

**418-430 Aqueduct Street and 650-678
Niagara Street
Transportation Study Update
Welland, ON**

The Development Squad GP Inc.



BURNSIDE

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Transportation Study Update
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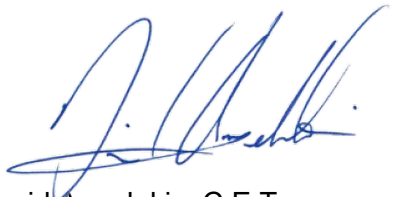
**April 2025
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Executive Summary

R.J. Burnside & Associates Limited (Burnside) was retained by The Development Squad GP Inc. (Client) to provide a Transportation Study for a proposed mixed-use development at 418-430 Aqueduct Street and 650-678 Niagara Street in the City of Welland. Three high-rise residential buildings with ground floor retail are proposed with 853 apartments, 26 townhomes and 1,121 m² of retail uses.

This report provides an update to the *670 Niagara Street Transportation Study* (the TIS), dated November 2023. Comments were received from the City of Welland (the City) via email on April 15, 2024, and from Niagara Region's (the Region) Growth Strategy and Economic Development Department on March 18, 2024. These comments were addressed in the *418–430 Aqueduct Street & 650–678 Niagara Street Response to Transportation Comments*, dated September 12, 2024.

Following a meeting with residents on January 21, 2025, the Region issued a letter containing additional transportation comments, dated January 27, 2025. In addition, since the submission of the TIS, the number of apartments was reduced by 317 units, and an updated analysis was completed to reflect these changes.

The following is a summary of our key findings.

Traffic Operations

Under existing conditions, all intersections operate within the Region's threshold capacity and a LOS D or better, except for a few movements at the Niagara Street / Woodlawn Road and Niagara Street / Thorold Road intersections.

Under future conditions, all intersections will operate within the Region's threshold capacity and a LOS of D or better, except for some movements at the Niagara Street / Woodlawn Road and Niagara Street / Thorold Road intersections.

All queues are and will be contained within their respective link distances and storage lengths, except for the westbound left turn movement, already under existing conditions, and southbound through / right movement, by background 2035 conditions, at the Niagara Street / Woodlawn Road intersection during the PM peak hour.

These conditions are primarily driven by background growth.

It is recommended that the Region continue to monitor these intersections for potential future improvements.

Signal Warrant Analysis

Traffic signal warrant analyses were conducted for the intersections of Niagara Street / Aqueduct Street (to confirm if the existing signal is still warranted) and at Niagara Street / Abbey Road / South Site Driveway. The analysis indicates that signals are not warranted at either intersection. Signalization of the south driveway will not result in a noticeable improvement to the north driveway's operations.

Transportation Demand Management

To further facilitate other modes of travel and reduce vehicle trips and parking demand, the following are proposed TDM measures:

- Parking spaces will not be bundled with apartments.
- Internal sidewalks will be provided with connections to the existing sidewalk network on Niagara Street.
- Internal secured bicycle storage will be provided within buildings and / or garages for residents.
- Strategically placed outdoor bicycle racks will be provided at ground level near the entrances for visitors.
- Bicycle repair stations located adjacent to bicycle storage rooms will be provided for residents' use.
- An information package on available transit/walking/cycling facilities will be provided to residents.
- Transit service real-time displays will be located in the lobbies of all buildings depending on the availability of data from local transit agencies.
- Residents will be provided with a \$25 transit subsidy.

Parking & Loading Review

According to the City's Zoning By-law 2017-117 (ZBL), there will be a surplus of 51 parking spaces. According to the ZBL, the development will require 8 barrier free spaces and 11 are proposed, which will exceed the ZBL requirements. The development proposes 393 bicycle spaces for residents and two spaces for retail use, which will meet, or exceed, the ZBL requirements. A minimum of three loading spaces are required by the ZBL and three spaces are proposed.

Site Plan Layout

The site plan is well designed to accommodate all expected users and design vehicles.

Sightline Analysis

The available sightlines at the proposed south site driveway exceeds the required stopping sight distance and intersections sight distances of the TAC Guide.

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Abbreviations

The following are abbreviations utilized within this report:

- Burnside – R.J. Burnside & Associates Limited
- City – City of Welland
- Region – Niagara Region
- Directions
 - EB – Eastbound
 - SB – Southbound
 - NB – Northbound
 - WB – Westbound
- Traffic Movements
 - LT – shared left-through movement
 - LTR – shared left-through-right movement
 - LR – shared left-right movement
 - TR – shared through-right movement
- ITE – Institute of Transportation Engineers
- LOS – Level of service
- PHF – Peak hour factor
- TDM – Transportation demand management
- v/c – Volume to capacity ratio

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1.0 Introduction

1.1 Background

R.J. Burnside & Associates Limited (Burnside) was retained by The Development Squad GP Inc. (Client) to provide a Transportation Study for a proposed mixed-use development at 418-430 Aqueduct Street and 650-678 Niagara Street in the City of Welland. Three high-rise residential buildings are proposed with 853 apartments, 26 townhomes and 1,121 m² of ground floor retail. Access to the site is proposed via two full-movement driveways on Niagara Street. Parking will be provided via surface parking lots and underground garages. The site location is illustrated in Figure 1.

Figure 1: Site Location



This report is part of Site Plan, Official Plan Amendment and Zoning By-law Amendment applications and provides an update to the *670 Niagara Street Transportation Study* (the TIS), dated November 2023. Comments were received from the City of Welland

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(the City) via email on April 15, 2024, and from Niagara Region's (the Region) Growth Strategy and Economic Development Department on March 18, 2024. These comments were addressed in the *418–430 Aqueduct Street & 650–678 Niagara Street Response to Transportation Comments*, dated September 12, 2024.

Following a meeting with residents on January 21, 2025, the Region issued a letter containing additional transportation comments, dated January 27, 2025. Based on these additional comments, an updated TIS was requested. Responses to the Region's most recent comments are provided in Appendix A. Since the submission of the TIS, the number of apartments were reduced by 317 units, and an updated analysis was completed to reflect these changes.

1.2 Scope of Work

The following scope of work was confirmed with the Region and the City prior to conducting this study.

Analysis Scenarios	- Existing traffic conditions 2030 background traffic conditions 2035 background traffic conditions 2030 total traffic conditions (2030 background traffic plus site traffic) 2035 total traffic conditions (2035 background traffic plus site traffic)
Analysis Time Periods	- Weekday AM Peak Period (7:00 a.m. – 9:00 a.m.) - Weekday PM Peak Period (4:00 p.m. – 6:00 p.m.)
Analysis Intersections (Study Area)	- Niagara Street / Woodlawn Road - Niagara Street / North Driveway - Niagara Street / Abbey Road / South Driveway - Niagara Street / Aqueduct Street - Niagara Street / Roger Drive - Niagara Street / Thorold Road
Signal Warrant Analysis	- Niagara Street / Aqueduct Street - Niagara Street / Abbey Road
Transportation Demand Management (TDM) Plan	Provide recommendations on feasible TDM strategies to discourage single occupant motor vehicle use.
Parking / Loading Review	Review of vehicular, accessible and bicycle parking supply and loading / refuse requirements.

1.3 Intersection Analysis Methodology

Signalized and unsignalized intersection operations were assessed for intersections in the study area using the software program Synchro 12, which employs methodology from the *Highway Capacity Manual (HCM 2000, HCM 2010 and HCM 6)*, published by the Transportation Research Board National Research Council.

Synchro 12 can analyze both signalized and unsignalized intersections in a road corridor or network taking into account the spacing, interaction, queues and operations between intersections. The analysis utilizes the HCM 2000 methodology.

Signalized intersection analysis considers two separate measures of performance:

- The capacity of all intersection movements, which is based on a volume to capacity ratio that is a measure of the degree of capacity utilized.
- The level of service (LOS) for all intersection movements, which is based on the average control delay per vehicle for the various movements through the intersection and overall. Delay is an indicator of how long a vehicle must wait to complete a movement and is represented by a letter between A and F, with F being the longest delay. The link between LOS and delay (in seconds) for signalized intersections is summarized below.

Level of Service	Control Delay per Vehicle(s)
A	≤10
B	> 10 – 20
C	> 20 – 35
D	> 35 – 55
E	> 55 – 80
F	> 80

Stop controlled intersection analysis considers two separate measures of performance:

- The capacity of the intersection's critical movements, which is based on a volume to capacity ratio.
- The level of service for the critical movements, which is based on the average control delay per vehicle for the various critical movements within the intersection. The link between LOS and delay (in seconds) for stop-controlled intersections is summarized below.

Level of Service	Control Delay per Vehicle(s)
A	0 – 10
B	> 10 – 15
C	> 15 – 25
D	> 25 – 35
E	> 35 – 50
F	> 50

2.0 Existing Conditions

2.1 Site Context

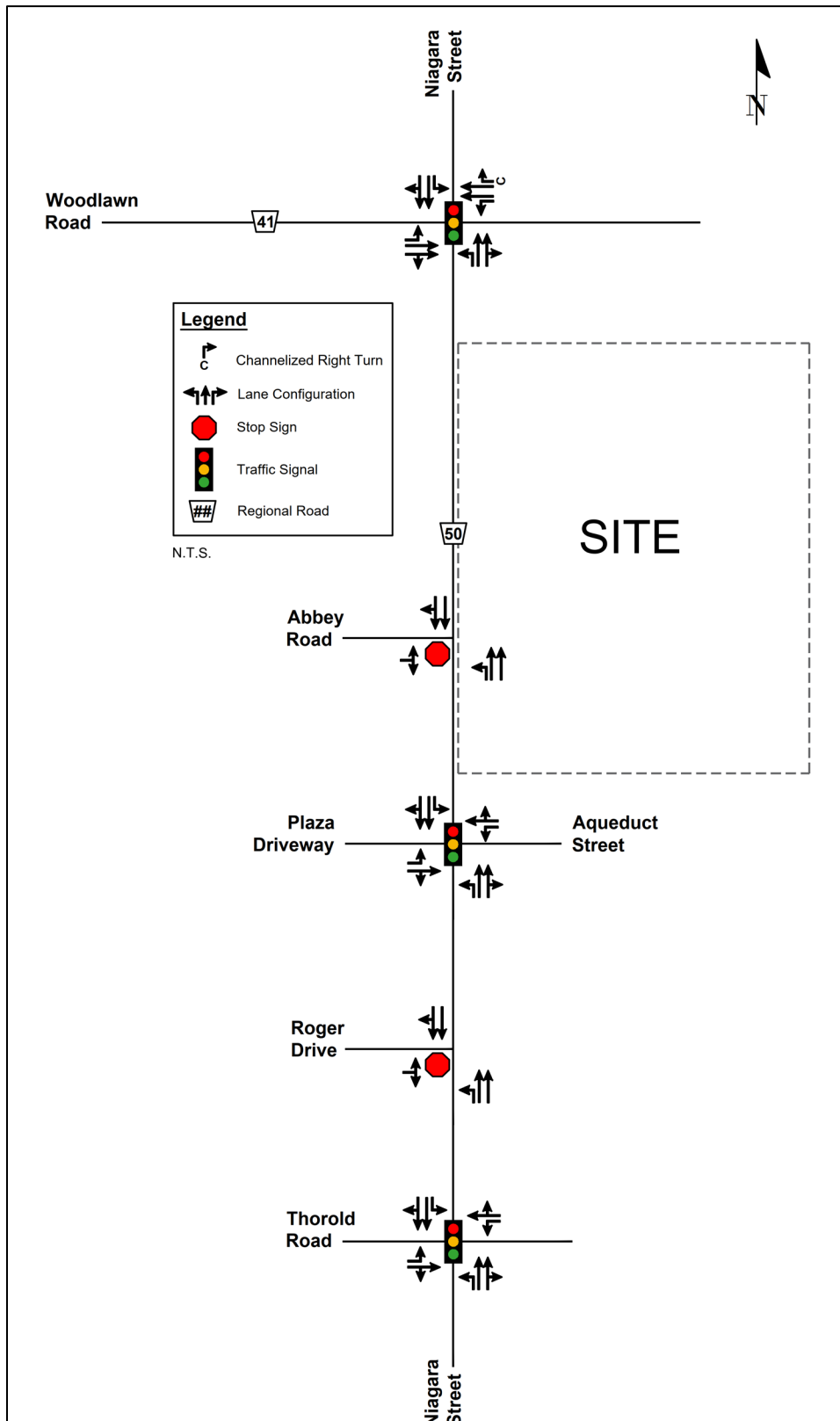
The site is located on the east side of Niagara Street, north of Aqueduct Street, and is currently occupied by eight detached homes. The site is bounded by residential uses to the north, east and south, and Niagara Street to the west.

2.2 Existing Road Network

The existing road network is described below and illustrated in Figure 2 with existing traffic control.

Niagara Street (Regional Road 50)	Niagara Street is a north-south arterial road under the jurisdiction of the Region with a posted speed limit of 50 km/h. The roadway consists of a 5-lane urban cross section with sidewalks on both sides and parking prohibited on both sides of the road.
Woodlawn Road (Regional Road 41)	Woodlawn Road is an east-west arterial road under the jurisdiction of the Region with a posted speed limit of 50 km/h. The roadway consists of a 4-lane urban cross section. Sidewalks are provided on both sides of the road to the west of Niagara Street and on the north side of the road to the east of Niagara Street. On-street parking is prohibited on both sides of the road.
Aqueduct Street	Aqueduct Street is a north-south local street under the jurisdiction of the City with a posted speed limit of 40 km/h. The roadway consists of a 2-lane urban cross section with sidewalks provided on both sides of the road. There is a heavy vehicle prohibition and parking is prohibited on the east side of the road.
Abbey Road	Abbey Road is an east-west local road under the jurisdiction of the City with an assumed unposted speed limit of 50 km/h. The roadway consists of a 2-lane rural cross section with no sidewalks and parking is prohibited on the north side of the road.

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Figure 2: Existing Road Network

Thorold Road

Thorold Road is under the jurisdiction of the City, has an assumed unposted speed limit of 50 km/h and is an east-west arterial road to the west of Niagara Street and a collector road to the east of Niagara Street. The roadway has a 3-lane urban cross section to the west of Niagara Street and a 2-lane urban cross section to the east of Niagara Street. Sidewalks are provided on both sides of the road. Bike lanes are provided on both sides of the road west of Niagara Street.

