APPENDIX

R

Merritt Road at Grisdale Road & Highway 406 Interchange Design Options Memo

If technical reports are required in an alternative format for accessibility needs, please contact:

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MEMO

TO: Kashif Hussain (MTO)

FROM: Mir Ahsan Talpur, M.Env.Sc., EP (WSP)

CC: Maged Elmadhoon (Niagara Region)

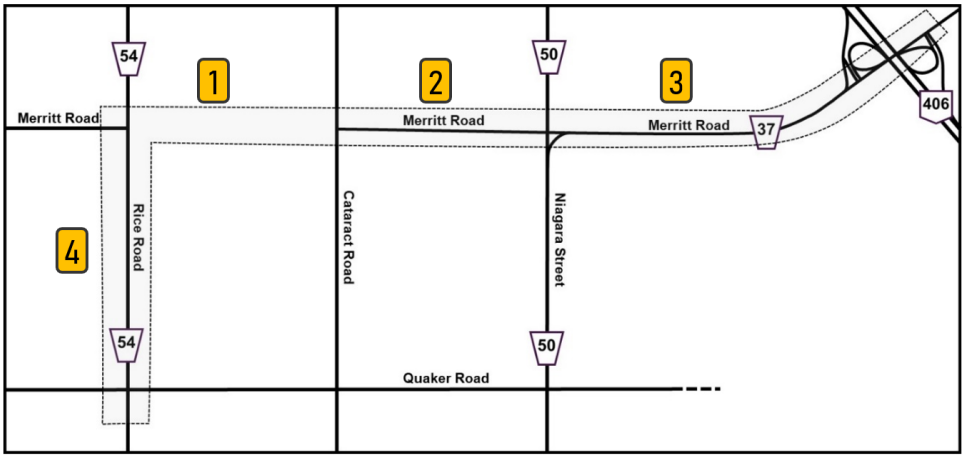
SUBJECT: IM20103036 – Merritt Road & Rice Road EA, Niagara Region

RE: Merritt Road, Grisdale Road & Highway 406 Interchange Design Options

DATE: May 25, 2023

1 INTRODUCTION

The Regional Municipality of Niagara (Niagara Region) is undertaking a Schedule 'C' Municipal Class Environmental Assessment Study (Class EA / the Study) for improvements to Merritt Road and Rice Road in the Town of Pelham, the City of Thorold, and the City of Welland. The study area is shown in the exhibit below.



The Study aims to determine and address future transportation needs of the surrounding community for all road users. For such, Niagara Region has retained WSP E&I Canada Limited (Formerly Wood Environment & Infrastructure Solutions) to undertake the Study which is being conducted in accordance with the Ontario Environmental Assessment Act (EAA) requirements for a Schedule 'C' Project (Phases 1-4) as outlined in the Municipal Engineers Association's Class EA document (Municipal Engineers Association, 2000 as amended in 2011 and 2015).

This study is building on the recommendations of the Niagara Region's Transportation Master Plan (TMP), which included the following:

- Extension of Merritt Road between Regional Road 54 (Rice Road) and Cataract Road;
- Capacity improvements of Merritt Road from Cataract Road to Highway 406; and,

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- Capacity improvements to Regional Road 54 (Rice Road) from 200 meters north of Merritt Road to Quaker Road.

The study will address active transportation needs by providing dedicated pedestrian and cyclist infrastructure that is safe, attractive, conforms to a complete streets approach, and compatible with the changing land use in the three local municipalities.

2 PURPOSE

The purpose of this memo is to identify and document future condition requirements in the vicinity of Highway 406 interchange at Merritt Road. Based on the traffic assessment undertaken as part of this Class EA study, it is recommended to widen Merritt Road to 4-lanes up to Highway 406. As a result, 2 eastbound and westbound through lanes are proposed at Grisdale Road intersection which is located ±205m west of Highway 406 westerly N-E/W Off-Ramp. It is noted that Grisdale Road provides a minor access to/from Merritt Road and generate very low traffic demand. Since the traffic volume to/from Grisdale Road are low, they are of lesser concern as compared to close proximity of Grisdale Road intersection with Highway 406 Off-Ramp which raises safety concerns due to shared existing westbound left (WBL) with westbound through (WBT) under existing condition.

To discuss future needs and potential improvements within the study area, WSP and the Region staff met virtually with the Ontario Ministry of Transportation (MTO) staff on January 17, 2022, and presented existing conditions, need for improvements and design Options 1, 2 and 3 which are later discussed in detail in sections below. The minutes of this meeting are provided as **Attachment A**. During the meeting, MTO staff suggested project team to develop an option providing an additional eastbound through (EBT) lane while maintaining existing eastbound left (EBL) turn lane at Highway 406 N-E/W Off-Ramp and E/W-S On-Ramp intersection at Merritt Road, referred as Option-4. The MTO staff also inquired about provision of active transportation connectivity across the bridge to the east side of Highway 406. Minutes of that meeting are included as an attachment to this memo for reference purposes. Furthermore, MTO staff in an email (dated January 26, 2022) requested the project team to assess provision of a roundabout at Highway 406 N-E/W Off-Ramp and E/W-S On-Ramp intersection at Merritt Road. WSP design team has prepared a 2-lane roundabout, referred as Option-5 in this memo.

After initial review of the memo by MTO, a follow-up meeting was arranged with the project team attended by WSP, Region and MTO staff on March 22, 2022, to discuss and receive feedback for design options 1 through 5 presented in the memo. During the meeting, MTO staff requested project team to determine feasibility of providing active transportation on the north side of the structure, having pedestrian crossing at the proposed signalized Highway 406 N-E/W Off-Ramp and E/W-S On-Ramp intersection at Merritt Road while removing channelized WBR turn and provide a short WBR turn lane at the intersection. This option is referred as Option 6 in the memo. WSP shared updated version of this memo with MTO (with Option 6) on April 13, 2022. MTO subsequently provided several rounds of comments on Option 6. An Executive Review Meeting was held with MTO's senior management on March 21, 2023, to present the preferred Option 6 and receive MTO's approval. Option 6 was accepted in principle by MTO senior management during the meeting with provision of minor comments.
The Project Team subsequently updated the Option 6 to address MTO Senior Management's comments.
On May 23, 2023, the MTO staff confirmed that they have no more comments on Option 6, and the Project Team could proceed with including the preferred Option 6 in the environmental assessment reporting. The current version of the memo incorporates MTO's comments.

3 DESIGN OPTIONS

To address future demand considering safety concerns noted above, WSP project team has prepared several geometric options to assess functionality and operations at Grisdale Road intersection in view of Merritt Road future widening. Details of these options are provided below, whereas illustrations and supporting traffic assessment report are provided as **Attachment B** and **Attachment C** respectively.

Option-1:

Under this option the Grisdale Road/Merritt Road intersection is Right-In/Right-Out (RIRO) only by providing a pork-chop island to restrict westbound left (WBL) and northbound left (NBL) movements. It should be noted that this type of treatment is not preferred as drivers may not comply with turn restrictions and potentially create greater safety concern.

Additionally, it is proposed that the existing exclusive eastbound left (EBL) turn lane carrying in-bound traffic to Highway 406 E/W-S On-Ramp be converted to a shared eastbound through-left (EBTL) to utilize existing capacity and avoid widening on the south side of Merritt Road.

Option-2:

Like Option-1, the Grisdale Road/Merritt Road intersection is considered as RIRO only by providing a raised concrete median along Merritt Road extending up to Highway 406 westerly Off-Ramp. This configuration ensures that westbound left (WBL) and northbound left (NBL) movements are not permitted to/from Grisdale Road. Under existing conditions, the Highway 406 N-E/W Off-Ramp has an exclusive channelized southbound right (SBR) turn lane which serves as a free-flow deceleration lane and a single shared southbound right/left lane at the terminal.

In addition to limiting Grisdale Road/Merritt Road intersection as RIRO only, a minor modification to the Highway 406 N-E/W Off-Ramp is also proposed in this option, which is the signalization of the ramp terminal and removal of channelized southbound right (SBR) turn lane while extending the lane to the intersection adjacent to southbound left (SBL) turn lane. It is anticipated that this modification will reduce speed of vehicles exiting the highway onto Merritt Road and will potentially increase the overall safety of the roadway.

Like Option-1, the existing exclusive eastbound left (EBL) turn lane carrying in-bound traffic to Highway 406 E/W-S On-Ramp is proposed be converted to a shared eastbound through-left (EBTL).

Option-3:

In this option, a WBL turn is permitted at Grisdale Road/Merritt Road intersection along with eastbound right (EBR) and northbound right (NBR) turning movements, in other words a RIRO plus WBL. Since NBL is again not permitted under this option, the median island and right-turn channel is designed to ensure that NBL is completely restricted. However, this option facilitates safer turn onto Grisdale Road from Merritt Road with a provision of a dedicated WBL turn lane.

Similar modification to Highway 406 N-E/W Off-Ramp as in Option-2 is proposed. However, two (2) dedicated SBR turn lane and an exclusive SBL turn lane is proposed along with signalization of ramp terminal.

Option-4:

This option is an enhanced version of Option-3 where all proposed improvements are carried with the exception of maintain an exclusive EBL turn and providing an additional EBT lane at Highway 406 N-E/W Off-Ramp and E/W-S On-Ramp intersection at Merritt Road. To avoid impacts and widening of the existing bridge structure over the

highway, it is intended to match eastbound lanes prior to bridge westerly abutment. However, this reconstruction of additional EBT lane will cause major impacts to vegetated area because of regrading of embankment on the south side of Merritt Road and relocation of guiderail as well.

Option-5:

In this option, the proposed improvements and restriction for Grisdale Road from Option 3 are carried forward. However, the Highway 406 westerly ramps (N-E/W Off-Ramp and E/W-S On-Ramp) intersection at Merritt Road is proposed to be converted to a two (2) lane roundabout with an inscribed circle diameter (ICD) of 55m.

A roundabout at ramp terminal in not uncommon on 400 series highways (one of the examples situated closer to the study area is Highway 406 terminus at East Main Street [Regional Road 27]), however, a roundabout is not considered a feasible option due to major property impacts and higher cost of construction because of much larger footprint than any given signalized/unsignalized intersection.

From the above, it is inferred that design Options 3, 4 and 5 provide better solution which allows improved safety for WBL turning vehicles and flexibility of future operation at Grisdale Road intersection and are carried forward for traffic assessment.

Option-6:

This option is a modified version of Option-4 in which an existing EBL turn is maintained and additional EBT lane is provided at Highway 406 N-E/W Off-Ramp and E/W-S On-Ramp intersection at Merritt Road., while matching eastbound lanes prior to bridge westerly abutment to avoid impacts and widening of the existing bridge structure over the highway. As mentioned under option 4, this reconstruction of additional EBT lane will have added impacts to vegetated area due to regrading embankment on the south side of Merritt Road and relocation of guiderail. In this option, a WBL turn is permitted at Grisdale Road/Merritt Road intersection along with eastbound right (EBR) and northbound right (NBR) turning movements, in other words a RIRO plus WBL. Since NBL is again not permitted under this option, the median island and right-turn channel is designed to ensure that NBL is completely restricted. This option would facilitate safer turn onto Grisdale Road from Merritt Road with a provision of a dedicated WBL turn lane.

Due to low traffic volumes, it is also proposed to remove WBR turn channel and provide a short WBR turn lane instead at the intersection. Removing WBR turn lane over the bridge will be a cost-effective solution where a Multi-Use Path (MUP) could be provided without widening bridge structure. Initially, a concrete median the MUP was proposed between the vehicular traffic lanes and the MUP, however, based on the Executive Review Meeting (held March 21, 2023), the concrete median was removed from the proposed cross-section. Further, the MUP was proposed as a raised MUP.

Provision of a raised MUP will require adjustment to the existing parapet wall and replacement of the railing system to accommodate the raised MUP. Detailed dimensions and design checks of the parapet wall and combination height railing will need to be determined during detailed design phase. In addition, a structural evaluation of the exterior girder will be required during detailed design phase to determine whether it can take the additional dead load from the raised MUP. The maintenance of the widened Merritt Road and the MUP would be Niagara Region's responsibility.

This option also provides safer pedestrian crossing at the proposed signalized intersection and not yielding at On-Ramps. For traffic assessment, 50 pedestrians/hour are assumed to be crossing at the intersection.

The design of the taper (length and configuration) for the left turn to Grisdale Road has been designed as per the MTO design supplement Exhibit 9-R (see below). Whereases due to constraint of the existing bridge, the proposed westbound right turn lane length is 95m (40m parallel with 55m taper), which is substandard to the MTO design standard in accordance with TAC Supplement Exhibit 9-J (60m parallel and 70m taper).

Exhibit 9-R
DECELERATION LENGTH FOR LEFT-TURN LANES, 2-LANES AND 4-LANE HIGHWAYS
FLAT GRADE 2% OR LESS

Design Speed (km/h)	Deceleration Length		Horizontal Curve to Smooth Taper R (m)
	Taper (m)	Parallel (m)	
50	85	20	500
60	100	30	750
70	115	40	1000
80	130	50	1200
90	145	60	1500
100	160	70	2000
110	170	80	2500

Design Criteria

All design changes /elements presented in the table below are designed in accordance with the TAC's G*eometric Design Guide for Canadian Roads* (2017). In addition, design criteria based on MTO's template is provided in **Attachment G**.

Items	Existing	Proposed
Minimum Radius at the Right-Turn Lanes	22.0 m	22.0 m
Through-Lane (Inner) Width at Bridge Structure	3.5 m	3.5 m
Through-Lane (Outer)/Right-Turn Lane Width at Bridge Structure	3.5 m	3.5 m
Right-Turn Lane (Parallel)	-	40 m
Right-Turn (Taper)	-	55 m
Shoulder Width	2.9 m	2.9 m
Median Width (where applicable)	-	1.5 m

Based on the TAC guidelines ***Section 9.4.2.4 – Cross Roadway Intersection Spacing Adjacent to Interchanges***, it is determined that the intersection spacing between the Highway 406 off-ramps and the nearest intersection is adequate. Figure 9.4.2 from the TAC guide is included below for reference.

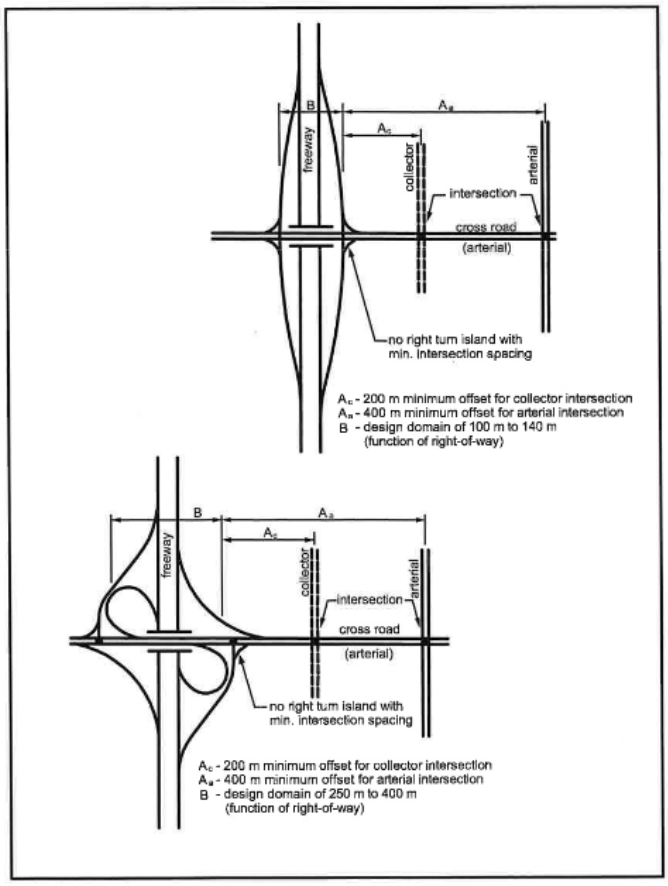


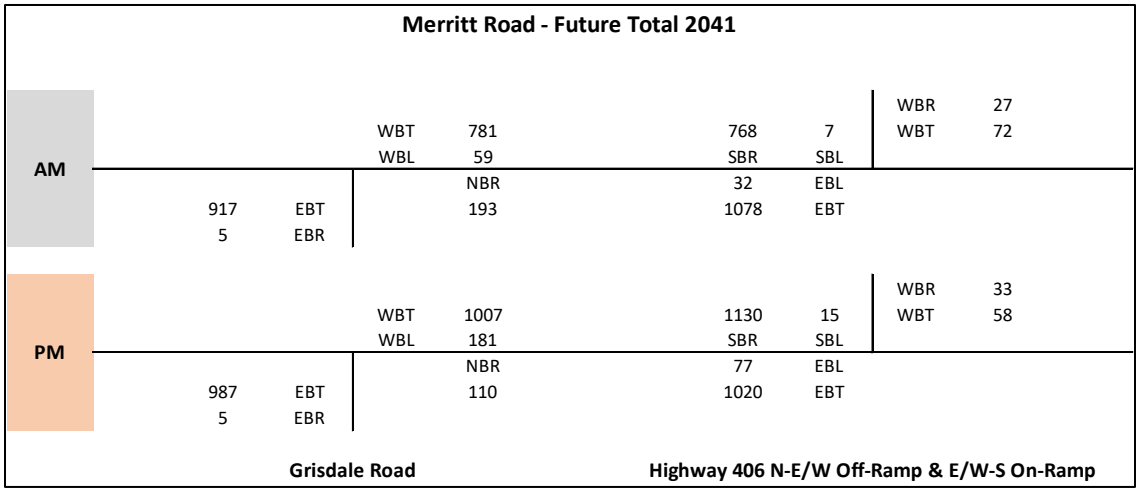
Figure 9.4.2: Cross Road Intersection Spacing Adjacent to Interchanges

4 TRAFFIC ASSESSMENT

WSP staff has performed a traffic assessment of design options 3, 4, 5 and 6 using Synchro software. Under Options 3, 4 and 6, two scenarios are assessed for Highway 406 N-E/W Off-Ramp & E/W-S On-Ramp:

- **Permitted / Protected** EB/WB movements
- **Split Phase** EB/WB movements

It should be noted that the Grisdale Road traffic demand is extracted from Merritt Meadows Development Traffic Impact Study by Paradigm. These traffic volumes are then forecasted to Future Total 2041 using a compound annual growth rate of 2%. The future total 2041 volumes are shown in figure below and results of the assessment are summarized in tables below.



OPTION 3 – Future Total 2041

Intersection	AM			PM		
	Delay	V/C	LOS	Delay	V/C	LOS
Merritt Rd at Hwy 406 SB Ramp **Permitted /Protected** EB/WB movements at Highway 406 N-E/W Off-Ramp & E/W-S On-Ramp	19.3	0.68	B	20.7	0.68	C
Merritt Rd at Grisdale Rd	2.2	0.53	A	1.8	0.51	A

OPTION 3 – Future Total 2041

Intersection	AM			PM		
	Delay	V/C	LOS	Delay	V/C	LOS
Merritt Rd at Hwy 406 SB Ramp **Split Phase** EB/WB movements at Highway 406 N-E/W Off-Ramp & E/W-S On-Ramp	21.7	0.72	C	23.3	0.72	C
Merritt Rd at Grisdale Rd	2.2	0.53	A	1.8	0.51	A

OPTION 4 – Future Total 2041

Intersection	AM			PM		
	Delay	V/C	LOS	Delay	V/C	LOS
Merritt Rd at Hwy 406 SB Ramp **Permitted /Protected** EB/WB movements at Highway 406 N-E/W Off-Ramp & E/W-S On-Ramp	19.2	0.64	B	19.9	0.62	B
Merritt Rd at Grisdale Rd	2.2	0.53	A	1.8	0.51	A

OPTION 4 – Future Total 2041

Intersection	AM			PM		
	Delay	V/C	LOS	Delay	V/C	LOS
Merritt Rd at Hwy 406 SB Ramp **Split Phase** EB/WB movements at Highway 406 N-E/W Off-Ramp & E/W-S On-Ramp	21.3	0.71	C	22.0	0.69	C
Merritt Rd at Grisdale Rd	2.2	0.53	A	1.8	0.51	A

OPTION 5 – Future Total 2041

Intersection	AM			PM		
	Delay	V/C	LOS	Delay	V/C	LOS
Merritt Rd at Hwy 406 SB Ramp **(Roundabout)**	-	0.61	B	-	0.86	E
Merritt Rd at Grisdale Rd	2.2	0.53	A	1.8	0.51	A

OPTION 6 – Future Total 2041

Intersection	AM			PM		
	Delay	V/C	LOS	Delay	V/C	LOS
Merritt Rd at Hwy 406 SB Ramp **Permitted /Protected** EB/WB movements at Highway 406 N-E/W Off-Ramp & E/W-S On-Ramp *(assumed 50 pedestrians per hour crossing at the intersection)*	19.2	0.64	B	19.9	0.62	B
Merritt Rd at Grisdale Rd	2.2	0.53	A	1.8	0.51	A

OPTION 6 – Future Total 2041

Intersection	AM			PM		
	Delay	V/C	LOS	Delay	V/C	LOS
Merritt Rd at Hwy 406 SB Ramp **Split Phase** EB/WB movements at Highway 406 N-E/W Off-Ramp & E/W-S On-Ramp *(assumed 50 pedestrians per hour crossing at the intersection)*	21.3	0.71	C	22.0	0.69	C
Merritt Rd at Grisdale Rd	2.2	0.53	C	1.8	0.51	A

Based on the assessment results it is noted that both intersections will operate well within capacity during AM & PM Peak periods under Future Total 2041 conditions.

5 QUEUEING ANALYSIS

WSP staff has also performed a 5-run simulation using SimTraffic for these options to determine WBL turn lane queuing at Grisdale Road and determined that the 95th percentile queue length for WBL does not exceed proposed storage length. The results of the simulation for each option are summarized below. Refer to **Attachment D** for detailed results of the Queuing Analysis.

95th Percentile Queue Length for WBL at Merritt Rd at Grisdale Rd – Future Total 2041

Scenario	AM	PM	Provided Storage (m)
OPTION 3 – **Permitted/Protected** EB/WB movements at Highway 406 N-E/W Off-Ramp & E/W-S On-Ramp	18.0	39.5	75.0
OPTION 3 – **Split Phase** EB/WB movements at Highway 406 N-E/W Off-Ramp & E/W-S On-Ramp	18.9	35.1	75.0
OPTION 4 – **Permitted/Protected** EB/WB movements at Highway 406 N-E/W Off-Ramp & E/W-S On-Ramp	13.1	31.5	75.0
OPTION 4 – **Split Phase** EB/WB movements at Highway 406 N-E/W Off-Ramp & E/W-S On-Ramp	18.2	35.5	75.0
OPTION 5 – **Roundabout**	15.9	37.6	75.0
OPTION 6 – **Permitted/Protected** EB/WB movements at Highway 406 N-E/W Off-Ramp & E/W-S On-Ramp	14.1	32.4	75.0
OPTION 6 – **Split Phase** EB/WB movements at Highway 406 N-E/W Off-Ramp & E/W-S On-Ramp	19.9	30.0	75.0

6 SIGNAL WARRANT ANALYSIS

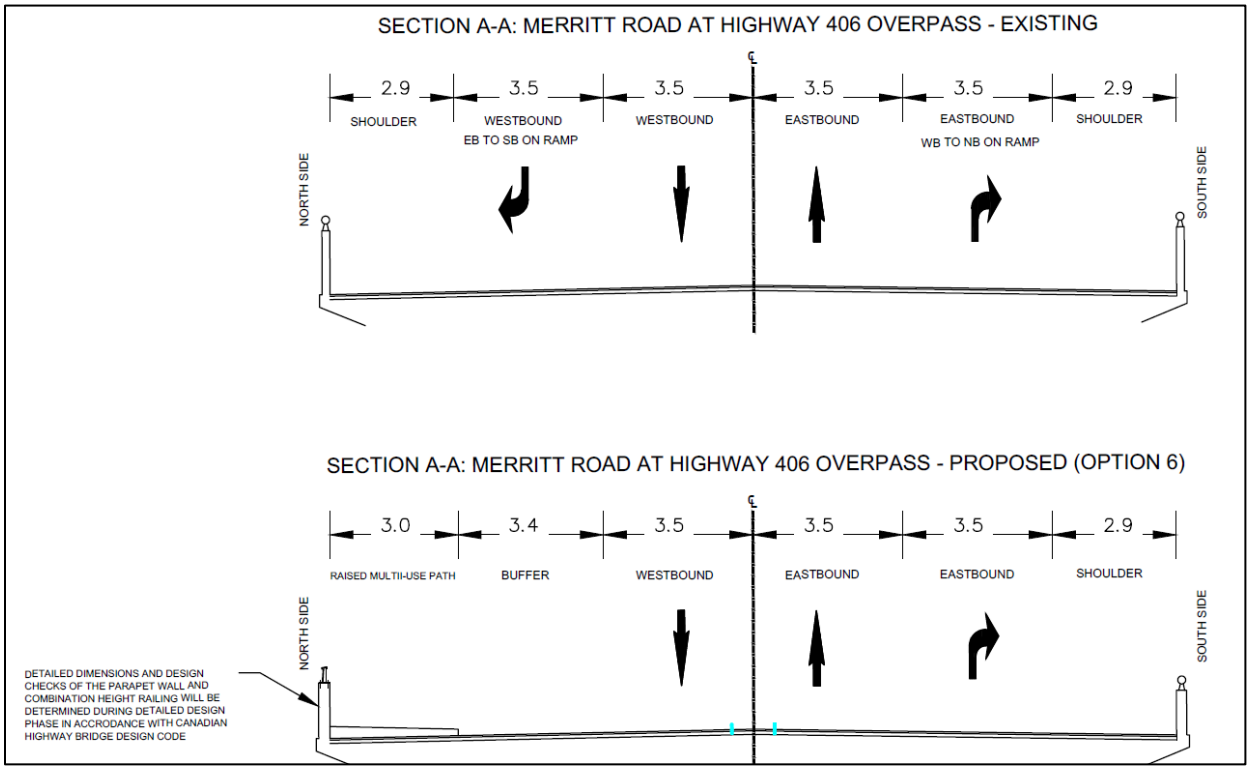
A Traffic Signal Warrant/Justification analysis was also undertaken for the Merritt Road / Highway 406 Westerly Ramps intersection for future (2041) horizon year. The results suggest that a signal is warranted based on the Minimum Vehicular Volume (Justification 1) and 4-Hr Volume (Justification 4). To ensure the safety of the pedestrians crossing the intersection to get to the Multi-Use Pathway extension to the east of the bridge, a traffic signal is recommended. The Traffic Signal Warrant spreadsheets can be found as **Attachment E.**

7 RECOMMENDATION

Based on the detailed assessment undertaken to assess the future condition requirements in the vicinity of Highway 406 interchange at Merritt Road, the WSP Staff makes the following recommendations:

- **Option 6** is recommended as the preferred option in terms of traffic safety, constructability, and cost-effectiveness. This option maintains the existing EBL turn lane and provides an additional EBT lane at Highway 406 N-E/W Off-Ramp and E/W-S On-Ramp intersection at Merritt Road, while matching eastbound lanes prior to bridge westerly abutment to avoid impacts and widening of the existing bridge structure over the highway. This option eliminates the need to widen the existing bridge structure through the removal of WBR turn channel and provision of a short WBR turn lane instead at the intersection. It should be noted that minor impacts to vegetated area are anticipated due to re-grading embankment on the south side of Merritt Road and

relocation of guiderail. In this option, a WBL turn is permitted at Grisdale Road/Merritt Road intersection along with eastbound right (EBR) and northbound right (NBR) turning movements, in other words a RIRO plus WBL. Since NBL is again not permitted under this option, the median island and right-turn channel is designed to ensure that NBL is completely restricted. This option would facilitate safer turn onto Grisdale Road from Merritt Road with a provision of a dedicated WBL turn lane. A MUP is also provided on the north side of the bridge structure as per the *MTO Bikeways Design Manual (March 2014)*. The existing and proposed cross-section at the bridge structure are shown in the figure below.



- It is also recommended to implement a traffic Signal at the Merritt Road / Highway 406 Westerly Ramps intersection to ensure pedestrian safety crossing the bride to get to the Multi-Use Pathway on the north side of the bridge.

Option 6 was accepted in principle by MTO senior management during the Executive Review Meeting (held March 21, 2023) with provision of minor comments. The Project Team subsequently updated the Option 6 to address MTO Senior Management's comments. On May 23, 2023, the MTO staff confirmed that they have no more comments on Option 6, and the Project Team could proceed with including the preferred Option 6 in the environmental assessment reporting.

Provision of a raised MUP will require adjustment to the existing parapet wall and replacement of the railing system to accommodate the raised MUP. Detailed dimensions and design checks of the parapet wall and combination height railing will need to be determined during detailed design phase. In addition, a structural evaluation of the exterior girder will be required during detailed design phase to determine whether it can take the additional dead load from the raised MUP.

A detailed illustration of option 6 is shown in the figure below.

