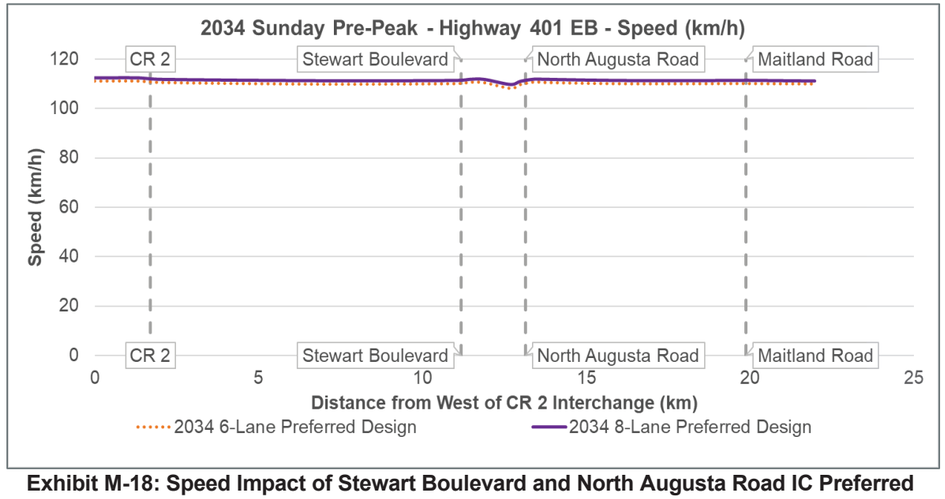

Exhibit M-18: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 Sunday Pre-Peak Hour (6-lane vs 8-lane)

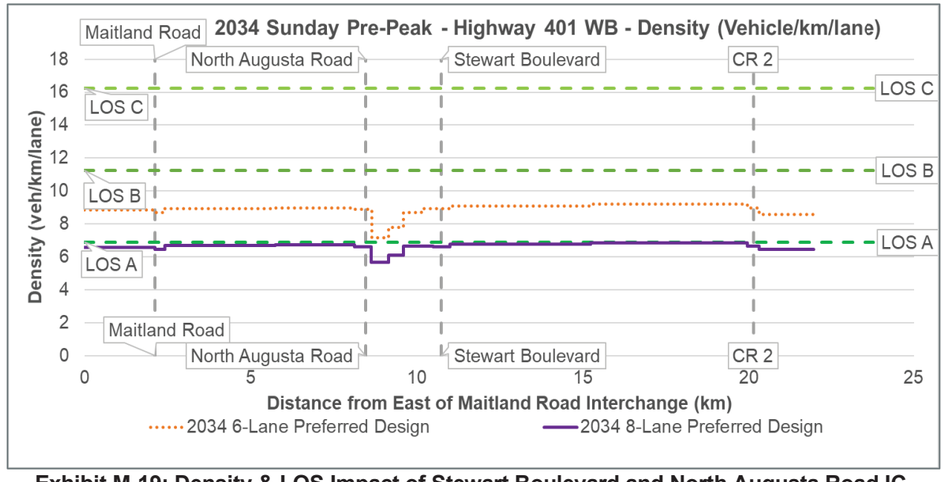

Exhibit M-19: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2034 Sunday Pre-Peak Hour (6-lane vs 8-lane)

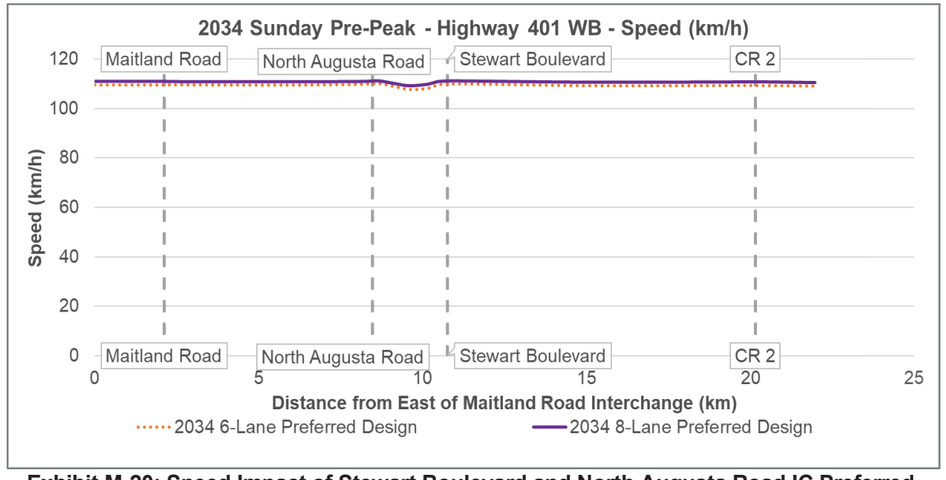

Exhibit M-20: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2034 Sunday Pre-Peak Hour (6-lane vs 8-lane)

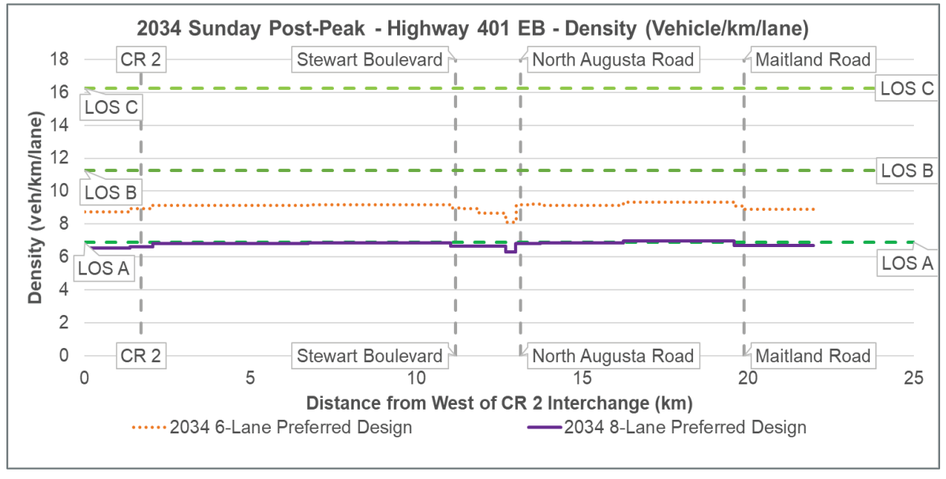

Exhibit M-21: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 Sunday Post-Peak Hour (6-lane vs 8-lane)