Roger Drive

Roger Drive is an east-west local road under the jurisdiction of the City with an assumed unposted speed limit of 50 km/h. The roadway consists of a 2-lane urban cross section with sidewalks provided on the south side of the road. Parking is prohibited on both sides of the road.

2.3 Existing Transit Service

Niagara Region Transit (NRT) provides weekday and weekend service along Niagara Street via Route 509. Bus stops are located on both sides of Niagara Road, with bus stops at Abbey Road, Aqueduct Street and Roger Drive. Route 509 currently operates with a 30-minute headway Monday to Friday from 6:00 a.m. to 10:29 p.m., a 60-minute headway on Saturday from 6:00 a.m. to 9:26 p.m. and a 60-minute headway on Sunday from 10:00 a.m. to 5:26 p.m. Route 509 provides connections to the Seaway Mall, Niagara College and Welland Bus Terminal. The bus route is illustrated in Figure 3.

In addition to local routes, NRT also provides regional routes that travel between cities within Niagara Region. Details about each of the routes that service Welland are summarized in Table 1 and the regional routes are illustrated in Figure 4.

Table 1: NRT Regional Routes to / from Welland

Route	Headway	Hours of Operation
25: Port Colborne ↔ Welland	60 min	Monday to Saturday: 6:30 a.m. – 10:21 p.m.
60: Niagara Fall → Welland 65: Welland → Niagara Falls	30 min	Monday to Saturday: 6:55 a.m. – 11:17 p.m.
70: St. Catharines → Welland 75: Welland → St. Catharines	30 min	Monday to Friday: 7:05 a.m. – 11:27 p.m. Saturday (60 min headway): 7:05 a.m. – 10:57 p.m.

Figure 3: NRT Route 509

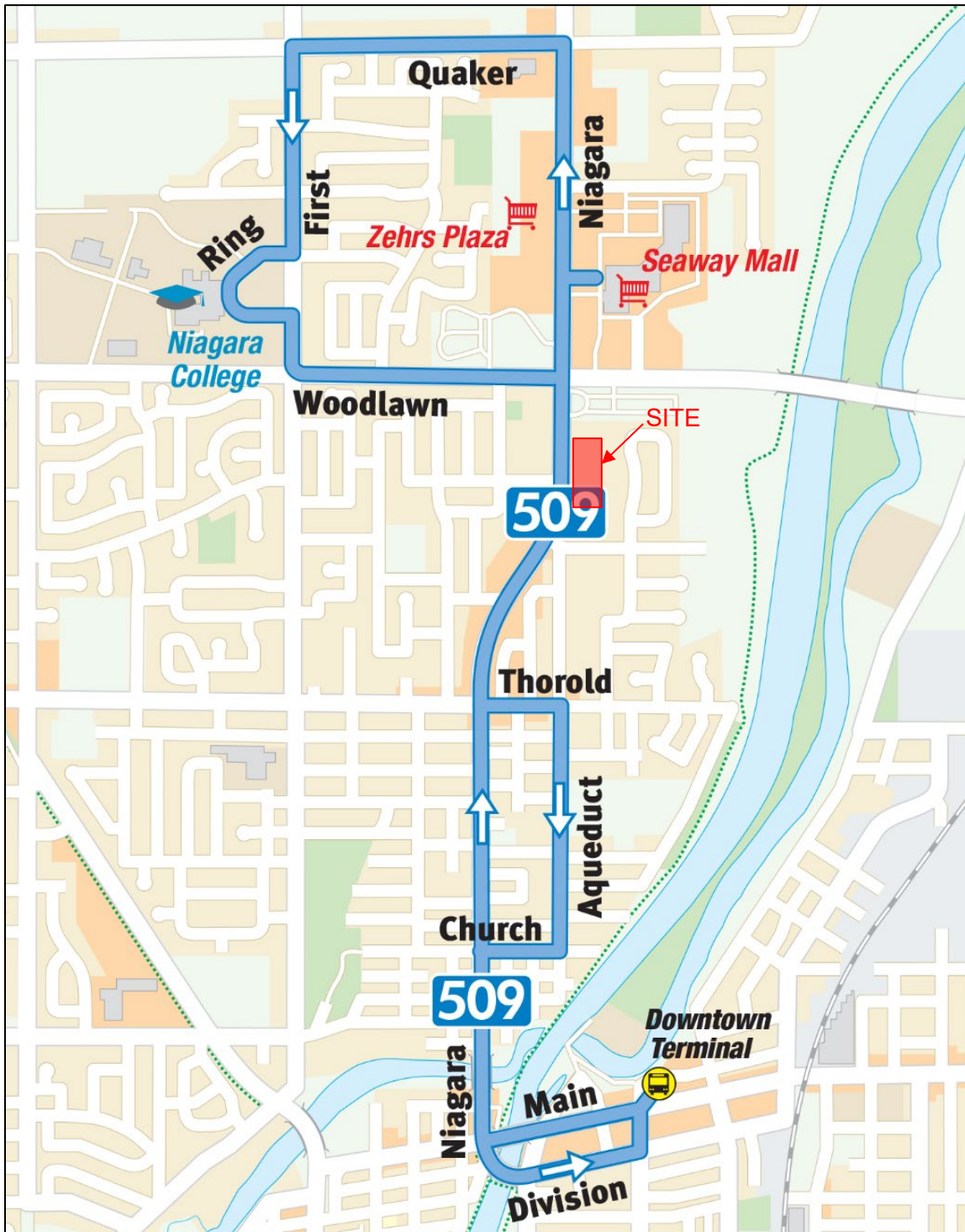
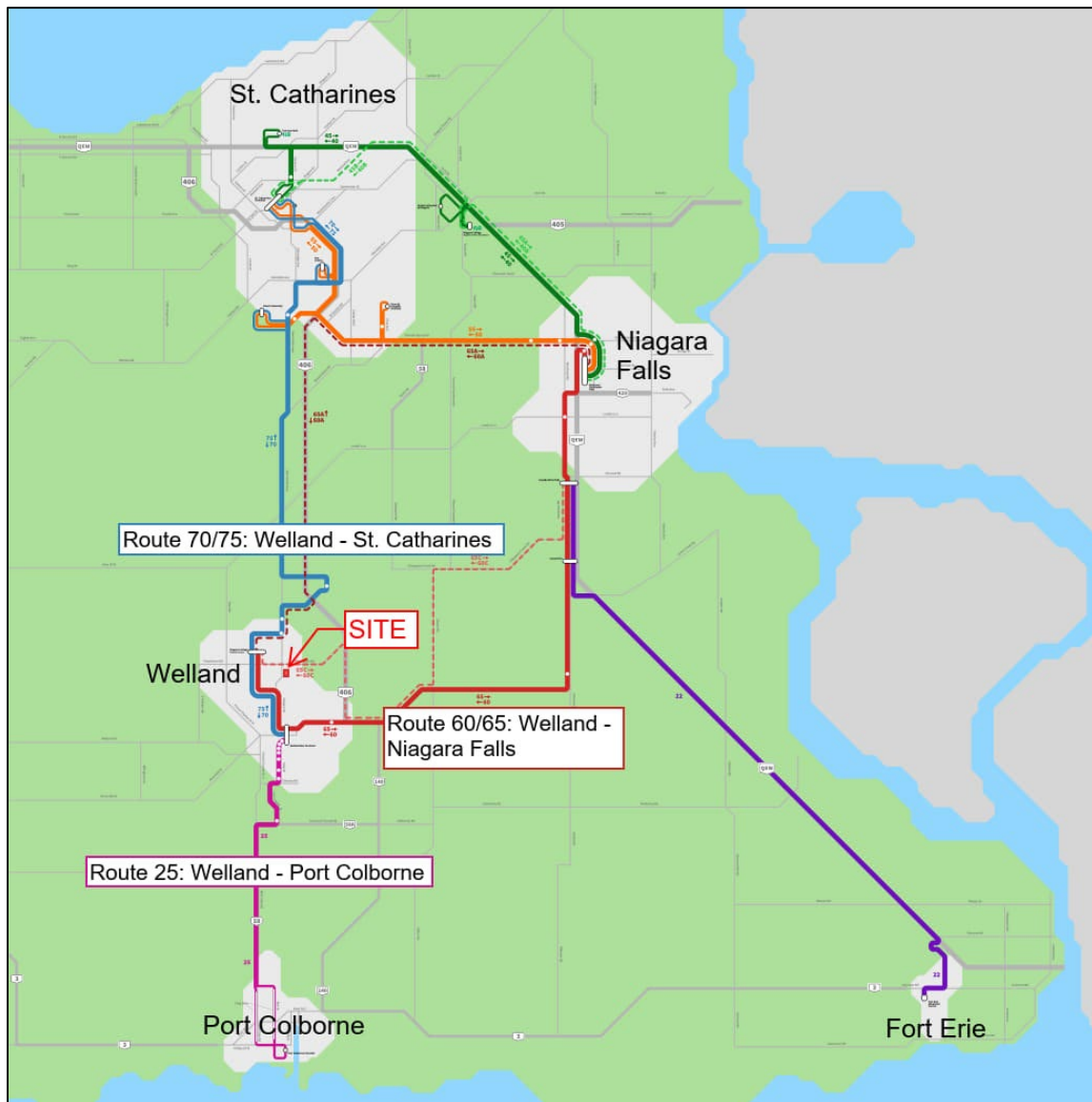


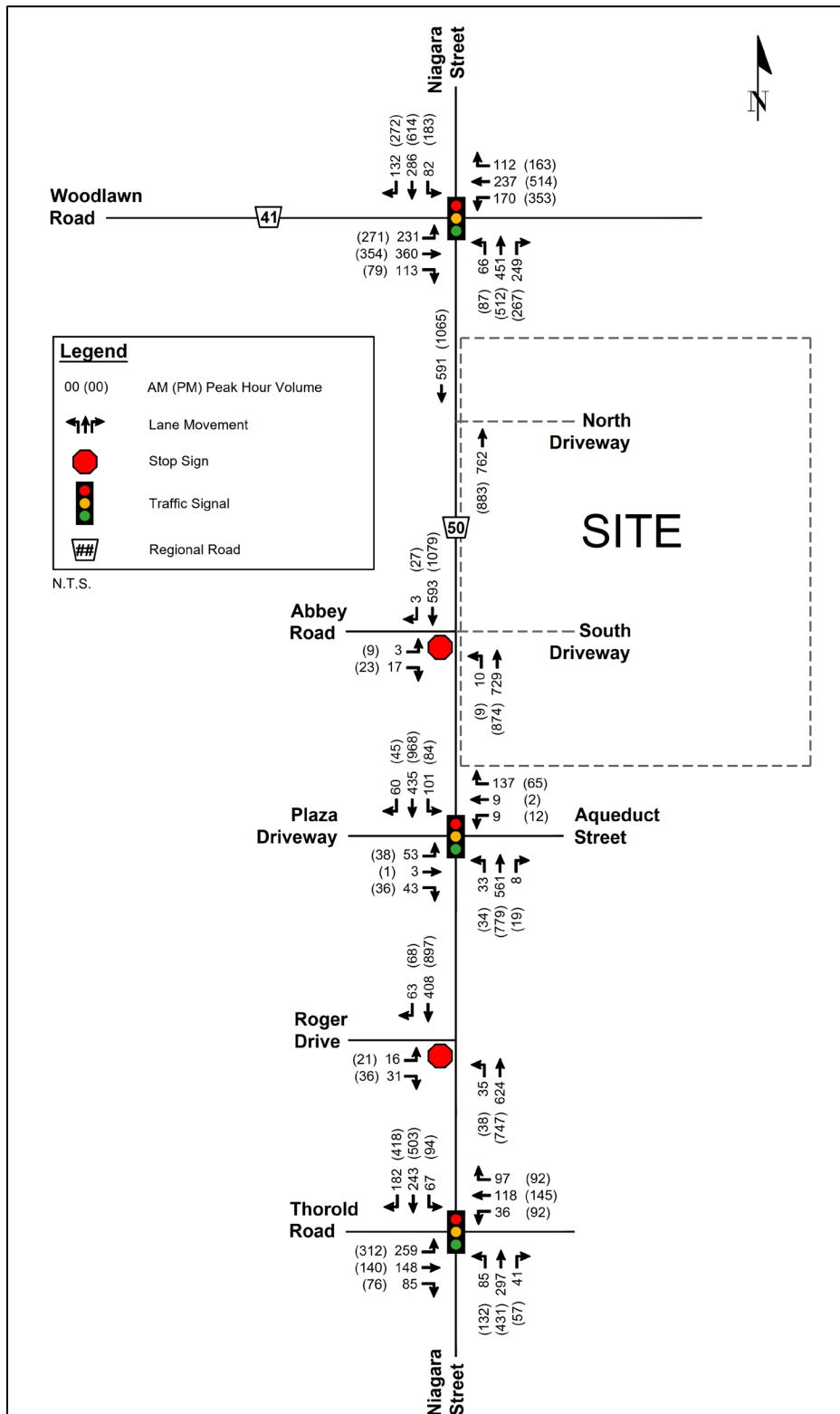
Figure 4: NRT Regional Routes

2.4 Existing Traffic Volumes

Existing weekday a.m. and p.m. traffic counts were conducted by Pyramid Traffic Inc. on behalf of Burnside, for the weekday morning (7:00 a.m. – 9:00 a.m.) and weekday evening (4:00 p.m. – 6:00 p.m.) peak periods on Wednesday October 4, 2023 and on Tuesday, April 23, 2024. 2025 traffic projections were determined by applying the growth rates that are discussed in Section 3.4. The existing 2025 traffic volumes are illustrated in Figure 5. All traffic counts and signal timing plans are provided in Appendix B

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Figure 5: Existing Traffic Volumes



3.0 Background Conditions

Future background traffic consists of existing traffic, background traffic growth and traffic from other developments. Background traffic growth and traffic from other developments are discussed below. Future road network and transit improvements within the study horizon year are also discussed. The horizon years of 2030 and 2035 were selected for future projections.

3.1 Future Road Network

There are no planned road network improvements on Niagara Street, Thorold Road or Woodlawn Road within the study area up to the horizon year of 2035.