GRISDALE ROAD - HIGHWAY 406 / MERRITT ROAD - OPTION 6

EXTEND SOUTHBOUND RIGHT TURN LANE TO THE INTERSECTION

PROVIDE TRAFFIC SIGNAL

REMOVE SOUTHBOUND RAMP AND PROVIDE WESTBOUND RIGHT TURN LANE

ONE WESTBOUND LANE TO BE REMOVED FOR 3.0m MULTI-USE PATH

RELOCATED GUIDERAIL

PROPOSED EDGE OF PAVEMENT

REMOVE SOUTHBOUND RIGHT TURN CHANNEL

PROVIDE CONCRETE MEDIAN

195

15 STORAGE LANE

50 PARALLEL LANE

130 TAPER LANE

40

55

A

A

130 TAPER LANE

50 PARALLEL LANE

15 STORAGE LANE

3.0m MULTI-USE PATH TO CROSS TO NORTH SIDE

RELOCATED GUIDERAIL

LEFT-IN /RIGHT-IN / RIGHT-OUT ONLY ACCESS

AREA TO BE REGRADED (LIMIT OF REGRADING TO BE DETERMINED DURING DETAILED DESIGN)

Merritt Road (Regional Road 37)

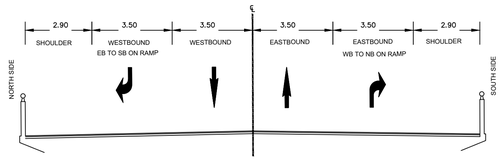
Highway 406

NORTH

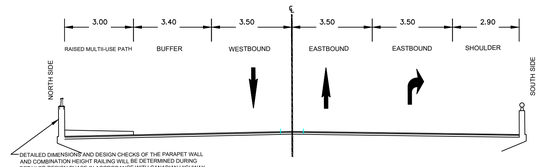
Grisdale Road

Kottmeier Road

SECTION A-A: MERRITT ROAD AT HIGHWAY 406 OVERPASS - EXISTING



SECTION A-A: MERRITT ROAD AT HIGHWAY 406 OVERPASS - PROPOSED (OPTION 6)



DETAILED DIMENSIONING AND DESIGN CHECKS OF THE PARAPET WALL AND COMBINATION HEIGHT RAILING WILL BE DETERMINED DURING DETAILED DESIGN PHASE IN ACCRODANCE WITH CANADIAN HIGHWAY BRIDGE DESIGN CODE

8 CONCLUSION

Active Transportation:

As noted in section 2 of this memo, the MTO staff has inquired project team regarding continuation of proposed active transportation to the east side of Highway 406. WSP has prepared exhibits based on the recommended Option-3 illustrating continuation of active transportation facility across the bridge structure to the east side of Highway 406 and are provided as Option-3b, 3c and 3d, which identifies need for widening exiting structure ±3m on the south side to accommodate a multi-use path across the bridge. Options '3c and 3d' are prepared for Ministry's consideration showing modifications to easterly E/W-N On-Ramp by providing a shared eastbound through right under Option 3c and a dedicated eastbound right with short taper under Option 3d. Both options suggest need for elimination of spiral on-ramp entry.

Active transportation under Option 6 is noted as preferred solution where active transportation is continued up to Highway 406 westerly ramps and crosses at the proposed signalized intersection. It will continue to the east by removing WBR turn over the structure, hence, eliminating need for bridge widening.

Grisdale Road and Highway 406 N-E/W Off-Ramp & E/W-S On-Ramp:

Based on the geometric and operational details along with supporting traffic assessment, it is concluded that the **Option-6** is considered as the best possible solution in view of traffic safety, constructability, and cost-effectiveness. An illustration of turning template for the preferred option based on WB-20 is included as **Attachment F** for reference purposes.

Attachments:

Attachment A – Minutes of Meeting with MTO on January 17, 2022
Attachment B – Design Options 1 through 6
Attachment C – Traffic Assessment Results (Synchro Analysis)
Attachment D – Queueing Analysis Results (SimTraffic Simulation)
Attachment E – Traffic Signal Warrant Analysis
Attachment F – Turning Templates for Preferred Option
Attachment G – Design Criteria
Attachment H – Minutes of the MTO Executive Review Meeting held on March 21, 2023

ATTACHMENT

A MINUTES OF MEETING WITH MTO – JANUARY 17, 2022

Meeting Minutes

Date: Tuesday, January 17, 2022, 1:00 PM **Meeting at:** Microsoft Teams
File No.: IM20103036
Subject/purpose: Merritt Road/Rice Road MCEA – Meeting to discuss design options for Merritt Rd over Highway 406 bridge

Attendees:

Maged Elmadhoon, Niagara Region
Sulaf Alkarawi, Niagara Region
Cam Milne, Niagara Region
Frank Tassone, Niagara Region
Samera Fares (MTO)
Martin (MTO)
Kashif Hussain (MTO)
Jason Lee (MTO)
Calvin Fong (MTO)
Samira Farahani (MTO)
Jordan Lee (MTO)
Eric Hakomaki (MTO)
Dermot Dusauzay (MTO)
Kaitlyn Greto (MTO)
Muhammad Khan, Wood
Mir Ahsan Talpur, Wood

Items Discussed:

1. Purpose of Meeting

The purpose of this meeting was to discuss with the Ministry of Transportation (MTO) the design options for Merritt Rd over Highway 406 bridge

2. Design Options for Merritt Rd at Highway 406 Bridge

The following three design options were presented:

Option 1: This option involves right-in and right-out access for vehicles on Grisdale Road and changing the left turn lane on Highway 406 ramp to shared Thru-left turn lane. It was noted that there are concerns associated with this option as the road users on Grisdale Rd may not comply and make left turn on Merritt Rd.

MTO staff inquired whether the bike tracks on Merritt Rd will be extended over Highway 406 bridge. The Study Team clarified that the current options consider ending the bike tracks at Grisdale Rd. The Environmental Study Report will note that the future extension

of bike tracks along Grisdale Rd to Welland Canal should be evaluated via a separate undertaking.

MTO staff inquired whether the topography of Merritt Rd and its impacts on the right in/right-out access on Grisdale Rd were reviewed. The Study Team responded that the topography and sightline distances were reviewed for this option, and it was confirmed that there will not be sight-line concerns. Changes to vertical profile are not being proposed.

Option 2: This option involves extending median along Merritt Road to Highway 406 N-E/W Off-Ramp, restricting access at Grisdale Road as Right-In/Right-Out only, and providing traffic signals at the ramp terminal. In order to make left turn, the traffic will need to use other roads, such as, Quaker Rd or Eastman Gateway.

Option 3: This option allows for traffic from Merritt Rd to make a left turn (westbound left) onto Grisdale Road, also allowing Right-In/Right-Out while a left turn off Grisdale Road (northbound left) onto Merritt Road will not be permitted. The existing right turn channel on southbound ramp on Highway 406 bridge will be replaced with two right turn lanes at the ramp terminal along with adjacent to southbound left turn lane, eliminating existing free flowing southbound channelized right turn lane.

Wood staff noted that drawings of design options will be provided to the MTO for detailed review and comment.

3. Open Discussion

Question: Did you do any split-phase analysis?
Response: No, a permitted-protected phase analysis was completed, which shows an intersection LOS B during Future 2041 AM and PM Peak hours

Question: How will the cyclists access the subdivision on the east side of the Highway 406 bridge?
Response: The Niagara Region will be willing to accommodate bike tracks across the bridge if the adequate space is available over the structure

Question: What is the proposed design speed?
Response: The proposed design speed is 70 km/h and the posted speed limit is 60 km/hm. The existing posted speed limit is 60 km/h.

Continued…

Question: Is there a raised median being proposed at the Grisdale Rd and Merritt Rd intersection?
Response: The first option excludes the raised median. The second option provides raised median up to the interchange. Third option provides a raised median, with left-in access to Grisdale Rd. The option 3 is preferred as it provides access, which is similar to redesigned Montrose Rd interchange. The option 1 is not preferred because of the potential safety concerns that the road users may use the intersection to make left turn on Merritt Rd.

Comment: MTO staff thinks that this project is different from Montrose Rd as there is future development being planned to the south side.
Response: The Niagara Region staff clarified that the Niagara Region has not received any development applications at this time. The Niagara Region staff raised the question whether the existing configuration of Highway 406 interchange intended to be a long-term configuration? MTO staff noted that the current configuration of the interchange was provided following the construction of the interchange as there were traffic issues at the interchange.

The Niagara Region staff noted that there have been six rear-end collisions at Grisdale Road since 2016. The turning movements from Grisdale Rd to Merritt Rd are very low.

Question: MTO staff asked that Wood to evaluate an option to provide two through lanes while maintaining dedicated eastbound left turn lane.
Response: Wood can look into providing additional through lane and potential active transportation facility over the structure, however, widening of bridge would be required. Further, based on the traffic analysis, the opposing traffic to left turn volumes (westbound through) at the westerly off ramp are low which may not require a dedicated left turn lane. Wood to complete the sensitivity analysis for Grisdale Road and Split Phasing Analysis at N-E/W Off-Ramp terminal for future horizon 2041 (**Action Item**).

Question: Is the median being provided as far as the Niagara Street, and whether the access will be provided to Eastman Gateway? In that case, everyone in that subdivision will use Eastman Gateway.
Response: The median extends to Niagara Street, however, full-access will be maintained at Eastman Gateway.

MTO suggested contacting the local municipality to confirm if there are any development applications for the lands on the south side of Grisdale Road.

Continued…

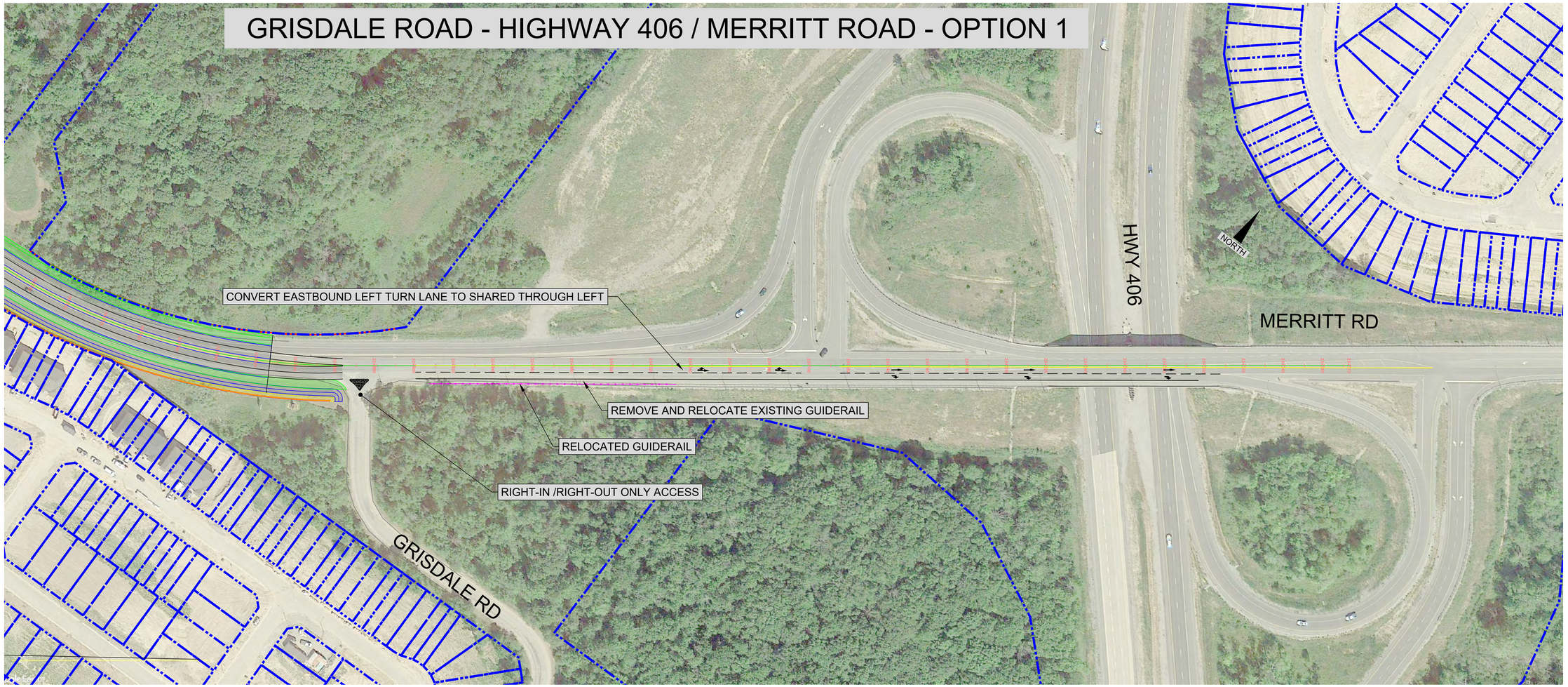
Comment: The MTO staff noted that the area residents would be concerned when they find out that there is no active transportation facility being provided across the bridge. The MTO added that the Niagara Region should take the responsibility for not providing active transpiration infrastructure over the bridge.
Response: The Niagara Region is willing to provide the active transportation infrastructure over the bridge, however there is not enough space on the bridge. Maged noted that the Study Team will look into the provision of active transportation infrastructure across Highway 406 bridge (**Action Item**).

Maged requested that the Study Team would appreciate MTO's expedited review as the Study Team would like to complete the EA study in early spring. MTO staff noted that once design options have been provided to the MTO, the staff will review those options and provide comments and confirm the need for another meeting.