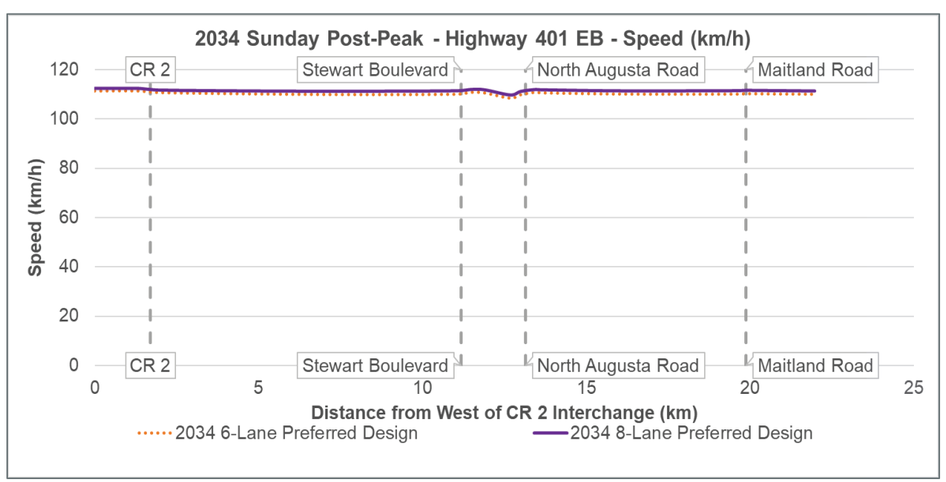

Exhibit M-22: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2034 Sunday Post-Peak Hour (6-lane vs 8-lane)

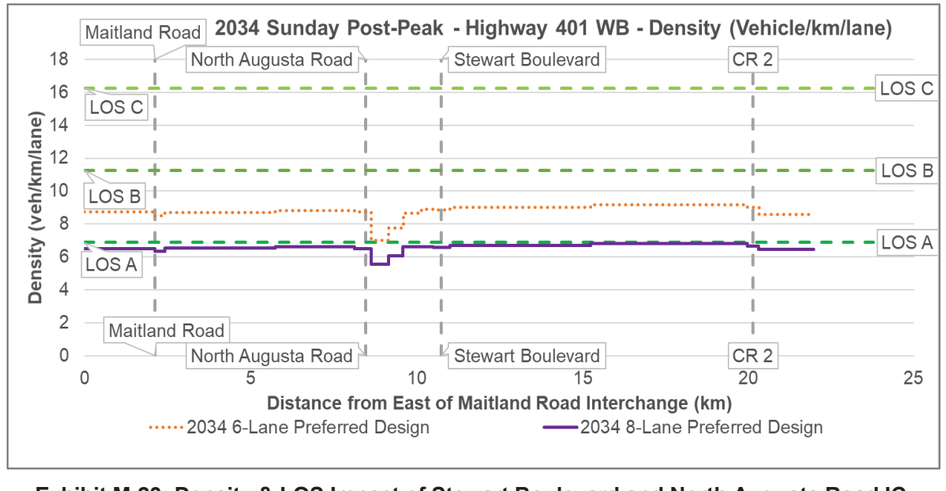

Exhibit M-23: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2034 Sunday Post-Peak Hour (6-lane vs 8-lane)

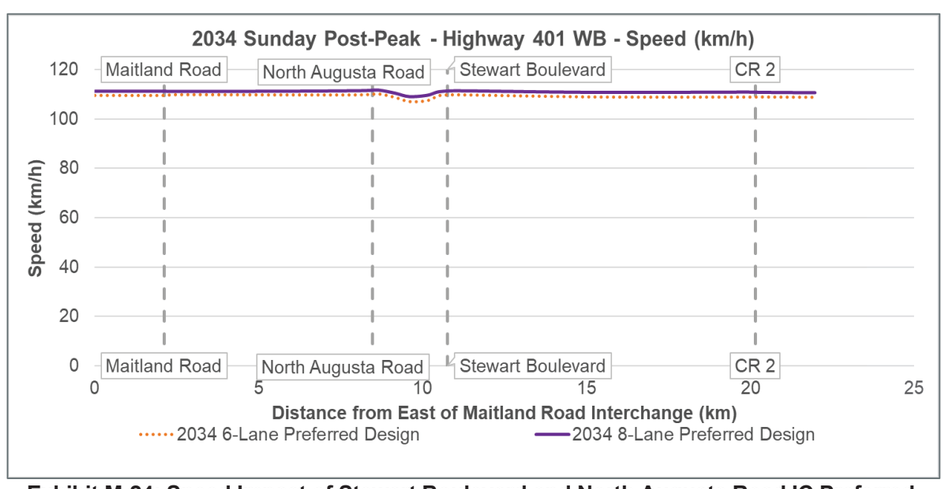

Exhibit M-24: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2034 Sunday Post-Peak Hour (6-lane vs 8-lane)

Appendix M:Preferred Design –Highway Mainline Operations
Interchange Design Alternative Analysis Report
Highway 401 Brockville - Preliminary Design and Environmental Assessment

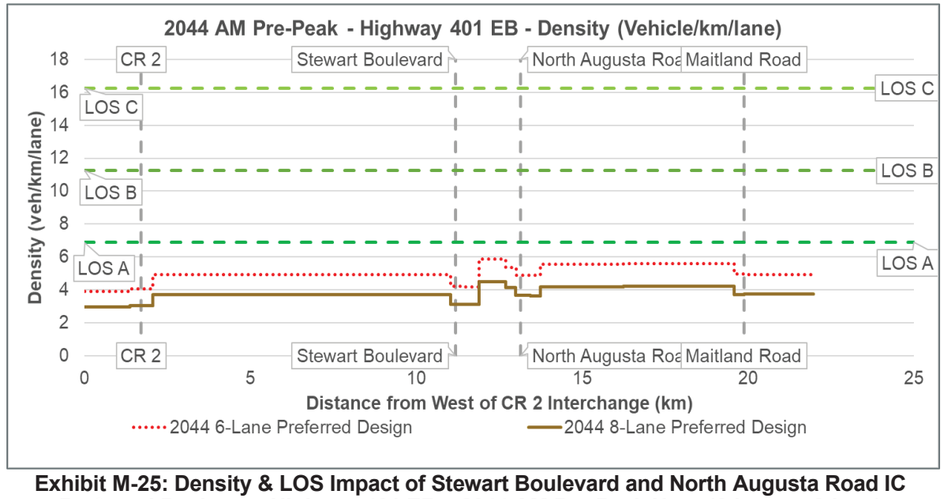

Exhibit M-25: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 AM Pre-Peak Hour (6-lane vs 8-lane)