3.2 Future Transit Network

According to the *Niagara Region Transportation Master Plan*, dated October 2017 (the Region TMP), new fixed-route transit and higher-order transit are recommended within the vicinity of the site. As shown in Figure 6, high-frequency fixed route transit will be added as warranted on major arterial roads. Future rapid transit will be considered once urban densities and local transit service levels can support it. Intercity express transit routes are recommended along Highway 406, which will be provided on exclusive transit lanes, as shown in Figure 7.

3.3 Future Active Transportation

According to the 2017 TMP *Strategic Cycling Network Development Technical Paper*, no future active transportation improvements are proposed within the study area.

3.4 Background Traffic Growth

Historical traffic counts provided by the Region were used to determine historical growth patterns. The observed growth rates are summarized in Table 2.

Table 2: Observed Growth Rates

Intersection	AM	PM
Niagara Street / Woodlawn Road	-1.5%	2.2%
Niagara Street / Aqueduct Street	-3.3%	0.7%
Niagara Street / Thorold Road	-3.1%	-0.7%

Historical traffic counts show negative growth at all intersections in the a.m. peak period and at the Niagara Street / Thorold Road intersection in the p.m. peak period. However, despite the observed negative growth, the Region requested growth rates based on the Region's Emme model, as summarized in Table 3.

Figure 6: Future Fixed-Route Transit Network



Figure 7: Future Higher-Order Transit Network

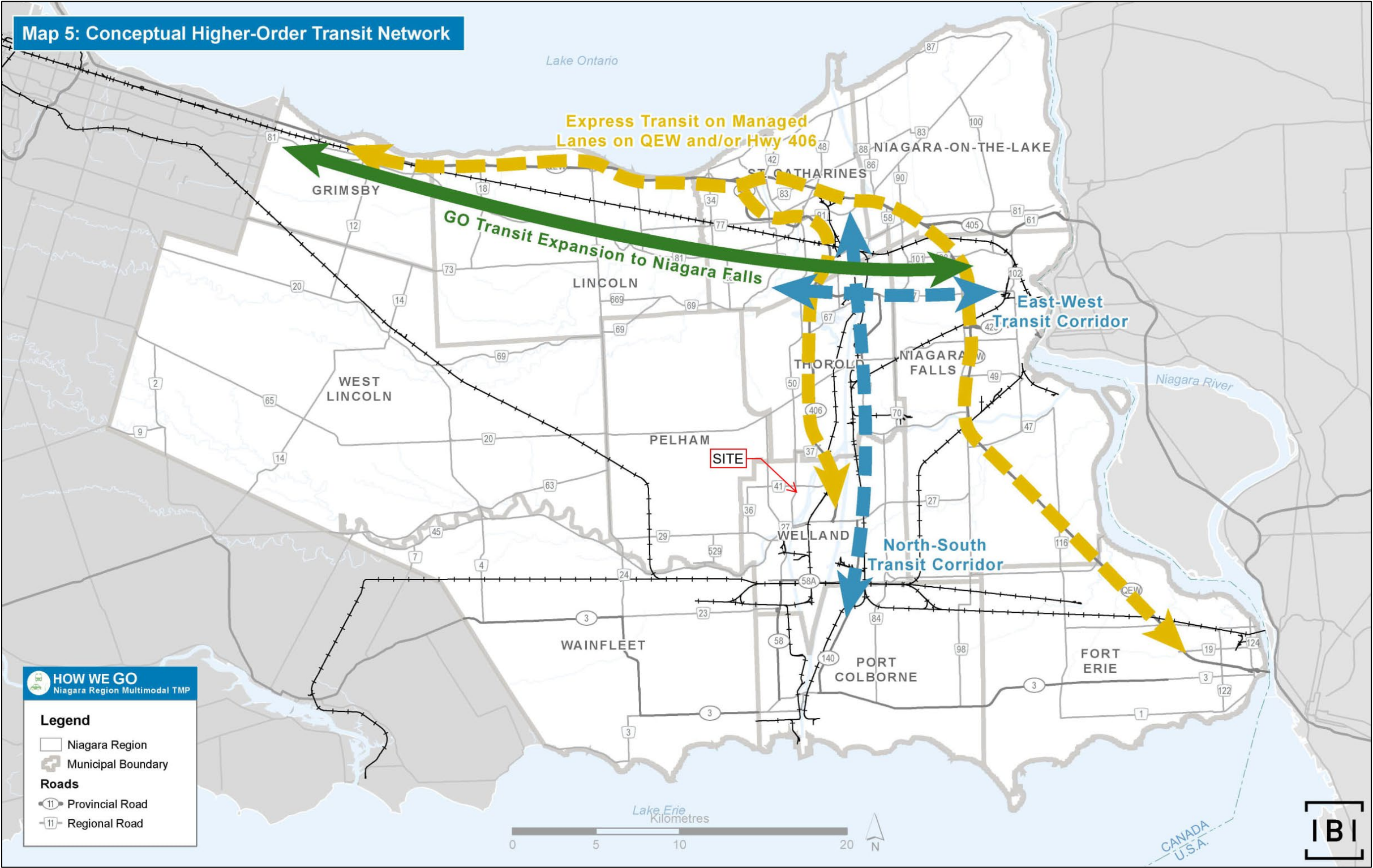


Table 3: Region's Emme Model Growth Rates

Intersection	2031 AM	2031 PM	2041 AM	2041 PM
Niagara Street / Woodlawn Road	1%	1.1%	1.5%	0.7%
Niagara Street / Aqueduct Street	2%	1.5%	1.5%	1.6%
Niagara Street / Thorold Road	1%	2%	2%	2%

The growth rates shown in Table 4 were applied for each horizon year. To provide a conservative estimate, the 2030 growth rates were aligned with the 2031 values, while the 2035 growth rates were interpolated from the 2041 projections, both of which are presented in Table 4.

Table 4: Average Annual Growth Rates Used

Intersection	2030 AM	2030 PM	2035 AM	2035 PM
Niagara Street / Woodlawn Road	1%	1.1%	1.2%	0.9%
Niagara Street / Aqueduct Street	2%	1.5%	1.8%	1.5%
Niagara Street / Thorold Road	1%	2%	1.4%	2%

Growth was applied to all movements at the intersections listed in the table above. For the remaining intersections along Niagara Street, only the through movements were grown, using the same rate as the Niagara Street / Aqueduct Street intersection.

3.5 Background Developments

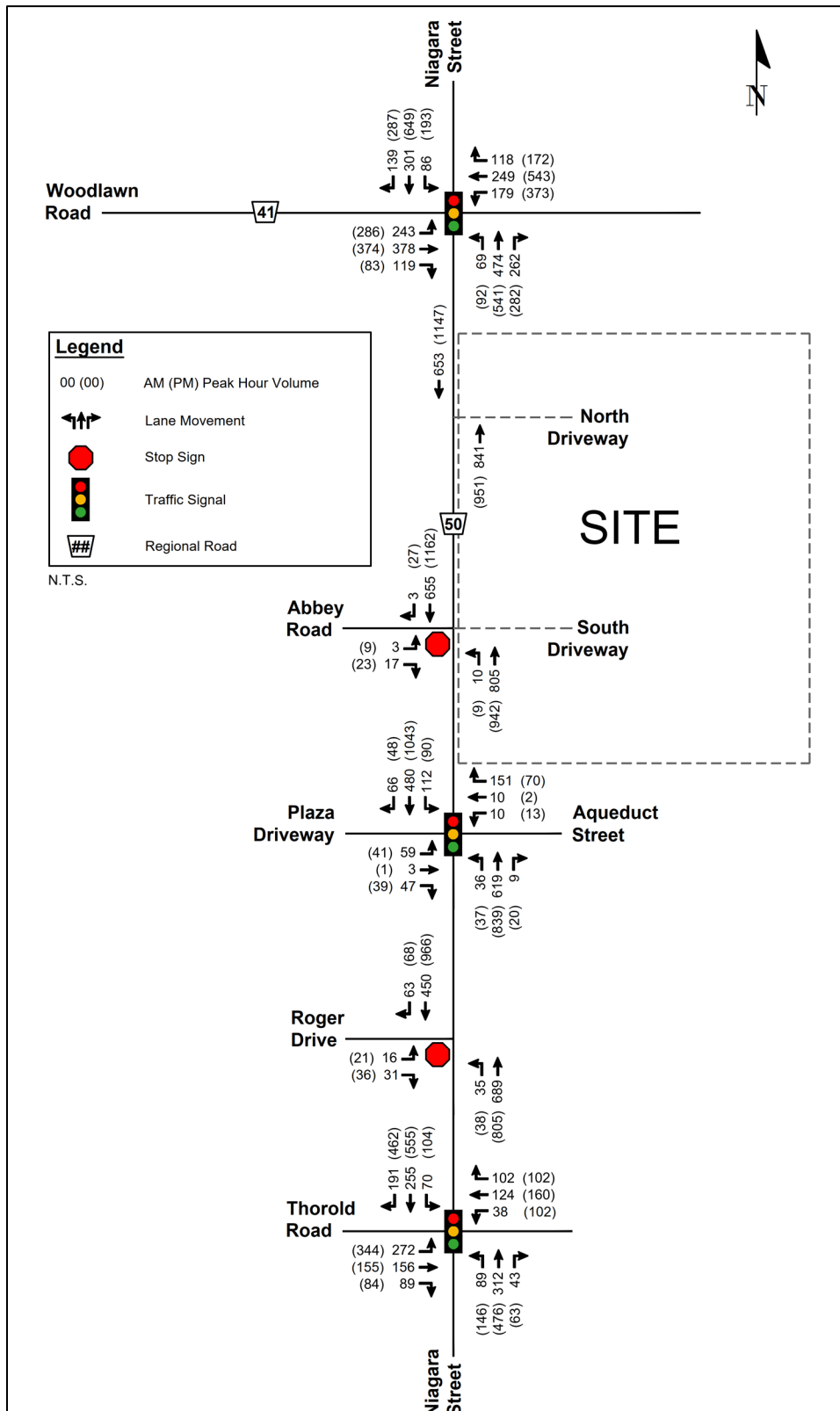
Based on consultation with the Region and the City, it was confirmed that other background developments within the vicinity of the site for the study horizon years is included in the traffic growth estimates from the Region's EMME travel demand model.

3.6 Background Traffic Volumes

Background traffic volumes for horizon years 2030 and 2035 consist of the application of growth per annum (up to 2030 and 2035, respectively) to existing traffic volumes shown in Figure 5. The resulting 2030 and 2035 background traffic volumes are shown in Figure 8 and Figure 9, respectively.

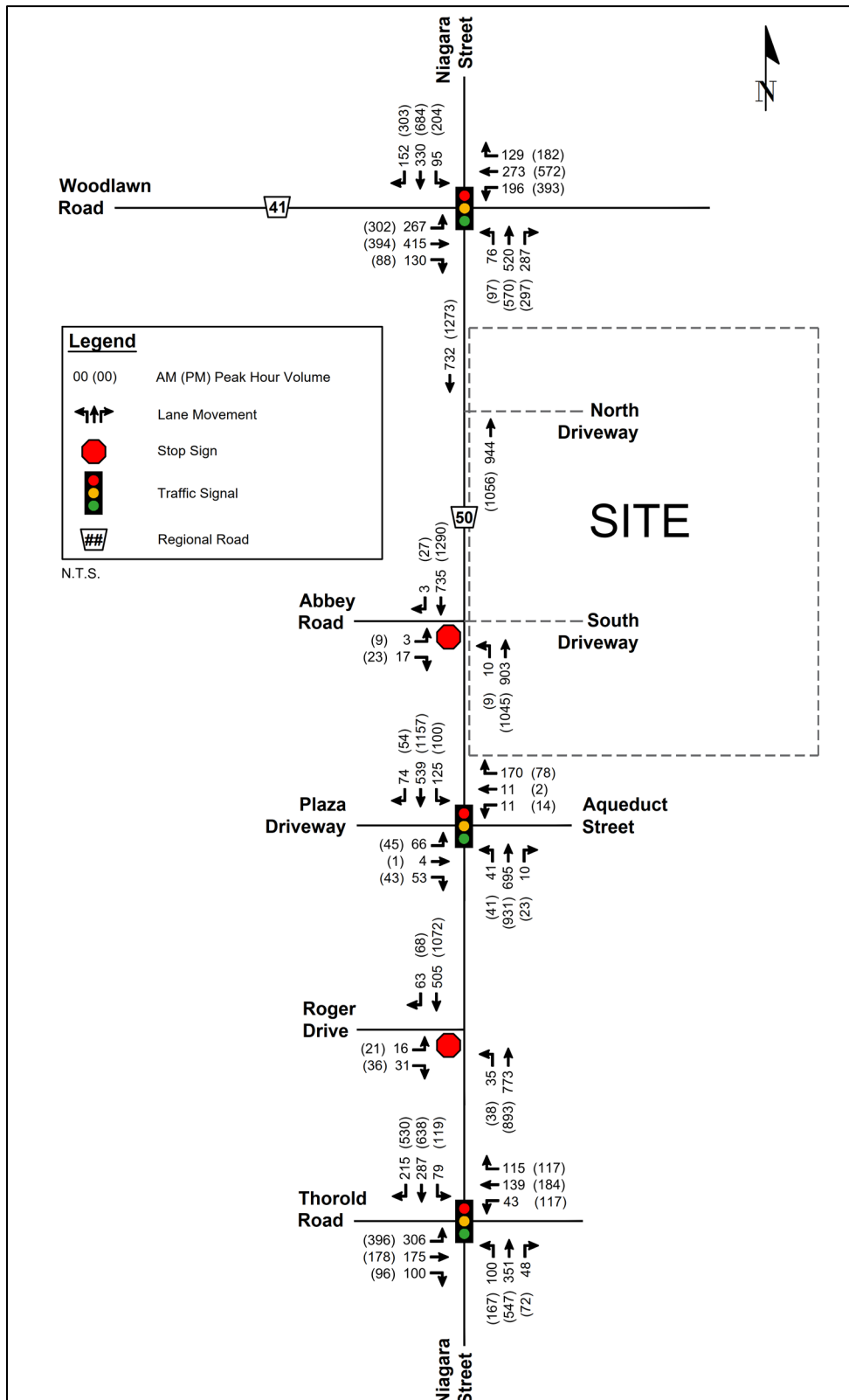
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Figure 8: 2030 Background Traffic Volumes



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Figure 9: 2035 Background Traffic Volumes



4.0 Proposed Development

The proposed development will consist of three high-rise residential buildings with ground floor retail for a total of 853 apartments, 26 townhomes and 1,121 m² of retail uses. Access to the site will be provided via two full-movement driveways on Niagara Street, one of which will be in line with Abbey Road. A comparison of the current site plan statistics to those of the previous TIS submission are provided in Table 5.