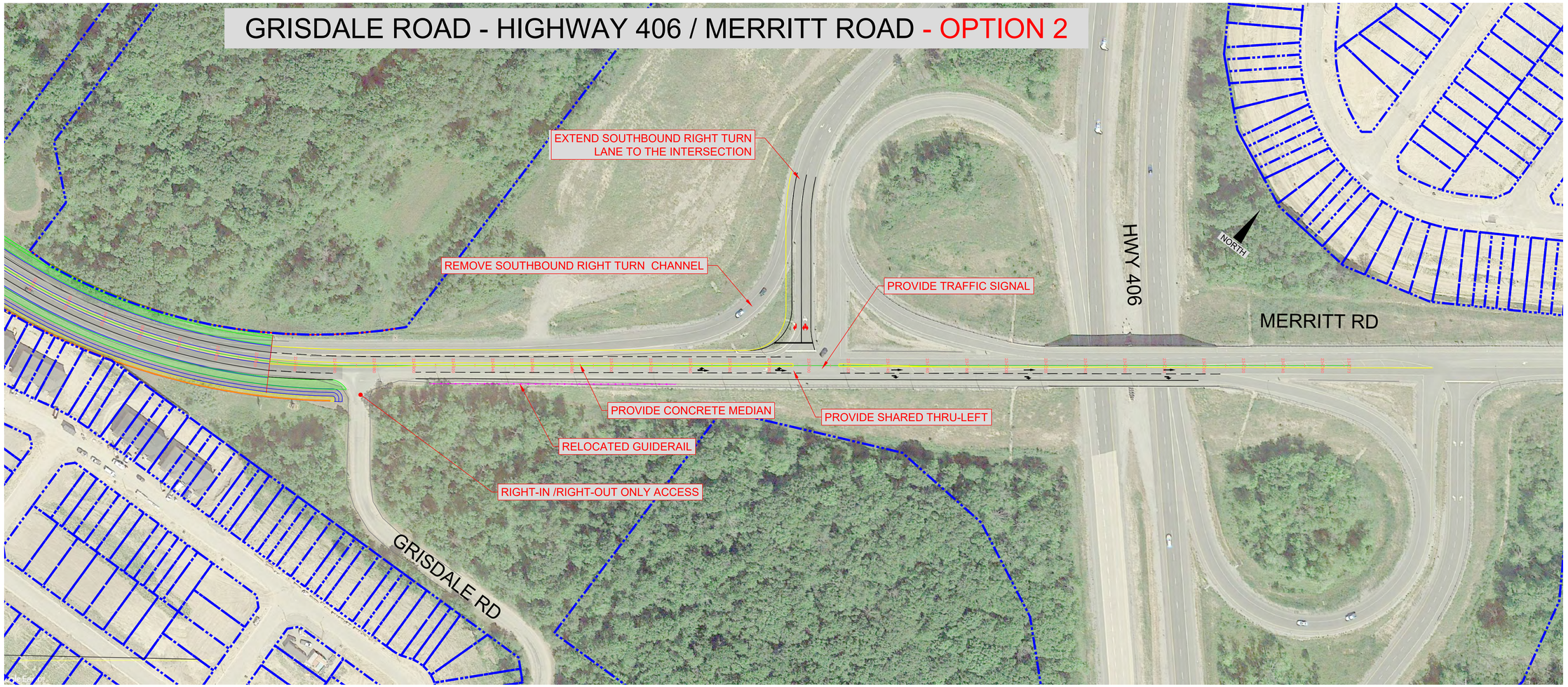
ATTACHMENT

B DESIGN OPTIONS 1 - 6

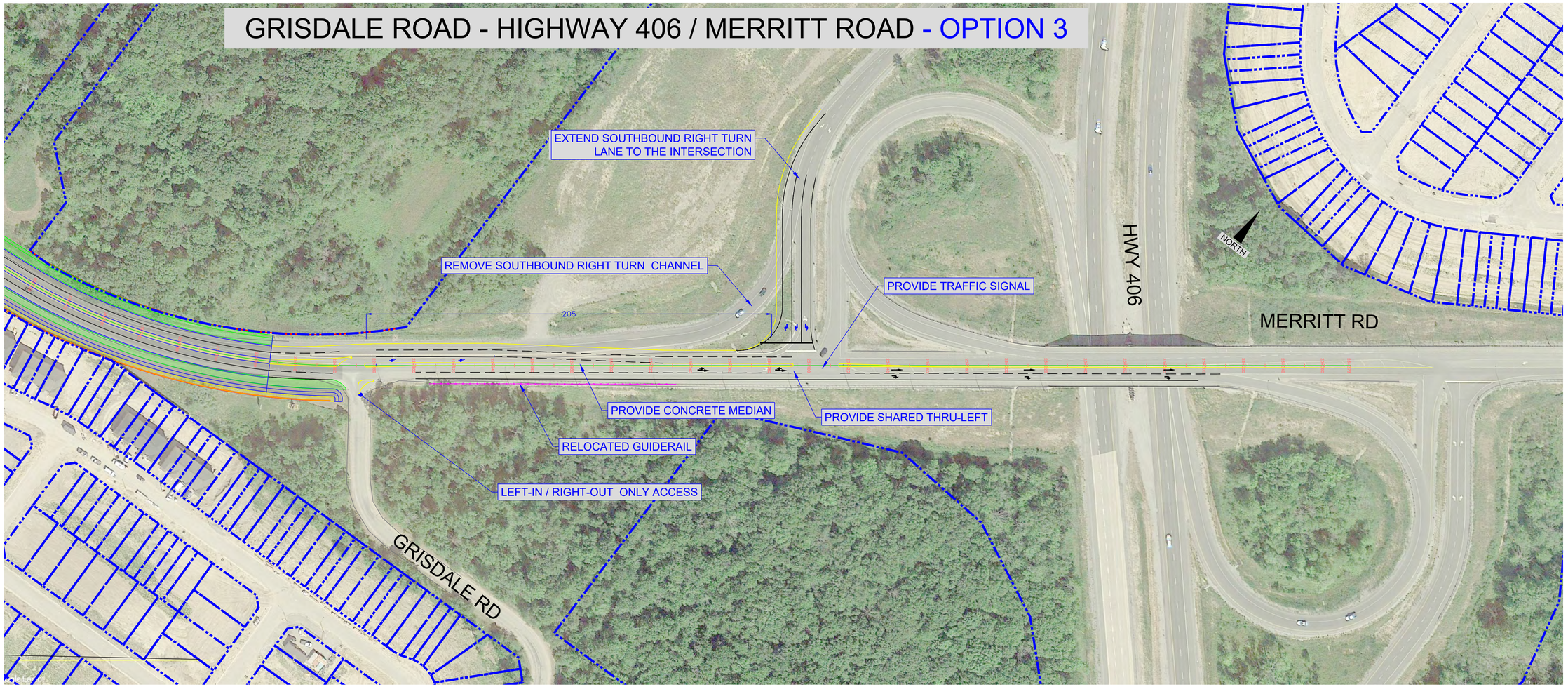
GRISDALE ROAD - HIGHWAY 406 / MERRITT ROAD - OPTION 1



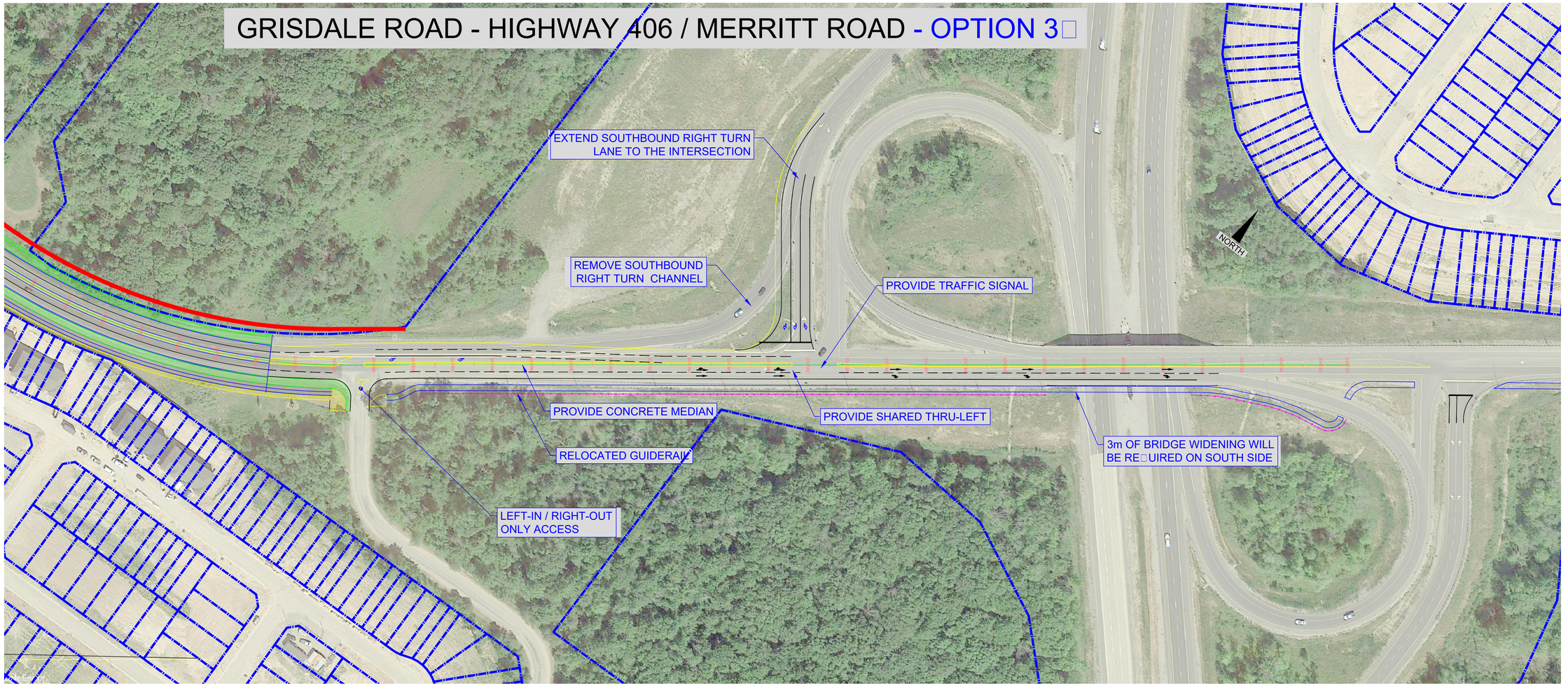
GRISDALE ROAD - HIGHWAY 406 / MERRITT ROAD - OPTION 2



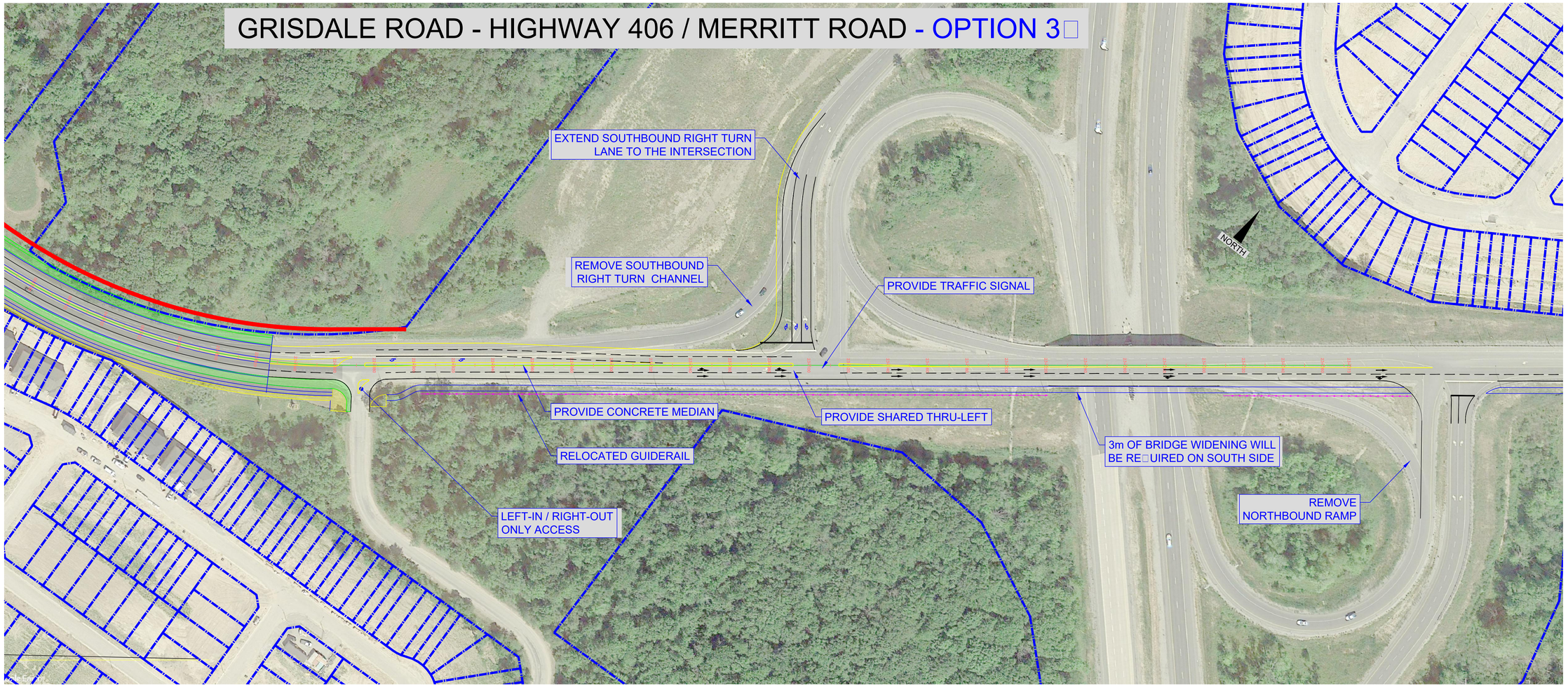
GRISDALE ROAD - HIGHWAY 406 / MERRITT ROAD - OPTION 3



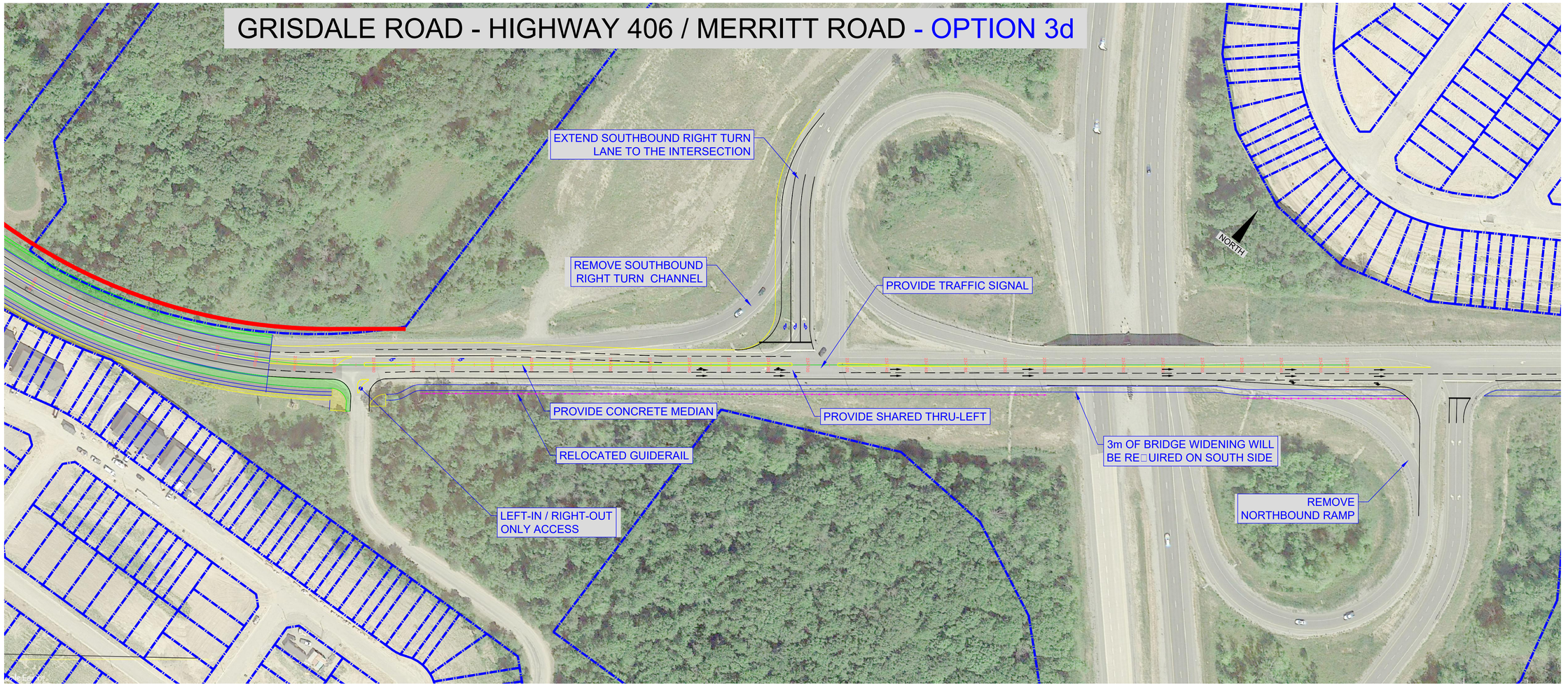
GRISDALE ROAD - HIGHWAY 406 / MERRITT ROAD - OPTION 3



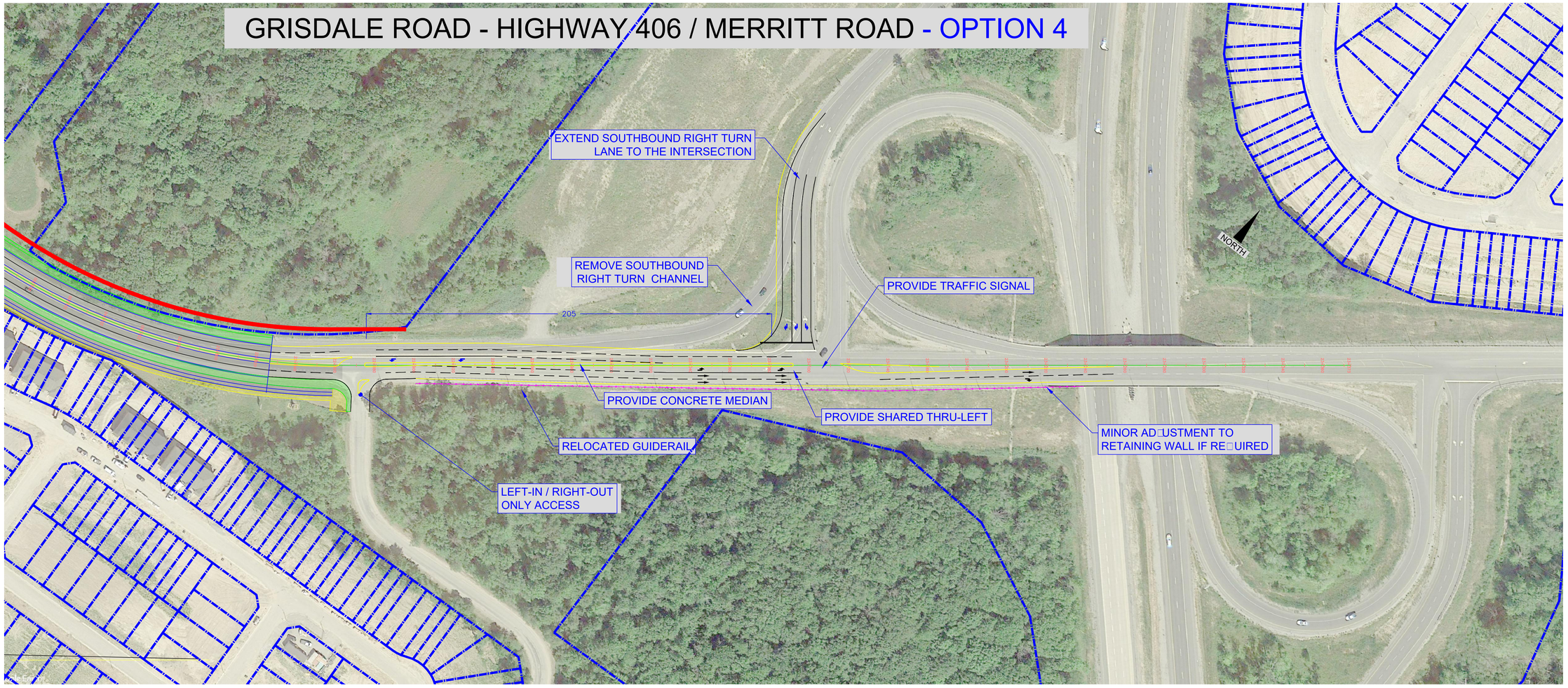
GRISDALE ROAD - HIGHWAY 406 / MERRITT ROAD - OPTION 3



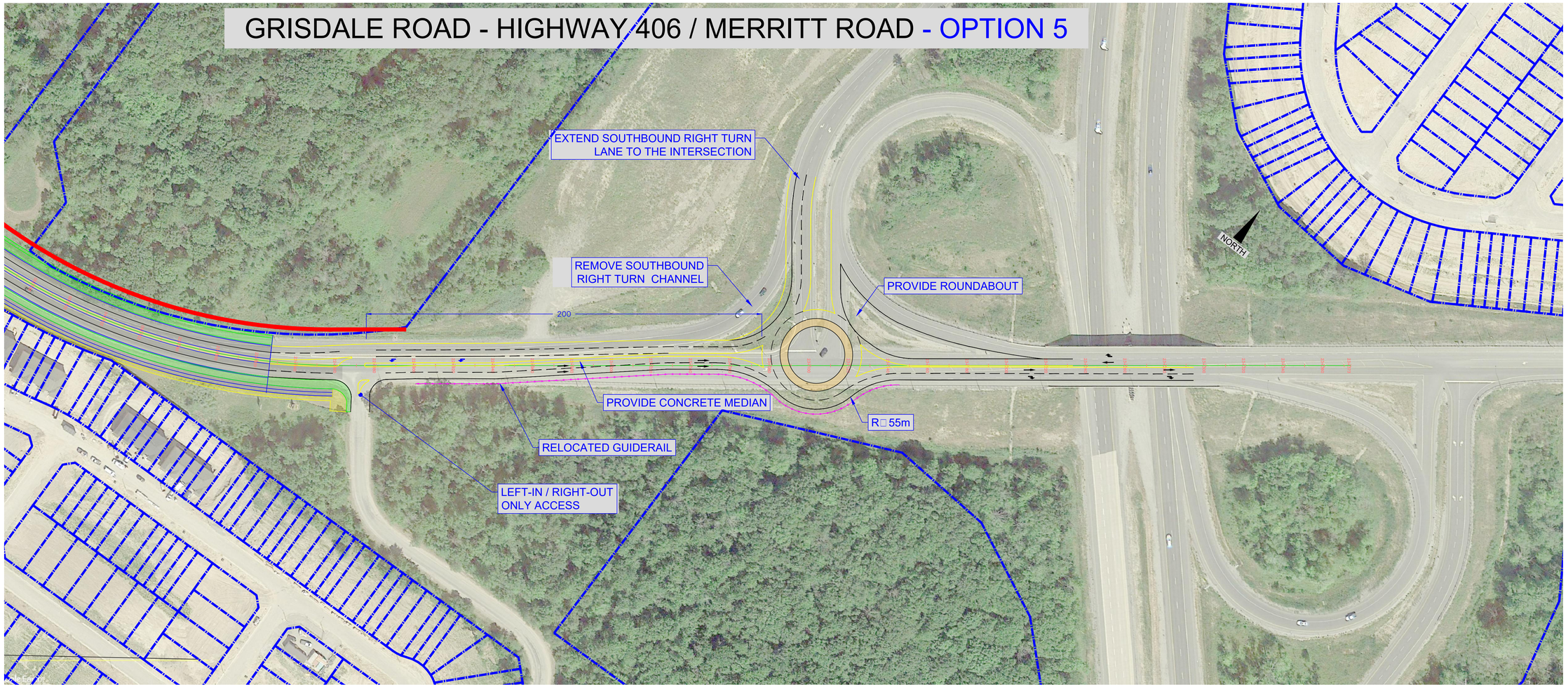
GRISDALE ROAD - HIGHWAY 406 / MERRITT ROAD - OPTION 3d



GRISDALE ROAD - HIGHWAY 406 / MERRITT ROAD - OPTION 4



GRISDALE ROAD - HIGHWAY 406 / MERRITT ROAD - OPTION 5



GRISDALE ROAD - HIGHWAY 406 / MERRITT ROAD - OPTION 6

EXTEND SOUTHBOUND RIGHT TURN LANE TO THE INTERSECTION

PROVIDE TRAFFIC SIGNAL

REMOVE SOUTHBOUND RAMP AND PROVIDE WESTBOUND RIGHT TURN LANE

ONE WESTBOUND LANE TO BE REMOVED FOR 3.0m MULTI-USE PATH

RELOCATED GUIDERAIL

PROPOSED EDGE OF PAVEMENT

REMOVE SOUTHBOUND RIGHT TURN CHANNEL

PROVIDE CONCRETE MEDIAN

195

15 STORAGE LANE

50 PARALLEL LANE

130 TAPER LANE

40

55

A

A

130 TAPER LANE

50 PARALLEL LANE

15 STORAGE LANE

3.0m MULTI-USE PATH TO CROSS TO NORTH SIDE

RELOCATED GUIDERAIL

LEFT-IN /RIGHT-IN / RIGHT-OUT ONLY ACCESS

AREA TO BE REGRADED (LIMIT OF REGRADING TO BE DETERMINED DURING DETAILED DESIGN)

Merritt Road (Regional Road 37)

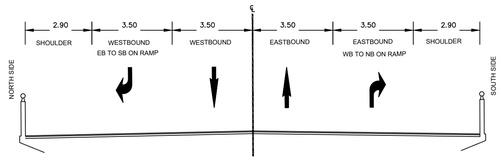
Highway 406

NORTH

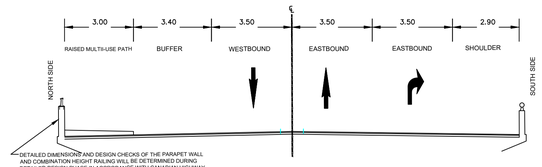
Grisdale Road

Kottmeier Road

SECTION A-A: MERRITT ROAD AT HIGHWAY 406 OVERPASS - EXISTING

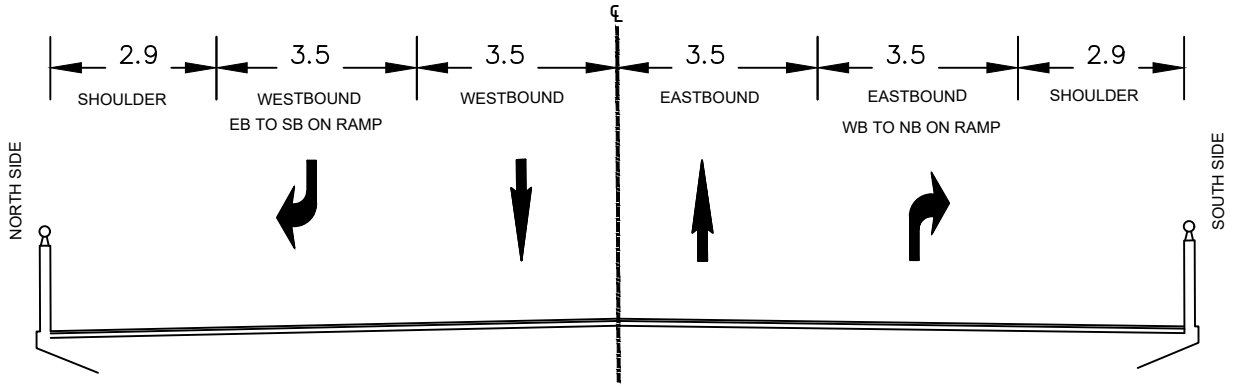


SECTION A-A: MERRITT ROAD AT HIGHWAY 406 OVERPASS - PROPOSED (OPTION 6)

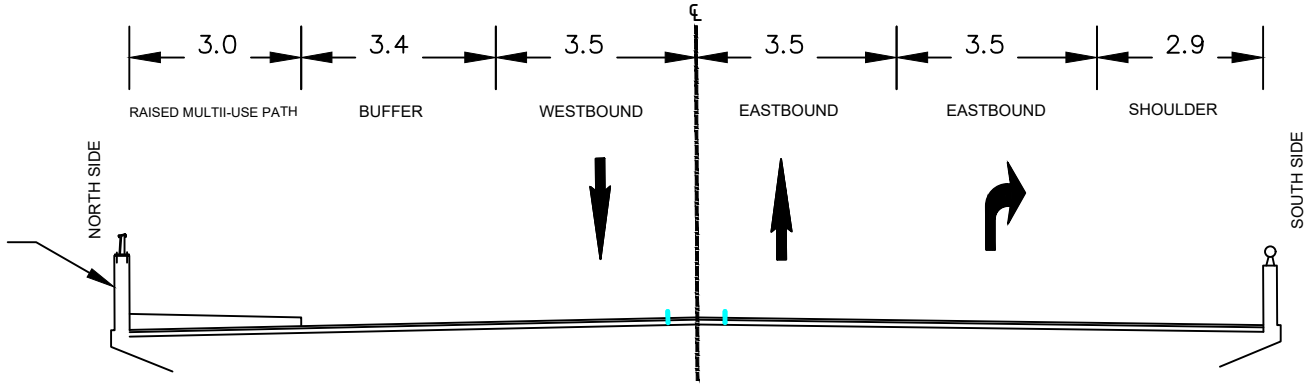


DETAILED DIMENSIONING AND DESIGN CHECKS OF THE PARAPET WALL AND COMBINATION HEIGHT RAILING WILL BE DETERMINED DURING DETAILED DESIGN PHASE IN ACCRODANCE WITH CANADIAN HIGHWAY BRIDGE DESIGN CODE

SECTION A-A: MERRITT ROAD AT HIGHWAY 406 OVERPASS - EXISTING



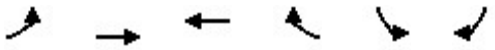
SECTION A-A: MERRITT ROAD AT HIGHWAY 406 OVERPASS - PROPOSED (OPTION 6)



FILENAME: S:\PLANNING DWGS\CA0002253.5346 – Merritt Road\MTO Interchange\Cross-sections\Cross-section (option 6).dwg
DATE: 1 May 2023

ATTACHMENT

C TRAFFIC ASSESSMENT RESULTS (SYNCHRO ANALYSIS

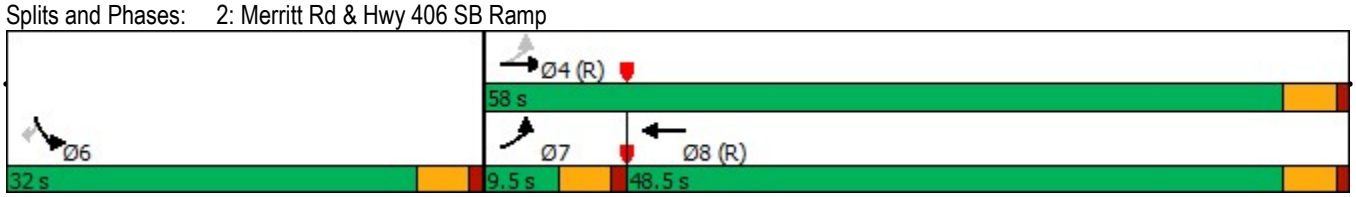


Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	32	1078	72	27	7	768
Future Volume (vph)	32	1078	72	27	7	768
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)	0.0			210.0	0.0	150.0
Storage Lanes	0			1	1	2
Taper Length (m)	2.5				2.5	
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	0.88
Frt				0.850		0.850
Flt Protected		0.999			0.950	
Satd. Flow (prot)	0	3115	1364	1438	1607	2457
Flt Permitted		0.945			0.950	
Satd. Flow (perm)	0	2946	1364	1438	1607	2457
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				33		937
Link Speed (k/h)		60	60		60	
Link Distance (m)		216.0	340.4		573.6	
Travel Time (s)		13.0	20.4		34.4	
Peak Hour Factor	0.82	0.82	0.82	0.82	0.82	0.82
Heavy Vehicles (%)	6%	3%	24%	0%	0%	3%
Adj. Flow (vph)	39	1315	88	33	9	937
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	1354	88	33	9	937
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		3.3	3.3		3.3	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		1.6	1.6		1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)	24			14	24	14
Number of Detectors	1	2	2	1	1	1
Detector Template	Left	Thru	Thru	Right	Left	Right
Leading Detector (m)	6.1	30.5	30.5	6.1	6.1	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	1.8	6.1	6.1	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 2 Position(m)		28.7	28.7			
Detector 2 Size(m)		1.8	1.8			
Detector 2 Type		Cl+Ex	Cl+Ex			
Detector 2 Channel						
Detector 2 Extend (s)		0.0	0.0			
Turn Type	pm+pt	NA	NA	Free	Prot	Perm
Protected Phases	7	4	8		6	

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Permitted Phases	4			Free		6
Detector Phase	7	4	8		6	6
Switch Phase						
Minimum Initial (s)	5.0	5.0	5.0		5.0	5.0
Minimum Split (s)	9.5	22.5	22.5		22.5	22.5
Total Split (s)	9.5	58.0	48.5		32.0	32.0
Total Split (%)	10.6%	64.4%	53.9%		35.6%	35.6%
Maximum Green (s)	5.0	53.5	44.0		27.5	27.5
Yellow Time (s)	3.5	3.5	3.5		3.5	3.5
All-Red Time (s)	1.0	1.0	1.0		1.0	1.0
Lost Time Adjust (s)		0.0	0.0		0.0	0.0
Total Lost Time (s)		4.5	4.5		4.5	4.5
Lead/Lag	Lead		Lag			
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Recall Mode	None	C-Max	C-Max		Max	Max
Act Effct Green (s)		53.5	53.5	90.0	27.5	27.5
Actuated g/C Ratio		0.59	0.59	1.00	0.31	0.31
v/c Ratio		0.77	0.11	0.02	0.02	0.67
Control Delay		17.6	8.4	0.0	22.1	4.4
Queue Delay		0.0	0.0	0.0	0.0	0.0
Total Delay		17.6	8.4	0.0	22.1	4.4
LOS		B	A	A	C	A
Approach Delay		17.6	6.1		4.6	
Approach LOS		B	A		A	
Queue Length 50th (m)		85.1	6.1	0.0	1.1	0.0
Queue Length 95th (m)		93.4	11.1	0.0	4.0	6.4
Internal Link Dist (m)		192.0	316.4		549.6	
Turn Bay Length (m)				210.0		150.0
Base Capacity (vph)		1751	810	1438	491	1401
Starvation Cap Reductn		0	0	0	0	0
Spillback Cap Reductn		0	0	0	0	0
Storage Cap Reductn		0	0	0	0	0
Reduced v/c Ratio		0.77	0.11	0.02	0.02	0.67

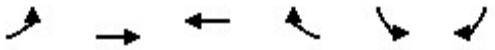
Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 90			
Offset: 0 (0%), Referenced to phase 4:EBTL and 8:WBT, Start of Green			
Natural Cycle: 60			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.77			
Intersection Signal Delay: 11.9		Intersection LOS: B	
Intersection Capacity Utilization 48.4%		ICU Level of Service A	
Analysis Period (min) 15			

Splits and Phases: 2: Merritt Rd & Hwy 406 SB Ramp



Lane Group	EBT	WBT	WBR	SBL	SBR
Lane Group Flow (vph)	1354	88	33	9	937
v/c Ratio	0.77	0.11	0.02	0.02	0.67
Control Delay	17.6	8.4	0.0	22.1	4.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	17.6	8.4	0.0	22.1	4.4
Queue Length 50th (m)	85.1	6.1	0.0	1.1	0.0
Queue Length 95th (m)	93.4	11.1	0.0	4.0	6.4
Internal Link Dist (m)	192.0	316.4		549.6	
Turn Bay Length (m)			210.0		150.0
Base Capacity (vph)	1751	810	1438	491	1401
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.77	0.11	0.02	0.02	0.67

Intersection Summary



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	32	1078	72	27	7	768
Future Volume (vph)	32	1078	72	27	7	768
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Total Lost time (s)		4.5	4.5	4.0	4.5	4.5
Lane Util. Factor		0.95	1.00	1.00	1.00	0.88
Frt		1.00	1.00	0.85	1.00	0.85
Flt Protected		1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)		3113	1364	1438	1607	2457
Flt Permitted		0.94	1.00	1.00	0.95	1.00
Satd. Flow (perm)		2946	1364	1438	1607	2457
Peak-hour factor, PHF	0.82	0.82	0.82	0.82	0.82	0.82
Adj. Flow (vph)	39	1315	88	33	9	937
RTOR Reduction (vph)	0	0	0	0	0	651
Lane Group Flow (vph)	0	1354	88	33	9	286
Heavy Vehicles (%)	6%	3%	24%	0%	0%	3%
Turn Type	pm+pt	NA	NA	Free	Prot	Perm
Protected Phases	7	4	8		6	
Permitted Phases	4			Free		6
Actuated Green, G (s)		53.5	53.5	90.0	27.5	27.5
Effective Green, g (s)		53.5	53.5	90.0	27.5	27.5
Actuated g/C Ratio		0.59	0.59	1.00	0.31	0.31
Clearance Time (s)		4.5	4.5		4.5	4.5
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		1751	810	1438	491	750
v/s Ratio Prot			0.06		0.01	
v/s Ratio Perm		c0.46		0.02		c0.12
v/c Ratio		0.77	0.11	0.02	0.02	0.38
Uniform Delay, d1		13.7	7.9	0.0	21.8	24.6
Progression Factor		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		2.2	0.3	0.0	0.1	1.5
Delay (s)		15.9	8.2	0.0	21.9	26.0
Level of Service		B	A	A	C	C
Approach Delay (s)		15.9	6.0		26.0	
Approach LOS		B	A		C	

Intersection Summary			
HCM 2000 Control Delay	19.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.5
Intersection Capacity Utilization	48.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

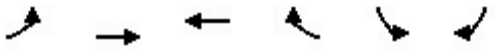
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1105	5	59	781	0	193
Future Volume (vph)	1105	5	59	781	0	193
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)		0.0	75.0		0.0	0.0
Storage Lanes		0	1		0	1
Taper Length (m)			2.5		2.5	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Frt	0.999					0.865
Flt Protected			0.950			
Satd. Flow (prot)	3148	0	1576	3151	0	1435
Flt Permitted			0.950			
Satd. Flow (perm)	3148	0	1576	3151	0	1435
Link Speed (k/h)	60			60	50	
Link Distance (m)	1070.4			216.0	379.7	
Travel Time (s)	64.2			13.0	27.3	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1201	5	64	849	0	210
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1206	0	64	849	0	210
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	3.3			3.3	0.0	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	1.6			1.6	1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)		14	24		24	14
Sign Control	Free			Free	Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	53.0%	ICU Level of Service	A
Analysis Period (min)	15		

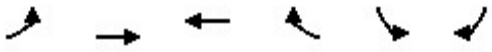
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	1105	5	59	781	0	193
Future Volume (Veh/h)	1105	5	59	781	0	193
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1201	5	64	849	0	210
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				216		
pX, platoon unblocked						
vC, conflicting volume			1206		1756	603
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1206		1756	603
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			89		100	52
cM capacity (veh/h)			574		68	442

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1
Volume Total	801	405	64	424	424	210
Volume Left	0	0	64	0	0	0
Volume Right	0	5	0	0	0	210
cSH	1700	1700	574	1700	1700	442
Volume to Capacity	0.47	0.24	0.11	0.25	0.25	0.48
Queue Length 95th (m)	0.0	0.0	2.8	0.0	0.0	19.0
Control Delay (s)	0.0	0.0	12.1	0.0	0.0	20.3
Lane LOS			B			C
Approach Delay (s)	0.0		0.8			20.3
Approach LOS						C

Intersection Summary			
Average Delay	2.2		
Intersection Capacity Utilization	53.0%	ICU Level of Service	A
Analysis Period (min)	15		



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	32	1078	72	27	7	768
Future Volume (vph)	32	1078	72	27	7	768
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)	0.0			210.0	0.0	150.0
Storage Lanes	0			1	1	2
Taper Length (m)	2.5				2.5	
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	0.88
Frt				0.850		0.850
Flt Protected		0.999			0.950	
Satd. Flow (prot)	0	3115	1364	1438	1607	2457
Flt Permitted		0.999			0.950	
Satd. Flow (perm)	0	3115	1364	1438	1607	2457
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				33		937
Link Speed (k/h)		60	60		60	
Link Distance (m)		216.0	340.4		573.6	
Travel Time (s)		13.0	20.4		34.4	
Peak Hour Factor	0.82	0.82	0.82	0.82	0.82	0.82
Heavy Vehicles (%)	6%	3%	24%	0%	0%	3%
Adj. Flow (vph)	39	1315	88	33	9	937
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	1354	88	33	9	937
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		3.3	3.3		3.3	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		1.6	1.6		1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)	24			14	24	14
Number of Detectors	1	2	2	1	1	1
Detector Template	Left	Thru	Thru	Right	Left	Right
Leading Detector (m)	6.1	30.5	30.5	6.1	6.1	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	1.8	6.1	6.1	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 2 Position(m)		28.7	28.7			
Detector 2 Size(m)		1.8	1.8			
Detector 2 Type		Cl+Ex	Cl+Ex			
Detector 2 Channel						
Detector 2 Extend (s)		0.0	0.0			
Turn Type	Split	NA	NA	Free	Prot	Perm
Protected Phases	4	4	8		6	



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Permitted Phases				Free		6
Detector Phase	4	4	8		6	6
Switch Phase						
Minimum Initial (s)	5.0	5.0	5.0		4.5	4.5
Minimum Split (s)	9.5	9.5	9.5		9.0	9.0
Total Split (s)	35.5	35.5	10.5		14.0	14.0
Total Split (%)	59.2%	59.2%	17.5%		23.3%	23.3%
Maximum Green (s)	31.0	31.0	6.0		9.5	9.5
Yellow Time (s)	3.5	3.5	3.5		3.5	3.5
All-Red Time (s)	1.0	1.0	1.0		1.0	1.0
Lost Time Adjust (s)		0.0	0.0		0.0	0.0
Total Lost Time (s)		4.5	4.5		4.5	4.5
Lead/Lag						
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Recall Mode	C-Max	C-Max	Max		Max	Max
Act Effct Green (s)		31.0	6.0	60.0	9.5	9.5
Actuated g/C Ratio		0.52	0.10	1.00	0.16	0.16
v/c Ratio		0.84	0.65	0.02	0.04	0.80
Control Delay		18.9	51.2	0.0	21.9	8.3
Queue Delay		0.0	0.0	0.0	0.0	0.0
Total Delay		18.9	51.2	0.0	21.9	8.3
LOS		B	D	A	C	A
Approach Delay		18.9	37.3		8.5	
Approach LOS		B	D		A	
Queue Length 50th (m)		61.3	9.6	0.0	0.9	0.0
Queue Length 95th (m)		73.5	#24.3	0.0	3.8	8.5
Internal Link Dist (m)		192.0	316.4		549.6	
Turn Bay Length (m)				210.0		150.0
Base Capacity (vph)		1609	136	1438	254	1177
Starvation Cap Reductn		0	0	0	0	0
Spillback Cap Reductn		0	0	0	0	0
Storage Cap Reductn		0	0	0	0	0
Reduced v/c Ratio		0.84	0.65	0.02	0.04	0.80

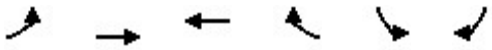
Intersection Summary			
Area Type:	Other		
Cycle Length: 60			
Actuated Cycle Length: 60			
Offset: 0 (0%), Referenced to phase 4:EBTL, Start of Green			
Natural Cycle: 55			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.84			
Intersection Signal Delay: 15.8		Intersection LOS: B	
Intersection Capacity Utilization 47.9%		ICU Level of Service A	
Analysis Period (min) 15			
# 95th percentile volume exceeds capacity, queue may be longer.			
Queue shown is maximum after two cycles.			