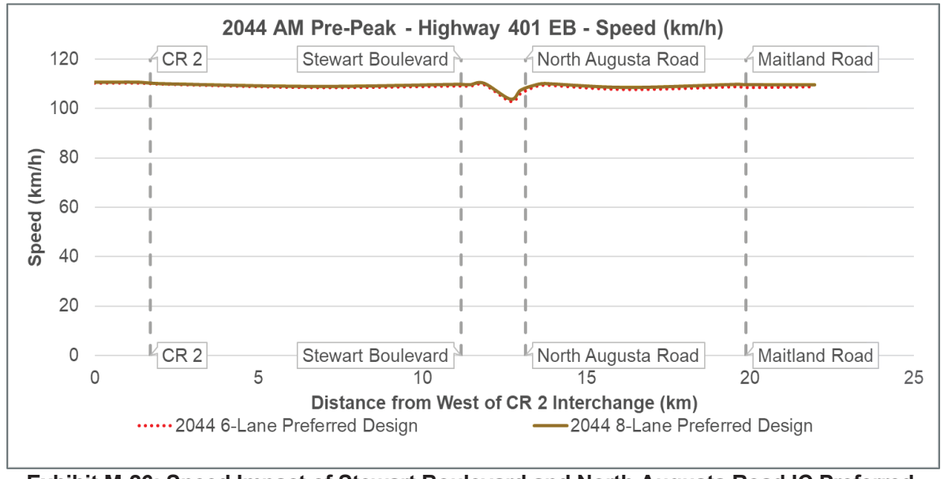

Exhibit M-26: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 AM Pre-Peak Hour (6-lane vs 8-lane)

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

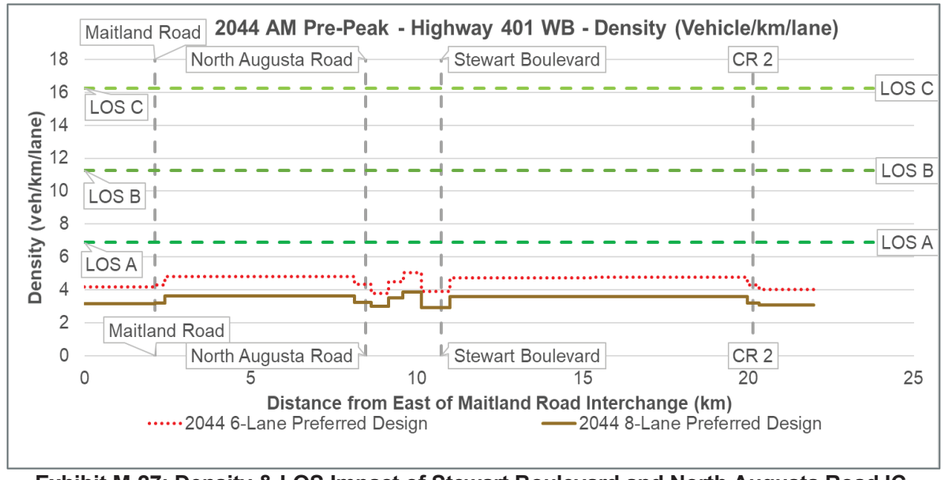

Exhibit M-27: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2044 AM Pre-Peak Hour (6-lane vs 8-lane)

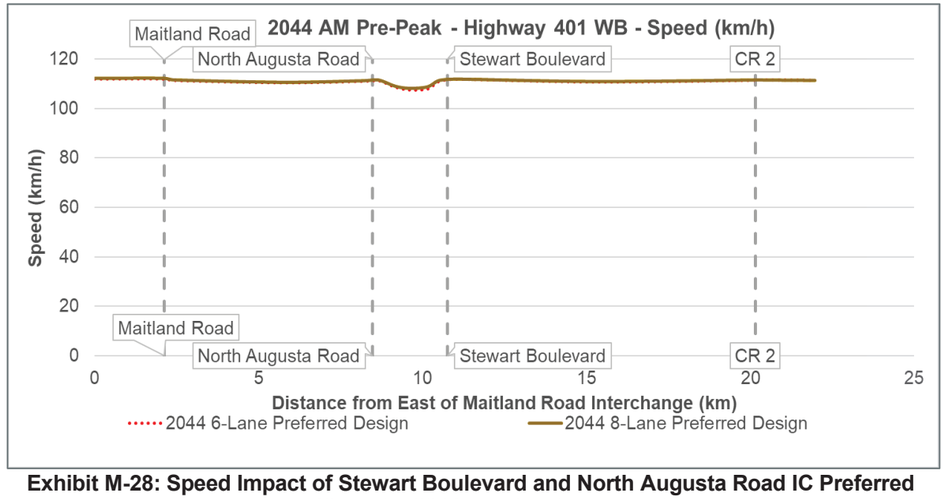

Exhibit M-28: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2044 AM Pre-Peak Hour (6-lane vs 8-lane)

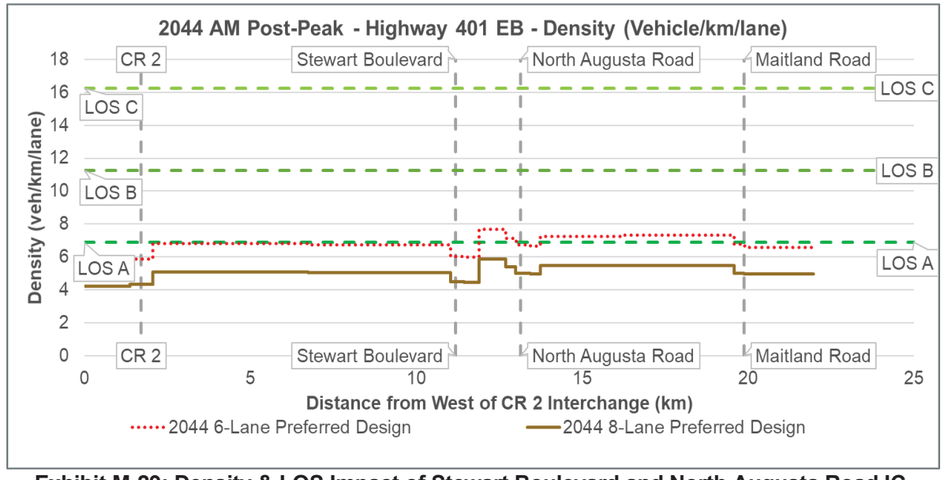

Exhibit M-29: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 AM Post-Peak Hour (6-lane vs 8-lane)