Table 5: Site Plan Comparison

	Previous TIS	Current	Difference
Apartments	1,170	853	-317
Townhomes	26	26	0
Retail (m ²)	1,121	1,121	0

The proposed conceptual site plan by McCallum Sather, dated August 27, 2024, is provided in Figure 10.

4.1 Trip Generation

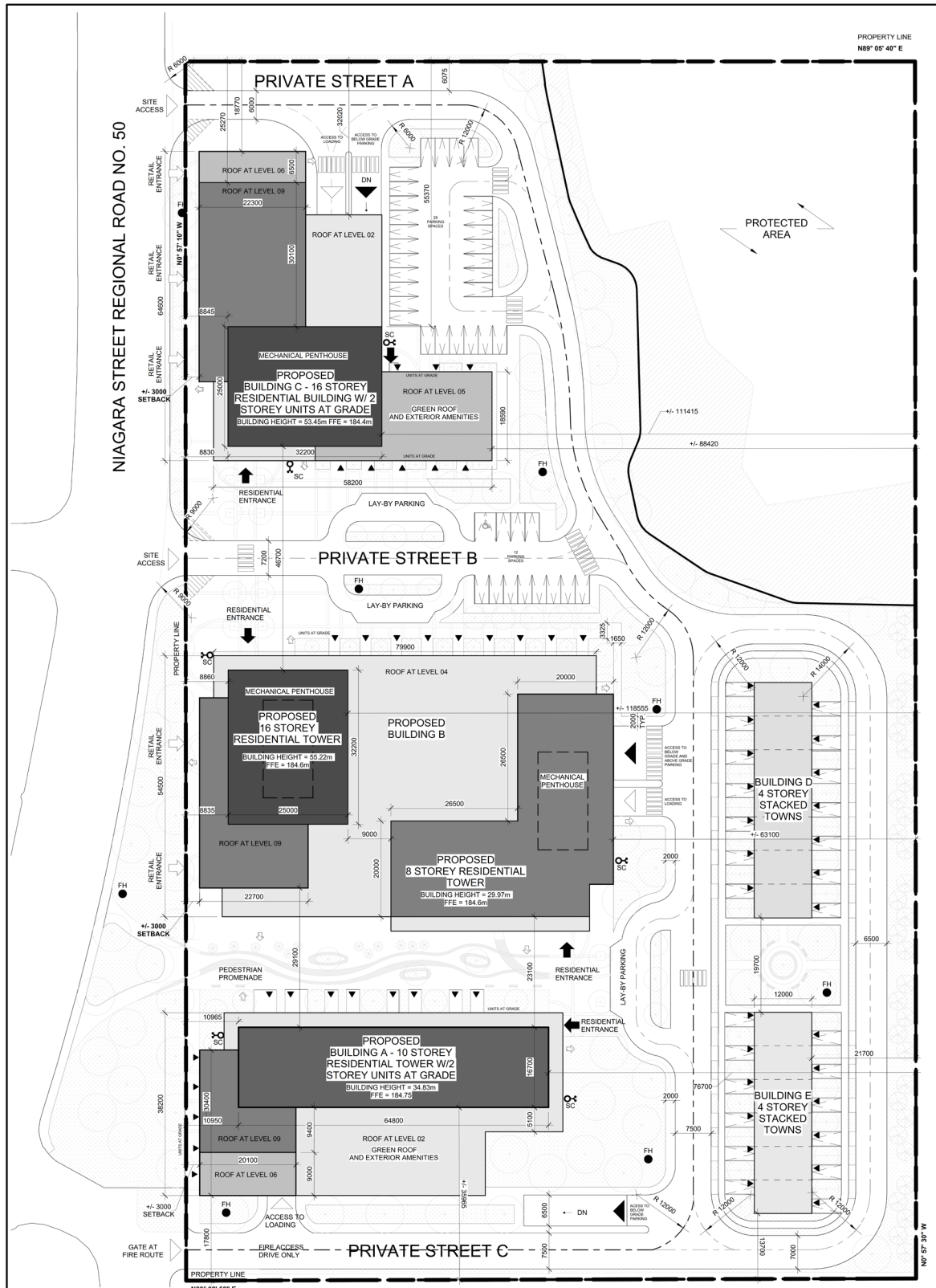
Trip generation was based on information contained in the *Trip Generation Manual*, 11th Edition, published by the Institute of Transportation Engineers (ITE). The following Land Use Codes (LUC) were used in the generation of trips based on a general urban / suburban environment.

- Apartments (10 and 16 storey towers): LUC 222 - Multifamily Housing (High – Rise)
- Stacked Townhouses: LUC 215 - Single-Family Attached Housing
- Retail: LUC 822 - Strip Retail Plaza (<40k)

The site is designed to encourage many modes of travel other than the single occupant motor vehicle. It is anticipated that transit use by future residents will be higher than current Citywide use. A review of the 2016 *Transportation Tomorrow Survey* (TTS) resulted published by the Data Management Group at the University of Toronto Transportation Research Institute indicate that 17% of trips made by residents of Welland (TTS Planning District 58) are by transit (11%), walking (1%) or cycling (5%). As the site gets built, it is anticipated that transit and active transportation (walking and cycling) usage will increase significantly along with a decrease in car use and ownership. Therefore, to reflect an emerging compact, walkable, and mixed-use community, a conservative modal split of 10% was assumed for the analysis, per the Region's request, to convey current and anticipated traffic patterns more accurately.

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Figure 10: Proposed Conceptual Site Plan



The land uses for this site will include the following trip making categories:

- New primary trips (i.e., trips that have the specific purpose of visiting the site)
- Pass-by trips (i.e., trips that are attracted to the retail on site when “passing by” the site on Study Area roadways, in this case northbound and southbound on Niagara Street)
- Internal interaction trips (i.e., between the residents retail on site)

To be conservative, no reductions for pass by trips or internal interaction trips were applied. The resulting trip generation is summarized in Table 6.

Table 6: Site Trip Generation

Land Use	Weekday AM Peak Hour			Weekday PM Peak Hour		
	In	Out	Total	In	Out	Total
Single-Family Attached Housing (LUC 215) - 26 Units						
Total Trips	3	9	12	9	6	15
Non-Vehicle Trips (10%)	0	1	1	1	1	2
New Trips	3	8	11	8	5	13
Multifamily Housing (High-Rise) (LUC 222) – 853 Units						
Total Trips	60	170	230	169	104	273
Non-Vehicle Trips (10%)	6	17	23	17	10	27
New Trips	54	153	207	152	94	246
Strip Plaza (<40K) (LUC 822) - 12,070 sq. ft.						
Total Trips	20	13	33	45	44	89
Non-Vehicle Trips (10%)	2	1	3	5	4	9
New Trips	18	12	30	40	40	80
Total Site Trips	75	173	248	200	139	339

Total trip generation is forecast to be 248 vehicles and 339 in the weekday a.m. and p.m. peak hours, respectively.

4.2 Trip Distribution and Assignment

Vehicle trip distribution and assignment was determined based on existing traffic patterns, the available road network, and the 2016 Transportation Tomorrow Survey (TTS). The estimated distribution of site trips is summarized in Table 7.

Table 7: Trip Distribution

To/From	Via	Distribution
West	Woodlawn Road	15%
East	Woodlawn Road	45%
North	Niagara Street	25%
South	Niagara Street	15%
Total		100%

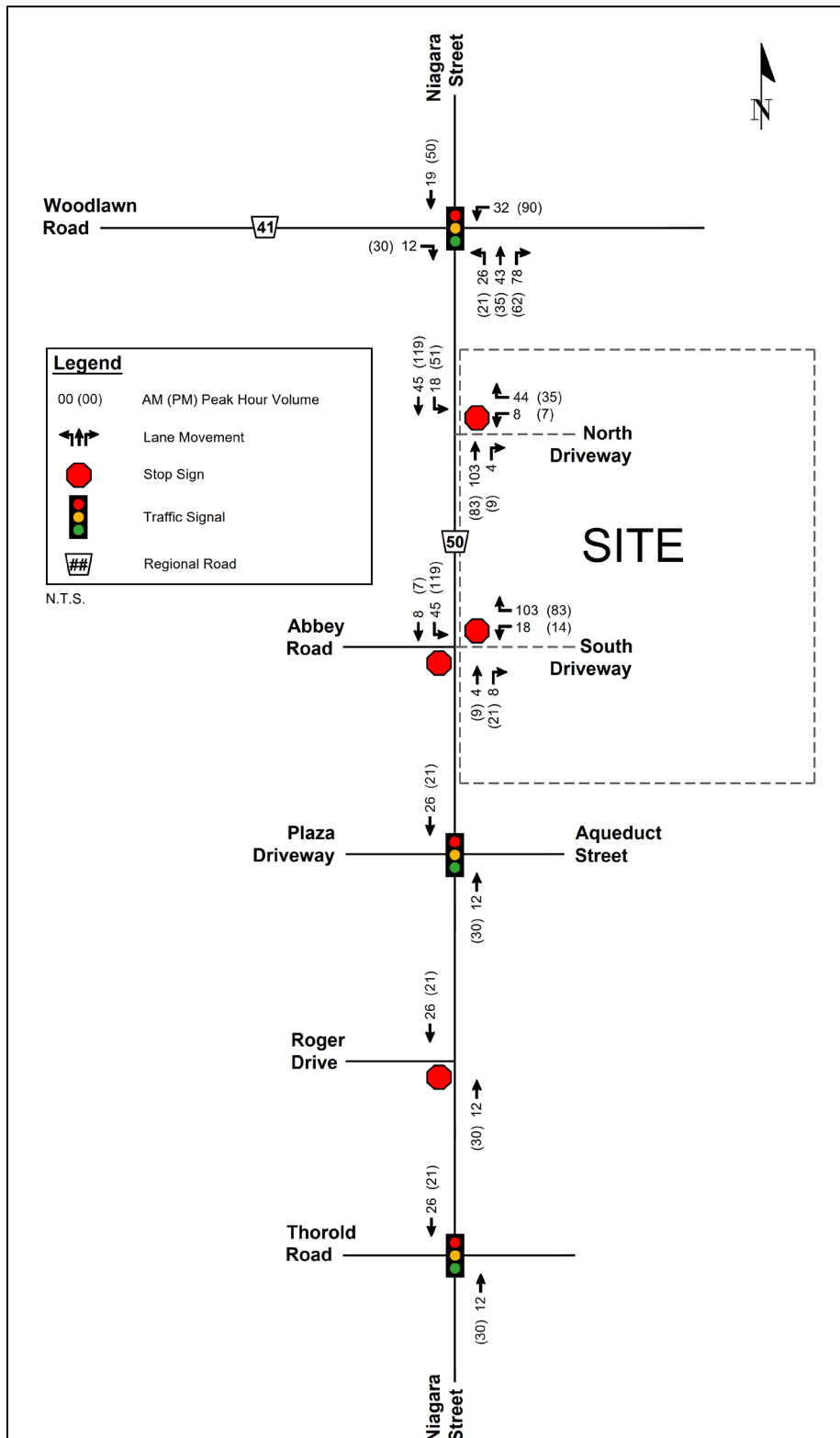
The resulting site traffic assignment is shown in Figure 11.

It was initially assumed that 30% of site-generated trips would use the north driveway, based on the distribution of units across the site. However, the Region noted that drivers may be more inclined to use the south driveway particularly for left-turn movements into or out of the site, especially if the south driveway is signalized.

A sensitivity analysis was conducted using an alternative driveway trip assignment, as shown in Figure 12 to assess potential impacts. The differences between the original and alternative assignments are limited to the driveways.

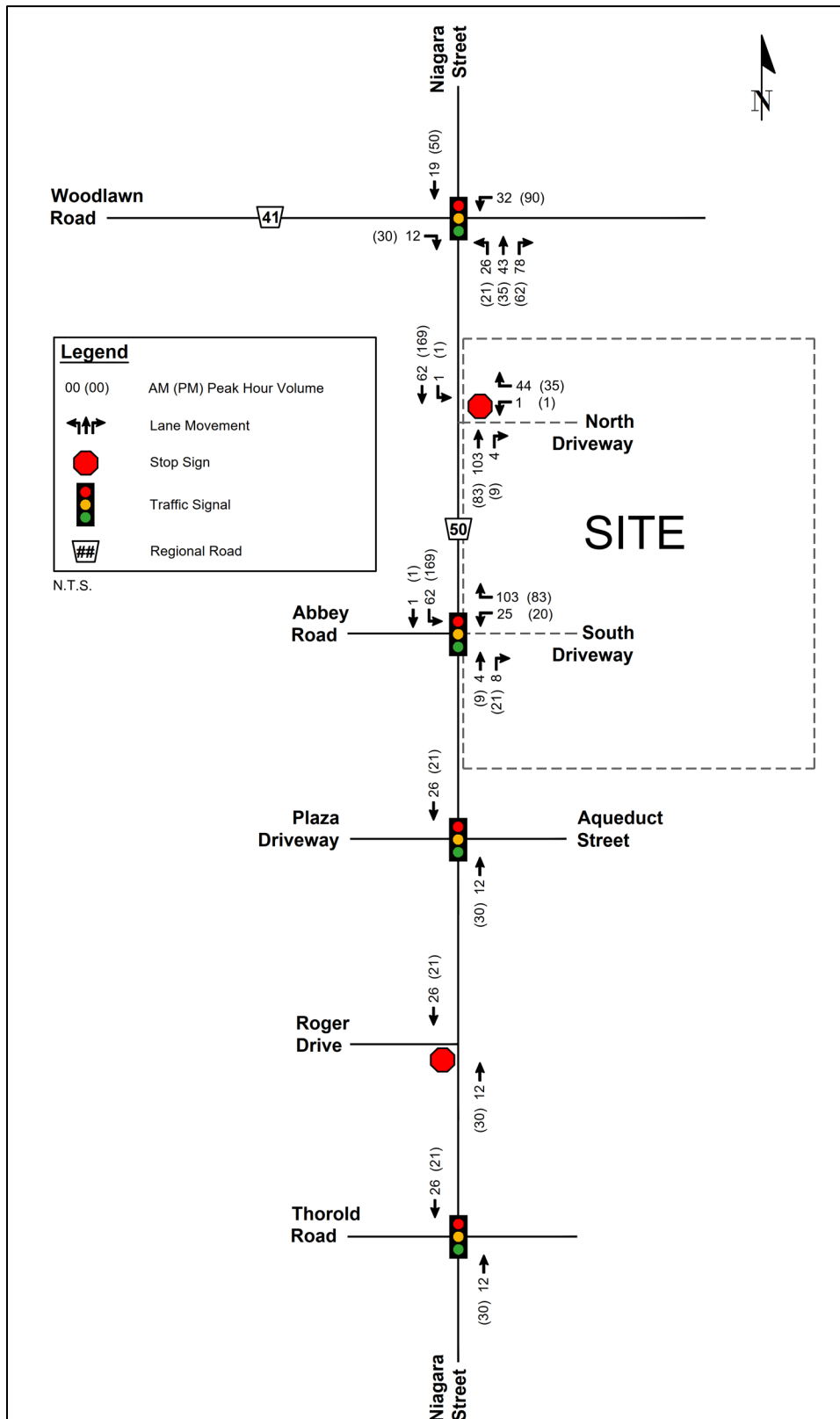
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Figure 11: Site Traffic Volumes