Splits and Phases: 2: Merritt Rd & Hwy 406 SB Ramp

Lane Group	EBT	WBT	WBR	SBL	SBR
Lane Group Flow (vph)	1354	88	33	9	937
v/c Ratio	0.84	0.65	0.02	0.04	0.80
Control Delay	18.9	51.2	0.0	21.9	8.3
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	18.9	51.2	0.0	21.9	8.3
Queue Length 50th (m)	61.3	9.6	0.0	0.9	0.0
Queue Length 95th (m)	73.5	#24.3	0.0	3.8	8.5
Internal Link Dist (m)	192.0	316.4		549.6	
Turn Bay Length (m)			210.0		150.0
Base Capacity (vph)	1609	136	1438	254	1177
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.84	0.65	0.02	0.04	0.80

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	32	1078	72	27	7	768
Future Volume (vph)	32	1078	72	27	7	768
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Total Lost time (s)		4.5	4.5	4.0	4.5	4.5
Lane Util. Factor		0.95	1.00	1.00	1.00	0.88
Frt		1.00	1.00	0.85	1.00	0.85
Flt Protected		1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)		3113	1364	1438	1607	2457
Flt Permitted		1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)		3113	1364	1438	1607	2457
Peak-hour factor, PHF	0.82	0.82	0.82	0.82	0.82	0.82
Adj. Flow (vph)	39	1315	88	33	9	937
RTOR Reduction (vph)	0	0	0	0	0	789
Lane Group Flow (vph)	0	1354	88	33	9	148
Heavy Vehicles (%)	6%	3%	24%	0%	0%	3%
Turn Type	Split	NA	NA	Free	Prot	Perm
Protected Phases	4	4	8		6	
Permitted Phases				Free		6
Actuated Green, G (s)		31.0	6.0	60.0	9.5	9.5
Effective Green, g (s)		31.0	6.0	60.0	9.5	9.5
Actuated g/C Ratio		0.52	0.10	1.00	0.16	0.16
Clearance Time (s)		4.5	4.5		4.5	4.5
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		1608	136	1438	254	389
v/s Ratio Prot		c0.43	c0.06		0.01	
v/s Ratio Perm				0.02		c0.06
v/c Ratio		0.84	0.65	0.02	0.04	0.38
Uniform Delay, d1		12.4	26.0	0.0	21.4	22.6
Progression Factor		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		5.5	21.4	0.0	0.3	2.8
Delay (s)		17.9	47.4	0.0	21.6	25.4
Level of Service		B	D	A	C	C
Approach Delay (s)		17.9	34.5		25.4	
Approach LOS		B	C		C	

Intersection Summary			
HCM 2000 Control Delay	21.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	13.5
Intersection Capacity Utilization	47.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

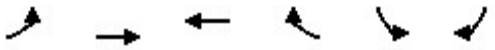
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1105	5	59	781	0	193
Future Volume (vph)	1105	5	59	781	0	193
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)		0.0	75.0		0.0	0.0
Storage Lanes		0	1		0	1
Taper Length (m)			2.5		2.5	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Frt	0.999					0.865
Flt Protected			0.950			
Satd. Flow (prot)	3148	0	1576	3151	0	1435
Flt Permitted			0.950			
Satd. Flow (perm)	3148	0	1576	3151	0	1435
Link Speed (k/h)	60			60	50	
Link Distance (m)	1070.4			216.0	379.7	
Travel Time (s)	64.2			13.0	27.3	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1201	5	64	849	0	210
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1206	0	64	849	0	210
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	3.3			3.3	0.0	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	1.6			1.6	1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)		14	24		24	14
Sign Control	Free			Free	Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	53.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	1105	5	59	781	0	193
Future Volume (Veh/h)	1105	5	59	781	0	193
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1201	5	64	849	0	210
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				216		
pX, platoon unblocked						
vC, conflicting volume			1206		1756	603
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1206		1756	603
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			89		100	52
cM capacity (veh/h)			574		68	442

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1
Volume Total	801	405	64	424	424	210
Volume Left	0	0	64	0	0	0
Volume Right	0	5	0	0	0	210
cSH	1700	1700	574	1700	1700	442
Volume to Capacity	0.47	0.24	0.11	0.25	0.25	0.48
Queue Length 95th (m)	0.0	0.0	2.8	0.0	0.0	19.0
Control Delay (s)	0.0	0.0	12.1	0.0	0.0	20.3
Lane LOS			B			C
Approach Delay (s)	0.0		0.8			20.3
Approach LOS						C

Intersection Summary				
Average Delay	2.2			
Intersection Capacity Utilization	53.0%	ICU Level of Service		A
Analysis Period (min)	15			

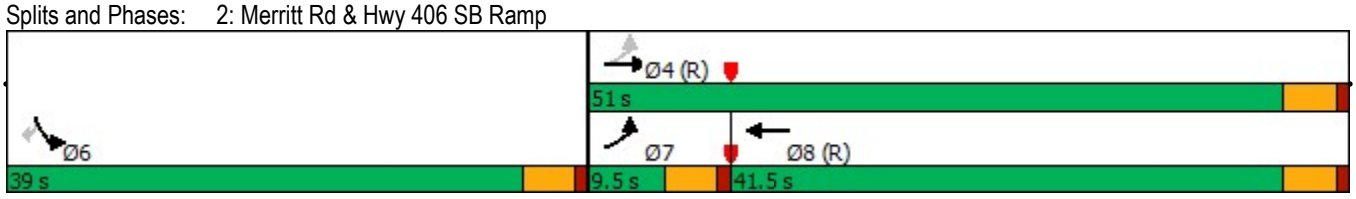


Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	77	1020	58	33	15	1130
Future Volume (vph)	77	1020	58	33	15	1130
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)	0.0			210.0	0.0	150.0
Storage Lanes	0			1	1	2
Taper Length (m)	2.5				2.5	
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	0.88
Frt				0.850		0.850
Flt Protected		0.997			0.950	
Satd. Flow (prot)	0	3090	1484	1438	1004	2506
Flt Permitted		0.926			0.950	
Satd. Flow (perm)	0	2870	1484	1438	1004	2506
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				34		1177
Link Speed (k/h)		60	60		60	
Link Distance (m)		216.0	340.4		573.6	
Travel Time (s)		13.0	20.4		34.4	
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Heavy Vehicles (%)	0%	4%	14%	0%	60%	1%
Adj. Flow (vph)	80	1063	60	34	16	1177
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	1143	60	34	16	1177
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		3.3	3.3		3.3	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		1.6	1.6		1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)	24			14	24	14
Number of Detectors	1	2	2	1	1	1
Detector Template	Left	Thru	Thru	Right	Left	Right
Leading Detector (m)	6.1	30.5	30.5	6.1	6.1	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	1.8	6.1	6.1	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 2 Position(m)		28.7	28.7			
Detector 2 Size(m)		1.8	1.8			
Detector 2 Type		Cl+Ex	Cl+Ex			
Detector 2 Channel						
Detector 2 Extend (s)		0.0	0.0			
Turn Type	pm+pt	NA	NA	Free	Prot	Perm
Protected Phases	7	4	8		6	

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Permitted Phases	4			Free		6
Detector Phase	7	4	8		6	6
Switch Phase						
Minimum Initial (s)	5.0	5.0	5.0		5.0	5.0
Minimum Split (s)	9.5	9.5	9.5		9.5	9.5
Total Split (s)	9.5	51.0	41.5		39.0	39.0
Total Split (%)	10.6%	56.7%	46.1%		43.3%	43.3%
Maximum Green (s)	5.0	46.5	37.0		34.5	34.5
Yellow Time (s)	3.5	3.5	3.5		3.5	3.5
All-Red Time (s)	1.0	1.0	1.0		1.0	1.0
Lost Time Adjust (s)		0.0	0.0		0.0	0.0
Total Lost Time (s)		4.5	4.5		4.5	4.5
Lead/Lag	Lead		Lag			
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Recall Mode	None	C-Max	C-Max		Max	Max
Act Effct Green (s)		46.5	46.5	90.0	34.5	34.5
Actuated g/C Ratio		0.52	0.52	1.00	0.38	0.38
v/c Ratio		0.77	0.08	0.02	0.04	0.70
Control Delay		21.9	11.4	0.0	17.9	3.8
Queue Delay		0.0	0.0	0.0	0.0	0.0
Total Delay		21.9	11.4	0.0	17.9	3.8
LOS		C	B	A	B	A
Approach Delay		21.9	7.3		4.0	
Approach LOS		C	A		A	
Queue Length 50th (m)		79.2	5.0	0.0	1.7	0.0
Queue Length 95th (m)		105.8	11.0	0.0	5.7	13.1
Internal Link Dist (m)		192.0	316.4		549.6	
Turn Bay Length (m)				210.0		150.0
Base Capacity (vph)		1482	766	1438	384	1686
Starvation Cap Reductn		0	0	0	0	0
Spillback Cap Reductn		0	0	0	0	0
Storage Cap Reductn		0	0	0	0	0
Reduced v/c Ratio		0.77	0.08	0.02	0.04	0.70

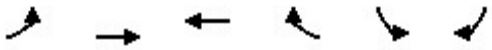
Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 90			
Offset: 0 (0%), Referenced to phase 4:EBTL and 8:WBT, Start of Green			
Natural Cycle: 40			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.77			
Intersection Signal Delay: 12.6		Intersection LOS: B	
Intersection Capacity Utilization 54.6%		ICU Level of Service A	
Analysis Period (min) 15			

Splits and Phases: 2: Merritt Rd & Hwy 406 SB Ramp



Lane Group	EBT	WBT	WBR	SBL	SBR
Lane Group Flow (vph)	1143	60	34	16	1177
v/c Ratio	0.77	0.08	0.02	0.04	0.70
Control Delay	21.9	11.4	0.0	17.9	3.8
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	21.9	11.4	0.0	17.9	3.8
Queue Length 50th (m)	79.2	5.0	0.0	1.7	0.0
Queue Length 95th (m)	105.8	11.0	0.0	5.7	13.1
Internal Link Dist (m)	192.0	316.4		549.6	
Turn Bay Length (m)			210.0		150.0
Base Capacity (vph)	1482	766	1438	384	1686
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.77	0.08	0.02	0.04	0.70

Intersection Summary



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	77	1020	58	33	15	1130
Future Volume (vph)	77	1020	58	33	15	1130
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Total Lost time (s)		4.5	4.5	4.0	4.5	4.5
Lane Util. Factor		0.95	1.00	1.00	1.00	0.88
Frt		1.00	1.00	0.85	1.00	0.85
Flt Protected		1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)		3088	1484	1438	1004	2506
Flt Permitted		0.93	1.00	1.00	0.95	1.00
Satd. Flow (perm)		2869	1484	1438	1004	2506
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	80	1062	60	34	16	1177
RTOR Reduction (vph)	0	0	0	0	0	726
Lane Group Flow (vph)	0	1143	60	34	16	451
Heavy Vehicles (%)	0%	4%	14%	0%	60%	1%
Turn Type	pm+pt	NA	NA	Free	Prot	Perm
Protected Phases	7	4	8		6	
Permitted Phases	4			Free		6
Actuated Green, G (s)		46.5	46.5	90.0	34.5	34.5
Effective Green, g (s)		46.5	46.5	90.0	34.5	34.5
Actuated g/C Ratio		0.52	0.52	1.00	0.38	0.38
Clearance Time (s)		4.5	4.5		4.5	4.5
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		1482	766	1438	384	960
v/s Ratio Prot			0.04		0.02	
v/s Ratio Perm		c0.40		0.02		c0.18
v/c Ratio		0.77	0.08	0.02	0.04	0.47
Uniform Delay, d1		17.5	11.0	0.0	17.4	20.9
Progression Factor		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		2.5	0.2	0.0	0.2	1.7
Delay (s)		20.0	11.2	0.0	17.6	22.5
Level of Service		C	B	A	B	C
Approach Delay (s)		20.0	7.1		22.5	
Approach LOS		C	A		C	

Intersection Summary			
HCM 2000 Control Delay	20.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.5
Intersection Capacity Utilization	54.6%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

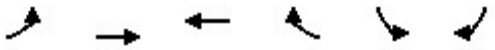
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1092	5	181	1007	0	110
Future Volume (vph)	1092	5	181	1007	0	110
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)		0.0	75.0		0.0	0.0
Storage Lanes		0	1		0	1
Taper Length (m)			2.5		2.5	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Frt	0.999					0.865
Flt Protected			0.950			
Satd. Flow (prot)	3148	0	1576	3151	0	1435
Flt Permitted			0.950			
Satd. Flow (perm)	3148	0	1576	3151	0	1435
Link Speed (k/h)	60			60	50	
Link Distance (m)	1069.8			216.0	379.7	
Travel Time (s)	64.2			13.0	27.3	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1187	5	197	1095	0	120
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1192	0	197	1095	0	120
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	3.3			3.3	0.0	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	1.6			1.6	1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)		14	24		24	14
Sign Control	Free			Free	Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	50.5%	ICU Level of Service	A
Analysis Period (min)	15		

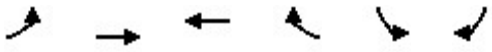
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	1092	5	181	1007	0	110
Future Volume (Veh/h)	1092	5	181	1007	0	110
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1187	5	197	1095	0	120
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				216		
pX, platoon unblocked						
vC, conflicting volume			1192		2131	596
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1192		2131	596
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			66		100	73
cM capacity (veh/h)			581		28	447

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1
Volume Total	791	401	197	548	548	120
Volume Left	0	0	197	0	0	0
Volume Right	0	5	0	0	0	120
cSH	1700	1700	581	1700	1700	447
Volume to Capacity	0.47	0.24	0.34	0.32	0.32	0.27
Queue Length 95th (m)	0.0	0.0	11.3	0.0	0.0	8.2
Control Delay (s)	0.0	0.0	14.3	0.0	0.0	16.0
Lane LOS			B			C
Approach Delay (s)	0.0		2.2			16.0
Approach LOS						C

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	50.5%	ICU Level of Service	A
Analysis Period (min)	15		



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	77	1020	58	33	15	1130
Future Volume (vph)	77	1020	58	33	15	1130
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)	0.0			210.0	0.0	150.0
Storage Lanes	0			1	1	2
Taper Length (m)	2.5				2.5	
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	0.88
Frt				0.850		0.850
Flt Protected		0.997			0.950	
Satd. Flow (prot)	0	3090	1484	1438	1004	2506
Flt Permitted		0.997			0.950	
Satd. Flow (perm)	0	3090	1484	1438	1004	2506
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				34		1177
Link Speed (k/h)		60	60		60	
Link Distance (m)		216.0	340.4		573.6	
Travel Time (s)		13.0	20.4		34.4	
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Heavy Vehicles (%)	0%	4%	14%	0%	60%	1%
Adj. Flow (vph)	80	1063	60	34	16	1177
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	1143	60	34	16	1177
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		3.3	3.3		3.3	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		1.6	1.6		1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)	24			14	24	14
Number of Detectors	1	2	2	1	1	1
Detector Template	Left	Thru	Thru	Right	Left	Right
Leading Detector (m)	6.1	30.5	30.5	6.1	6.1	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	1.8	6.1	6.1	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 2 Position(m)		28.7	28.7			
Detector 2 Size(m)		1.8	1.8			
Detector 2 Type		Cl+Ex	Cl+Ex			
Detector 2 Channel						
Detector 2 Extend (s)		0.0	0.0			
Turn Type	Split	NA	NA	Free	Prot	Perm
Protected Phases	4	4	8		6	



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Permitted Phases				Free		6
Detector Phase	4	4	8		6	6
Switch Phase						
Minimum Initial (s)	5.0	5.0	5.0		5.0	5.0
Minimum Split (s)	9.5	9.5	9.5		9.5	9.5
Total Split (s)	31.2	31.2	9.5		19.3	19.3
Total Split (%)	52.0%	52.0%	15.8%		32.2%	32.2%
Maximum Green (s)	26.7	26.7	5.0		14.8	14.8
Yellow Time (s)	3.5	3.5	3.5		3.5	3.5
All-Red Time (s)	1.0	1.0	1.0		1.0	1.0
Lost Time Adjust (s)		0.0	0.0		0.0	0.0
Total Lost Time (s)		4.5	4.5		4.5	4.5
Lead/Lag						
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Recall Mode	C-Max	C-Max	None		Max	Max
Act Effct Green (s)		26.7	5.0	60.0	18.6	18.6
Actuated g/C Ratio		0.44	0.08	1.00	0.31	0.31
v/c Ratio		0.83	0.49	0.02	0.05	0.74
Control Delay		21.7	41.5	0.0	18.1	5.0
Queue Delay		0.0	0.0	0.0	0.0	0.0
Total Delay		21.7	41.5	0.0	18.1	5.0
LOS		C	D	A	B	A
Approach Delay		21.7	26.5		5.2	
Approach LOS		C	C		A	
Queue Length 50th (m)		55.0	6.5	0.0	1.4	0.0
Queue Length 95th (m)		#83.8	#19.2	0.0	5.3	14.6
Internal Link Dist (m)		192.0	316.4		549.6	
Turn Bay Length (m)				210.0		150.0
Base Capacity (vph)		1375	123	1438	311	1588
Starvation Cap Reductn		0	0	0	0	0
Spillback Cap Reductn		0	0	0	0	0
Storage Cap Reductn		0	0	0	0	0
Reduced v/c Ratio		0.83	0.49	0.02	0.05	0.74

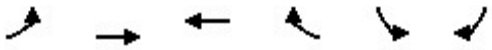
Intersection Summary			
Area Type:	Other		
Cycle Length: 60			
Actuated Cycle Length: 60			
Offset: 0 (0%), Referenced to phase 4:EBTL, Start of Green			
Natural Cycle: 60			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.83			
Intersection Signal Delay: 13.8		Intersection LOS: B	
Intersection Capacity Utilization 54.6%		ICU Level of Service A	
Analysis Period (min) 15			
# 95th percentile volume exceeds capacity, queue may be longer.			
Queue shown is maximum after two cycles.			

Splits and Phases: 2: Merritt Rd & Hwy 406 SB Ramp

Lane Group	EBT	WBT	WBR	SBL	SBR
Lane Group Flow (vph)	1143	60	34	16	1177
v/c Ratio	0.83	0.49	0.02	0.05	0.74
Control Delay	21.7	41.5	0.0	18.1	5.0
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	21.7	41.5	0.0	18.1	5.0
Queue Length 50th (m)	55.0	6.5	0.0	1.4	0.0
Queue Length 95th (m)	#83.8	#19.2	0.0	5.3	14.6
Internal Link Dist (m)	192.0	316.4		549.6	
Turn Bay Length (m)			210.0		150.0
Base Capacity (vph)	1375	123	1438	311	1588
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.83	0.49	0.02	0.05	0.74

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	77	1020	58	33	15	1130
Future Volume (vph)	77	1020	58	33	15	1130
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Total Lost time (s)		4.5	4.5	4.0	4.5	4.5
Lane Util. Factor		0.95	1.00	1.00	1.00	0.88
Frt		1.00	1.00	0.85	1.00	0.85
Flt Protected		1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)		3088	1484	1438	1004	2506
Flt Permitted		1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)		3088	1484	1438	1004	2506
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	80	1062	60	34	16	1177
RTOR Reduction (vph)	0	0	0	0	0	812
Lane Group Flow (vph)	0	1143	60	34	16	365
Heavy Vehicles (%)	0%	4%	14%	0%	60%	1%
Turn Type	Split	NA	NA	Free	Prot	Perm
Protected Phases	4	4	8		6	
Permitted Phases				Free		6
Actuated Green, G (s)		24.9	3.0	60.0	18.6	18.6
Effective Green, g (s)		24.9	3.0	60.0	18.6	18.6
Actuated g/C Ratio		0.41	0.05	1.00	0.31	0.31
Clearance Time (s)		4.5	4.5		4.5	4.5
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		1281	74	1438	311	776
v/s Ratio Prot		c0.37	c0.04		0.02	
v/s Ratio Perm				0.02		c0.15
v/c Ratio		0.89	0.81	0.02	0.05	0.47
Uniform Delay, d1		16.3	28.2	0.0	14.5	16.7
Progression Factor		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		9.7	46.8	0.0	0.3	2.0
Delay (s)		26.0	75.0	0.0	14.8	18.8
Level of Service		C	E	A	B	B
Approach Delay (s)		26.0	47.9		18.7	
Approach LOS		C	D		B	

Intersection Summary			
HCM 2000 Control Delay	23.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	13.5
Intersection Capacity Utilization	54.6%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

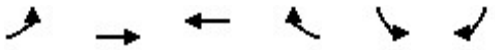
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1092	5	181	1007	0	110
Future Volume (vph)	1092	5	181	1007	0	110
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)		0.0	75.0		0.0	0.0
Storage Lanes		0	1		0	1
Taper Length (m)			2.5		2.5	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Frt	0.999					0.865
Flt Protected			0.950			
Satd. Flow (prot)	3148	0	1576	3151	0	1435
Flt Permitted			0.950			
Satd. Flow (perm)	3148	0	1576	3151	0	1435
Link Speed (k/h)	60			60	50	
Link Distance (m)	1069.8			216.0	379.7	
Travel Time (s)	64.2			13.0	27.3	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1187	5	197	1095	0	120
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1192	0	197	1095	0	120
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	3.3			3.3	0.0	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	1.6			1.6	1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)		14	24		24	14
Sign Control	Free			Free	Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	50.5%	ICU Level of Service	A
Analysis Period (min)	15		

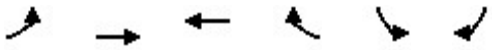
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	1092	5	181	1007	0	110
Future Volume (Veh/h)	1092	5	181	1007	0	110
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1187	5	197	1095	0	120
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				216		
pX, platoon unblocked						
vC, conflicting volume			1192		2131	596
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1192		2131	596
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			66		100	73
cM capacity (veh/h)			581		28	447

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1
Volume Total	791	401	197	548	548	120
Volume Left	0	0	197	0	0	0
Volume Right	0	5	0	0	0	120
cSH	1700	1700	581	1700	1700	447
Volume to Capacity	0.47	0.24	0.34	0.32	0.32	0.27
Queue Length 95th (m)	0.0	0.0	11.3	0.0	0.0	8.2
Control Delay (s)	0.0	0.0	14.3	0.0	0.0	16.0
Lane LOS			B			C
Approach Delay (s)	0.0		2.2			16.0
Approach LOS						C

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	50.5%	ICU Level of Service	A
Analysis Period (min)	15		



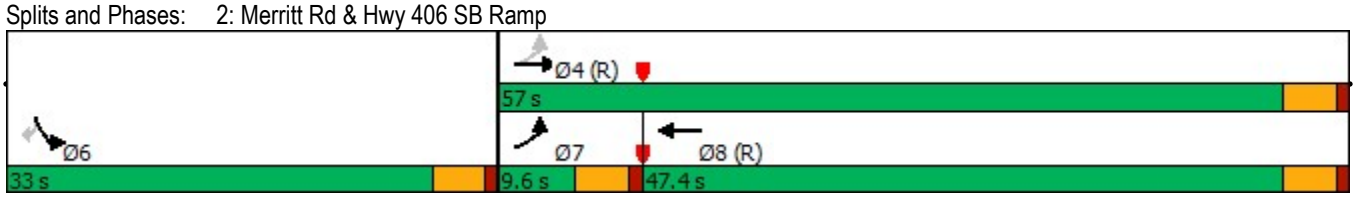
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	32	1078	72	27	7	768
Future Volume (vph)	32	1078	72	27	7	768
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)	80.0			210.0	0.0	150.0
Storage Lanes	1			1	1	2
Taper Length (m)	2.5				2.5	
Lane Util. Factor	1.00	0.95	1.00	1.00	1.00	0.88
Frt				0.850		0.850
Flt Protected	0.950				0.950	
Satd. Flow (prot)	1516	3121	1364	1438	1607	2457
Flt Permitted	0.636				0.950	
Satd. Flow (perm)	1015	3121	1364	1438	1607	2457
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				33		937
Link Speed (k/h)		60	60		60	
Link Distance (m)		216.0	340.4		573.6	
Travel Time (s)		13.0	20.4		34.4	
Peak Hour Factor	0.82	0.82	0.82	0.82	0.82	0.82
Heavy Vehicles (%)	6%	3%	24%	0%	0%	3%
Adj. Flow (vph)	39	1315	88	33	9	937
Shared Lane Traffic (%)						
Lane Group Flow (vph)	39	1315	88	33	9	937
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		3.3	3.3		3.3	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		1.6	1.6		1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)	24			14	24	14
Number of Detectors	1	2	2	1	1	1
Detector Template	Left	Thru	Thru	Right	Left	Right
Leading Detector (m)	6.1	30.5	30.5	6.1	6.1	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	1.8	6.1	6.1	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 2 Position(m)		28.7	28.7			
Detector 2 Size(m)		1.8	1.8			
Detector 2 Type		Cl+Ex	Cl+Ex			
Detector 2 Channel						
Detector 2 Extend (s)		0.0	0.0			
Turn Type	pm+pt	NA	NA	Free	Prot	Perm
Protected Phases	7	4	8		6	

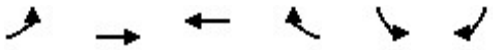


Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Permitted Phases	4			Free		6
Detector Phase	7	4	8		6	6
Switch Phase						
Minimum Initial (s)	5.0	5.0	5.0		5.0	5.0
Minimum Split (s)	9.5	9.5	9.5		9.5	9.5
Total Split (s)	9.6	57.0	47.4		33.0	33.0
Total Split (%)	10.7%	63.3%	52.7%		36.7%	36.7%
Maximum Green (s)	5.1	52.5	42.9		28.5	28.5
Yellow Time (s)	3.5	3.5	3.5		3.5	3.5
All-Red Time (s)	1.0	1.0	1.0		1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0		0.0	0.0
Total Lost Time (s)	4.5	4.5	4.5		4.5	4.5
Lead/Lag	Lead		Lag			
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Recall Mode	None	C-Max	C-Max		Max	Max
Act Effct Green (s)	52.5	52.5	46.7	90.0	28.5	28.5
Actuated g/C Ratio	0.58	0.58	0.52	1.00	0.32	0.32
v/c Ratio	0.06	0.72	0.12	0.02	0.02	0.66
Control Delay	8.3	16.4	13.1	0.0	21.4	4.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	8.3	16.4	13.1	0.0	21.4	4.3
LOS	A	B	B	A	C	A
Approach Delay		16.2	9.6		4.4	
Approach LOS		B	A		A	
Queue Length 50th (m)	2.7	79.5	8.2	0.0	1.1	0.0
Queue Length 95th (m)	6.0	87.4	15.0	0.0	4.0	6.3
Internal Link Dist (m)		192.0	316.4		549.6	
Turn Bay Length (m)	80.0			210.0		150.0
Base Capacity (vph)	620	1820	708	1438	508	1418
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.06	0.72	0.12	0.02	0.02	0.66

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 90			
Offset: 0 (0%), Referenced to phase 4:EBTL and 8:WBT, Start of Green			
Natural Cycle: 45			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.72			
Intersection Signal Delay: 11.3		Intersection LOS: B	
Intersection Capacity Utilization 44.0%		ICU Level of Service A	
Analysis Period (min) 15			

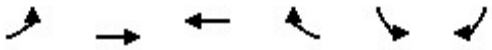
Splits and Phases: 2: Merritt Rd & Hwy 406 SB Ramp





Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Group Flow (vph)	39	1315	88	33	9	937
v/c Ratio	0.06	0.72	0.12	0.02	0.02	0.66
Control Delay	8.3	16.4	13.1	0.0	21.4	4.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	8.3	16.4	13.1	0.0	21.4	4.3
Queue Length 50th (m)	2.7	79.5	8.2	0.0	1.1	0.0
Queue Length 95th (m)	6.0	87.4	15.0	0.0	4.0	6.3
Internal Link Dist (m)		192.0	316.4		549.6	
Turn Bay Length (m)	80.0			210.0		150.0
Base Capacity (vph)	620	1820	708	1438	508	1418
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.06	0.72	0.12	0.02	0.02	0.66

Intersection Summary



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	32	1078	72	27	7	768
Future Volume (vph)	32	1078	72	27	7	768
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Total Lost time (s)	4.5	4.5	4.5	4.0	4.5	4.5
Lane Util. Factor	1.00	0.95	1.00	1.00	1.00	0.88
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1516	3121	1364	1438	1607	2457
Flt Permitted	0.64	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1015	3121	1364	1438	1607	2457
Peak-hour factor, PHF	0.82	0.82	0.82	0.82	0.82	0.82
Adj. Flow (vph)	39	1315	88	33	9	937
RTOR Reduction (vph)	0	0	0	0	0	640
Lane Group Flow (vph)	39	1315	88	33	9	297
Heavy Vehicles (%)	6%	3%	24%	0%	0%	3%
Turn Type	pm+pt	NA	NA	Free	Prot	Perm
Protected Phases	7	4	8		6	
Permitted Phases	4			Free		6
Actuated Green, G (s)	52.5	52.5	44.9	90.0	28.5	28.5
Effective Green, g (s)	52.5	52.5	44.9	90.0	28.5	28.5
Actuated g/C Ratio	0.58	0.58	0.50	1.00	0.32	0.32
Clearance Time (s)	4.5	4.5	4.5		4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	609	1820	680	1438	508	778
v/s Ratio Prot	0.00	c0.42	0.06		0.01	
v/s Ratio Perm	0.04			0.02		c0.12
v/c Ratio	0.06	0.72	0.13	0.02	0.02	0.38
Uniform Delay, d1	8.1	13.5	12.1	0.0	21.1	23.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.0	2.5	0.4	0.0	0.1	1.4
Delay (s)	8.2	16.0	12.5	0.0	21.2	25.3
Level of Service	A	B	B	A	C	C
Approach Delay (s)		15.8	9.1		25.3	
Approach LOS		B	A		C	

Intersection Summary			
HCM 2000 Control Delay	19.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.5
Intersection Capacity Utilization	44.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

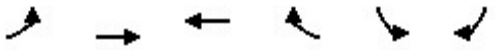
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1105	5	59	781	0	193
Future Volume (vph)	1105	5	59	781	0	193
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)		0.0	75.0		0.0	0.0
Storage Lanes		0	1		0	1
Taper Length (m)			2.5		2.5	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Frt	0.999					0.865
Flt Protected			0.950			
Satd. Flow (prot)	3148	0	1576	3151	0	1435
Flt Permitted			0.950			
Satd. Flow (perm)	3148	0	1576	3151	0	1435
Link Speed (k/h)	60			60	50	
Link Distance (m)	1070.4			216.0	379.7	
Travel Time (s)	64.2			13.0	27.3	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1201	5	64	849	0	210
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1206	0	64	849	0	210
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	3.3			3.3	0.0	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	1.6			1.6	1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)		14	24		24	14
Sign Control	Free			Free	Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	53.0%	ICU Level of Service	A
Analysis Period (min)	15		

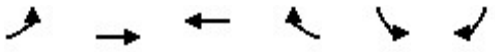
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	1105	5	59	781	0	193
Future Volume (Veh/h)	1105	5	59	781	0	193
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1201	5	64	849	0	210
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				216		
pX, platoon unblocked						
vC, conflicting volume			1206		1756	603
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1206		1756	603
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			89		100	52
cM capacity (veh/h)			574		68	442