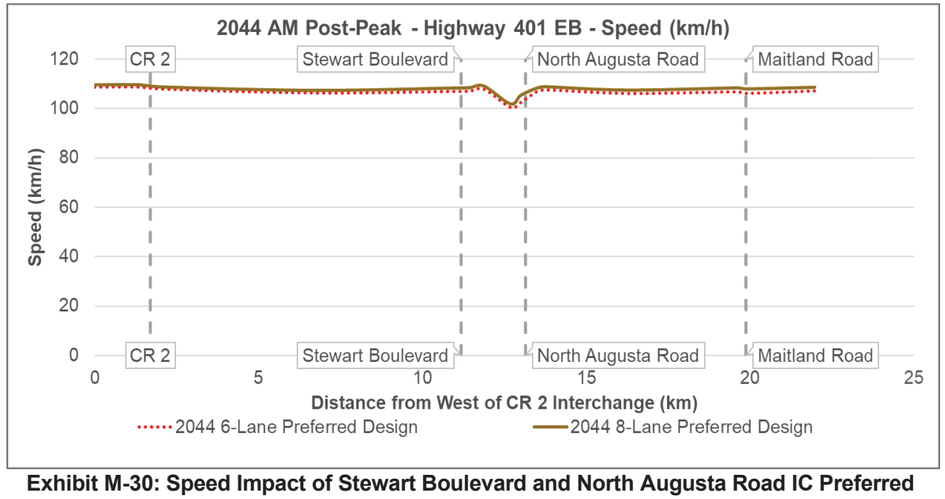

Exhibit M-30: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 AM Post-Peak Hour (6-lane vs 8-lane)

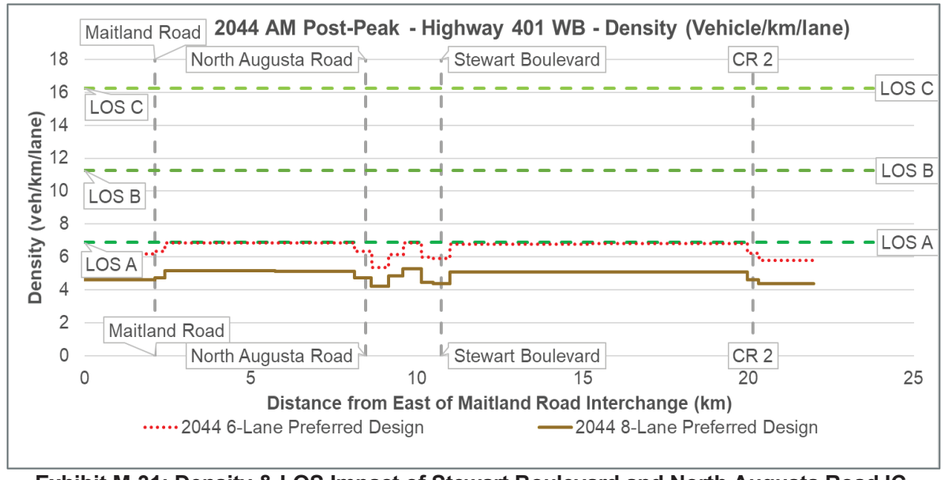

Exhibit M-31: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2044 AM Post-Peak Hour (6-lane vs 8-lane)

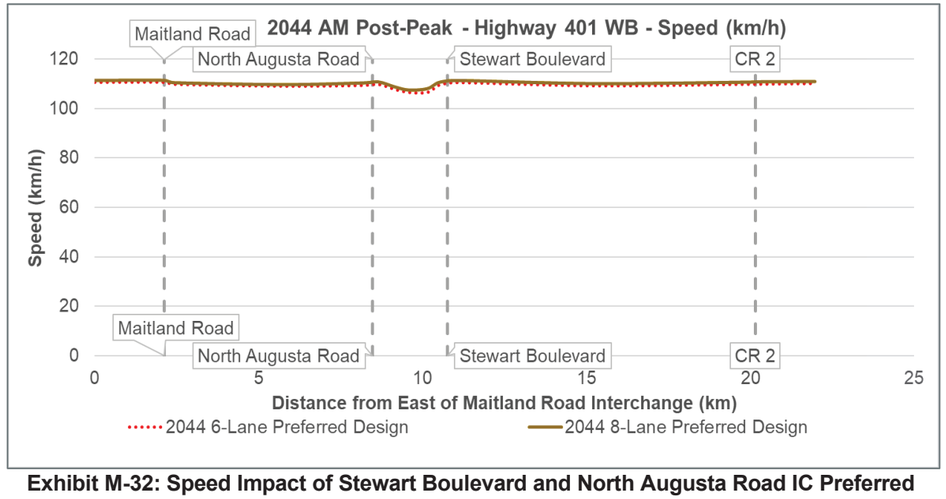

Exhibit M-32: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2044 AM Post-Peak Hour (6-lane vs 8-lane)

Appendix M:Preferred Design –Highway Mainline Operations
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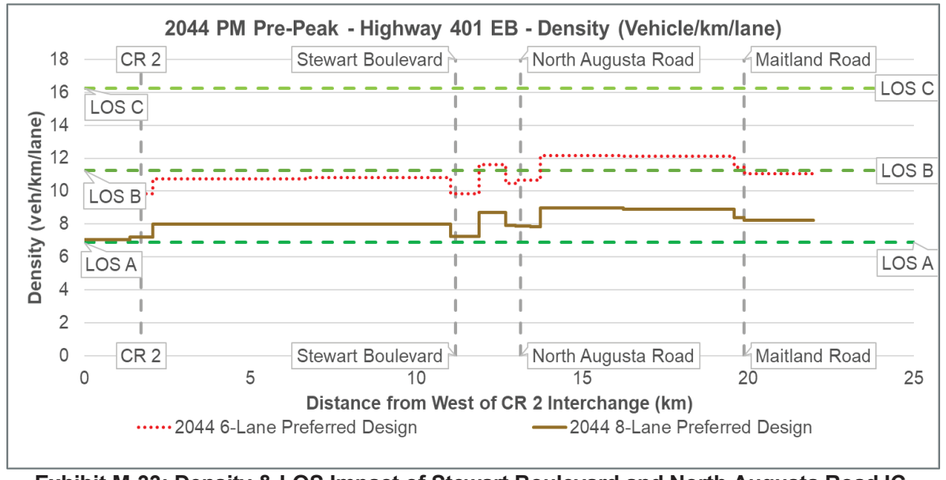