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Figure 12: Site Traffic Volumes – Alternate Assignment



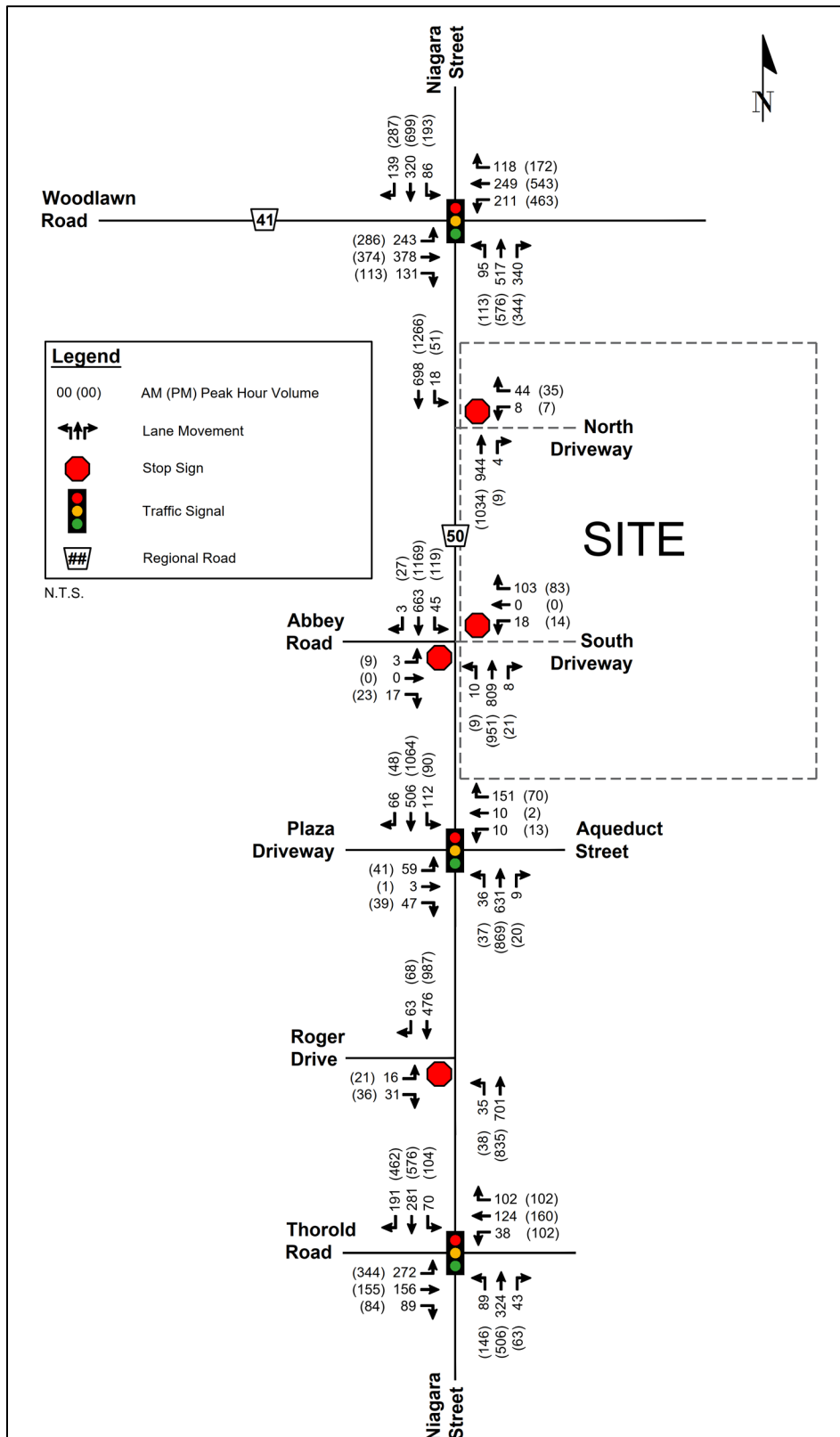
5.0 Total Conditions

5.1 Total Traffic Volumes

Total traffic volumes consist of the background traffic volumes from Figure 8 and Figure 9 plus site traffic from Figure 11. The resulting 2030 and 2035 total traffic volumes are shown in Figure 13 and Figure 14, respectively. Considering the alternative assignment of site traffic from Figure 12, the resulting total traffic volumes at the driveway intersections are shown in Figure 15.

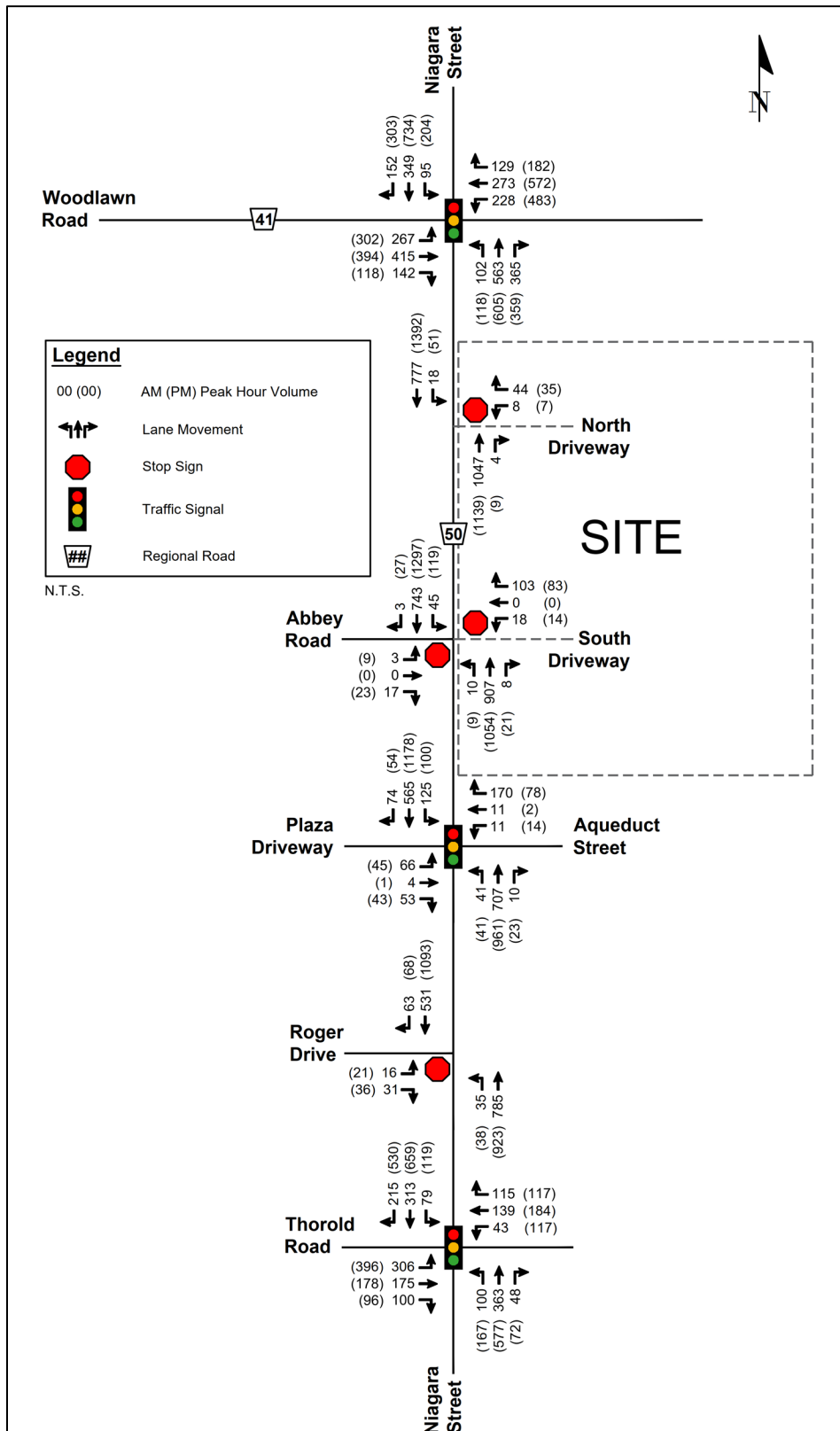
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Figure 13: Total 2030 Traffic Volumes



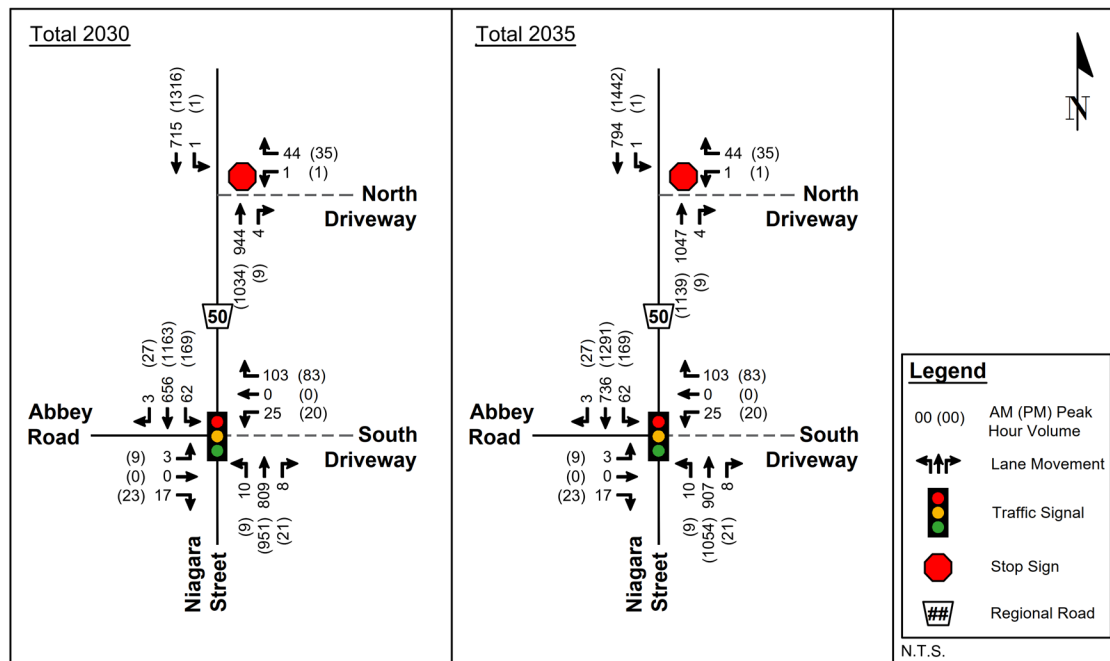
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Figure 14: Total 2035 Traffic Volumes



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Figure 15: Total 2030 and 2035 Traffic Volumes – Alternative Assignment



6.0 Traffic Operations Analysis

Traffic operations analyses were conducted for existing and future traffic volumes for the weekday a.m. and p.m. peak hours at all study intersections. Queueing was reviewed based on the 95th percentile queue. A comparison of the existing storage/link distances and projected queues are summarized for all movements. Detailed Synchro and queue reports are provided in Appendices D to G for all analyses.

The Region's Transportation Impact Assessment Guidelines (Region's TIS Guidelines), dated July 24, 2023, indicates the thresholds at which a movement is critical. At signalized intersections, movements with volume to capacity (v/c) ratio greater than 0.85 and/or level of service (LOS) E or worse are deemed to be critical, whereas at unsignalized intersections, movements with LOS D or worse and/or where the estimated 95th percentile queue length exceeds the available queuing space are deemed to be critical. The critical movements have all been identified by bolding the values.

6.1 Niagara Street / Woodlawn Road

Existing and future traffic operations at the Niagara Street / Woodlawn Road intersection are summarized in Table 8.