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1
Volume Total	801	405	64	424	424	210
Volume Left	0	0	64	0	0	0
Volume Right	0	5	0	0	0	210
cSH	1700	1700	574	1700	1700	442
Volume to Capacity	0.47	0.24	0.11	0.25	0.25	0.48
Queue Length 95th (m)	0.0	0.0	2.8	0.0	0.0	19.0
Control Delay (s)	0.0	0.0	12.1	0.0	0.0	20.3
Lane LOS			B			C
Approach Delay (s)	0.0		0.8			20.3
Approach LOS						C

Intersection Summary			
Average Delay	2.2		
Intersection Capacity Utilization	53.0%	ICU Level of Service	A
Analysis Period (min)	15		



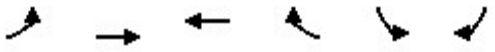
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	32	1078	72	27	7	768
Future Volume (vph)	32	1078	72	27	7	768
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)	80.0			210.0	0.0	150.0
Storage Lanes	1			1	1	2
Taper Length (m)	2.5				2.5	
Lane Util. Factor	1.00	0.95	1.00	1.00	1.00	0.88
Frt				0.850		0.850
Flt Protected	0.950				0.950	
Satd. Flow (prot)	1516	3121	1364	1438	1607	2457
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1516	3121	1364	1438	1607	2457
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				33		937
Link Speed (k/h)		60	60		60	
Link Distance (m)		216.0	340.4		573.6	
Travel Time (s)		13.0	20.4		34.4	
Peak Hour Factor	0.82	0.82	0.82	0.82	0.82	0.82
Heavy Vehicles (%)	6%	3%	24%	0%	0%	3%
Adj. Flow (vph)	39	1315	88	33	9	937
Shared Lane Traffic (%)						
Lane Group Flow (vph)	39	1315	88	33	9	937
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		3.3	3.3		3.3	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		1.6	1.6		1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)	24			14	24	14
Number of Detectors	1	2	2	1	1	1
Detector Template	Left	Thru	Thru	Right	Left	Right
Leading Detector (m)	6.1	30.5	30.5	6.1	6.1	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	1.8	6.1	6.1	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 2 Position(m)		28.7	28.7			
Detector 2 Size(m)		1.8	1.8			
Detector 2 Type		Cl+Ex	Cl+Ex			
Detector 2 Channel						
Detector 2 Extend (s)		0.0	0.0			
Turn Type	Split	NA	NA	Free	Prot	Perm
Protected Phases	4	4	8		6	



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Permitted Phases				Free		6
Detector Phase	4	4	8		6	6
Switch Phase						
Minimum Initial (s)	5.0	5.0	5.0		5.0	5.0
Minimum Split (s)	9.5	9.5	9.5		9.5	9.5
Total Split (s)	35.0	35.0	10.0		15.0	15.0
Total Split (%)	58.3%	58.3%	16.7%		25.0%	25.0%
Maximum Green (s)	30.5	30.5	5.5		10.5	10.5
Yellow Time (s)	3.5	3.5	3.5		3.5	3.5
All-Red Time (s)	1.0	1.0	1.0		1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0		0.0	0.0
Total Lost Time (s)	4.5	4.5	4.5		4.5	4.5
Lead/Lag						
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Recall Mode	C-Max	C-Max	Max		Max	Max
Act Effct Green (s)	30.5	30.5	5.5	60.0	10.5	10.5
Actuated g/C Ratio	0.51	0.51	0.09	1.00	0.18	0.18
v/c Ratio	0.05	0.83	0.70	0.02	0.03	0.78
Control Delay	7.8	18.6	59.3	0.0	21.0	7.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	7.8	18.6	59.3	0.0	21.0	7.5
LOS	A	B	E	A	C	A
Approach Delay		18.3	43.2		7.6	
Approach LOS		B	D		A	
Queue Length 50th (m)	2.0	59.4	9.6	0.0	0.8	0.0
Queue Length 95th (m)	5.2	71.4	#25.7	0.0	3.7	8.4
Internal Link Dist (m)		192.0	316.4		549.6	
Turn Bay Length (m)	80.0			210.0		150.0
Base Capacity (vph)	770	1586	125	1438	281	1203
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.05	0.83	0.70	0.02	0.03	0.78

Intersection Summary			
Area Type:	Other		
Cycle Length: 60			
Actuated Cycle Length: 60			
Offset: 0 (0%), Referenced to phase 4:EBTL, Start of Green			
Natural Cycle: 60			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.83			
Intersection Signal Delay: 15.4		Intersection LOS: B	
Intersection Capacity Utilization 44.0%		ICU Level of Service A	
Analysis Period (min) 15			
# 95th percentile volume exceeds capacity, queue may be longer.			
Queue shown is maximum after two cycles.			

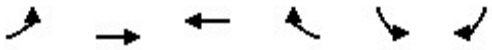
Splits and Phases: 2: Merritt Rd & Hwy 406 SB Ramp



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Group Flow (vph)	39	1315	88	33	9	937
v/c Ratio	0.05	0.83	0.70	0.02	0.03	0.78
Control Delay	7.8	18.6	59.3	0.0	21.0	7.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	7.8	18.6	59.3	0.0	21.0	7.5
Queue Length 50th (m)	2.0	59.4	9.6	0.0	0.8	0.0
Queue Length 95th (m)	5.2	71.4	#25.7	0.0	3.7	8.4
Internal Link Dist (m)		192.0	316.4		549.6	
Turn Bay Length (m)	80.0			210.0		150.0
Base Capacity (vph)	770	1586	125	1438	281	1203
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.05	0.83	0.70	0.02	0.03	0.78

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	32	1078	72	27	7	768
Future Volume (vph)	32	1078	72	27	7	768
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Total Lost time (s)	4.5	4.5	4.5	4.0	4.5	4.5
Lane Util. Factor	1.00	0.95	1.00	1.00	1.00	0.88
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1516	3121	1364	1438	1607	2457
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1516	3121	1364	1438	1607	2457
Peak-hour factor, PHF	0.82	0.82	0.82	0.82	0.82	0.82
Adj. Flow (vph)	39	1315	88	33	9	937
RTOR Reduction (vph)	0	0	0	0	0	773
Lane Group Flow (vph)	39	1315	88	33	9	164
Heavy Vehicles (%)	6%	3%	24%	0%	0%	3%
Turn Type	Split	NA	NA	Free	Prot	Perm
Protected Phases	4	4	8		6	
Permitted Phases				Free		6
Actuated Green, G (s)	30.5	30.5	5.5	60.0	10.5	10.5
Effective Green, g (s)	30.5	30.5	5.5	60.0	10.5	10.5
Actuated g/C Ratio	0.51	0.51	0.09	1.00	0.18	0.18
Clearance Time (s)	4.5	4.5	4.5		4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	770	1586	125	1438	281	429
v/s Ratio Prot	0.03	c0.42	c0.06		0.01	
v/s Ratio Perm				0.02		c0.07
v/c Ratio	0.05	0.83	0.70	0.02	0.03	0.38
Uniform Delay, d1	7.4	12.5	26.5	0.0	20.5	21.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	5.2	28.3	0.0	0.2	2.6
Delay (s)	7.6	17.7	54.7	0.0	20.7	24.5
Level of Service	A	B	D	A	C	C
Approach Delay (s)		17.4	39.8		24.4	
Approach LOS		B	D		C	

Intersection Summary			
HCM 2000 Control Delay	21.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	13.5
Intersection Capacity Utilization	44.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

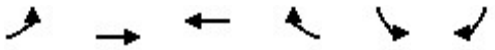
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1105	5	59	781	0	193
Future Volume (vph)	1105	5	59	781	0	193
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)		0.0	75.0		0.0	0.0
Storage Lanes		0	1		0	1
Taper Length (m)			2.5		2.5	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Frt	0.999					0.865
Flt Protected			0.950			
Satd. Flow (prot)	3148	0	1576	3151	0	1435
Flt Permitted			0.950			
Satd. Flow (perm)	3148	0	1576	3151	0	1435
Link Speed (k/h)	60			60	50	
Link Distance (m)	1070.4			216.0	379.7	
Travel Time (s)	64.2			13.0	27.3	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1201	5	64	849	0	210
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1206	0	64	849	0	210
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	3.3			3.3	0.0	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	1.6			1.6	1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)		14	24		24	14
Sign Control	Free			Free	Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	53.0%	ICU Level of Service	A
Analysis Period (min)	15		

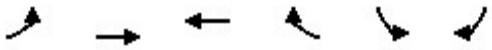
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	1105	5	59	781	0	193
Future Volume (Veh/h)	1105	5	59	781	0	193
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1201	5	64	849	0	210
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				216		
pX, platoon unblocked						
vC, conflicting volume			1206		1756	603
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1206		1756	603
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			89		100	52
cM capacity (veh/h)			574		68	442

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1
Volume Total	801	405	64	424	424	210
Volume Left	0	0	64	0	0	0
Volume Right	0	5	0	0	0	210
cSH	1700	1700	574	1700	1700	442
Volume to Capacity	0.47	0.24	0.11	0.25	0.25	0.48
Queue Length 95th (m)	0.0	0.0	2.8	0.0	0.0	19.0
Control Delay (s)	0.0	0.0	12.1	0.0	0.0	20.3
Lane LOS			B			C
Approach Delay (s)	0.0		0.8			20.3
Approach LOS						C

Intersection Summary				
Average Delay	2.2			
Intersection Capacity Utilization	53.0%	ICU Level of Service		A
Analysis Period (min)	15			



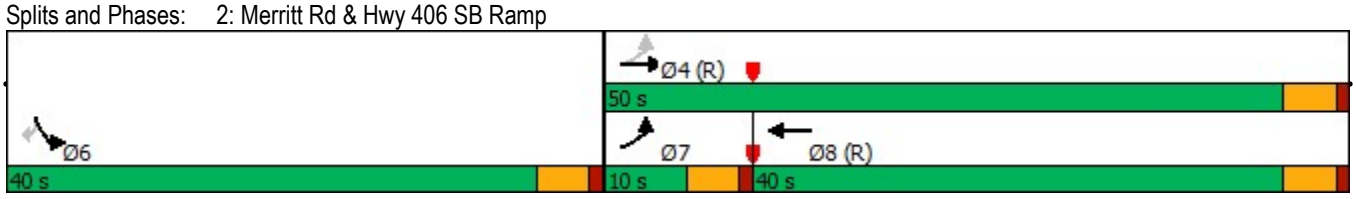
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	77	1020	58	33	15	1130
Future Volume (vph)	77	1020	58	33	15	1130
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)	80.0			210.0	0.0	150.0
Storage Lanes	1			1	1	2
Taper Length (m)	2.5				2.5	
Lane Util. Factor	1.00	0.95	1.00	1.00	1.00	0.88
Frt				0.850		0.850
Flt Protected	0.950				0.950	
Satd. Flow (prot)	1607	3091	1484	1438	1004	2506
Flt Permitted	0.639				0.950	
Satd. Flow (perm)	1081	3091	1484	1438	1004	2506
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				34		1177
Link Speed (k/h)		60	60		60	
Link Distance (m)		216.0	340.4		573.6	
Travel Time (s)		13.0	20.4		34.4	
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Heavy Vehicles (%)	0%	4%	14%	0%	60%	1%
Adj. Flow (vph)	80	1063	60	34	16	1177
Shared Lane Traffic (%)						
Lane Group Flow (vph)	80	1063	60	34	16	1177
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		3.3	3.3		3.3	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		1.6	1.6		1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)	24			14	24	14
Number of Detectors	1	2	2	1	1	1
Detector Template	Left	Thru	Thru	Right	Left	Right
Leading Detector (m)	6.1	30.5	30.5	6.1	6.1	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	1.8	6.1	6.1	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 2 Position(m)		28.7	28.7			
Detector 2 Size(m)		1.8	1.8			
Detector 2 Type		Cl+Ex	Cl+Ex			
Detector 2 Channel						
Detector 2 Extend (s)		0.0	0.0			
Turn Type	pm+pt	NA	NA	Free	Prot	Perm
Protected Phases	7	4	8		6	

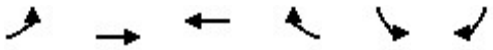


Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Permitted Phases	4			Free		6
Detector Phase	7	4	8		6	6
Switch Phase						
Minimum Initial (s)	5.0	5.0	5.0		5.0	5.0
Minimum Split (s)	9.5	9.5	9.5		9.5	9.5
Total Split (s)	10.0	50.0	40.0		40.0	40.0
Total Split (%)	11.1%	55.6%	44.4%		44.4%	44.4%
Maximum Green (s)	5.5	45.5	35.5		35.5	35.5
Yellow Time (s)	3.5	3.5	3.5		3.5	3.5
All-Red Time (s)	1.0	1.0	1.0		1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0		0.0	0.0
Total Lost Time (s)	4.5	4.5	4.5		4.5	4.5
Lead/Lag	Lead		Lag			
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Recall Mode	None	C-Max	C-Max		Max	Max
Act Effct Green (s)	45.5	45.5	37.5	90.0	35.5	35.5
Actuated g/C Ratio	0.51	0.51	0.42	1.00	0.39	0.39
v/c Ratio	0.14	0.68	0.10	0.02	0.04	0.69
Control Delay	12.3	19.6	17.9	0.0	17.3	3.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	12.3	19.6	17.9	0.0	17.3	3.7
LOS	B	B	B	A	B	A
Approach Delay		19.1	11.4		3.9	
Approach LOS		B	B		A	
Queue Length 50th (m)	6.8	69.4	6.4	0.0	1.7	0.0
Queue Length 95th (m)	14.0	91.3	14.2	0.0	5.6	12.9
Internal Link Dist (m)		192.0	316.4		549.6	
Turn Bay Length (m)	80.0			210.0		150.0
Base Capacity (vph)	578	1562	618	1438	396	1701
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.14	0.68	0.10	0.02	0.04	0.69

Intersection Summary			
Area Type:	Other		
Cycle Length: 90			
Actuated Cycle Length: 90			
Offset: 0 (0%), Referenced to phase 4:EBTL and 8:WBT, Start of Green			
Natural Cycle: 50			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.69			
Intersection Signal Delay: 11.3		Intersection LOS: B	
Intersection Capacity Utilization 54.6%		ICU Level of Service A	
Analysis Period (min) 15			

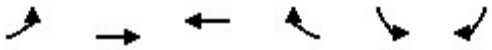
Splits and Phases: 2: Merritt Rd & Hwy 406 SB Ramp





Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Group Flow (vph)	80	1063	60	34	16	1177
v/c Ratio	0.14	0.68	0.10	0.02	0.04	0.69
Control Delay	12.3	19.6	17.9	0.0	17.3	3.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	12.3	19.6	17.9	0.0	17.3	3.7
Queue Length 50th (m)	6.8	69.4	6.4	0.0	1.7	0.0
Queue Length 95th (m)	14.0	91.3	14.2	0.0	5.6	12.9
Internal Link Dist (m)		192.0	316.4		549.6	
Turn Bay Length (m)	80.0			210.0		150.0
Base Capacity (vph)	578	1562	618	1438	396	1701
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.14	0.68	0.10	0.02	0.04	0.69

Intersection Summary



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	77	1020	58	33	15	1130
Future Volume (vph)	77	1020	58	33	15	1130
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Total Lost time (s)	4.5	4.5	4.5	4.0	4.5	4.5
Lane Util. Factor	1.00	0.95	1.00	1.00	1.00	0.88
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1607	3091	1484	1438	1004	2506
Flt Permitted	0.64	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1081	3091	1484	1438	1004	2506
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	80	1062	60	34	16	1177
RTOR Reduction (vph)	0	0	0	0	0	713
Lane Group Flow (vph)	80	1063	60	34	16	464
Heavy Vehicles (%)	0%	4%	14%	0%	60%	1%
Turn Type	pm+pt	NA	NA	Free	Prot	Perm
Protected Phases	7	4	8		6	
Permitted Phases	4			Free		6
Actuated Green, G (s)	45.5	45.5	36.6	90.0	35.5	35.5
Effective Green, g (s)	45.5	45.5	36.6	90.0	35.5	35.5
Actuated g/C Ratio	0.51	0.51	0.41	1.00	0.39	0.39
Clearance Time (s)	4.5	4.5	4.5		4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	572	1562	603	1438	396	988
v/s Ratio Prot	0.01	c0.34	0.04		0.02	
v/s Ratio Perm	0.06			0.02		c0.19
v/c Ratio	0.14	0.68	0.10	0.02	0.04	0.47
Uniform Delay, d1	11.7	16.8	16.5	0.0	16.8	20.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	2.4	0.3	0.0	0.2	1.6
Delay (s)	11.8	19.2	16.8	0.0	17.0	21.9
Level of Service	B	B	B	A	B	C
Approach Delay (s)		18.7	10.8		21.8	
Approach LOS		B	B		C	

Intersection Summary			
HCM 2000 Control Delay	19.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.5
Intersection Capacity Utilization	54.6%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

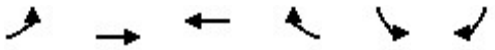
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1092	5	181	1007	0	110
Future Volume (vph)	1092	5	181	1007	0	110
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)		0.0	75.0		0.0	0.0
Storage Lanes		0	1		0	1
Taper Length (m)			2.5		2.5	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Frt	0.999					0.865
Flt Protected			0.950			
Satd. Flow (prot)	3148	0	1576	3151	0	1435
Flt Permitted			0.950			
Satd. Flow (perm)	3148	0	1576	3151	0	1435
Link Speed (k/h)	60			60	50	
Link Distance (m)	1069.8			216.0	379.7	
Travel Time (s)	64.2			13.0	27.3	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1187	5	197	1095	0	120
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1192	0	197	1095	0	120
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	3.3			3.3	0.0	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	1.6			1.6	1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)		14	24		24	14
Sign Control	Free			Free	Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	50.5%	ICU Level of Service	A
Analysis Period (min)	15		

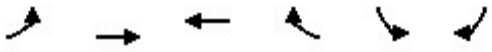
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	1092	5	181	1007	0	110
Future Volume (Veh/h)	1092	5	181	1007	0	110
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1187	5	197	1095	0	120
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				216		
pX, platoon unblocked						
vC, conflicting volume			1192		2131	596
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1192		2131	596
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			66		100	73
cM capacity (veh/h)			581		28	447

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1
Volume Total	791	401	197	548	548	120
Volume Left	0	0	197	0	0	0
Volume Right	0	5	0	0	0	120
cSH	1700	1700	581	1700	1700	447
Volume to Capacity	0.47	0.24	0.34	0.32	0.32	0.27
Queue Length 95th (m)	0.0	0.0	11.3	0.0	0.0	8.2
Control Delay (s)	0.0	0.0	14.3	0.0	0.0	16.0
Lane LOS			B			C
Approach Delay (s)	0.0		2.2			16.0
Approach LOS						C

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	50.5%	ICU Level of Service	A
Analysis Period (min)	15		



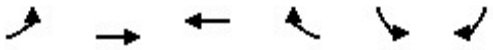
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	77	1020	58	33	15	1130
Future Volume (vph)	77	1020	58	33	15	1130
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)	80.0			210.0	0.0	150.0
Storage Lanes	1			1	1	2
Taper Length (m)	2.5				2.5	
Lane Util. Factor	1.00	0.95	1.00	1.00	1.00	0.88
Frt				0.850		0.850
Flt Protected	0.950				0.950	
Satd. Flow (prot)	1607	3091	1484	1438	1004	2506
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1607	3091	1484	1438	1004	2506
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				34		1177
Link Speed (k/h)		60	60		60	
Link Distance (m)		216.0	340.4		573.6	
Travel Time (s)		13.0	20.4		34.4	
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Heavy Vehicles (%)	0%	4%	14%	0%	60%	1%
Adj. Flow (vph)	80	1063	60	34	16	1177
Shared Lane Traffic (%)						
Lane Group Flow (vph)	80	1063	60	34	16	1177
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		3.3	3.3		3.3	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		1.6	1.6		1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)	24			14	24	14
Number of Detectors	1	2	2	1	1	1
Detector Template	Left	Thru	Thru	Right	Left	Right
Leading Detector (m)	6.1	30.5	30.5	6.1	6.1	6.1
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Position(m)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Size(m)	6.1	1.8	1.8	6.1	6.1	6.1
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 2 Position(m)		28.7	28.7			
Detector 2 Size(m)		1.8	1.8			
Detector 2 Type		Cl+Ex	Cl+Ex			
Detector 2 Channel						
Detector 2 Extend (s)		0.0	0.0			
Turn Type	Split	NA	NA	Free	Prot	Perm
Protected Phases	4	4	8		6	



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Permitted Phases				Free		6
Detector Phase	4	4	8		6	6
Switch Phase						
Minimum Initial (s)	5.0	5.0	5.0		5.0	5.0
Minimum Split (s)	9.5	9.5	9.5		9.5	9.5
Total Split (s)	30.1	30.1	9.5		20.4	20.4
Total Split (%)	50.2%	50.2%	15.8%		34.0%	34.0%
Maximum Green (s)	25.6	25.6	5.0		15.9	15.9
Yellow Time (s)	3.5	3.5	3.5		3.5	3.5
All-Red Time (s)	1.0	1.0	1.0		1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0		0.0	0.0
Total Lost Time (s)	4.5	4.5	4.5		4.5	4.5
Lead/Lag						
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Recall Mode	C-Max	C-Max	None		Max	Max
Act Effct Green (s)	25.6	25.6	5.0	60.0	19.7	19.7
Actuated g/C Ratio	0.43	0.43	0.08	1.00	0.33	0.33
v/c Ratio	0.12	0.81	0.49	0.02	0.05	0.73
Control Delay	11.0	21.3	41.5	0.0	17.2	4.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	11.0	21.3	41.5	0.0	17.2	4.6
LOS	B	C	D	A	B	A
Approach Delay		20.6	26.5		4.8	
Approach LOS		C	C		A	
Queue Length 50th (m)	5.1	51.2	6.5	0.0	1.3	0.0
Queue Length 95th (m)	11.8	#74.8	#19.2	0.0	5.1	14.2
Internal Link Dist (m)		192.0	316.4		549.6	
Turn Bay Length (m)	80.0			210.0		150.0
Base Capacity (vph)	685	1318	123	1438	330	1613
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.12	0.81	0.49	0.02	0.05	0.73

Intersection Summary			
Area Type:	Other		
Cycle Length: 60			
Actuated Cycle Length: 60			
Offset: 0 (0%), Referenced to phase 4:EBTL, Start of Green			
Natural Cycle: 60			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.81			
Intersection Signal Delay: 13.1		Intersection LOS: B	
Intersection Capacity Utilization 54.6%		ICU Level of Service A	
Analysis Period (min) 15			
# 95th percentile volume exceeds capacity, queue may be longer.			
Queue shown is maximum after two cycles.			

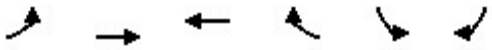
Splits and Phases: 2: Merritt Rd & Hwy 406 SB Ramp



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Group Flow (vph)	80	1063	60	34	16	1177
v/c Ratio	0.12	0.81	0.49	0.02	0.05	0.73
Control Delay	11.0	21.3	41.5	0.0	17.2	4.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	11.0	21.3	41.5	0.0	17.2	4.6
Queue Length 50th (m)	5.1	51.2	6.5	0.0	1.3	0.0
Queue Length 95th (m)	11.8	#74.8	#19.2	0.0	5.1	14.2
Internal Link Dist (m)		192.0	316.4		549.6	
Turn Bay Length (m)	80.0			210.0		150.0
Base Capacity (vph)	685	1318	123	1438	330	1613
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.12	0.81	0.49	0.02	0.05	0.73

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	77	1020	58	33	15	1130
Future Volume (vph)	77	1020	58	33	15	1130
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Total Lost time (s)	4.5	4.5	4.5	4.0	4.5	4.5
Lane Util. Factor	1.00	0.95	1.00	1.00	1.00	0.88
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1607	3091	1484	1438	1004	2506
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1607	3091	1484	1438	1004	2506
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	80	1062	60	34	16	1177
RTOR Reduction (vph)	0	0	0	0	0	791
Lane Group Flow (vph)	80	1063	60	34	16	386
Heavy Vehicles (%)	0%	4%	14%	0%	60%	1%
Turn Type	Split	NA	NA	Free	Prot	Perm
Protected Phases	4	4	8		6	
Permitted Phases				Free		6
Actuated Green, G (s)	23.8	23.8	3.0	60.0	19.7	19.7
Effective Green, g (s)	23.8	23.8	3.0	60.0	19.7	19.7
Actuated g/C Ratio	0.40	0.40	0.05	1.00	0.33	0.33
Clearance Time (s)	4.5	4.5	4.5		4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	637	1226	74	1438	329	822
v/s Ratio Prot	0.05	c0.34	c0.04		0.02	
v/s Ratio Perm				0.02		c0.15
v/c Ratio	0.13	0.87	0.81	0.02	0.05	0.47
Uniform Delay, d1	11.5	16.6	28.2	0.0	13.8	16.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.4	8.4	46.8	0.0	0.3	1.9
Delay (s)	11.9	25.0	75.0	0.0	14.0	17.9
Level of Service	B	C	E	A	B	B
Approach Delay (s)		24.1	47.9		17.9	
Approach LOS		C	D		B	

Intersection Summary			
HCM 2000 Control Delay	22.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	13.5
Intersection Capacity Utilization	54.6%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

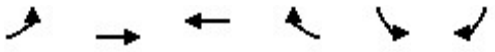
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1092	5	181	1007	0	110
Future Volume (vph)	1092	5	181	1007	0	110
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)		0.0	75.0		0.0	0.0
Storage Lanes		0	1		0	1
Taper Length (m)			2.5		2.5	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Frt	0.999					0.865
Flt Protected			0.950			
Satd. Flow (prot)	3148	0	1576	3151	0	1435
Flt Permitted			0.950			
Satd. Flow (perm)	3148	0	1576	3151	0	1435
Link Speed (k/h)	60			60	50	
Link Distance (m)	1069.8			216.0	379.7	
Travel Time (s)	64.2			13.0	27.3	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1187	5	197	1095	0	120
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1192	0	197	1095	0	120
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	3.3			3.3	0.0	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	1.6			1.6	1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)		14	24		24	14
Sign Control	Free			Free	Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	50.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	1092	5	181	1007	0	110
Future Volume (Veh/h)	1092	5	181	1007	0	110
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1187	5	197	1095	0	120
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				216		
pX, platoon unblocked						
vC, conflicting volume			1192		2131	596
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1192		2131	596
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			66		100	73
cM capacity (veh/h)			581		28	447

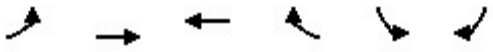
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1
Volume Total	791	401	197	548	548	120
Volume Left	0	0	197	0	0	0
Volume Right	0	5	0	0	0	120
cSH	1700	1700	581	1700	1700	447
Volume to Capacity	0.47	0.24	0.34	0.32	0.32	0.27
Queue Length 95th (m)	0.0	0.0	11.3	0.0	0.0	8.2
Control Delay (s)	0.0	0.0	14.3	0.0	0.0	16.0
Lane LOS			B			C
Approach Delay (s)	0.0		2.2			16.0
Approach LOS						C

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	50.5%	ICU Level of Service	A
Analysis Period (min)	15		



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	32	1078	72	27	7	768
Future Volume (vph)	32	1078	72	27	7	768
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)	80.0			210.0	0.0	150.0
Storage Lanes	0			1	1	1
Taper Length (m)	2.5				2.5	
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	0.95
Frt				0.850	0.853	0.850
Flt Protected		0.999			0.999	
Satd. Flow (prot)	0	3115	1364	1438	1400	1326
Flt Permitted		0.999			0.999	
Satd. Flow (perm)	0	3115	1364	1438	1400	1326
Link Speed (k/h)		60	60		60	
Link Distance (m)		216.0	340.4		573.6	
Travel Time (s)		13.0	20.4		34.4	
Peak Hour Factor	0.82	0.82	0.82	0.82	0.82	0.82
Heavy Vehicles (%)	6%	3%	24%	0%	0%	3%
Adj. Flow (vph)	39	1315	88	33	9	937
Shared Lane Traffic (%)						50%
Lane Group Flow (vph)	0	1354	88	33	478	468
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		3.3	3.3		3.3	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		1.6	1.6		1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)	24			14	24	14
Sign Control		Yield	Yield		Yield	

Intersection Summary			
Area Type:	Other		
Control Type: Roundabout			
Intersection Capacity Utilization	61.0%	ICU Level of Service	B
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Right Turn Channelized				MOYes		
Traffic Volume (veh/h)	32	1078	72	27	7	768
Future Volume (veh/h)	32	1078	72	27	7	768
Peak Hour Factor	0.82	0.82	0.82	0.82	0.82	0.82
Hourly flow rate (vph)	39	1315	88	33	9	937
Approach Volume (veh/h)		1354	88		946	
Crossing Volume (veh/h)		9	39		88	
High Capacity (veh/h)		1375	1343		1293	
High v/c (veh/h)		0.98	0.07		0.73	
Low Capacity (veh/h)		1152	1123		1078	
Low v/c (veh/h)		1.17	0.08		0.88	

Intersection Summary			
Maximum v/c High	0.98		
Maximum v/c Low	1.17		
Intersection Capacity Utilization	61.0%	ICU Level of Service	B

Intersection	
Intersection Delay, s/veh	90.0
Intersection LOS	F

Approach	EB	WB	SB
Entry Lanes	2	1	2
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	1354	121	946
Demand Flow Rate, veh/h	1395	142	974
Vehicles Circulating, veh/h	9	41	109
Vehicles Exiting, veh/h	1074	1363	41
Follow-Up Headway, s	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	133.7	4.7	38.4
Approach LOS	F	A	E