Exhibit M-33: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 PM Pre-Peak Hour (6-lane vs 8-lane)

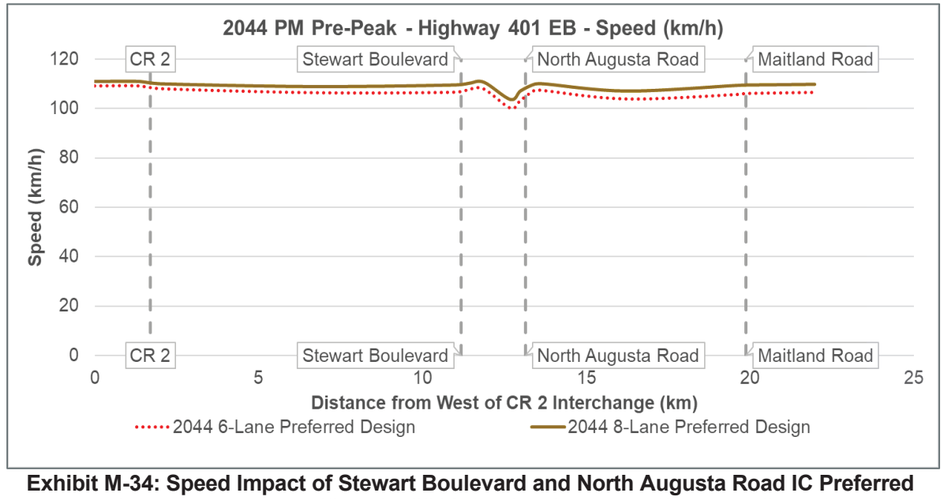

Exhibit M-34: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 PM Pre-Peak Hour (6-lane vs 8-lane)

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

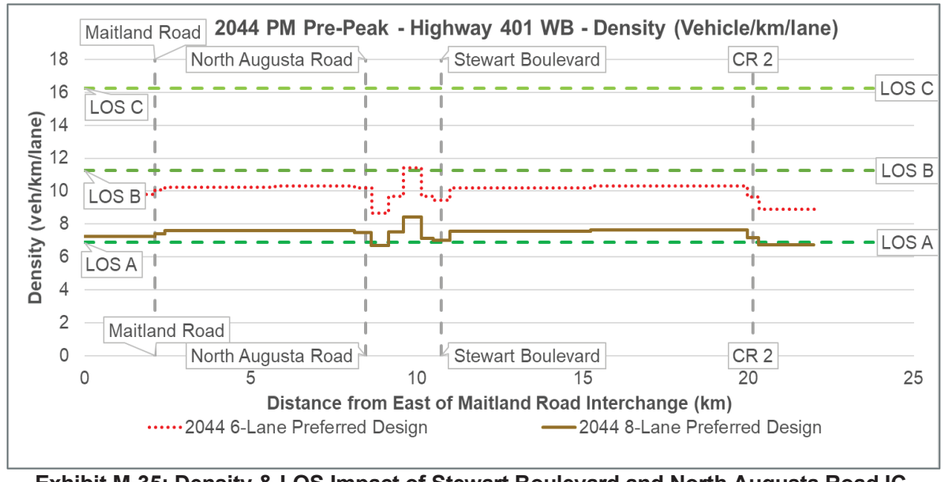

Exhibit M-35: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2044 PM Pre-Peak Hour (6-lane vs 8-lane)

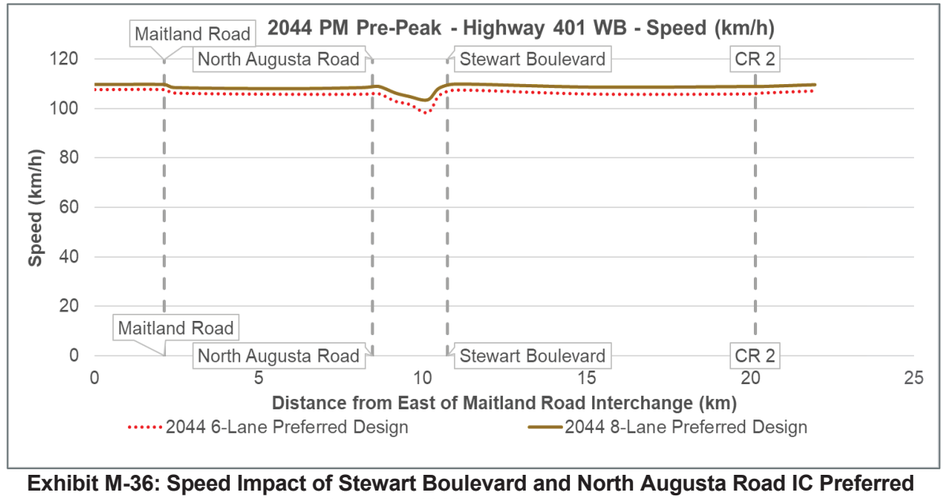

Exhibit M-36: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2044 PM Pre-Peak Hour (6-lane vs 8-lane)

Appendix M:Preferred Design –Highway Mainline Operations
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Highway 401 Brockville - Preliminary Design and Environmental Assessment