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Table 8: Niagara Street / Woodlawn Road Intersection Operations

Scenario & Movement	Existing Storage / Link Distance (m)	Weekday AM Peak Hour			Weekday PM Peak Hour		
		v/c	LOS	95th Queue (m)	v/c	LOS	95th Queue (m)
Existing Conditions							
Overall	-	0.57	D	-	0.85	D	-
EBL	115	0.69	D	77	0.85	E	81
EBTR	200+	0.83	E	96	0.81	E	89
WBL	103	0.72	E	56	0.96	E	141
WBT	206	0.52	E	53	0.78	E	109
WBR	136	0.10	E	19	0.14	D	22
NBL	97	0.16	B	20	0.44	C	29
NBTR	250+	0.47	C	111	0.68	D	148
SBL	134	0.29	B	24	0.72	C	58
SBTR	209	0.28	C	60	0.70	D	177
Background 2030 Conditions ¹							
Overall	-	0.61	D	-	0.91	E	-
EBL	115	0.72	D	82	0.91	E	95
EBTR	200+	0.83	E	99	0.85	E	97
WBL	103	0.75	E	60	0.97	E	155
WBT	206	0.49	E	53	0.73	E	110
WBR	139	0.10	E	18	0.15	D	21
NBL	97	0.17	B	21	0.55	C	29
NBTR	250+	0.50	C	118	0.77	D	163
SBL	134	0.33	B	25	0.80	D	75
SBTR	209	0.30	C	61	0.75	D	173
Total 2030 Conditions ¹							
Overall	-	0.68	D	-	0.95	E	-
EBL	115	0.70	D	79	0.82	E	81
EBTR	200+	0.84	E	102	0.87	E	103
WBL	103	0.82	E	68	0.98	E	190
WBT	206	0.43	E	51	0.61	D	110
WBR	136	0.10	D	17	0.15	D	21
NBL	97	0.25	B	28	0.74	D	55
NBTR	250+	0.59	C	141	0.96	E	208
SBL	134	0.40	C	26	0.93	F	106
SBTR	209	0.32	C	65	0.88	E	203

Table 8: Niagara Street / Woodlawn Road Intersection Operations Continued

Scenario & Movement	Existing Storage / Link Distance (m)	Weekday AM Peak Hour			Weekday PM Peak Hour		
		v/c	LOS	95th Queue (m)	v/c	LOS	95th Queue (m)
Background 2035 Conditions ¹							
Overall	-	0.67	D	-	0.96	E	-
EBL	115	0.76	D	87	0.88	E	92
EBTR	200+	0.84	E	108	0.87	E	103
WBL	103	0.80	E	62	0.96	E	155
WBT	206	0.50	E	57	0.76	E	119
WBR	139	0.11	D	19	0.16	D	22
NBL	97	0.21	C	24	0.66	D	41
NBTR	250+	0.58	C	137	0.93	E	209
SBL	134	0.42	C	28	0.90	E	108
SBTR	209	0.34	C	68	0.86	D	216
Total 2035 Conditions ¹							
Overall	-	0.75	D	-	1.11	F	-
EBL	115	0.74	D	88	0.90	E	93
EBTR	200+	0.87	E	113	0.89	E	110
WBL	103	0.88	E	82	1.15	F	239
WBT	206	0.46	E	57	0.65	D	112
WBR	139	0.11	D	19	0.16	D	21
NBL	97	0.29	C	30	0.89	F	68
NBTR	250+	0.68	D	161	1.05	F	221
SBL	134	0.50	C	28	0.98	F	116
SBTR	209	0.37	C	72	0.96	E	225

Note: ¹. Signal timing plans were optimized for all future conditions, maintaining existing cycle lengths.

Existing Conditions

Under existing conditions, during both peak hours, all movements are operating with excess capacity and a LOS D or better, except for the following movements, which are deemed critical based on the Region's TIS Guidelines:

- Eastbound left turn movement operates at threshold capacity with a LOS E during the p.m. peak hour.
- Eastbound through / right turn movement operates with a LOS E, during both peak hours.
- Westbound left turn movement operates with a LOS E during the a.m. peak hour and operates over threshold capacity with a LOS E during the PM peak hour.
- Westbound through and right turn movements operates with a LOS E during the a.m. peak hour.

Future Conditions

Under 2030 and 2035 future conditions, the following movements will exceed the Region's threshold capacity, in addition to those identified under existing conditions:

- Eastbound through / right turn movement will operate at threshold capacity with a LOS E by background 2030 during the PM peak hour and over threshold capacity with a LOS E by total 2035 during the a.m. peak hour.
- Westbound left turn movement will operate at theoretical lane capacity (v/c 1.00) with a LOS E by background 2030 during the p.m. peak hour and over threshold capacity with a LOS E by total 2035 during the a.m. peak hour.
- Westbound through movement will operate under threshold capacity, however with a LOS E due to high delay during the p.m. peak hour.
- Northbound through / right turn movement will operate over threshold capacity with a LOS E by total 2030 conditions, during the p.m. peak hour.
- Northbound left turn movement will operate over threshold capacity with a LOS F by total 2035 conditions, during the p.m. peak hour.
- Southbound left turn movement will operate over threshold capacity with a LOS F by total 2030 conditions, during the p.m. peak hour.
- Southbound through / right turn movement will operate over threshold capacity with a LOS E by total 2030 conditions, during the p.m. peak hour.

All queues are and will be contained within their respective link distances and storage lengths, except for the westbound left turn movement, which is already exceeding the storage length under existing conditions during the PM peak hour, and the southbound through / right movement, which will exceed its storage length by background 2035 during the p.m. peak hour.

This intersection is currently operating beyond the Region's threshold for some critical movements and additional critical movements are expected to continue to operate beyond the Region's thresholds under future conditions, as acknowledged by the Region. These conditions are primarily driven by background growth.

There is limited opportunity for short-term improvements given the limited available right-of-way and area for widenings, with cemeteries located on the northwest and southeast corners. The Region has indicated that it is possible this intersection could be subject to a future environmental study to consider major improvements. It is recommended that this intersection continue to be monitored by the Region for future improvements.

6.2 Niagara Street / Abbey Road / South Driveway

Traffic operations at the Niagara Street / Abbey Road / South Driveway intersection are summarized in Table 9.

Table 9: Niagara Street / Abbey Road / South Driveway Intersection Operations

Scenario & Movement	Existing Storage / Link Distance (m)	Weekday AM Peak Hour			Weekday PM Peak Hour		
		v/c	LOS	95th Queue (m)	v/c	LOS	95th Queue (m)
Existing Conditions							
EBLR	50+	0.04	B	1	0.07	B	2
NBL	35	0.01	A	1	0.02	B	1
Background 2030 Conditions							
EBLR	50+	0.04	B	1	0.07	B	2
NBL	35	0.01	A	1	0.02	B	1
Total 2030 Conditions							
EBLTR	50+	0.04	B	1	0.17	D	5
WBL	20+	0.07	C	2	0.09	D	3
WBTR	30+	0.16	B	5	0.13	B	4
NBL	35	0.01	A	1	0.02	B	1
SBL	50+	0.06	A	2	0.18	B	5
Background 2035 Conditions							
EBLR	50+	0.04	B	1	0.08	B	2
NBL	35	0.01	A	1	0.02	B	1
Total 2035 Conditions							
EBLTR	50+	0.05	B	2	0.17	D	5
WBL	20+	0.08	C	2	0.08	D	2
WBTR	30+	0.17	B	5	0.14	B	4
NBL	35	0.01	A	1	0.02	B	1
SBL	50+	0.06	B	2	0.19	B	6

During both peak hours, all movements are operating and will operate with excess capacity and LOS C or better, except for the eastbound left-through-right and westbound left turn movements under the total 2030 and total 2035 scenarios during the p.m. peak hour, which operate at LOS D. These movements will operate with excess capacity and a maximum delay of 28.2 seconds. All queues are and will be contained within their respective link distances and storage lengths.

A sensitivity analysis was conducted based on the alternate assignment of site traffic and signalization at this intersection. Since the traffic signals along the Niagara Street corridor are fully actuated, it was assumed that the cycle length would be the same. The result of the analysis is provided in Table 10.

Table 10: Niagara Street / Abbey Road / South Driveway Intersection Operations – Alternate Assignment

Scenario & Movement	Existing Storage / Link Distance (m)	Weekday AM Peak Hour			Weekday PM Peak Hour		
		v/c	LOS	95th Queue (m)	v/c	LOS	95th Queue (m)
Total 2030 Conditions							
Overall	-	0.33	A	-	0.49	A	-
EBLTR	50+	0.04	D	7	0.13	D	10
WBL	20+	0.29	D	12	0.25	D	10
WBTR	30+	0.08	D	6	0.06	D	4
NBL	35	0.02	A	2	0.04	A	2
NBTR	100+	0.33	A	24	0.39	A	29
SBL	50+	0.16	A	6	0.51	A	25
SBTR	100+	0.27	A	19	0.47	A	39
Total 2035 Conditions							
Overall	-	0.36	A	-	0.56	A	-
EBLTR	50+	0.04	D	7	0.13	D	10
WBL	20+	0.29	D	12	0.25	D	10
WBTR	30+	0.08	D	10	0.06	D	9
NBL	35	0.02	A	2	0.04	A	2
NBTR	100+	0.37	A	28	0.43	A	33
SBL	50+	0.18	A	6	0.58	B	35
SBTR	100+	0.30	A	21	0.52	A	46

During both peak hours, all movements will operate with excess capacity and LOS D or better. All queues are and will be contained within their respective link distances and storage lengths. The delays would be greater under this scenario (up to 38.5 seconds) compared to the unsignalized scenario (up to 28.2 seconds). Therefore, signalization may not improve operations.

6.2.1 Signal Warrant Analysis

A signal warrant analysis for this intersection was completed based on the methodology contained in the *Ontario Traffic Manual Book 12* (OTM Book 12), published by the Ministry of Transportation. The results of the signal warrant analysis are summarized in Table 11. Detailed analyses are provided in Appendix H. It should be noted that this intersection is roughly 125 m from the signalized Niagara Street / Aqueduct Street intersection, whereas the Region's *Access Management Guidelines*, dated July 25, 2023 specify that the desirable intersection spacing for signalization intersections is 350 m, with 250 m being the minimum spacing.

Table 11: Niagara Street / Abbey Road / South Driveway Signal Warrant Analysis

Condition	Justification	Justification 1 Minimum Vehicular Volume1		Justification 2 Delay to Cross Traffic1		Justification 3 Combination2	
		1A	1B	2A	2B	3A	3B
Existing 2023	Compliance	94%	5%	92%	4%	5%	4%
	Justified	No		No		No	
Total 2035	Compliance	125%	40%	118%	15%	40%	15%
	Justified	No		No		No	
Total 2035 (Alternate Assignment)	Compliance	127%	42%	119%	47%	42%	47%
	Justified	No		No		No	

Note: 1. 1A and 2A are total intersection volumes while 1B and 2B are crossing (of the main road) volumes.

2. 3A is Justification 1, while 3B is Justification 2.

For each justification, the lower percentage governs the warrant. The threshold required for existing volumes is 100% for Justification 1 and 2, and 80% for Justification 3. The threshold required for each justification is 120% for projected volumes. A traffic signal is not warranted under existing and future conditions at this intersection. With the alternate assignment, assuming most left turning drivers would choose to use this site driveway rather than the north driveway, a traffic signal continues to not be warranted.

6.3 Niagara Street / Aqueduct Street

Traffic operations at the Niagara Street / Aqueduct Street intersection are summarized in Table 12.

Table 12: Niagara Street / Aqueduct Street Intersection Operations

Scenario & Movement	Existing Storage / Link Distance (m)	Weekday AM Peak Hour			Weekday PM Peak Hour		
		v/c	LOS	95th Queue (m)	v/c	LOS	95th Queue (m)
Existing Conditions							
Overall	-	0.29	A	-	0.44	A	-
EBL	20+	0.40	D	19	0.36	D	15
EBTR	10+	0.05	C	10	0.04	C	9
WBL	20	0.06	C	6	0.11	D	7
WBTR	200+	0.17	C	18	0.07	C	12
NBL	92	0.07	A	6	0.12	A	6
NBTR	200+	0.27	A	28	0.35	A	37
SBL	67	0.23	A	15	0.23	A	12
SBTR	200+	0.24	A	23	0.45	A	51

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Table 12: Niagara Street / Aqueduct Street Intersection Operations Continued

Scenario & Movement	Existing Storage / Link Distance (m)	Weekday AM Peak Hour			Weekday PM Peak Hour		
		v/c	LOS	95th Queue (m)	v/c	LOS	95th Queue (m)
Background 2030 Conditions ¹							
Overall	-	0.33	B	-	0.47	A	-
EBL	20+	0.46	D	21	0.38	D	16
EBTR	10+	0.06	C	10	0.05	C	9
WBL	20	0.07	C	6	0.11	D	7
WBTR	200+	0.19	C	18	0.07	C	12
NBL	92	0.08	A	6	0.15	A	7
NBTR	200+	0.30	A	33	0.38	A	42
SBL	67	0.27	A	17	0.27	A	14
SBTR	200+	0.27	A	27	0.49	A	59
Total 2030 Conditions ¹							
Overall	-	0.33	B	-	0.48	A	-
EBL	20+	0.46	D	21	0.38	D	16
EBTR	10+	0.06	C	10	0.07	C	10
WBL	20	0.07	C	6	0.11	D	7
WBTR	200+	0.20	C	18	0.11	C	13
NBL	92	0.08	A	6	0.16	A	7
NBTR	200+	0.31	A	33	0.40	A	44
SBL	67	0.28	A	18	0.28	A	14
SBTR	200+	0.28	A	29	0.50	A	60
Background 2035 Conditions ¹							
Overall	-	0.38	B	-	0.53	A	-
EBL	20+	0.52	D	22	0.41	D	17
EBTR	10+	0.06	C	10	0.17	D	12
WBL	20	0.07	C	6	0.12	C	8
WBTR	200+	0.43	C	28	0.26	D	17
NBL	92	0.10	A	8	0.20	A	8
NBTR	200+	0.34	A	42	0.43	A	49
SBL	67	0.34	A	23	0.34	A	18
SBTR	200+	0.30	A	35	0.54	A	71
Total 2035 Conditions ¹							
Overall	-	0.38	B	-	0.53	A	-
EBL	20+	0.52	D	22	0.41	D	17
EBTR	10+	0.06	C	10	0.18	D	13
WBL	20	0.07	C	6	0.12	C	8
WBTR	200+	0.45	C	28	0.29	D	18
NBL	92	0.10	A	8	0.21	A	8
NBTR	200+	0.35	A	43	0.44	A	52
SBL	67	0.35	A	24	0.36	A	18
SBTR	200+	0.32	A	37	0.55	A	73

Note: 1. Signal timing plans were optimized for all future conditions, maintaining existing cycle lengths.

During both peak hours, all movements are operating and will operate with excess capacity and LOS D or better. All queues are and will be contained within their respective link distances and storage lengths.

6.3.1 Signal Warrant Analysis

A signal warrant analysis for this intersection was completed based on the methodology contained in OTM Book 12 to confirm if the existing traffic signal is still warranted. The results of the signal warrant analysis are summarized in Table 13. Detailed analyses are provided in Appendix H.

Table 13: Niagara Street / Aqueduct Street Signal Warrant Analysis

Condition	Justification	Justification 1 Minimum Vehicular Volume ¹		Justification 2 Delay to Cross Traffic ¹		Justification 3 Combination ²	
		1A	1B	2A	2B	3A	3B
Existing 2025	Compliance	98%	60%	87%	41%	60%	41%
	Justified	No		No		No	
Total 2035	Compliance	122%	74%	108%	71%	74%	71%
	Justified	No		No		No	

Note: 1. 1A and 2A are total intersection volumes while 1B and 2B are crossing (of the main road) volumes.
2. 3A is Justification 1, while 3B is Justification 2.