Lane	Left	Left	Bypass	Left	Right
Designated Moves	LT	T	R	L	TR
Assumed Moves	LT	T	R	L	TR
RT Channelized			Yield		
Lane Util	1.000	1.000		0.009	0.991
Critical Headway, s	5.193	5.193		5.193	5.193
Entry Flow, veh/h	1395	109	33	9	965
Cap Entry Lane, veh/h	1120	1085	1085	1013	1013
Entry HV Adj Factor	0.970	0.806	1.000	1.000	0.971
Flow Entry, veh/h	1354	88	33	9	937
Cap Entry, veh/h	1087	875	1085	1013	984
V/C Ratio	1.246	0.101	0.030	0.009	0.952
Control Delay, s/veh	133.7	5.1	3.6	3.6	38.7
LOS	F	A	A	A	E
95th %tile Queue, veh	45	0	0	0	16

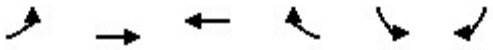
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1105	5	59	781	0	193
Future Volume (vph)	1105	5	59	781	0	193
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)		0.0	75.0		0.0	0.0
Storage Lanes		0	1		0	1
Taper Length (m)			2.5		2.5	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Frt	0.999					0.865
Flt Protected			0.950			
Satd. Flow (prot)	3148	0	1576	3151	0	1435
Flt Permitted			0.950			
Satd. Flow (perm)	3148	0	1576	3151	0	1435
Link Speed (k/h)	60			60	50	
Link Distance (m)	1070.4			216.0	379.7	
Travel Time (s)	64.2			13.0	27.3	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1201	5	64	849	0	210
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1206	0	64	849	0	210
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	3.3			3.3	0.0	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	1.6			1.6	1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)		14	24		24	14
Sign Control	Free			Free	Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	53.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	1105	5	59	781	0	193
Future Volume (Veh/h)	1105	5	59	781	0	193
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1201	5	64	849	0	210
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			1206		1756	603
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1206		1756	603
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			89		100	52
cM capacity (veh/h)			574		68	442

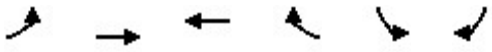
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1
Volume Total	801	405	64	424	424	210
Volume Left	0	0	64	0	0	0
Volume Right	0	5	0	0	0	210
cSH	1700	1700	574	1700	1700	442
Volume to Capacity	0.47	0.24	0.11	0.25	0.25	0.48
Queue Length 95th (m)	0.0	0.0	2.8	0.0	0.0	19.0
Control Delay (s)	0.0	0.0	12.1	0.0	0.0	20.3
Lane LOS			B			C
Approach Delay (s)	0.0		0.8			20.3
Approach LOS						C

Intersection Summary			
Average Delay	2.2		
Intersection Capacity Utilization	53.0%	ICU Level of Service	A
Analysis Period (min)	15		



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	77	1020	58	33	15	1130
Future Volume (vph)	77	1020	58	33	15	1130
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)	80.0			210.0	0.0	150.0
Storage Lanes	0			1	1	1
Taper Length (m)	2.5				2.5	
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	1.00
Frt				0.850		0.850
Flt Protected		0.997			0.950	
Satd. Flow (prot)	0	3090	1484	1438	1004	1424
Flt Permitted		0.997			0.950	
Satd. Flow (perm)	0	3090	1484	1438	1004	1424
Link Speed (k/h)		60	60		60	
Link Distance (m)		216.0	340.4		573.6	
Travel Time (s)		13.0	20.4		34.4	
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Heavy Vehicles (%)	0%	4%	14%	0%	60%	1%
Adj. Flow (vph)	80	1063	60	34	16	1177
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	1143	60	34	16	1177
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		3.3	3.3		3.3	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		1.6	1.6		1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)	24			14	24	14
Sign Control		Yield	Yield		Yield	

Intersection Summary			
Area Type:	Other		
Control Type: Roundabout			
Intersection Capacity Utilization 86.0%		ICU Level of Service E	
Analysis Period (min) 15			



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Right Turn Channelized				MOYes		
Traffic Volume (veh/h)	77	1020	58	33	15	1130
Future Volume (veh/h)	77	1020	58	33	15	1130
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Hourly flow rate (vph)	80	1063	60	34	16	1177
Approach Volume (veh/h)		1143	60		1193	
Crossing Volume (veh/h)		16	80		60	
High Capacity (veh/h)		1367	1301		1321	
High v/c (veh/h)		0.84	0.05		0.90	
Low Capacity (veh/h)		1146	1085		1104	
Low v/c (veh/h)		1.00	0.06		1.08	

Intersection Summary				
Maximum v/c High		0.90		
Maximum v/c Low		1.08		
Intersection Capacity Utilization		86.0%	ICU Level of Service	E

Intersection	
Intersection Delay, s/veh	75.4
Intersection LOS	F

Approach	EB	WB	SB
Entry Lanes	2	1	2
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	1143	94	1193
Demand Flow Rate, veh/h	1186	102	1215
Vehicles Circulating, veh/h	26	80	68
Vehicles Exiting, veh/h	1257	1132	80
Follow-Up Headway, s	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	69.9	4.2	86.3
Approach LOS	F	A	F

Lane	Left	Left	Bypass	Left	Right
Designated Moves	LT	T	R	L	TR
Assumed Moves	LT	T	R	L	TR
RT Channelized			Yield		
Lane Util	1.000	1.000		0.021	0.979
Critical Headway, s	5.193	5.193		5.193	5.193
Entry Flow, veh/h	1186	68	34	26	1189
Cap Entry Lane, veh/h	1101	1043	1043	1056	1056
Entry HV Adj Factor	0.964	0.877	1.000	0.615	0.990
Flow Entry, veh/h	1143	60	34	16	1177
Cap Entry, veh/h	1061	915	1043	650	1045
V/C Ratio	1.077	0.065	0.033	0.025	1.126
Control Delay, s/veh	69.9	4.5	3.7	5.8	87.4
LOS	F	A	A	A	F
95th %tile Queue, veh	26	0	0	0	31

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1092	5	181	1007	0	110
Future Volume (vph)	1092	5	181	1007	0	110
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Storage Length (m)		0.0	75.0		0.0	0.0
Storage Lanes		0	1		0	1
Taper Length (m)			2.5		2.5	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Frt	0.999					0.865
Flt Protected			0.950			
Satd. Flow (prot)	3148	0	1576	3151	0	1435
Flt Permitted			0.950			
Satd. Flow (perm)	3148	0	1576	3151	0	1435
Link Speed (k/h)	60			60	50	
Link Distance (m)	1069.8			216.0	379.7	
Travel Time (s)	64.2			13.0	27.3	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1187	5	197	1095	0	120
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1192	0	197	1095	0	120
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	3.3			3.3	0.0	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	1.6			1.6	1.6	
Two way Left Turn Lane						
Headway Factor	1.16	1.16	1.16	1.16	1.16	1.16
Turning Speed (k/h)		14	24		24	14
Sign Control	Free			Free	Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	50.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	1092	5	181	1007	0	110
Future Volume (Veh/h)	1092	5	181	1007	0	110
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1187	5	197	1095	0	120
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			1192		2131	596
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1192		2131	596
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			66		100	73
cM capacity (veh/h)			581		28	447

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1
Volume Total	791	401	197	548	548	120
Volume Left	0	0	197	0	0	0
Volume Right	0	5	0	0	0	120
cSH	1700	1700	581	1700	1700	447
Volume to Capacity	0.47	0.24	0.34	0.32	0.32	0.27
Queue Length 95th (m)	0.0	0.0	11.3	0.0	0.0	8.2
Control Delay (s)	0.0	0.0	14.3	0.0	0.0	16.0
Lane LOS			B			C
Approach Delay (s)	0.0		2.2			16.0
Approach LOS						C

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	50.5%	ICU Level of Service	A
Analysis Period (min)	15		

ATTACHMENT

D QUEUEING ANALYSIS RESULTS (SIMTRAFFIC SIMULATION)

SimTraffic Simulation Summary
Future (2041) AM

03/02/2023

Summary of All Intervals

Start Time	6:50
End Time	8:00
Total Time (min)	70
Time Recorded (min)	60
# of Intervals	2
# of Recorded Intervals	1
Vehs Entered	5658
Vehs Exited	5643
Starting Vehs	428
Ending Vehs	443
Travel Distance (km)	16959
Travel Time (hr)	449.4
Total Delay (hr)	119.9
Total Stops	11828
Fuel Used (l)	1348.4

Interval #0 Information Seeding

Start Time	6:50
End Time	7:00
Total Time (min)	10

Volumes adjusted by Growth Factors.

No data recorded this interval.

Interval #1 Information Recording

Start Time	7:00
End Time	8:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Vehs Entered	5658
Vehs Exited	5643
Starting Vehs	428
Ending Vehs	443
Travel Distance (km)	16959
Travel Time (hr)	449.4
Total Delay (hr)	119.9
Total Stops	11828
Fuel Used (l)	1348.4

Intersection: 2: Merritt Rd & Hwy 406 SB Ramp

Movement	EB	EB	WB	SB	SB	SB
Directions Served	LT	T	T	L	R	R
Maximum Queue (m)	78.4	100.3	22.3	6.4	45.4	37.1
Average Queue (m)	46.1	71.0	6.3	0.2	21.7	21.1
95th Queue (m)	77.5	101.4	16.4	2.1	35.1	32.8
Link Distance (m)	202.0	202.0	326.7	564.3		
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (m)					150.0	150.0
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 29: Grisdale Rd & Merritt Rd

Movement	EB	WB	NB
Directions Served	TR	L	R
Maximum Queue (m)	6.9	22.9	42.2
Average Queue (m)	0.2	7.4	21.6
95th Queue (m)	2.3	18.0	37.1
Link Distance (m)	1055.6		369.9
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (m)		75.0	
Storage Blk Time (%)			
Queuing Penalty (veh)			

Zone Summary

Zone wide Queuing Penalty: 0

SimTraffic Simulation Summary
Future (2041) AM

03/02/2023

Summary of All Intervals

Start Time	6:50
End Time	8:00
Total Time (min)	70
Time Recorded (min)	60
# of Intervals	2
# of Recorded Intervals	1
Vehs Entered	5653
Vehs Exited	5637
Starting Vehs	436
Ending Vehs	452
Travel Distance (km)	16752
Travel Time (hr)	450.4
Total Delay (hr)	123.6
Total Stops	12155
Fuel Used (l)	1339.4

Interval #0 Information Seeding

Start Time	6:50
End Time	7:00
Total Time (min)	10

Volumes adjusted by Growth Factors.

No data recorded this interval.

Interval #1 Information Recording

Start Time	7:00
End Time	8:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Vehs Entered	5653
Vehs Exited	5637
Starting Vehs	436
Ending Vehs	452
Travel Distance (km)	16752
Travel Time (hr)	450.4
Total Delay (hr)	123.6
Total Stops	12155
Fuel Used (l)	1339.4

Queuing and Blocking Report
Future (2041) AM

03/02/2023

Intersection: 2: Merritt Rd & Hwy 406 SB Ramp

Movement	EB	EB	WB	SB	SB	SB
Directions Served	LT	T	T	L	R	R
Maximum Queue (m)	94.0	112.6	35.2	6.9	36.0	29.7
Average Queue (m)	46.9	70.9	17.3	0.4	21.4	20.1
95th Queue (m)	79.7	103.1	31.2	3.0	31.6	28.4
Link Distance (m)	202.0	202.0	326.7	564.3		
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (m)					150.0	150.0
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 29: Grisdale Rd & Merritt Rd

Movement	WB	NB
Directions Served	L	R
Maximum Queue (m)	28.0	41.7
Average Queue (m)	8.8	23.1
95th Queue (m)	18.9	40.2
Link Distance (m)		369.9
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (m)	75.0	
Storage Blk Time (%)		
Queuing Penalty (veh)		

Zone Summary

Zone wide Queuing Penalty: 0

SimTraffic Simulation Summary
Future (2041) PM

03/02/2023

Summary of All Intervals

Start Time	6:50
End Time	8:00
Total Time (min)	70
Time Recorded (min)	60
# of Intervals	2
# of Recorded Intervals	1
Vehs Entered	6986
Vehs Exited	6911
Starting Vehs	557
Ending Vehs	632
Travel Distance (km)	20391
Travel Time (hr)	634.4
Total Delay (hr)	237.3
Total Stops	15459
Fuel Used (l)	1691.6

Interval #0 Information Seeding

Start Time	6:50
End Time	7:00
Total Time (min)	10

Volumes adjusted by Growth Factors.

No data recorded this interval.

Interval #1 Information Recording

Start Time	7:00
End Time	8:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Vehs Entered	6986
Vehs Exited	6911
Starting Vehs	557
Ending Vehs	632
Travel Distance (km)	20391
Travel Time (hr)	634.4
Total Delay (hr)	237.3
Total Stops	15459
Fuel Used (l)	1691.6

Intersection: 2: Merritt Rd & Hwy 406 SB Ramp

Movement	EB	EB	WB	SB	SB	SB
Directions Served	LT	T	T	L	R	R
Maximum Queue (m)	102.6	111.4	41.4	25.8	43.4	47.7
Average Queue (m)	55.7	71.3	7.9	2.1	31.2	30.9
95th Queue (m)	92.7	106.8	22.3	12.2	45.3	45.8
Link Distance (m)	202.0	202.0	326.7	564.3		
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (m)					150.0	150.0
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 28: Grisdale Rd & Merritt Rd

Movement	WB	NB
Directions Served	L	R
Maximum Queue (m)	60.2	27.6
Average Queue (m)	18.1	12.3
95th Queue (m)	39.5	20.7
Link Distance (m)		369.9
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (m)	75.0	
Storage Blk Time (%)		
Queuing Penalty (veh)		

Zone Summary

Zone wide Queuing Penalty: 0

SimTraffic Simulation Summary
Future (2041) PM

03/02/2023

Summary of All Intervals

Start Time	6:50
End Time	8:00
Total Time (min)	70
Time Recorded (min)	60
# of Intervals	2
# of Recorded Intervals	1
Vehs Entered	6780
Vehs Exited	6721
Starting Vehs	534
Ending Vehs	593
Travel Distance (km)	19734
Travel Time (hr)	605.6
Total Delay (hr)	220.7
Total Stops	15130
Fuel Used (l)	1633.5

Interval #0 Information Seeding

Start Time	6:50
End Time	7:00
Total Time (min)	10

Volumes adjusted by Growth Factors.

No data recorded this interval.

Interval #1 Information Recording

Start Time	7:00
End Time	8:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Vehs Entered	6780
Vehs Exited	6721
Starting Vehs	534
Ending Vehs	593
Travel Distance (km)	19734
Travel Time (hr)	605.6
Total Delay (hr)	220.7
Total Stops	15130
Fuel Used (l)	1633.5

Intersection: 2: Merritt Rd & Hwy 406 SB Ramp

Movement	EB	EB	WB	SB	SB	SB
Directions Served	LT	T	T	L	R	R
Maximum Queue (m)	94.1	103.8	39.6	22.1	45.8	43.3
Average Queue (m)	53.5	73.4	16.5	4.5	31.5	28.7
95th Queue (m)	81.2	101.5	32.3	17.2	43.7	41.6
Link Distance (m)	202.0	202.0	326.7	564.3		
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (m)					150.0	150.0
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 28: Grisdale Rd & Merritt Rd

Movement	WB	NB
Directions Served	L	R
Maximum Queue (m)	48.0	29.0
Average Queue (m)	17.7	12.9
95th Queue (m)	35.1	21.1
Link Distance (m)		369.9
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (m)	75.0	
Storage Blk Time (%)		
Queuing Penalty (veh)		

Zone Summary

Zone wide Queuing Penalty: 0

SimTraffic Simulation Summary
Future (2041) AM

03/02/2023

Summary of All Intervals

Start Time	6:50
End Time	8:00
Total Time (min)	70
Time Recorded (min)	60
# of Intervals	2
# of Recorded Intervals	1
Vehs Entered	5880
Vehs Exited	5863
Starting Vehs	470
Ending Vehs	487
Travel Distance (km)	17504
Travel Time (hr)	482.1
Total Delay (hr)	141.1
Total Stops	12793
Fuel Used (l)	1401.1

Interval #0 Information Seeding

Start Time	6:50
End Time	7:00
Total Time (min)	10

Volumes adjusted by Growth Factors.

No data recorded this interval.

Interval #1 Information Recording

Start Time	7:00
End Time	8:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Vehs Entered	5880
Vehs Exited	5863
Starting Vehs	470
Ending Vehs	487
Travel Distance (km)	17504
Travel Time (hr)	482.1
Total Delay (hr)	141.1
Total Stops	12793
Fuel Used (l)	1401.1

Intersection: 2: Merritt Rd & Hwy 406 SB Ramp

Movement	EB	EB	EB	WB	SB	SB	SB
Directions Served	L	T	T	T	L	R	R
Maximum Queue (m)	9.3	106.3	130.7	27.2	7.0	43.5	41.0
Average Queue (m)	3.6	47.4	75.5	6.5	0.5	22.4	20.5
95th Queue (m)	10.3	81.8	109.5	20.4	3.3	35.2	34.0
Link Distance (m)		202.0	202.0	326.7	564.3		
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (m)	80.0					150.0	150.0
Storage Blk Time (%)		0					
Queuing Penalty (veh)		0					

Intersection: 29: Grisdale Rd & Merritt Rd

Movement	WB	NB
Directions Served	L	R
Maximum Queue (m)	15.2	42.8
Average Queue (m)	6.0	22.2
95th Queue (m)	13.1	37.9
Link Distance (m)		369.9
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (m)	75.0	
Storage Blk Time (%)		
Queuing Penalty (veh)		

Zone Summary

Zone wide Queuing Penalty: 0

SimTraffic Simulation Summary
Future (2041) AM

03/02/2023

Summary of All Intervals

Start Time	6:50
End Time	8:00
Total Time (min)	70
Time Recorded (min)	60
# of Intervals	2
# of Recorded Intervals	1
Vehs Entered	5790
Vehs Exited	5771
Starting Vehs	463
Ending Vehs	482
Travel Distance (km)	17271
Travel Time (hr)	470.6
Total Delay (hr)	133.2
Total Stops	12724
Fuel Used (l)	1372.1

Interval #0 Information Seeding

Start Time	6:50
End Time	7:00
Total Time (min)	10

Volumes adjusted by Growth Factors.

No data recorded this interval.

Interval #1 Information Recording

Start Time	7:00
End Time	8:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Vehs Entered	5790
Vehs Exited	5771
Starting Vehs	463
Ending Vehs	482
Travel Distance (km)	17271
Travel Time (hr)	470.6
Total Delay (hr)	133.2
Total Stops	12724
Fuel Used (l)	1372.1

Intersection: 2: Merritt Rd & Hwy 406 SB Ramp

Movement	EB	EB	EB	WB	SB	SB	SB
Directions Served	L	T	T	T	L	R	R
Maximum Queue (m)	9.3	88.7	133.0	32.8	14.2	38.2	36.5
Average Queue (m)	3.4	47.6	70.1	14.7	0.9	22.9	20.3
95th Queue (m)	9.8	80.3	105.5	29.7	5.6	32.4	31.0
Link Distance (m)		202.0	202.0	326.7	564.3		
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (m)	80.0					150.0	150.0
Storage Blk Time (%)		0					
Queuing Penalty (veh)		0					

Intersection: 29: Grisdale Rd & Merritt Rd

Movement	WB	NB
Directions Served	L	R
Maximum Queue (m)	27.6	48.1
Average Queue (m)	8.4	19.5
95th Queue (m)	18.2	33.0
Link Distance (m)		369.9
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (m)	75.0	
Storage Blk Time (%)		
Queuing Penalty (veh)		

Zone Summary

Zone wide Queuing Penalty: 0

SimTraffic Simulation Summary
Future (2041) PM

03/02/2023

Summary of All Intervals

Start Time	6:50
End Time	8:00
Total Time (min)	70
Time Recorded (min)	60
# of Intervals	2
# of Recorded Intervals	1
Vehs Entered	6848
Vehs Exited	6823
Starting Vehs	555
Ending Vehs	580
Travel Distance (km)	20161
Travel Time (hr)	620.4
Total Delay (hr)	227.5
Total Stops	15611
Fuel Used (l)	1660.8

Interval #0 Information Seeding

Start Time	6:50
End Time	7:00
Total Time (min)	10

Volumes adjusted by Growth Factors.

No data recorded this interval.

Interval #1 Information Recording

Start Time	7:00
End Time	8:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Vehs Entered	6848
Vehs Exited	6823
Starting Vehs	555
Ending Vehs	580
Travel Distance (km)	20161
Travel Time (hr)	620.4
Total Delay (hr)	227.5
Total Stops	15611
Fuel Used (l)	1660.8

Intersection: 2: Merritt Rd & Hwy 406 SB Ramp

Movement	EB	EB	EB	WB	SB	SB	SB
Directions Served	L	T	T	T	L	R	R
Maximum Queue (m)	82.2	108.5	130.3	33.7	25.8	48.6	45.4
Average Queue (m)	12.2	54.5	76.1	8.3	5.4	30.8	28.5
95th Queue (m)	36.0	89.2	111.9	21.5	18.0	44.7	41.5
Link Distance (m)		202.0	202.0	326.7	564.3		
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (m)	80.0					150.0	150.0
Storage Blk Time (%)	0	1					
Queuing Penalty (veh)	0	0					

Intersection: 28: Grisdale Rd & Merritt Rd

Movement	WB	NB
Directions Served	L	R
Maximum Queue (m)	46.0	48.9
Average Queue (m)	18.2	16.5
95th Queue (m)	31.5	31.6
Link Distance (m)		369.9
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (m)	75.0	
Storage Blk Time (%)		
Queuing Penalty (veh)		

Zone Summary

Zone wide Queuing Penalty: 0

SimTraffic Simulation Summary
Future (2041) PM

03/02/2023

Summary of All Intervals

Start Time	6:50
End Time	8:00
Total Time (min)	70
Time Recorded (min)	60
# of Intervals	2
# of Recorded Intervals	1
Vehs Entered	6956
Vehs Exited	6906
Starting Vehs	536
Ending Vehs	586
Travel Distance (km)	20329
Travel Time (hr)	645.4
Total Delay (hr)	250.0
Total Stops	15821
Fuel Used (l)	1697.6

Interval #0 Information Seeding

Start Time	6:50
End Time	7:00
Total Time (min)	10

Volumes adjusted by Growth Factors.

No data recorded this interval.

Interval #1 Information Recording

Start Time	7:00
End Time	8:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Vehs Entered	6956
Vehs Exited	6906
Starting Vehs	536
Ending Vehs	586
Travel Distance (km)	20329
Travel Time (hr)	645.4
Total Delay (hr)	250.0
Total Stops	15821
Fuel Used (l)	1697.6

Intersection: 2: Merritt Rd & Hwy 406 SB Ramp

Movement	EB	EB	EB	WB	SB	SB	SB
Directions Served	L	T	T	T	L	R	R
Maximum Queue (m)	29.1	92.7	125.5	30.3	32.4	49.4	49.2
Average Queue (m)	11.5	59.7	81.3	12.8	3.0	31.9	28.3
95th Queue (m)	21.7	92.1	116.0	26.9	14.8	49.1	44.6
Link Distance (m)		202.0	202.0	326.7	564.3		
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (m)	80.0					150.0	150.0
Storage Blk Time (%)		0					
Queuing Penalty (veh)		0					

Intersection: 28: Grisdale Rd & Merritt Rd

Movement	WB	NB
Directions Served	L	R
Maximum Queue (m)	53.2	40.4
Average Queue (m)	18.5	16.6
95th Queue (m)	35.5	30.7
Link Distance (m)		369.9
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (m)	75.0	
Storage Blk Time (%)		
Queuing Penalty (veh)		

Zone Summary

Zone wide Queuing Penalty: 0

SimTraffic Simulation Summary
Future (2041) AM

03/02/2023

Summary of All Intervals

Start Time	6:50
End Time	8:00
Total Time (min)	70
Time Recorded (min)	60
# of Intervals	2
# of Recorded Intervals	1
Vehs Entered	5623
Vehs Exited	5713
Starting Vehs	496
Ending Vehs	406
Travel Distance (km)	17199
Travel Time (hr)	473.9
Total Delay (hr)	139.1
Total Stops	11218
Fuel Used (l)	1380.8

Interval #0 Information Seeding

Start Time	6:50
End Time	7:00
Total Time (min)	10

Volumes adjusted by Growth Factors.

No data recorded this interval.

Interval #1 Information Recording

Start Time	7:00
End Time	8:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Vehs Entered	5623
Vehs Exited	5713
Starting Vehs	496
Ending Vehs	406
Travel Distance (km)	17199
Travel Time (hr)	473.9
Total Delay (hr)	139.1
Total Stops	11218
Fuel Used (l)	1380.8

Intersection: 2: Merritt Rd & Hwy 406 SB Ramp

Movement	EB	EB	WB	SB	SB
Directions Served	LT		T	L	R
Maximum Queue (m)	215.3	209.4	22.6	7.1	25.3
Average Queue (m)	63.5	41.3	0.8	1.3	5.4
95th Queue (m)	214.3	177.4	7.4	5.5	15.8
Link Distance (m)	200.9	200.9	319.1	557.4	
Upstream Blk Time (%)	9	2			
Queuing Penalty (veh)	60	10			
Storage Bay Dist (m)					150.0
Storage Blk Time (%)					
Queuing Penalty (veh)					

Intersection: 29: Grisdale Rd & Merritt Rd

Movement	EB	EB	WB	NB
Directions Served	T	TR	L	R
Maximum Queue (m)	125.9	104.7	21.5	46.9
Average Queue (m)	20.1	13.9	6.8	16.6
95th Queue (m)	82.4	63.9	15.9	31.1
Link Distance (m)	1055.6	1055.6		369.9
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (m)			75.0	
Storage Blk Time (%)				
Queuing Penalty (veh)				

Zone Summary

Zone wide Queuing Penalty: 70

SimTraffic Simulation Summary
Future (2041) PM

03/02/2023

Summary of All Intervals

Start Time	6:50
End Time	8:00
Total Time (min)	70
Time Recorded (min)	60
# of Intervals	2
# of Recorded Intervals	1
Vehs Entered	6812
Vehs Exited	6680
Starting Vehs	501
Ending Vehs	633
Travel Distance (km)	19926
Travel Time (hr)	590.5
Total Delay (hr)	202.4
Total Stops	13242
Fuel Used (l)	1623.6

Interval #0 Information Seeding

Start Time	6:50
End Time	7:00
Total Time (min)	10

Volumes adjusted by Growth Factors.

No data recorded this interval.