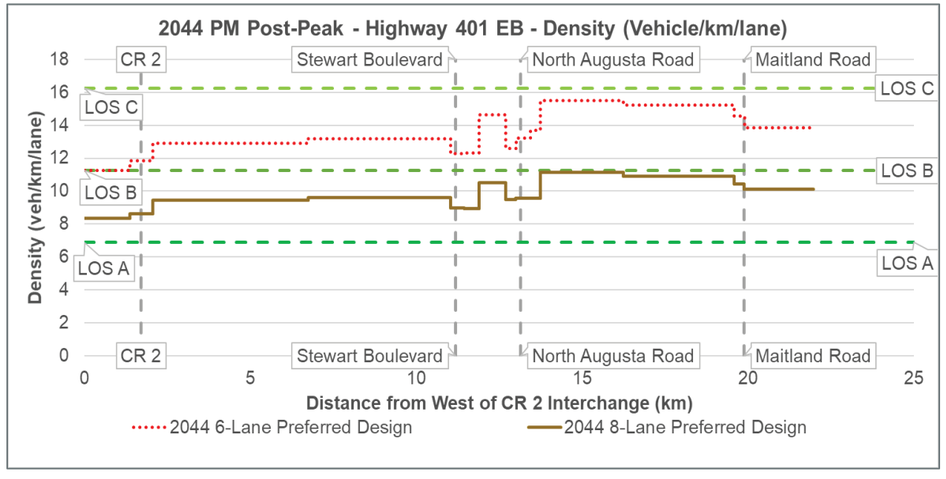

Exhibit M-37: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 PM Post-Peak Hour (6-lane vs 8-lane)

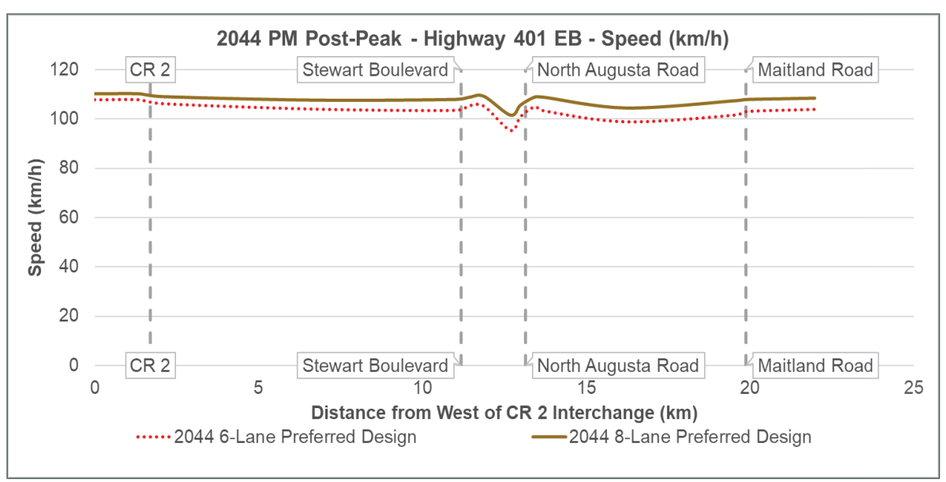

Exhibit M-38: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 PM Post-Peak Hour (6-lane vs 8-lane)

B001091C – Highway 401 Brockville – Preliminary EA and Design B001091C_Interchange_Alternative_Analysis_e04.docx

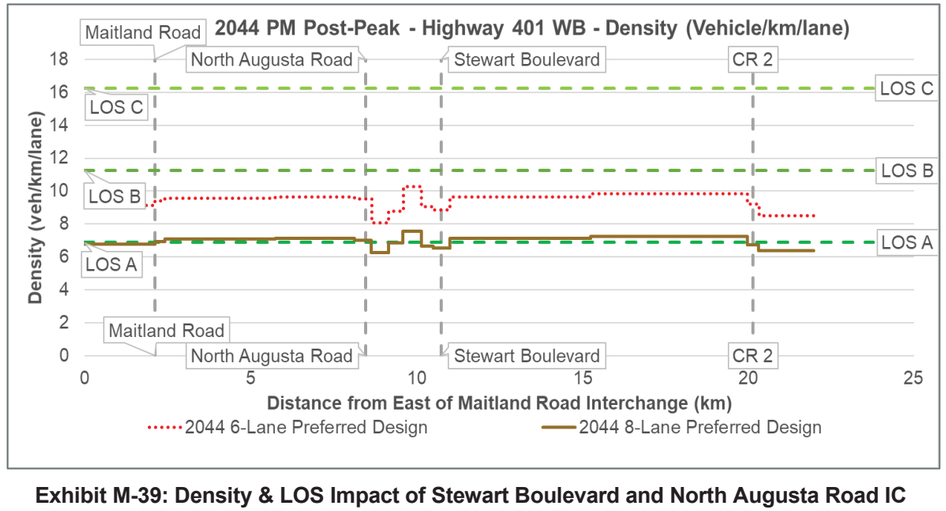

Exhibit M-39: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2044 PM Post-Peak Hour (6-lane vs 8-lane)

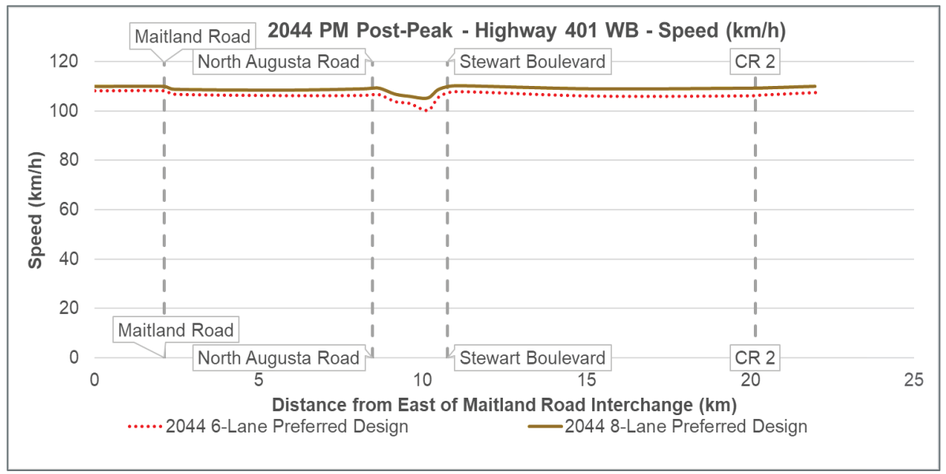

Exhibit M-40: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2044 PM Post-Peak Hour (6-lane vs 8-lane)