For each justification, the lower percentage governs the warrant. A signal can be warranted by just one of the justifications, provided that it meets the threshold for both subcategories. The threshold required for existing volumes is 100% for Justification 1 and 2, and 80% for Justification 3. The threshold required for each justification is 120% for projected volumes. Therefore, a traffic signal is not warranted under existing and future conditions at this intersection.

6.4 Niagara Street / Roger Drive

Traffic operations at the Niagara Street / Roger Drive intersection are summarized in Table 14.

Table 14: Niagara Street / Roger Drive Intersection Operations

Scenario & Movement	Existing Storage / Link Distance (m)	Weekday AM Peak Hour			Weekday PM Peak Hour		
		v/c	LOS	95th Queue (m)	v/c	LOS	95th Queue (m)
Existing Conditions							
EBLR	50+	0.08	B	2	0.13	B	4
NBL	50+	0.04	A	1	0.06	B	2
Background 2030 Conditions							
EBLR	50+	0.09	B	3	0.13	B	4
NBL	50+	0.04	A	1	0.06	B	2
Total 2030 Conditions							
EBLR	50+	0.09	B	3	0.14	B	4
NBL	50+	0.04	A	1	0.06	B	2
Background 2035 Conditions							
EBLR	50+	0.09	B	3	0.14	B	4
NBL	50+	0.04	A	1	0.07	B	2
Total 2035 Conditions							
EBLR	50+	0.09	B	3	0.14	B	4
NBL	50+	0.04	A	1	0.07	B	2

During both peak hours for all scenarios, all movements are operating and will operate with excess capacity and LOS B or better. All queues are and will be contained within their respective link distances and storage lengths.

6.5 Niagara Street / Thorold Road

Traffic operations at the Niagara Street / Thorold Road intersection are summarized in Table 15.

Table 15: Niagara Street / Thorold Road Intersection Operations

Scenario & Movement	Existing Storage / Link Distance (m)	Weekday AM Peak Hour			Weekday PM Peak Hour		
		v/c	LOS	95th Queue (m)	v/c	LOS	95th Queue (m)
Existing Conditions							
Overall	-	0.53	C	-	0.88	D	-
EBL	150+	0.88	D	67	1.09	F	89
EBTR	200+	0.66	D	68	0.63	D	64
WBL	67	0.16	C	11	0.32	C	23
WBTR	227	0.76	D	62	0.81	D	71
NBL	85	0.24	B	19	0.61	C	28
NBTR	200+	0.26	B	40	0.38	C	59
SBL	6	0.17	B	15	0.27	B	20
SBTR	200+	0.27	B	35	0.70	C	109

Table 15: Niagara Street / Thorold Road Intersection Operations Continued

Scenario & Movement	Existing Storage / Link Distance (m)	Weekday AM Peak Hour			Weekday PM Peak Hour		
		v/c	LOS	95th Queue (m)	v/c	LOS	95th Queue (m)
Background 2030 Conditions ¹							
Overall	-	0.53	C	-	0.96	D	-
EBL	150+	0.73	C	53	0.98	E	76
EBTR	200+	0.53	C	58	0.57	C	63
WBL	67	0.18	C	10	0.32	C	23
WBTR	227	0.75	D	62	0.86	E	80
NBL	85	0.30	B	23	0.81	D	43
NBTR	200+	0.32	C	47	0.48	C	71
SBL	64	0.21	B	19	0.37	B	25
SBTR	200+	0.33	C	43	0.91	D	148
Total 2030 Conditions ¹							
Overall	-	0.55	C	-	0.97	D	-
EBL	150+	0.73	C	53	0.98	E	89
EBTR	200+	0.53	C	58	0.57	C	63
WBL	67	0.18	C	10	0.32	C	23
WBTR	227	0.75	D	62	0.86	E	85
NBL	85	0.31	B	23	0.81	D	61
NBTR	200+	0.33	C	48	0.51	C	73
SBL	64	0.21	B	19	0.38	B	24
SBTR	200+	0.36	C	49	0.94	D	151
Background 2035 Conditions ¹							
Overall	-	0.62	C	-	0.99	E	-
EBL	150+	0.77	C	56	0.98	F	77
EBTR	200+	0.56	C	62	0.63	C	74
WBL	67	0.19	C	10	0.38	C	26
WBTR	227	0.80	D	70	0.91	E	107
NBL	85	0.39	B	27	0.98	F	75
NBTR	200+	0.40	C	55	0.58	C	81
SBL	64	0.28	C	22	0.45	B	26
SBTR	200+	0.44	C	53	1.04	E	173
Total 2035 Conditions ¹							
Overall	-	0.64	C	-	1.13	F	-
EBL	150+	0.80	C	59	1.02	E	116
EBTR	200+	0.58	C	65	0.58	C	73
WBL	67	0.19	C	10	0.35	C	24
WBTR	227	0.82	D	72	0.91	E	107
NBL	85	0.39	B	26	0.98	F	74
NBTR	200+	0.39	C	55	0.68	D	89
SBL	64	0.27	C	22	0.56	C	29
SBTR	200+	0.45	C	56	1.24	F	197

Note: 1. Signal timing plans were optimized for all future conditions, maintaining existing cycle lengths.

Existing Conditions

Under existing conditions, during both peak hours, all movements are operating with excess capacity and a LOS D or better, except for the following movement, which are deemed critical based on the Region's TIS Guidelines:

- Eastbound left turn movement operates over threshold capacity during the a.m. peak hour and operates over threshold capacity with a LOS F during the p.m. peak hour.

Future Conditions

Under 2030 and 2035 future conditions, the following movements will exceed the Region's threshold capacity during the p.m. peak hour, in addition to those identified under existing conditions:

- Westbound through / right turn movement will operate over threshold capacity with a LOS E by background 2030 conditions.
- Northbound left turn movement will operate over threshold capacity with a LOS F by background 2035 conditions.
- Southbound through / right turn movement will operate over threshold capacity by background 2030 conditions and over capacity with a LOS E by background 2035 conditions.

These conditions are primarily driven by background growth.

All queues are and will be contained within their respective link distances and storage lengths.

It is recommended that the Region continue to monitor this intersection for possible future improvements, such as dual left turn lanes for the eastbound approach.

6.6 Niagara Street / North Driveway

Traffic operations at the Niagara Street / North Site Driveway intersection are summarized in Table 16. Analysis has also been provided based on the alternate assignment, under the assumption that the south driveway intersection would be signalized and that drivers making left turns in or out of the site would prefer to do so at a signalized intersection.

Table 16: Niagara Street / North Driveway Intersection Operations

Scenario & Movement	Existing Storage / Link Distance (m)	Weekday AM Peak Hour			Weekday PM Peak Hour		
		v/c	LOS	95th Queue (m)	v/c	LOS	95th Queue (m)
Total 2030 Conditions							
WBLR	25+	0.11	B	3	0.09	B	3
SBL	25+	0.03	B	1	0.08	B	3
Total 2030 Conditions – Alternate Assignment							
WBLR	25+	0.08	B	2	0.07	B	2
SBL	25+	0.00	B	0	0.00	B	0
Total 2035 Conditions							
WBLR	25+	0.12	B	4	0.10	B	3
SBL	25+	0.03	B	1	0.09	B	3
Total 2035 Conditions – Alternate Assignment							
WBLR	25+	0.09	B	3	0.07	B	2
SBL	25+	0.00	B	0	0.00	B	0

During both peak hours, all movements will operate with excess capacity and LOS B or better in both scenarios. All queues will be contained within their respective link distances and storage lengths. Signalization of the south driveway will not result in a noticeable improvement to the north driveway's operations.

7.0 Transportation Demand Management

The proposed site plan incorporates design elements to support pedestrians, cyclists, and transit users to discourage the dependency on motor vehicles. This complements the City's overall transportation vision to achieve a greater sustainable transportation system by promoting and encouraging alternative modes of travel including walking, cycling and transit. To further facilitate other modes of travel and reduce vehicle trips and parking demand, the following are proposed TDM measures:

- Parking spaces will not be bundled with apartments.
- Internal sidewalks will be provided with connections to the existing sidewalk network on Niagara Street.
- Internal secured bicycle storage will be provided within buildings and/or garages for residents.
- Strategically placed outdoor bicycle racks will be provided at ground level near entrances for visitors.
- Bicycle repair stations located adjacent to bicycle storage rooms will be provided for resident's use.
- An information package on available transit/walking/cycling facilities will be provided to residents.
- Transit service real-time displays will be located in the lobbies of all buildings depending on the availability of data from local transit agencies.

- Residents will be provided with a \$25 transit subsidy.

These measures are expected to reduce not only vehicular trips but also parking demand.

8.0 Parking Review

8.1 Vehicle Parking

The City's Zoning By-law 2017-117 (ZBL) was reviewed to determine vehicle parking requirements for the proposed development. The results of the analysis are summarized in Table 17 and the applicable excerpts are provided in Appendix I.

Table 17: Vehicle Parking Requirements

Use	ZBL Use	Size (units or sqm)	Parking Rate	Req'd Spaces	Supply	Deficit / Surplus
Townhouse	Street Townhouse Dwelling	26	1 / unit	26	26	0
Apartment (Building A & B)	Apartment Dwelling (unit < 50 sqm)	250	0.3 / unit	367	657	+48
	Apartment Dwelling	292	1 / unit			
Apartment (Building C)	Apartment Dwelling (unit < 50 sqm)	98	0.3 / unit	242		
	Apartment Dwelling	213	1 / unit			
Residential Subtotal				635	683	+48
Retail	Retail	1,121	1 / 30 sqm	37	40	+3
Total				672	723	+51

Note: As per the ZBL, the minimum number of spaces required is increased to the next highest whole number if the fraction is greater than or equal to 0.5.

The proposed parking supply will have a surplus of 51 parking spaces according to ZBL requirements. The allocation of parking spaces for visitors has not been identified, as this is not a requirement of the ZBL. However, it is recommended to provide a minimum of 10% of the total parking spaces for visitors.

8.2 Accessible Parking Requirements

The ZBL requires a minimum of two barrier free parking space plus one space for every additional 100 required spaces for a parking supply of 100 or more spaces. Therefore, eight barrier free parking spaces are required for the development. The site proposes 11 barrier free parking spaces, which will exceed the ZBL requirement. All barrier free

spaces will be located near main entrances or elevator lobbies within garages for ease of access.

8.3 Bicycle Parking

The ZBL contains bicycle parking requirements for long-term resident spaces and for short-term retail spaces. The resulting bicycle parking requirements for the development are summarized in Table 18.

Table 18: ZBL Bicycle Parking Requirements

Proposed Use	Parking Rate	Required Parking	Proposed Supply	Deficit / Surplus
Townhouse and Apartment Dwelling (379 Units)	0.25 / unit	220	393	+173
Retail (1,121 m ²)	1 per 1,000 m ²	2	2	0
Total		222	395	+173

Note: As per the ZBL, the minimum number of spaces required is increased to the next highest whole number if the fraction is greater than or equal to 0.5.

The proposed long-term spaces will exceed the ZBL requirements and short-term bicycle spaces will meet the ZBL requirements.

8.4 Loading

According to the ZBL, a minimum of one loading space is required in conjunction with every principal building, excluding residential buildings less than four stories high. Therefore, a minimum of three loading spaces will be required according to the ZBL. The proposed supply of loading spaces meets the ZBL requirements. The applicable excerpts from the ZBL are provided in Appendix I.

9.0 Site Plan Review

A review was conducted of the proposed site plan for circulation, access, loading and parking garage layout. The access analysis, utilizing AutoTURN, was conducted for a PTAC or passenger car design vehicle, a refuse pickup truck and delivery vehicle or HSU design vehicle. The site and garage will be able to accommodate all design vehicles as shown in Appendix J.

10.0 Sightline Analysis

A sightline analysis was conducted at the driveway location on Niagara Street opposite Abbey Road. Based on the *Geometric Design Guide for Canadian Roads* from the Transportation Association of Canada (TAC Guide), the minimum required intersection sight distance (ISD) is 150 m and 130 m for left turn and right turn movements,

respectively, and the minimum required stopping sight distance (SSD) is 105 m, considering a design speed of 70 km/h. The available sightline is greater than 300 m and 250 m to the north (left turn) and south (right turn), respectively. The SSD and ISD requirements are met, as shown in the figures provided in Appendix K.

11.0 Conclusions

11.1 Traffic Operations

Under existing and future conditions, all intersections operate and will operate within the Region's threshold capacity and a LOS D or better, except for a few movements at the Niagara Street / Woodlawn Road and Niagara Street / Thorold Road intersections as follows:

Niagara Street / Woodlawn Road

Under existing conditions the following movements are deemed critical based on the Region's TIS Guidelines:

- Eastbound left turn movement operates at threshold capacity with a LOS E during the p.m. peak hour.
- Eastbound through / right turn movement operates with a LOS E, during both peak hours.
- Westbound left turn movement operates with a LOS E during the a.m. peak hour and operates over threshold capacity with a LOS E during the PM peak hour.
- Westbound through and right turn movements operates with a LOS E during the a.m. peak hour.

Under future conditions, the following movements will exceed the Region's threshold capacity, in addition to those identified under existing conditions:

- Eastbound through / right turn movement will operate at threshold capacity with a LOS E by background 2030 during the PM peak hour and over threshold capacity with a LOS E by total 2035 during the a.m. peak hour.
- Westbound left turn movement will operate at theoretical lane capacity (v/c 1.00) with a LOS E by background 2030 during the p.m. peak hour and over threshold capacity with a LOS E by total 2035 during the a.m. peak hour.
- Westbound through movement will operate under threshold capacity, however with a LOS E due to high delay during the p.m. peak hour.
- Northbound through / right turn movement will operate over threshold capacity with a LOS E by total 2030 conditions, during the p.m. peak hour.
- Northbound left turn movement will operate over threshold capacity with a LOS F by total 2035 conditions, during the p.m. peak hour.

- Southbound left turn movement will operate over threshold capacity with a LOS F by total 2030 conditions, during the p.m. peak hour.
- Southbound through / right turn movement will operate over threshold capacity with a LOS E by total 2030 conditions, during the p.m. peak hour.