Interval #1 Information Recording

Start Time	7:00
End Time	8:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Vehs Entered	6812
Vehs Exited	6680
Starting Vehs	501
Ending Vehs	633
Travel Distance (km)	19926
Travel Time (hr)	590.5
Total Delay (hr)	202.4
Total Stops	13242
Fuel Used (l)	1623.6

Intersection: 2: Merritt Rd & Hwy 406 SB Ramp

Movement	EB	EB	WB	SB	SB
Directions Served	LT		T	L	R
Maximum Queue (m)	177.6	121.3	22.6	18.5	134.7
Average Queue (m)	16.3	4.0	1.6	2.6	19.0
95th Queue (m)	75.1	40.0	10.3	11.9	67.3
Link Distance (m)	200.9	200.9	319.1	557.4	
Upstream Blk Time (%)					
Queuing Penalty (veh)					
Storage Bay Dist (m)					150.0
Storage Blk Time (%)					
Queuing Penalty (veh)					

Intersection: 28: Grisdale Rd & Merritt Rd

Movement	WB	NB
Directions Served	L	R
Maximum Queue (m)	46.6	22.2
Average Queue (m)	20.3	10.5
95th Queue (m)	37.6	18.4
Link Distance (m)		369.9
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (m)	75.0	
Storage Blk Time (%)		
Queuing Penalty (veh)		

Zone Summary

Zone wide Queuing Penalty: 0

ATTACHMENT

E TRAFFIC SIGNAL WARRANT ANALYSIS

Analysis Sheet

Input Sheet | Results Sheet | Proposed Collision

GO TO Justification:

Intersection: Merritt Road / Highway 406 westerly ramps intersection Count Date: 2022

Justification 1: Minimum Vehicle Volumes

Restricted Flow Urban Conditions

Justification	Guidance Approach Lanes				Percentage Warrant								Total Across	Section Percent
	1 Lanes		2 or More Lanes		Hour Ending									
Flow Condition	FREE FLOW ☐	RESTR. FLOW ☐	FREE FLOW ☐	RESTR. FLOW ☑	7:00	8:00	9:00	10:00	15:00	16:00	17:00	18:00		
1A	480	720	600	900	1,984	1,984	1,984	1,984	2,333	2,333	2,333	2,333		
	COMPLIANCE %				100	100	100	100	100	100	100	100	800	100
1B	180	255	180	255	775	775	775	775	1,145	1,145	1,145	1,145		
	COMPLIANCE %				100	100	100	100	100	100	100	100	800	100
Restricted Flow Signal Justification 1:					Both 1A and 1B 100% Fulfilled each of 8 hours — Yes ☑ No ☐									
					Lesser of 1A or 1B at least 80% fulfilled each of 8 hours — Yes ☑ No ☐									

Justification 2: Delay to Cross Traffic

Restricted Flow Urban Conditions

Justification	Guidance Approach Lanes				Percentage Warrant								Total Across	Section Percent
	1 lanes		2 or More lanes		Hour Ending									
Flow Condition	FREE FLOW ☐	RESTR. FLOW ☐	FREE FLOW ☐	RESTR. FLOW ☑	7:00	8:00	9:00	10:00	15:00	16:00	17:00	18:00		
2A	480	720	600	900	1,209	1,209	1,209	1,209	1,188	1,188	1,188	1,188		
	COMPLIANCE %				100	100	100	100	100	100	100	100	800	100
2B	50	75	50	75	17	17	17	17	25	25	25	25		
	COMPLIANCE %				23	23	23	23	33	33	33	33	224	28
Restricted Flow Signal Justification 2:					Both 2A and 2B 100% fulfilled each of 8 hours — Yes ☐ No ☑									
					Lesser of 2A or 2B at least 80% fulfilled each of 8 hours — Yes ☐ No ☑									

Justification 3: Combination

Combination Justification 1 and 2

	Justification Satisfied 80% or More			Two Justifications Satisfied 80% or More	
Justification 1	Minimum Vehicle Volume	YES ☑	NO ☐	YES ☐	NO ☑
Justification 2	Delay Cross Traffic	YES ☐	NO ☑		NOT JUSTIFIED

Justification 4: Four Hour Volume

Justification	Time Period	Total Volume of Both Approaches (Main) X	Heaviest Minor Approach Y (actual)	Required Value Y (warrant threshold)	Average % Compliance	Overall % Compliance
Justification 4	7:00	1,209	775	135	100 %	100 %
	8:00	1,209	775	135	100 %	
	9:00	1,209	775	135	100 %	
	10:00	1,209	775	135	100 %	

Analysis Sheet

Input Sheet | Results Sheet | Proposed Collision

GO TO Justification:

Intersection: Merritt Road / Highway 406 westerly ramps intersection Count Date: 2022

Justification 5: Collision Experience

Justification	Preceding Months	% Fulfillment	Overall % Compliance
Justification 5	1-12	0 %	0 %
	13-24	0 %	
	25-36	0 %	

Justification 6: Pedestrian Volume

Pedestrian Volume Analysis

8 Hour Vehicular Volume V_8		Net 8 Hour Pedestrian Volume				
		< 200	200 - 275	276 - 475	476 - 1000	>1000
Justification 6A	< 1440					
	1440 - 2600					
	2601 - 7000	Not Justified				
	> 7000					

Pedestrian Delay Analysis

Net Total 8 Hour Volume of Total Pedestrians		Net Total 8 Hour Volume of Delayed Pedestrians		
		< 75	75 - 130	> 130
Justification 6B	< 200	Not Justified		
	200 - 300			
	> 300			

Input Data Sheet

Analysis Sheet | Results Sheet | Proposed Collision

GO TO Justification:

What are the intersecting roadways? Merritt Road / Highway 406 westerly ramps intersection

What is the direction of the Main Road street? East-West

When was the data collected? 2022

Justification 1 - 4: Volume Warrants

a.- Number of lanes on the Main Road? 2 or more

b.- Number of lanes on the Minor Road? 2 or more

c.- How many approaches? 3

d.- What is the operating environment? Urban **Population >= 10,000 AND Speed < 70 km/hr**

e.- What is the eight hour vehicle volume at the intersection? (Please fill in table below)

Hour Ending	Main Eastbound Approach			Minor Northbound Approach			Main Westbound Approach			Minor Southbound Approach			Pedestrians Crossing Main Road
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
7:00	32	1,078						72	27	7		768	10
8:00	32	1,078						72	27	7		768	10
9:00	32	1,078						72	27	7		768	10
10:00	32	1,078						72	27	7		768	10
15:00	77	1,020						58	33	15		1,130	10
16:00	77	1,020						58	33	15		1,130	10
17:00	77	1,020						58	33	15		1,130	10
18:00	77	1,020						58	33	15		1,130	10
Total	**436**	**8,392**	**0**	**0**	**0**	**0**	**0**	**520**	**240**	**88**	**0**	**7,592**	**80**

Justification 5: Collision Experience

Preceding Months	Number of Collisions*
1-12	
13-24	
25-36	

* Include only collisions that are susceptable to correction through the installation of traffic signal control

Justification 6: Pedestrian Volume

a.- Please fill in table below summarizing total pedestrians crossing major roadway at the intersection or in proximity to the intersection (zones). Please reference Section 4.8 of the Manual for further explanation and graphical representation.

	Zone 1		Zone 2		Zone 3 (if needed)		Zone 4 (if needed)		Total
	Assisted	Unassisted	Assisted	Unassisted	Assisted	Unassisted	Assisted	Unassisted	
Total 8 hour pedestrian volume									
Factored 8 hour pedestrian volume	0		0		0		0		
% Assigned to crossing rate	100%		50%		0%		0%		
Net 8 Hour Pedestrian Volume at Crossing									0
Net 8 Hour Vehicular Volume on Street Being Crossed									6,411

b.- Please fill in table below summarizing delay to pedestrians crossing major roadway at the intersection or in proximity to the intersection (zones). Please reference Section 4.8 of the Manual for further explanation and graphical representation.

	Zone 1		Zone 2		Zone 3 (if needed)		Zone 4 (if needed)		Total
	Assisted	Unassisted	Assisted	Unassisted	Assisted	Unassisted	Assisted	Unassisted	
Total 8 hour pedestrian volume	0	0	0	0	0	0	0	0	
Total 8 hour pedestrians delayed greater than 10 seconds									
Factored volume of total pedestrians	0		0		0		0		
Factored volume of delayed pedestrians	0		0		0		0		
% Assigned to Crossing Rate	100%		50%		0%		0%		
Net 8 Hour Volume of Total Pedestrians									0
Net 8 Hour Volume of Delayed Pedestrians									0

Results Sheet

Input Sheet | Analysis Sheet | Proposed Collision

GO TO Justification:

Intersection: Merritt Road / Highway 406 westerly ramps intersecti Count Date: 2022

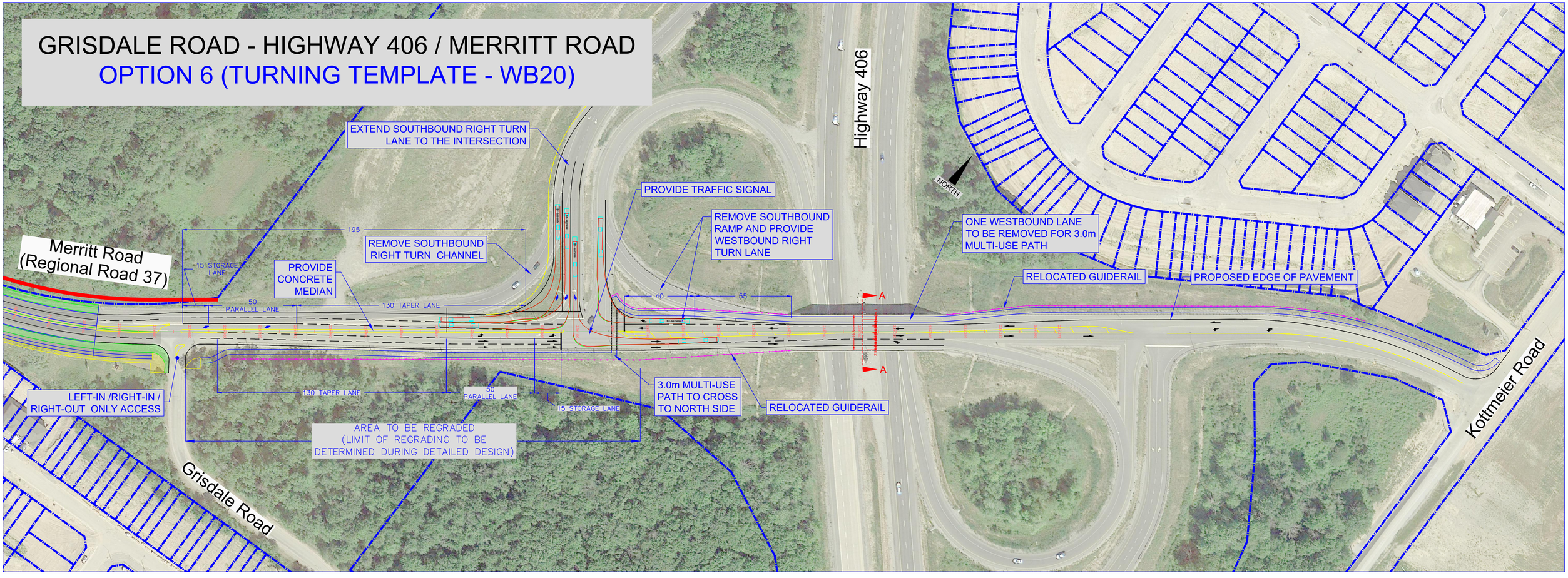
Summary Results

Justification			Compliance		Signal Justified? YES	Signal Justified? NO
1. Minimum Vehicular Volume	A	Total Volume	100	%	☑	☐
	B	Crossing Volume	100	%		
2. Delay to Cross Traffic	A	Main Road	100	%	☐	☑
	B	Crossing Road	28	%		
3. Combination	A	Justificaton 1	100	%	☐	☑
	B	Justification 2	28	%		
4. 4-Hr Volume			100	%	☑	☐
5. Collision Experience			0	%	☐	☑
6. Pedestrians	A	Volume	Justification not met		☐	☑
	B	Delay	Justification not met			

ATTACHMENT

F TURNING TEMPLATE FOR PREFERRED OPTION

GRISDALE ROAD - HIGHWAY 406 / MERRITT ROAD
OPTION 6 (TURNING TEMPLATE - WB20)



ATTACHMENT

G DESIGN CRITERIA

Ministry of Transportation
Ministère des Transports

Ontario

DESIGN CRITERIA

Group Work Project No.	GWP xxxx-xx-xx	Highway No. 406	Page 1 of 5
Work Project No(s).	WP xxxx-xx-xx		Date: 24-05-2023
	WP xxxx-xx-xx		

Asset Work Type xx

Length 780 m

Location Merritt Rd / Hwy 406 (Overpass) between Grisdale Rd and Kottmeier Rd

Municipal Jurisdictions	City of Thorold, Niagara Region
Geographic Township(s)	xx
County of	xx

Recommended by:

Signature:

Printed Name and Title:

Date:

Recommended by:

Signature:

Printed Name and Title:

Date:

Approved by:

Signature:

Printed Name and Title:

Date:

Standards Table: Merritt Road at Highway 406

Design Year: 2031		Superelevation Maximum Rate for Determining the Radius: 6%		
	Present Conditions	Design Standards	Reference (Design Standards)	Proposed Standards
Functional Highway Classification	RAU80	UAU80	MTO design supplement 2020 (Exhibit 2-G)	UAU80
Minimum Stopping Sight Distance (m)	>105	105	TAC 2017 (2.5.3: Table 2.5.2)	>105
Crest: Minimum "K" factor for Stopping Sight Distance	TBD[1]	N/A	TAC 2017 (3.3.3.3: Table 3.3.2)	TBD[1]
Sag: Minimum "K" factor for Stopping Sight Distance	TBD[1]	N/A	TAC 2017 (3.3.3.4: Table 3.3.4)	TBD[1]
Grades Maximum (%)	TBD[1]	N/A	TAC 2017 (3.3.2.4: Table 3.3.1)	TBD[1]
Radius Minimum (m)	Tangent	290	TAC 2017 (Table 3.2.8)	Tangent
Lane Widths (m)	4 x 3.50 m	3.0 m – 3.70 m	TAC 2017 (4.2.2)	3 x 3.50 m
Shoulder Width (Left / Right) (m)	2.9 / 2.9	N/A	TAC 2017 (4.4.2)	1.2 / 2.9
Multi-Use Path (m)	N/A	3.0 m – 6.00 m	TAC 2017 (5.3.1.4: Table 5.3.5)	3.0 m
Shoulder Rounding (m)	N/A	N/A	N/A	N/A
Median Width (m)	1.00 - 3.7 (Flushed)	1.50 – 2.0 (Concrete) 1.00 – 4.00 (Flushed)	TAC 2017 (4.5.3)	1.50 - 2.0 (Concrete) 1.00 – 4.00 (Flushed)
R.O.W. Width - nominal (m)	19.8			19.8
Posted Speed - prevailing (km/h)	60 km/h	60 km/h		60 km/h
Miscellaneous	N/A	N/A	N/A	N/A

Notes:

1. Vertical profile to match existing and will be determined during detailed design.

Interchange Standards Table: Interchange Name: Highway 406 N - Merritt Road E/W Ramp

	Ramp Name	Present Conditions	Design Standards	Reference (Design Standards)	Proposed Standards
Crossing Road Design Speed (km/h)		80 km/h	80 km/h	MTO design supplement 2020 (10.6.2.1)	80 km/h
Ramp Design Speed (km/h)		80 km/h	80 km/h	MTO design supplement 2020 (10.6.2.1: Exhibit 10-D)	80 km/h
Sight Distance Requirement for Stopping, Crossing and Turning Movements at the Crossing Road (m)		See Note 1	130	TAC 2017 (2.5.3: Table 2.5.2)	See Note 1
Crest: Minimum “K” factor for Stopping Sight Distance		See Note 1	26	TAC 2017 (3.3.3.3: Table 3.3.2)	See Note 1
Sag: Minimum “K” factor for Stopping Sight Distance		See Note 1	30	TAC 2017 (3.3.3.4: Table 3.3.4)	See Note 1
Grades Maximum (%)		See Note 1	6%	TAC 2017 (3.3.2.4: Table 3.3.1)	See Note 1
Radius Minimum (m)		250 m	130 m	MTO design supplement 2020 (10.6.2.1: Exhibit 10-D	250 m
Superelevation Maximum Rate (%)		0.06 m/m	0.06 m/m	MTO design supplement 2020 (10.6.2.1: Exhibit 10-D)	0.06 m/m
Lane Widths (m)		2 x 4.8 m	4.8 m	TAC 2017 (10.6.2.5)	3 x 4.8 m [2]
Shoulder Width (Left / Right) (m)		1.0 m left 3.0 m right	1.0 m Left 2.5 m Right	MTO design supplement 2020 (Section 4.4.2)	1.0 m Left 3.0 m Right
Shoulder Rounding (m)		0.5 m (min)	0.5 m	TAC 2017 (4.4.5)	0.5 m
Sight Distance at Exit Terminal (m)		See Note 3	-	-	See Note 3
Exit Terminal Speed-Change Lane Length (m)		See Note 3	-	-	See Note 3
Sight Distance at Entrance Terminal (m)		See Note 3	-	-	See Note 3
Entrance Terminal Speed-Change Lane Length (m)		See Note 3	-	-	See Note 3

Notes:

1. Proposed work is limited to intersection tie-in. Existing ramp profile to be maintained.
2. Existing two lanes (left/ right turn lanes) will be converted to 2 right and 1 left turning lanes approaching intersection at Merritt Road.
3. Existing entrance and exit terminal and speed-change lanes to be maintained.

DESIGN CRITERIA

Standards Table: Highway 406 (Beaverdams Road to Robinson Road)

Design Year: 20232031		Superelevation Maximum Rate for Determining the Radius: Not Available		
	Present Conditions	Design Standards	Reference (Design Standards)	Proposed Standards [1]
Functional Highway Classification	RFD120	RFD120	RFD120	RFD120
Minimum Stopping Sight Distance (m)	245 m	250	TAC 2017 (2.5.3: Table 2.5.2)	245 m
Crest: Minimum "K" factor for Stopping Sight Distance	120 m	95	TAC 2017 (3.3.3.3: Table 3.3.2)	120 m
Sag: Minimum "K" factor for Stopping Sight Distance	60 m	63	TAC 2017 (3.3.3.4: Table 3.3.4)	60 m
Grades Maximum (%)	3%	5%	TAC 2017 (3.3.2.4: Table 3.3.1)	3%
Radius Minimum (m)	1800 m	750	TAC 2017 (Table 3.2.6)	1800 m
Lane Widths (m)	2 X 3.75 m	3.75	MTO design supplement 2020 (Exhibit 4-A)	2 X 3.75 m
Shoulder Width (Left / Right) (m)	Right – 3.0 m Left – 1.5 m	3.0	MTO design supplement 2020 (Exhibit 4-J)	Right – 3.0 m Left – 1.5 m
Shoulder Rounding (m)	1.5 m	1.0	MTO RDM 2.3.3	1.5 m
Median Width (m)	22 m	N/A	N/A	22 m
R.O.W. Width - nominal (m)	N/A	N/A	N/A	N/A
Posted Speed - prevailing (km/h)	100 km/h	100 km/h	N/A	100 km/h
Miscellaneous	N/A	N/A	N/A	N/A

Notes:

1. The existing conditions for Highway 406 will be maintained. No changes are proposed to Highway 406 mainline. Existing information listed in this table was provided to the Niagara Region by the Ministry of Transportation.

Traffic:

Remarks:

Remarks Applicable to the Project

Subject	Applicable to the Project	
	Yes	No *
1. Project Purpose and Scope	X	
2. Design Year	X	
3. Related Studies and Adjacent Projects		X
4. Environmental Assessment	X	
5. Pavement	X	
6. Cross-Fall	X	
7. Superelevation		X
8. Drainage	X	
9. Roadside Safety	X	
10. Signing	X	
11. Illumination	X	
12. Traffic Signals	X	
13. Commercial Entrances		X
14. Intersections	X	
15. Structures	X	
16. Pavement Widening on Curves		X
17. Passing Lanes and Truck Climbing Lanes		X
18. Fencing		X
19. Active Transportation Infrastructure	X	
20. Property Requirements		X
21. Railway Crossings		X
22. Utilities and Pipelines	X	
23. Construction Staging	X	
24. Legal Agreements and Approvals	X	
25. Miscellaneous		X

* No indicates: Not applicable to this project as there will be no work completed related to the topic.

1. Project Purpose and Scope

Scope of Work

As part of the Municipal Class Environmental Assessment Study for Merritt Road and Rice Road, the Regional Municipality of Niagara is proposing to introduce a multi-use path to Merritt Road, east of Grisdale Road over Highway 406 interchange located in the City of Thorold. As a result of provision of this active transportation facility, the following change are proposed to the interchange to address any potential safety concerns to the multi-use path users:

- Removal of southbound right turn channel to Merritt Road.
- Removal of southbound right turn ramp to Highway 406.
- Provision of a traffic signal on the intersection of Highway 406 southbound ramp and Merritt Road.
- Modification of the Grisdale Road / Merritt Road intersection to left-in / right-out only access.
- Provision of a concrete median from Grisdale Road to the intersection of Highway 406 southbound ramp and Merritt Road.
- Relocation of guiderails to accommodate the above design changes.

Horizontal Alignment

Existing horizontal alignment on Merritt Road and ramps will be maintained.

Vertical Alignment

Existing vertical alignment on Merritt Road will be maintained but will be further explored during detailed design stage.

2. Design Year

2031

3. Related Studies and Adjacent Projects

N/A

4. Environmental Assessment

The proposed works are being recommended as part of Niagara Region’s Municipal Class Environmental Assessment Study for improvements to Merritt Road and Rice Road.

5. Pavement

Removal and resurface of existing westbound shoulder and lane is required in order to construct proposed MUP and buffer.

Removal of southbound right turn channel at ramp and constructing 2 southbound right and 1 left turning lanes approaching intersection at Merritt Road are required.

6. Cross-fall

Existing cross-fall will be maintained. This will be further explored in detail design stage.

7. Superelevation

Existing superelevation will be maintained.

8. Drainage

Stormwater Management Report will be provided to the Ministry of Transportation as part of the Environmental Assessment Report review package.

9. Roadside Safety

Roadside safety improvements will be reviewed during detail design stage.

10. Signing

Existing signing and signing improvements will be reviewed in accordance with Ontario Traffic Manual during detail design stage.

11. Illumination

Existing and proposed lighting system will be reviewed during detailed design stage.

12. Traffic Signals

A new Traffic signal will be introduced at Merritt Road and Highway 406 southbound ramp intersection.

13. Commercial Entrance

N/A

14. Intersections

- Highway 406 Ramp/ Merritt Road intersection to be signalized. Modifications to the on/off ramps are proposed including the following:
    - Existing two lane exit ramp (left/right turn lanes) from Hwy 406 to Merritt Road will be modified at the approach to Merritt Road as follows:
        - Removal of existing southbound right turn channelization
        - Reconfigure approaching lanes to Merritt Road to include 2 right turn and 1 left turn lanes.
    - Removal of Merritt Rd E – Hwy 406 S Channelized Ramp, and provision of a single westbound right turn lane. Ramp entrance for both Merritt Rd EB and WB traffic will be via the signalized intersection. Due to constraint of the existing bridge, the proposed westbound right turn lane length is 95m (40m parallel with 55m taper), which is substandard to the MTO design standard in accordance with TAC Supplement Exhibit 9-J (60m parallel and 70m taper).
- New islands at Grisdale Road intersection which will restrict to left-in / right-out only access.

15. Structures

Existing structure will be maintained. Lane configuration on the structure will be modified to accommodate the proposed condition.

16. Pavement Widening on Curves

N/A

17. Passing Lanes / Truck Climbing Lanes

N/A

18. Fencing

N/A

19. Active Transportation Infrastructures

Proposed multi-use path along Merritt Road, from Grisdale Road to Kottmeir Road

20. Property Requirements

N/A

21. Railway Crossing

N/A

22. Utilities and Pipelines

Any utility relocation will be confirmed and coordinated during detailed design phase.

23. Construction Staging

Construction staging will be completed accordance with OTM Book 7 “Temporary Conditions”.

Construction staging plan will be discussed further during detailed design stage.

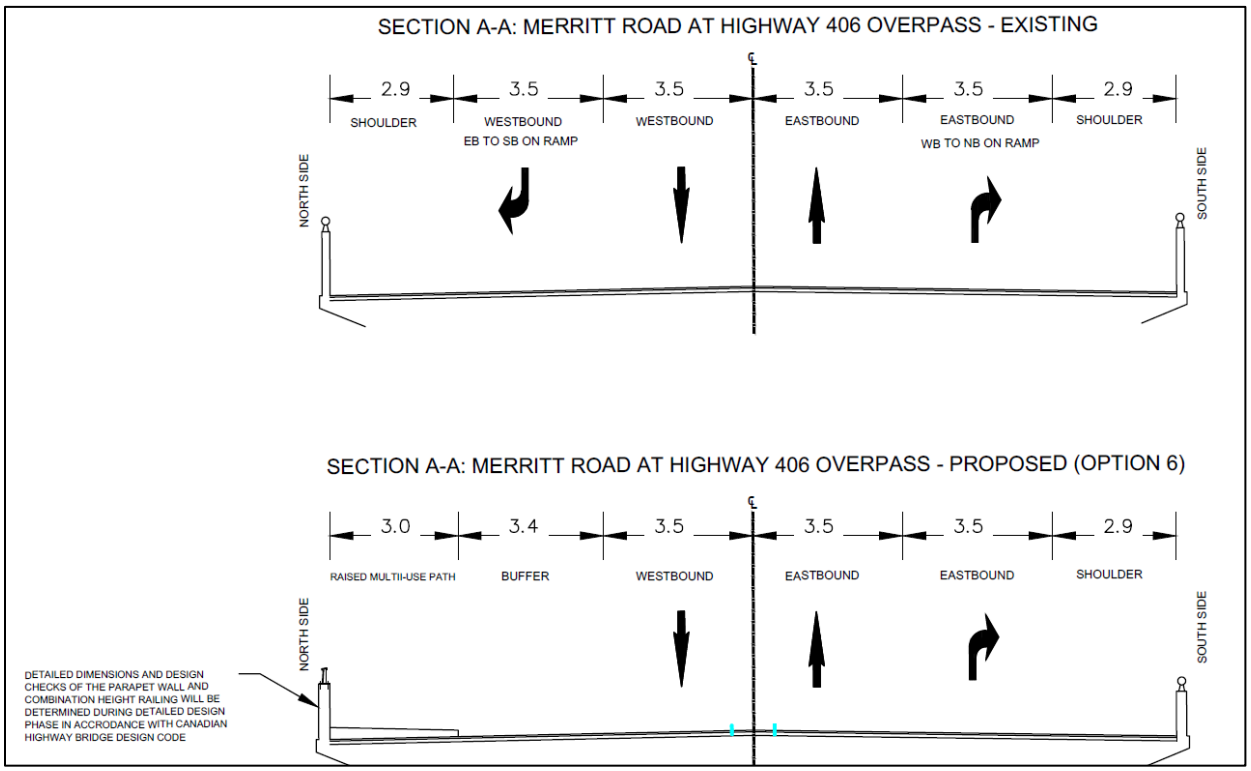
24. Legal Agreements and Approvals

An MTO Encroachment Permit will be obtained by the Niagara Region, prior to implementing the proposed changes.

25. Miscellaneous

N/A

Typical Road Sections



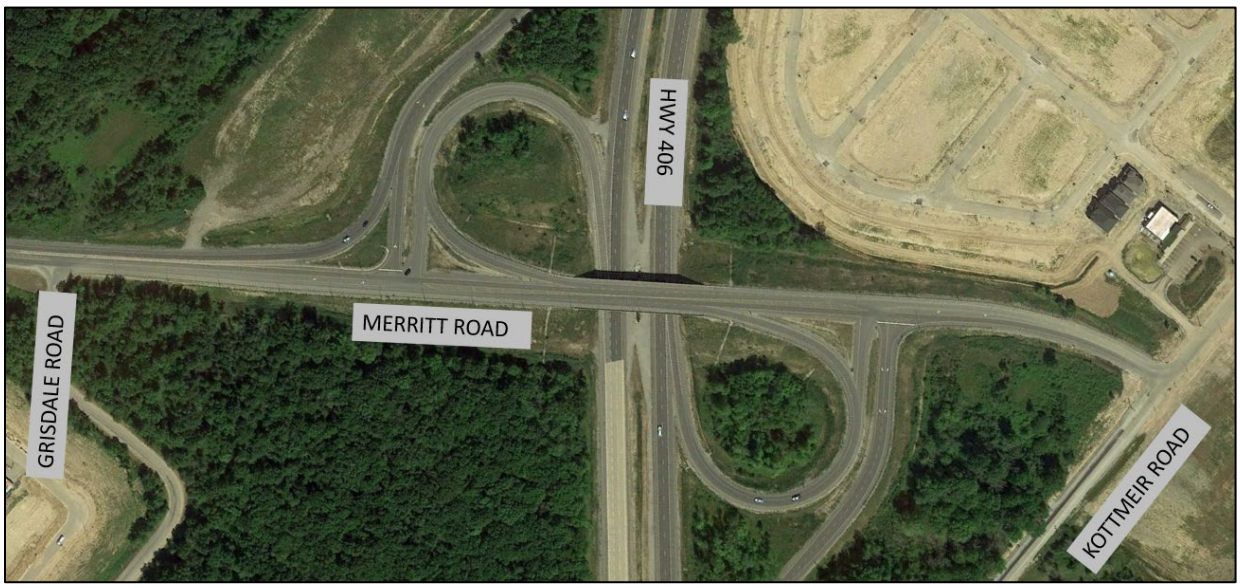
Typical Structure Sections

N/A

Interchange Sketch

N/A

Location Map



ATTACHMENT

H MTO EXECUTIVE REVIEW MEETING (MARCH 21, 2023)

MEETING NOTES

JOB TITLE	Merritt Road-Rice Road – Schedule 'C' Municipal Class Environmental Assessment		
PROJECT NUMBER	IM20103036	**DATE**	21 March 2023
TIME	1:00 PM	**VENUE**	MS Teams
SUBJECT	Ministry of Transportation Executive Review Meeting		
CLIENT	Regional Municipality of Niagara		

ATTENDEES			
Name	**Company**	**Phone**	**Email**
Maged Elmadhoon	Niagara Region		maged.elmadhoon@niagararegion.ca
Scott Fraser	Niagara Region		scott.fraser@niagararegion.ca
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Felix Wong	WSP E&I Canada Limited		felix.wong@wsp.com
Kari Fellows	WSP E&I Canada Limited		kari.fellows@wsp.com
Mir Ahsan Talpur	WSP E&I Canada Limited		mir.talpur@wsp.com
Kashif Hussain	Ministry of Transportation		kashif.hussain@ontario.ca

ADDITIONAL DISTRIBUTION			
Name	**Company**	**Phone**	**Email**
Other MTO Attendees	MTO		

MATTERS ARISING	**ACTION**
1.0 PURPOSE OF THE MEETING	
1.1 The purpose of the meeting was to seek Ministry of Transportation's approval of the preferred design for Merritt Road at Grisdale Road and Highway 406 interchange developed as part of Niagara Region's Municipal Class Environmental Assessment for Merritt Road and Rice Road in the Town of Pelham, the City of Thorold and the City of Welland. The Study Team presented the following information to MTO staff.	
2.0 PREFERRED DESIGN FOR MERRITT ROAD AT GRISDALE ROAD AND HIGHWAY 406	
The study team provided a Presentation, documenting the project background and the preferred design of Merritt Road at Highway 406. A copy of the presentation is attached. The Study Team noted that the preferred design for Merritt Road at Grisdale Road and Highway 406 interchange was identified in consultation with MTO staff, and comments received from MTO were addressed. The Study Team highlighted the following key features of the preferred design:	

2.1	The existing Merritt Road / Grisdale Road intersection is proposed to be converted into a left-in / right-in / right-out only access intersection. Two eastbound lanes and one left turn lane for Highway 406 southbound traffic are being proposed. In addition, there is a traffic signal being proposed at the west ramp intersection. The 2041 forecast for the west ramp intersection of Highway 406 and Merritt Road indicates that a traffic signal is warranted based on Minimum Vehicular Volume with proposed lane configuration.	
2.2	The two-way cycle-track along Merritt Road is proposed to transition to a multi-use path to the east of Grisdale Road. The multi-use path is proposed to cross to the north side of the interchange at the traffic signal to provide a safe pedestrian crossing, and continue as active transportation facility up to Kottmeier Road.	
2.3	Due to low traffic volumes, and to accommodate the multi-use path on the bridge, the existing westbound right turn channel is proposed to be removed, and a short westbound right turn lane will be provided at the intersection.	
2.4	Due to constraint of the existing bridge, the proposed westbound right turn lane length is 95m (40m parallel with 55m taper), which is substandard to the MTO design standard in accordance with TAC Supplement Exhibit 9-J (60m parallel and 70m taper).	
3.0	**QUESTIONS / ANSWERS**	
Following the presentation, the Study Team invited MTO staff to ask any questions or share any comments. MTO staff did not raise any significant questions or comments about the recommended design. The following summarizes questions from MTO staff and Study Team's responses:		
3.1	MTO staff noted that the concrete median barriers between active transportation facilities and vehicular traffic lanes often pose challenges from maintenance point of view for MTO as well as the local municipalities. MTO staff questioned how was the requirement identified for the concrete median barrier? — The Study Team noted the multi-use path across Highway 406 interchange was identified in accordance with *MTO Bikeways Design Manual (March 2014)*. — MTO staff noted that the concrete barrier may not be required based on MTO standard. It was suggested that the Study Team review *Ontario Traffic Manual - Book 18 - Cycling Facilities (June 2021)* and *MTO Bikeways Design Manual (March 2014)* to confirm whether a concrete barrier or a separation buffer would be appropriate between the multi-use path and the vehicular traffic lanes (**Action Item**). — The Study Team noted that the multi-use path will be considered as an on-road two way cycling facility as there is no curb or grade difference to the path.	WSP
3.2	MTO staff inquired how will the multiuse path be transitioned to Kottmeier Road? — The Study Team responded that initially the cycling path was proposed until Grisdale Road along Merritt Road, where the cyclists would have been directed to use Grisdale Road. Based on MTO staff's feedback, the Study Team identified a safe active transportation facility across Highway 406 interchange that would end at Kottmeier Road. Any future active transportation facility along Kottmeier Road may be identified via a separate assignment in future.	
3.3	MTO staff sought clarification on whether any design changes were proposed east of Highway 406 northbound off ramp. — Study Team clarified that no design changes were proposed east of Highway 406 northbound off ramp. Study Team will update the design to remove any excessive linework to avoid confusion (**Action Item**).	WSP

These minutes are considered to be accurate recording of all items discussed. Written notice of discrepancies, errors or omission must be given within seven (7) days, otherwise the minutes will be accepted as written.