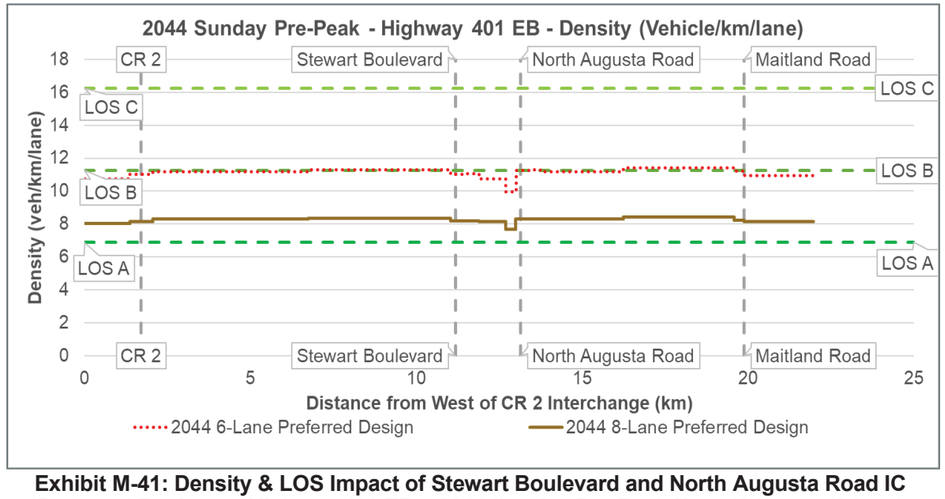

Exhibit M-41: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 Sunday Pre-Peak Hour (6-lane vs 8-lane)

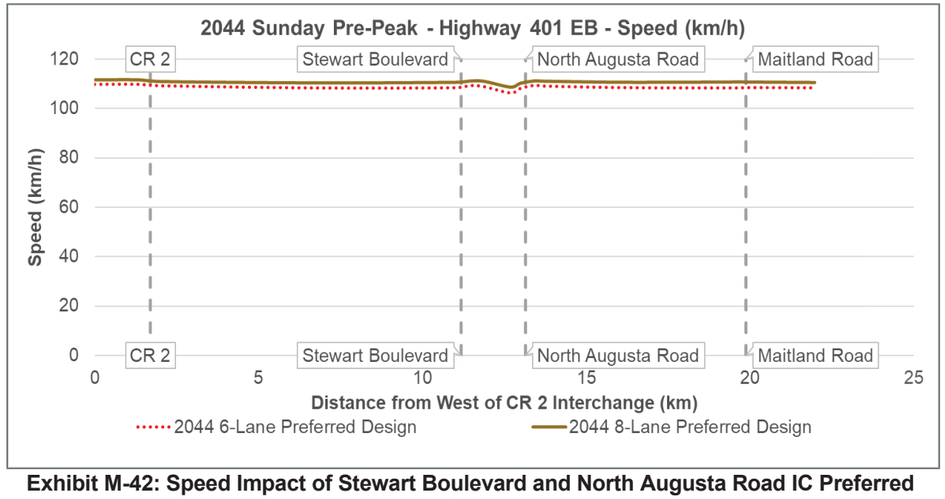

Exhibit M-42: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 Sunday Pre-Peak Hour (6-lane vs 8-lane)

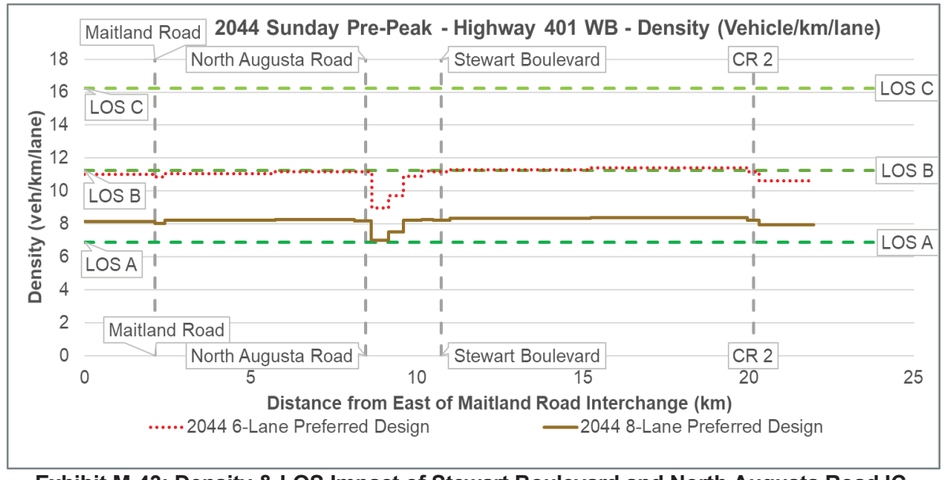

Exhibit M-43: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2044 Sunday Pre-Peak Hour (6-lane vs 8-lane)

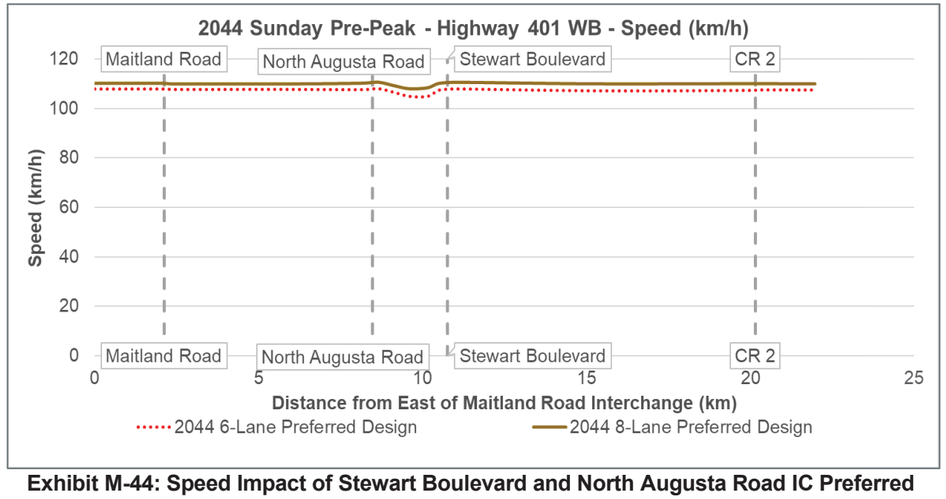

Exhibit M-44: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2044 Sunday Pre-Peak Hour (6-lane vs 8-lane)