Ministry of Transportation Executive Review Meeting

Municipal Class Environmental Assessment Study for Merritt Road and Rice Road in Pelham, Thorold and Welland

March 21, 2023

MOVING ROADS FORWARD

CONNECTING MORE PEOPLE TO MORE POSSIBILITIES

Niagara Region

Agenda

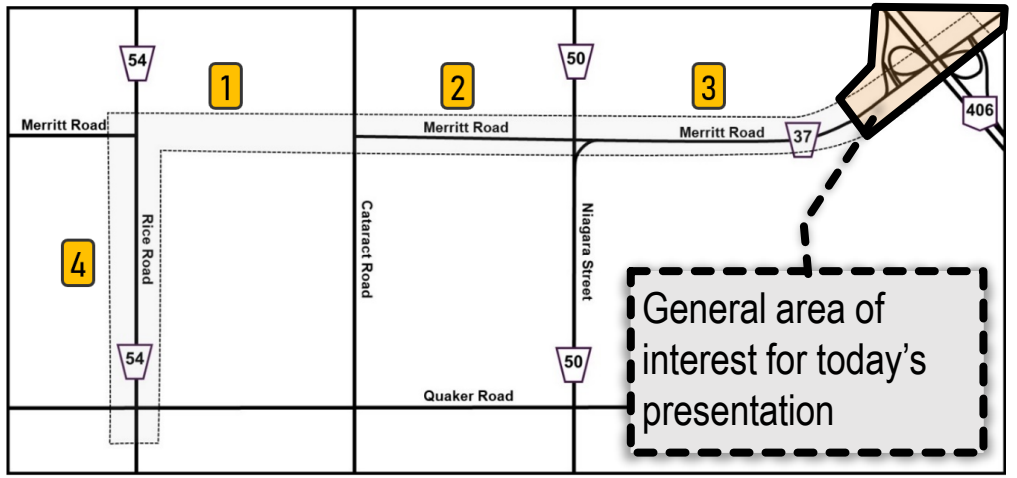
Meeting Objective: Seek Ministry of Transportation's approval of the recommended design for Merritt Rd at Grisdale Rd and Hwy 406 developed as part of Niagara Region's Merritt Rd - Rice Rd Municipal Class EA

Presentation Outline:

- Merritt Rd and Rice Rd Municipal Class EA – Overview and Existing Conditions
- Merritt Rd at Grisdale Rd and Hwy 406 – Existing Conditions
- Preferred Design for Merritt Rd (Segment 3) West of Hwy 406
- Preferred Design for Merritt Rd at Grisdale Rd and Hwy 406
- Consideration of MTO Staff Feedback into the Identification of Preferred Design
- Next Steps

Merritt Rd and Rice Rd Municipal Class EA – Overview and Existing Conditions

- Building upon the recommendations of the Niagara Region Transportation Master Plan (2017).
- Capacity improvements and active transportation facilities are required to accommodate future growth a result of proposed developments in the Town of Pelham, the City of Thorold and the City of Welland.



Segment 1: Merritt Rd (Rice Rd - Cataract Rd)
- Unopened road allowance
- Located within the Town of Pelham and City of Thorold.

Segment 2: Merritt Rd (Cataract Rd - Merrittville Hwy / Niagara St)
- Minor arterial roadway
- Posted Speed Limit: 50km/h
- Located within City of Thorold

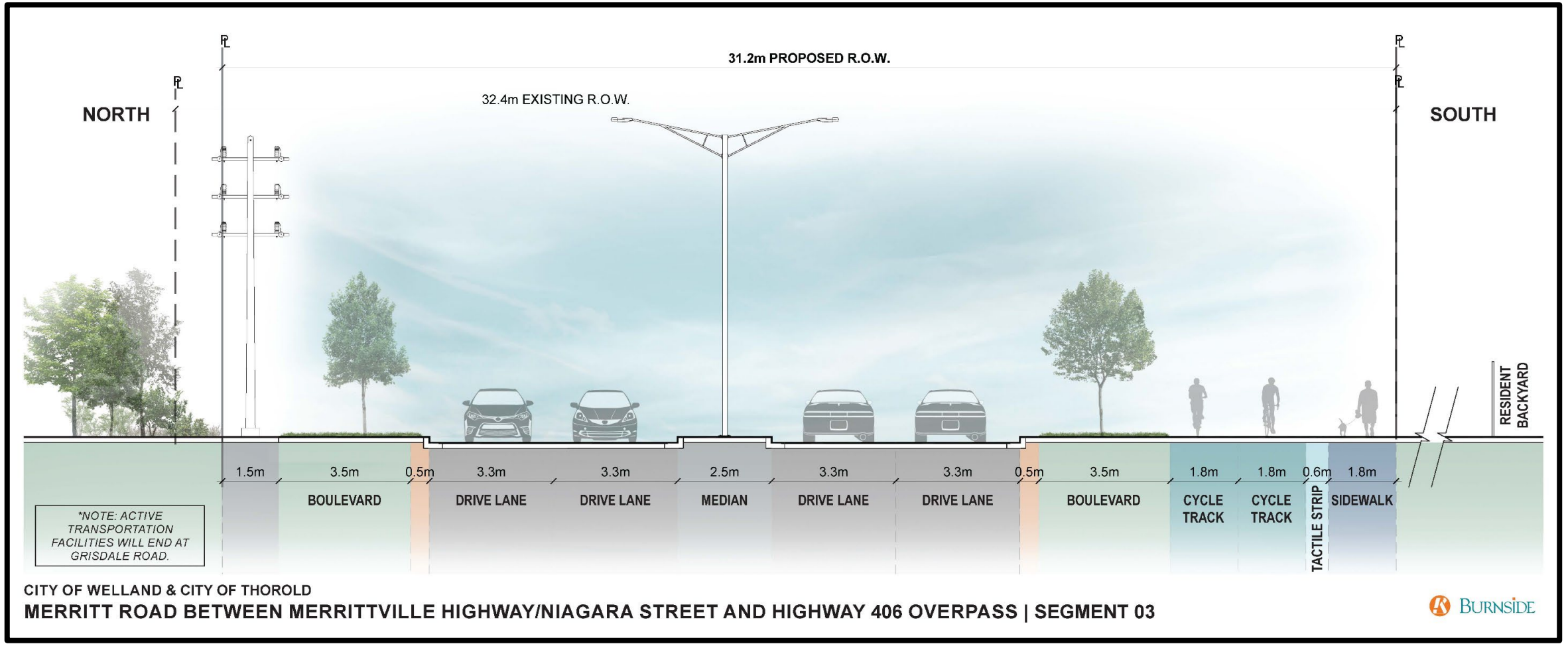
Segment 3: Merritt Rd (Merrittville Hwy / Niagara St - Hwy 406)
- Minor arterial roadway
- Posted Speed Limit: 60km/h
- Located within the City of Thorold

Segment 4: Rice Road (200 m north of Merritt Rd - Quaker Rd)
- Minor arterial roadway
- Posted Speed Limit: 50km/h
- Located in the Town of Pelham and the City of Welland

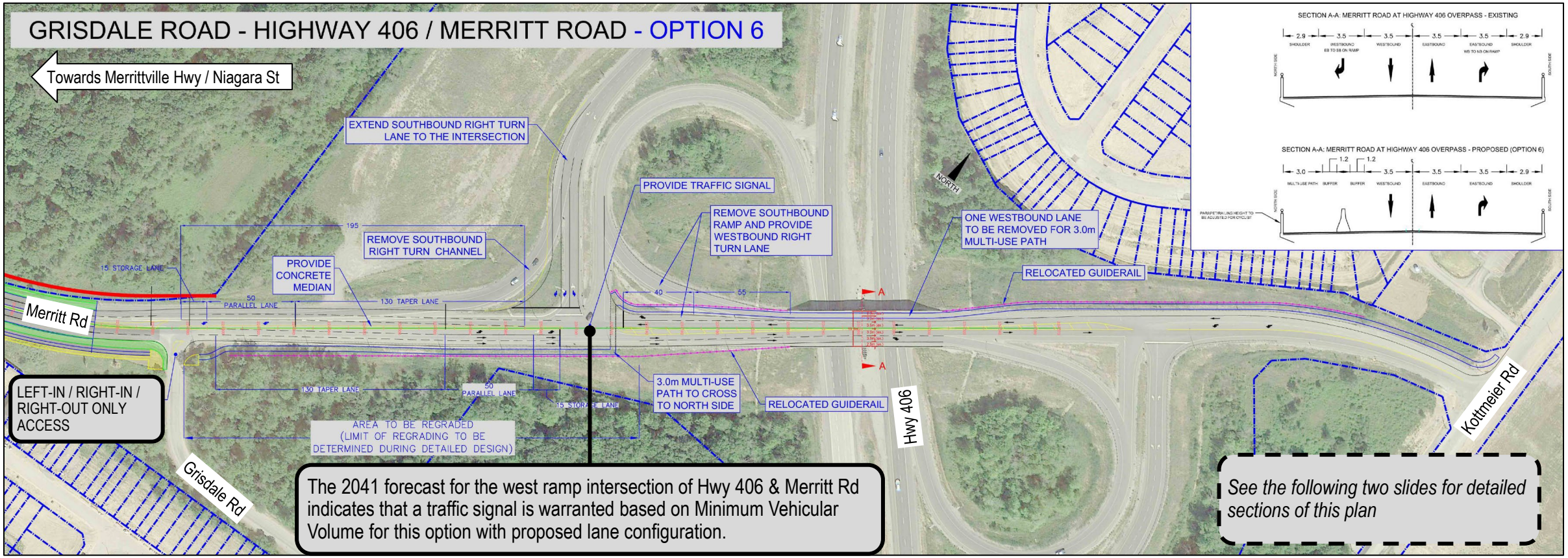
Merritt Rd at Grisdale Rd and Hwy 406 – Existing Conditions

Preferred Design for Merritt Rd (Segment 3) West of Hwy 406

- Four 3.3 m drive lanes separated by a 2.5 m median
- 1.8 m sidewalk on the south side
- A 3.6 m separated two-way cycle track on the south side



Preferred Design for Merritt Rd at Grisdale Rd and Hwy 406

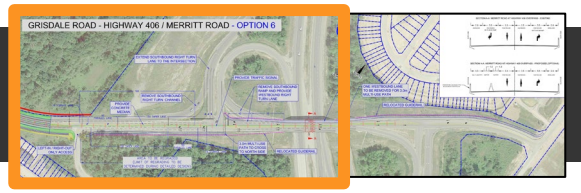


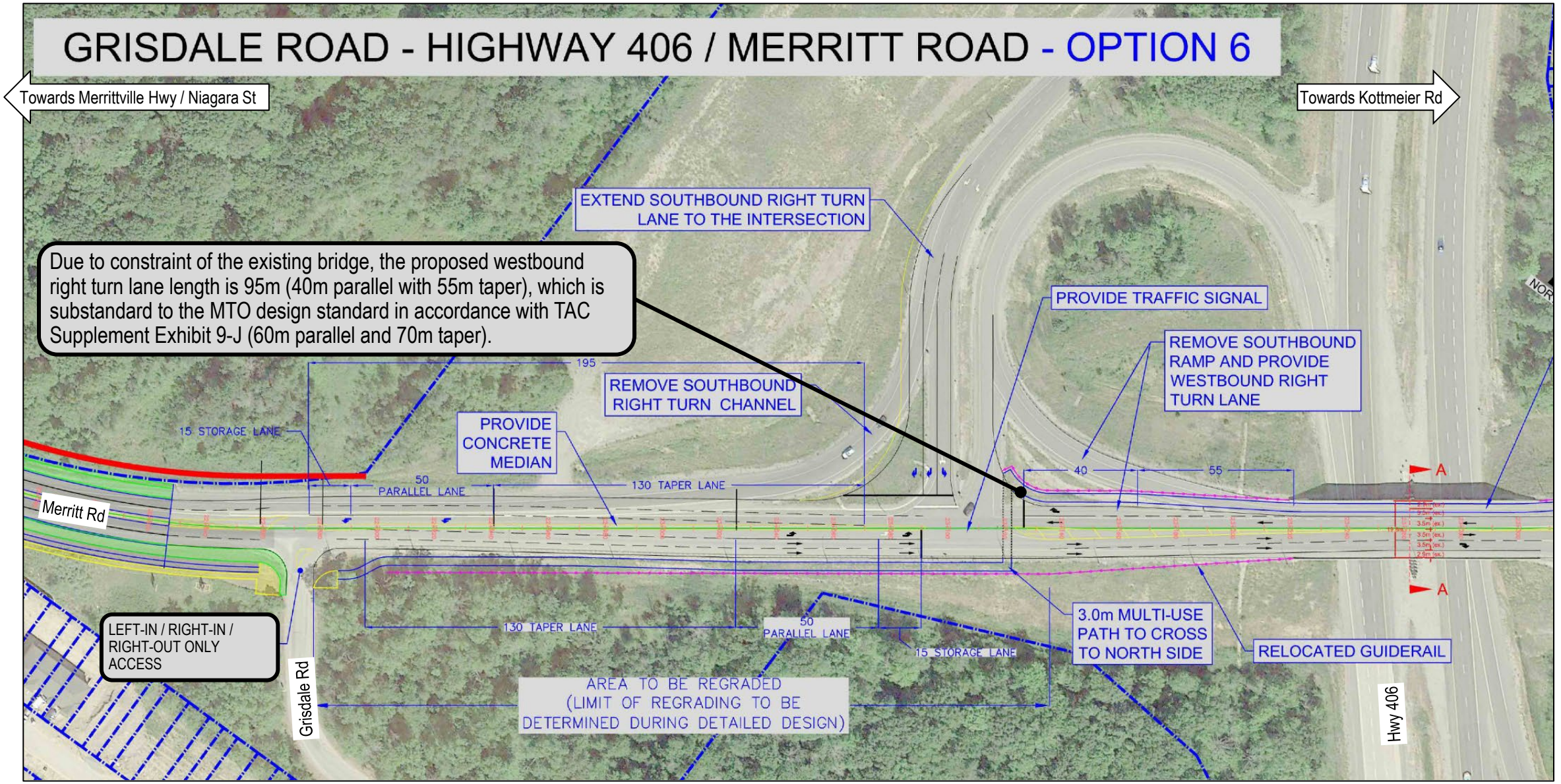
MOVING ROADS FORWARD

CONNECTING MORE PEOPLE TO MORE POSSIBILITIES

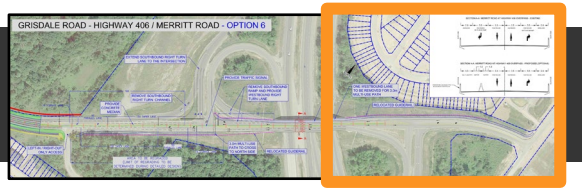
Niagara Region

Preferred Design for Merritt Rd at Grisdale Rd and Hwy 406





Preferred Design for Merritt Rd at Grisdale Rd and Hwy 406



Towards Grisdale Rd

NORTH

ONE WESTBOUND LANE
TO BE REMOVED FOR 3.0m
MULTI-USE PATH

RELOCATED GUIDERAIL

Hwy 406

Kottmeier Rd

SECTION A-A: MERRITT ROAD AT HIGHWAY 406 OVERPASS - EXISTING

2.9 SHOULDER | 3.5 WESTBOUND (EB TO SB ON RAMP) | 3.5 WESTBOUND | 3.5 EASTBOUND | 3.5 EASTBOUND (WB TO NB ON RAMP) | 2.9 SHOULDER

NORTH SIDE / SOUTH SIDE

SECTION A-A: MERRITT ROAD AT HIGHWAY 406 OVERPASS - PROPOSED (OPTION 6)

3.0 MULTI-USE PATH | 1.2 BUFFER | 1.2 BUFFER | 3.5 WESTBOUND | 3.5 EASTBOUND | 3.5 EASTBOUND | 2.9 SHOULDER

PARAPET/RAILING HEIGHT TO BE ADJUSTED FOR CYCLIST

NORTH SIDE / SOUTH SIDE

Consideration of MTO Staff Feedback into the Identification of Preferred Design

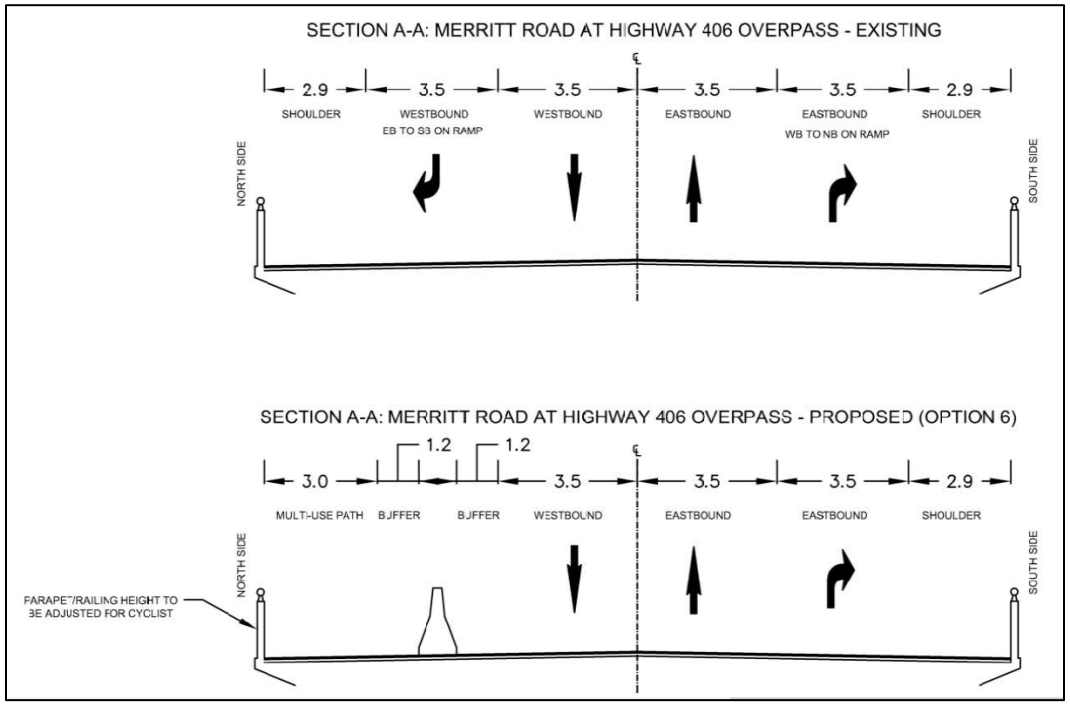
A total of six (6) design options were identified. The design presented herein was identified as preferred in consultation with MTO staff in terms of traffic safety, constructability and cost effectiveness.

The preferred design will provide a continuous active transportation connection (MUP) between Grisdale Rd and Kottmeier Rd.

The preferred design will provide safer pedestrian crossing at the proposed signalized intersection.

Due to low traffic volumes, the existing westbound right turn channel will be removed, and a short westbound right turn lane will be provided at the intersection.

A roundabout option was also identified, but it was not considered as feasible option due to significant property impacts and higher cost of construction.



Design Criteria: Standards Table: Merritt Rd at Hwy 406

DESIGN CRITERIA

Group Work Project No. GWP xxxx-xx-xx Highway No. 406 Page 2 of 9
Work Project No(s). WP xxxx-xx-xx Date: Mar 9, 2023
WP xxxx-xx-xx

Standards Table: Merritt Road at Highway 406

Design Year: 2031		Superelevation Maximum Rate for Determining the Radius: 6%		
	Present Conditions	Design Standards	Reference (Design Standards)	Proposed Standards
Functional Highway Classification	RAU80	UAU80	MTO design supplement 2020 (Exhibit 2-G)	UAU80
Minimum Stopping Sight Distance (m)	>105	105	TAC 2017 (2.5.3: Table 2.5.2)	>105
Crest: Minimum "K" factor for Stopping Sight Distance	TBD[1]	N/A	TAC 2017 (3.3.3.3: Table 3.3.2)	TBD[1]
Sag: Minimum "K" factor for Stopping Sight Distance	TBD[1]	N/A	TAC 2017 (3.3.3.4: Table 3.3.4)	TBD[1]
Grades Maximum (%)	TBD[1]	N/A	TAC 2017 (3.3.2.4: Table 3.3.1)	TBD[1]
Radius Minimum (m)	Tangent	290	TAC 2017 (Table 3.2.8)	Tangent
Lane Widths (m)	4 x 3.50 m	3.0 m – 3.70 m	TAC 2017 (4.2.2)	3 x 3.50 m
Shoulder Width (Left / Right) (m)	2.9 / 2.9	N/A	TAC 2017 (4.4.2)	1.2 / 2.9
Multi-Use Path (m)	N/A	3.0 m – 6.00 m	TAC 2017 (5.3.1.4: Table 5.3.5)	3.0 m
Shoulder Rounding (m)	N/A	N/A	N/A	N/A
Median Width (m)	1.00 - 3.7 (Flushed)	1.50 – 2.0 (Concrete) 1.00 – 4.00 (Flushed)	TAC 2017 (4.5.3)	1.50 - 2.0 (Concrete) 1.00 – 4.00 (Flushed)
R.O.W. Width - nominal (m)	19.8			19.8
Posted Speed - prevailing (km/h)	60 km/h	60 km/h		60 km/h
Miscellaneous	N/A	N/A	N/A	N/A

Notes:

1. Vertical profile to match existing and will be determined during detailed design.

Design Criteria: Interchange Standards Table: Highway 406 N – Merritt Road E/W Ramp

DESIGN CRITERIA

Group Work Project No. GWP xxxx-xx-xx Highway No. 406 Page 3 of 9
Work Project No(s). WP xxxx-xx-xx Date: Mar 9, 2023
WP xxxx-xx-xx

Interchange Standards Table: Interchange Name: Highway 406 N - Merritt Road E/W Ramp

	Ramp Name	Present Conditions	Design Standards	Reference (Design Standards)	Proposed Standards
Crossing Road Design Speed (km/h)	X	80 km/h	80 km/h	MTO design supplement 2020 (10.6.2.1)	80 km/h
Ramp Design Speed (km/h)		80 km/h	80 km/h	MTO design supplement 2020 (10.6.2.1: Exhibit 10-D)	80 km/h
Sight Distance Requirement for Stopping, Crossing and Turning Movements at the Crossing Road (m)		See Note 1	130	TAC 2017 (2.5.3: Table 2.5.2)	See Note 1
Crest: Minimum "K" factor for Stopping Sight Distance		See Note 1	26	TAC 2017 (3.3.3.3: Table 3.3.2)	See Note 1
Sag: Minimum "K" factor for Stopping Sight Distance		See Note 1	30	TAC 2017 (3.3.3.4: Table 3.3.4)	See Note 1
Grades Maximum (%)		See Note 1	6%	TAC 2017 (3.3.2.4: Table 3.3.1)	See Note 1
Radius Minimum (m)		250 m	130 m	MTO design supplement 2020 (10.6.2.1: Exhibit 10-D	250 m
Superelevation Maximum Rate (%)		0.06 m/m	0.06 m/m	MTO design supplement 2020 (10.6.2.1: Exhibit 10-D)	0.06 m/m
Lane Widths (m)		2 x 4.8 m	4.8 m	TAC 2017 (10.6.2.5)	3 x 4.8 m [2]
Shoulder Width (Left / Right) (m)		1.0 m left 3.0 m right	1.0 m Left 2.5 m Right	MTO design supplement 2020 (Section 4.4.2)	1.0 m Left 3.0 m Right
Shoulder Rounding (m)		0.5 m (min)	0.5 m	TAC 2017 (4.4.5)	0.5 m
Sight Distance at Exit Terminal (m)		See Note 3	-	-	See Note 3
Exit Terminal Speed-Change Lane Length (m)		See Note 3	-	-	See Note 3
Sight Distance at Entrance Terminal (m)		See Note 3	-	-	See Note 3
Entrance Terminal Speed-Change Lane Length (m)		See Note 3	-	-	See Note 3

Notes:

1. Proposed work is limited to intersection tie-in. Existing ramp profile to be maintained.
2. Existing two lanes (left/ right turn lanes) will be converted to 2 right and 1 left turning lanes approaching intersection at Merritt Road.
3. Existing entrance and exit terminal and speed-change lanes to be maintained.

Design Criteria: Hwy 406 (Beaverdams Rd to Robinson Rad)

DESIGN CRITERIA

Group Work Project No. GWP xxxx-xx-xx Highway No. 406 Page 4 of 9
Work Project No(s). WP xxxx-xx-xx Date: Mar 9, 2023
WP xxxx-xx-xx

Standards Table: Highway 406 (Beaverdams Road to Robinson Road)

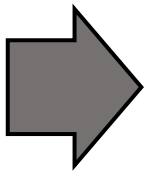
Design Year: 20232031		Superelevation Maximum Rate for Determining the Radius: Not Available		
	Present Conditions	Design Standards	Reference (Design Standards)	Proposed Standards [1]
Functional Highway Classification	RFD120	RFD120	RFD120	RFD120
Minimum Stopping Sight Distance (m)	245 m	250	TAC 2017 (2.5.3: Table 2.5.2)	245 m
Crest: Minimum "K" factor for Stopping Sight Distance	120 m	95	TAC 2017 (3.3.3.3: Table 3.3.2)	120 m
Sag: Minimum "K" factor for Stopping Sight Distance	60 m	63	TAC 2017 (3.3.3.4: Table 3.3.4)	60 m
Grades Maximum (%)	3%	5%	TAC 2017 (3.3.2.4: Table 3.3.1)	3%
Radius Minimum (m)	1800 m	750	TAC 2017 (Table 3.2.6)	1800 m
Lane Widths (m)	2 X 3.75 m	3.75	MTO design supplement 2020 (Exhibit 4-A)	2 X 3.75 m
Shoulder Width (Left / Right) (m)	Right – 3.0 m Left – 1.5 m	3.0	MTO design supplement 2020 (Exhibit 4-J)	Right – 3.0 m Left – 1.5 m
Shoulder Rounding (m)	1.5 m	1.0	MTO RDM 2.3.3	1.5 m
Median Width (m)	22 m	N/A	N/A	22 m
R.O.W. Width - nominal (m)	N/A	N/A	N/A	N/A
Posted Speed - prevailing (km/h)	100 km/h	100 km/h	N/A	100 km/h
Miscellaneous	N/A	N/A	N/A	N/A

Notes:

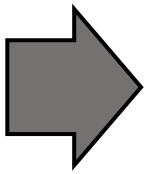
1. The existing conditions for Highway 406 will be maintained. No changes are proposed to Highway 406 mainline. Existing information listed in this table was provided to the Niagara Region by the Ministry of Transportation.

Next Steps

Complete Environmental Study Report and initiate 30-day public review in Spring / Summer 2023



Initiate Detailed Design process (*timing to be determined*



Continue to consult with MTO during detailed design process