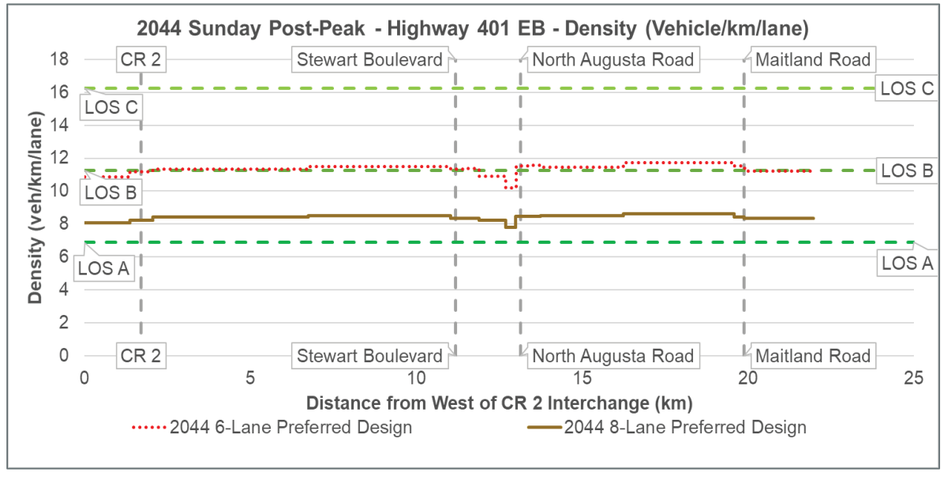

Exhibit M-45: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 Sunday Post-Peak Hour (6-lane vs 8-lane)

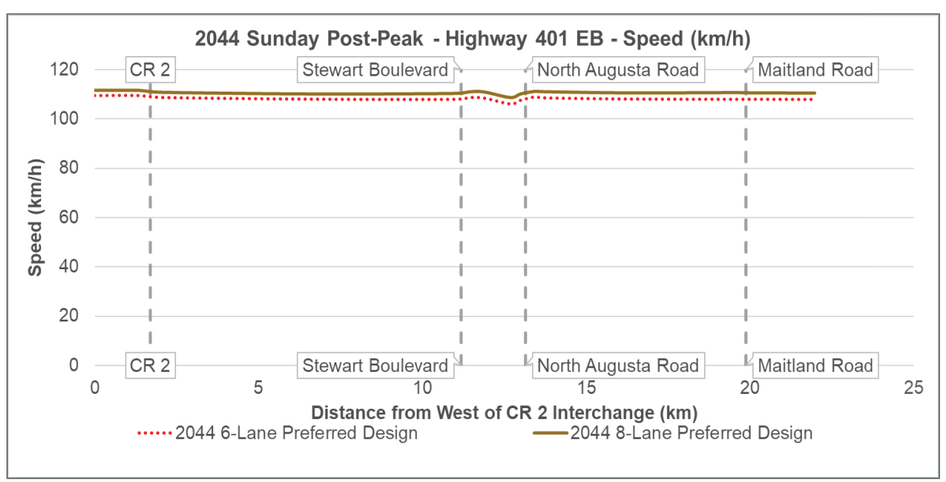

Exhibit M-46: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 EB – 2044 Sunday Post-Peak Hour (6-lane vs 8-lane)

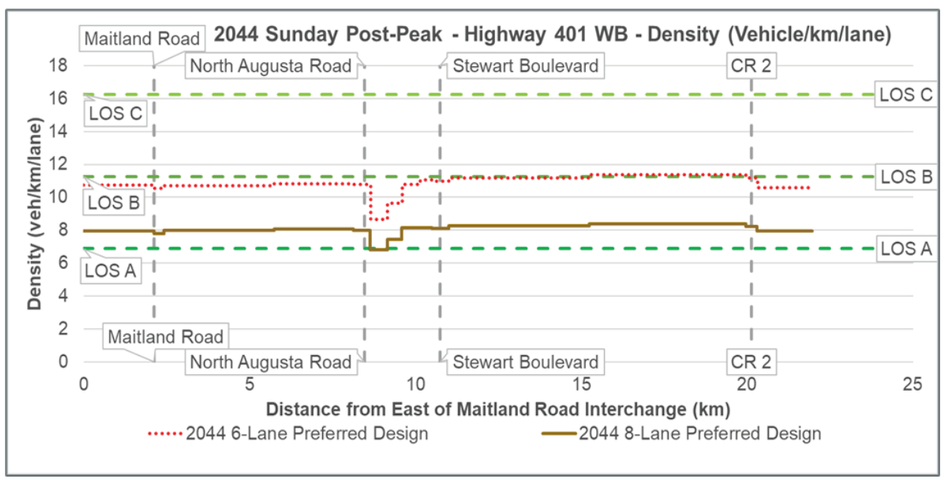

Exhibit M-47: Density & LOS Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2044 Sunday Post-Peak Hour (6-lane vs 8-lane)

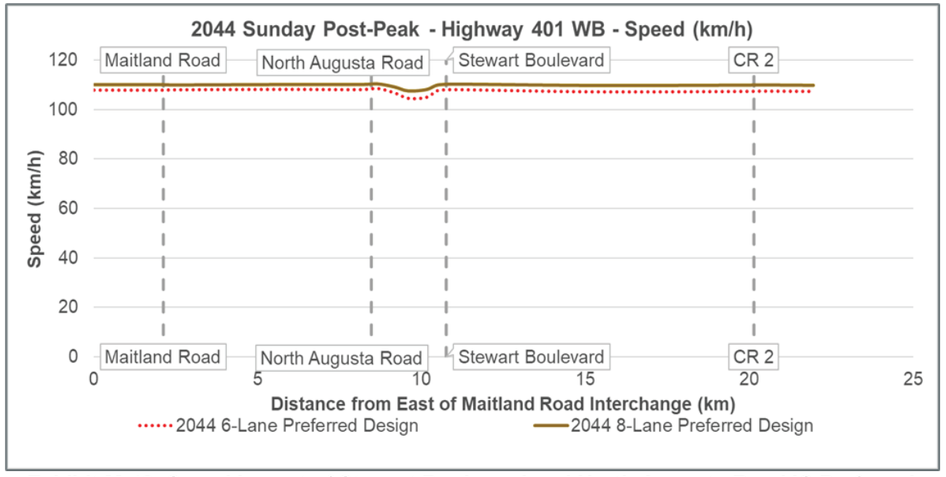

Exhibit M-48: Speed Impact of Stewart Boulevard and North Augusta Road IC Preferred Design on Highway 401 WB – 2044 Sunday Post-Peak Hour (6-lane vs 8-lane)