All queues are and will be contained within their respective link distances and storage lengths, except for the westbound left turn movement, which is already exceeding the storage length under existing conditions during the p.m. peak hour, and the southbound through / right movement, which will exceed its storage length by background 2035 during the p.m. peak hour.

This intersection is currently operating beyond the Region's threshold for some critical movements and additional critical movements are expected to continue to operate beyond the Region's thresholds under future conditions. These conditions are primarily driven by background growth

There is limited opportunity for short-term improvements given the limited available right-of-way and area for widenings, with cemeteries located on the northwest and southeast corners. The Region has indicated that it is possible this intersection could be subject to a future environmental study to consider major improvements. It is recommended that this intersection continue to be monitored by the Region for future improvements.

Niagara Street / Thorold Road

Under existing conditions, the eastbound left turn movement operates over threshold capacity during the a.m. peak hour and operates over threshold capacity with a LOS F during the p.m. peak hour.

Under future conditions, the following movements will exceed the Region's threshold capacity during the p.m. peak hour, in addition to the above movement under existing conditions:

- Westbound through / right turn movement will operate over threshold capacity with a LOS E by background 2030 conditions.
- Northbound left turn movement will operate over threshold capacity with a LOS F by background 2035 conditions.
- Southbound through / right turn movement will operate over threshold capacity by background 2030 conditions and over capacity with a LOS E by background 2035 conditions.

These conditions are primarily driven by background growth.

All queues are and will be contained within their respective link distances and storage lengths.

It is recommended that the Region continue to monitor this intersection for possible future improvements, such as dual left turn lanes for the eastbound approach.

11.2 Signal Warrant Analysis

A signal warrant analysis was conducted for the intersections of Niagara Street / Aqueduct Street (to confirm if the existing signal is still warranted) and at Niagara Street / Abbey Road / South Site Driveway. The analysis indicates that signals are not warranted at either intersection.

Signalization of the south driveway will not result in a noticeable improvement to the north driveway's operations.

11.3 Transportation Demand Management

To further facilitate other modes of travel and reduce vehicle trips and parking demand, the following are proposed TDM measures:

- Parking spaces will not be bundled with apartments.
- Internal sidewalks will be provided with connections to the existing sidewalk network on Niagara Street.
- Internal secured bicycle storage will be provided within buildings and/or garages for residents.
- Strategically placed outdoor bicycle racks will be provided at ground level near the entrances for visitors.
- Bicycle repair stations located adjacent to bicycle storage rooms will be provided for resident's use.
- An information package on available transit / walking / cycling facilities will be provided to residents.
- Transit service real-time displays will be located in the lobbies of all buildings depending on the availability of data from local transit agencies.
- Residents will be provided with a \$25 transit subsidy.

11.4 Parking Review

11.4.1 Vehicle Parking

According to the City's Zoning By-law 2017-117 (ZBL), there will be a surplus of 51 parking spaces. The total of 657 parking spaces in Towers A, B, and C will accommodate both residents and visitors. It is proposed to provide 10% of the total parking supply for visitors.

11.4.2 Barrier Free Parking

According to the ZBL, the development will require 8 barrier free parking spaces and the proposed supply is 11 spaces, which will exceed the ZBL requirements.

11.4.3 Bicycle Parking

The ZBL requires 0.25 long-term, resident, bicycle spaces per unit and one short-term retail bicycle space per 1,000 m². The proposed supply is 2 short term retail spaces and 393 long term resident spaces, which meets or exceeds the required 2 short term retail spaces and 220 long term resident spaces required.

11.4.4 Loading

The proposed three loading spaces will meet the ZBL requirement for a minimum of three loading spaces.

11.5 Site Plan Layout

An access analysis was conducted for the site and parking garages for a PTAC or passenger car design vehicle, refuse pickup truck and delivery vehicle or HSU design vehicle, utilizing AutoTURN. The site and garage can accommodate all expected design vehicles.

11.6 Sightline Analysis

A sightline analysis was conducted at the driveway location on Niagara Street opposite Abbey Road. The available sightline is greater than 300 m and 250 m to the north and south, respectively, which exceeds the required stopping sight distance and intersection sight distances according to the TAC Guide.



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Appendix A

Response to Niagara Region Comments



April 24, 2025

Via: Appendix A of 418-430 Aqueduct St and 650-678 Niagara Street Transportation Study Update

Josh Wilson
Manager (acting), Development Engineering
Niagara Region
1815 Sir Isaac Brock Way
Thorold ON L2V 4T7

Dear Josh:

**Re: 418-430 Aqueduct St & 650-678 Niagara St Response to Additional Transportation Comments
Welland, ON
City File No.: OPA No. 49 & 2024-01
Region File No.: D.10.11.OPA-24-0001 & D.18.11.ZA-24-0003
Project No.: 300052233.0000**

R.J. Burnside & Associates Limited (Burnside) provides this response to Niagara Region's *Additional Transportation Comments*, dated January 27, 2025, on Burnside's Transportation Study, dated November 2023, and Traffic Response Letter, dated September 12, 2024.

The comments have been repeated below in italics with our responses following each set of comments.

1. Constraints at Niagara Street RR 50 and Woodlawn Road RR 41 Intersection

It is acknowledged that this intersection already operates with delays and will be close to capacity in the future background scenario. It is possible this intersection could be subject to a future environmental study to consider major improvements; however no such project is currently included in the Region's 10-year capital budget forecast.

While traffic generated from the proposed development may cause operations to further deteriorate, it is understood that there is limited opportunity for short-term improvements given the limited available right-of-way, with cemeteries located on the NW and SE corners. The revised Transportation Study should comment on these constraints.

Please see Section 6.1 of the Transportation Study Update where these constraints are discussed.

2. Signalization of Middle Access (Private Street B) and Abbey Road

While the included signal warrant analysis indicates that traffic signals are not justified, the trip assignment figures appear to have underestimated traffic volumes under this scenario. The Region believes the majority of inbound and outbound left turning movements would utilize the signalized access during peak hours, were it provided. The revised Transportation Study should provide updated trip generation and distribution figures for this scenario and include a revised signal warrant analysis.

The revised Transportation Study should also provide updated capacity analysis and queue assessment for the signalized scenario to address the following:

- a) Whether the signalized access would benefit from two outbound lanes (e.g., through/right & left) based on the 95th percentile queue lengths.*
- b) Whether a second access (the north access) remains justified, and if so whether it could be restricted to right-in/right-out, which would be the Region's preference.*

The revised Transportation Study has been updated to include an analysis scenario where site traffic has been assigned such that all traffic making left turn in or out of the north driveway would use the south driveway instead (except for 1 left turn in and 1 left turn out), assuming the south driveway were to be signalized. This analysis has been provided in Section 6.2. A signal warrant analysis for this scenario was also provided in Section 6.2.1.

Rerouting left turns from the north driveway to the south driveway was found to have negligible impacts on the operations of the north driveway, indicating that restricting this access to right-in/right-out is not necessary.

With the additional left turns at the south driveway, a traffic signal warrant continues to not be met. Signalizing the intersection result in traffic operations meeting the Region's threshold for LOS due to the different requirements for signalized versus unsignalized intersections. However, considering maximum delays, the intersection would have delays up to 38.5 seconds if signalized compared to 28.2 seconds if unsignalized.

This intersection is proposed to have two outbound lanes (a westbound left turn lane and shared through/right turn lane). All analysis was completed with this future configuration.

3. Modal Split and Active Transportation

The response letter states, "In our opinion, a 15% non-auto mode share is therefore conservative. The site is designed to encourage many modes of travel other than the single occupant motor vehicle and the site is located close to many commercial retail locations, including being within a 10-minute walk of the Seaway Mall where there is a bus hub.

The Region does not support this statement as it does not reflect the existing modal split pattern given the current state of transit and cycling infrastructure. The Seaway Mall bus hub is not within close enough proximity in the Region's opinion to support this mode share.

The Region also does not agree that the TTS transit split of 11% is directly applicable in this context. This figure is significantly influenced by student-driven transit use, which may not accurately reflect the broader transit usage patterns for this development. The lack of nearby institutional land uses and limited active transportation infrastructure further reduces the likelihood of achieving such a mode share in this area.

While the Region acknowledges and supports the initiative to promote alternative travel modes such as cycling and walking, there are no plans to construct active transportation infrastructure on Niagara St. in the short term. As such, the Region requests the revised Transportation Study use modal split of 10% (rather than 15%) to convey current and anticipated traffic patterns more accurately.

The modal split used in the analysis was revised to 10%.

4. Region's Traffic Counts

The Region regularly updates its turning movement count database as part of its Traffic Data Collection Program. Coincidentally, the latest TMC for Niagara Street (RR 50) and Woodlawn Road (RR 41) intersection was conducted on Wednesday October 11th, 2023, one week after those conducted by Pyramid Traffic Inc. for the purposes of the TIS.

It is noted that the Region's TMC shows higher traffic volumes than that recorded by Pyramid Traffic Inc. The Region asks that the consultant review and compare the traffic counts to provide some rationale for the discrepancy. Without suitable rationale, the Region may require that the analysis to be revised using the Region's traffic counts to ensure accuracy and consistency.

Please note the Region also has TMCs for the following intersections:

- *Niagara Street RR50 and Thorold Road – TMC August 9th, 2023*
- *Niagara Street RR50 and Aqueduct Street – TMC November 19th, 2024*

Pyramid Traffic Inc. also collected a TMC at the Niagara Street / Woodlawn Road intersection on April 23, 2024. After receiving confirmation from the Region via email on March 19, 2025, the analysis was updated to use this most recent count.

5. Background Development and EMME Growth Rates

Section 3.5 of the Transportation Study states, "Based on consultation with the Region and the City, no background developments were identified within the proximity of the site during the study horizon years."

This statement could be interpreted incorrectly to mean that the traffic analysis accounted for no future development growth. The traffic growth estimates were informed by the Region's EMME travel demand model, which reflects anticipated population and employment forecasts and therefore inherently account for other planned developments. The revised Transportation Study should update this messaging to clarify this point.

Please see Section 3.5 (Background Developments), which has been updated to provide clarification.

Should you require any clarification on the above, please contact either of the undersigned.

Yours truly,

R.J. Burnside & Associates Limited



Rebecca Rust
Transportation Planner
RR/DWA:ao/cvh



David Angelakis, C.E.T.
Senior Project Manager – Transportation

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Appendix A_LTR_Response to Comments
24/04/2025 9:07 AM



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Appendix B

Existing Traffic Counts and Signal Timings

Niagara St @ Woodlawn Rd

Morning Peak Diagram

Specified Period

From: 7:00:00

To: 9:00:00

One Hour Peak

From: 8:00:00

To: 9:00:00

Municipality: Welland

Site #: 0000000001

Intersection: Niagara St & Woodlawn Rd

TFR File #: 1

Count date: 23-Apr-2024

Weather conditions:

Cloudy/Dry

Person(s) who counted:

Pyramid Traffic Inc

** Signalized Intersection **

Major Road: Niagara St runs N/S

North Leg Total: 1282

North Entering: 495

North Peds: 4

Peds Cross: $\times$

Heavys	10	16	10	36
Trucks	0	0	0	0
Cars	121	267	71	459
Totals	131	283	81	



Heavys 18

Trucks 0

Cars 769

Totals 787

East Leg Total: 1198

East Entering: 514

East Peds: 9

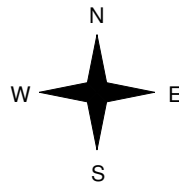
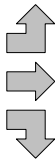
Peds Cross: $\times$

Heavys	Trucks	Cars	Totals
19	0	412	431



Woodlawn Rd

Heavys	Trucks	Cars	Totals
6	0	223	229
10	0	346	356
5	0	107	112
21	0	676	



Niagara St



Cars	Trucks	Heavys	Totals
111	0	0	111
228	0	7	235
166	0	2	168
505	0	9	

Woodlawn Rd



Cars	Trucks	Heavys	Totals
660	0	24	684

Peds Cross: $\times$

West Peds: 3

West Entering: 697

West Leg Total: 1128

Cars	540	Cars	63	435	243	741
Trucks	0	Trucks	0	0	0	0
Heavys	23	Heavys	2	12	4	18
Totals	563	Totals	65	447	247	



Peds Cross: $\times$

South Peds: 2

South Entering: 759

South Leg Total: 1322

Comments

Niagara St @ Woodlawn Rd

Afternoon Peak Diagram

Specified Period

From: 16:00:00

To: 18:00:00

One Hour Peak

From: 16:00:00

To: 17:00:00

Municipality: Welland

Site #: 0000000001

Intersection: Niagara St & Woodlawn Rd

TFR File #: 1

Count date: 23-Apr-2024

Weather conditions:

Cloudy/Dry

Person(s) who counted:

Pyramid Traffic Inc

** Signalized Intersection **

Major Road: Niagara St runs N/S

North Leg Total: 1992

North Entering: 1057

North Peds: 17

Peds Cross: $\times$

	Heavys	Trucks	Cars	Totals
North	3	0	266	269
East	6	0	601	607
South	5	0	176	181
West	14	0	1043	1057



	Heavys	Trucks	Cars	Totals
North	16	0	919	935

East Leg Total: 1813

East Entering: 1018

East Peds: 21

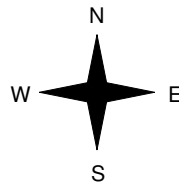
Peds Cross: $\times$

Heavys	Trucks	Cars	Totals
13	0	850	863



Woodlawn Rd

Heavys	Trucks	Cars	Totals
4	0	264	268
10	0	340	350
3	0	75	78
17	0	679	696



Niagara St



Cars	Trucks	Heavys	Totals
159	0	2	161
499	0	9	508
347	0	2	349
1005	0	13	1018

Woodlawn Rd



Cars	Trucks	Heavys	Totals
778	0	17	795

Peds Cross: $\times$

West Peds: 14

West Entering: 696

West Leg Total: 1559

	Cars	Trucks	Heavys	Totals
West	1023	0	11	1034
South	85	0	1	86
East	496	0	10	506
North	262	0	2	264
Totals	843	0	13	856



Peds Cross: $\times$

South Peds: 12

South Entering: 856

South Leg Total: 1890

Comments

Niagara St @ Abbey Rd

Morning Peak Diagram

Specified Period

From: 7:00:00

To: 9:00:00

One Hour Peak

From: 7:45:00

To: 8:45:00

Municipality: Welland

Site #: 0000000002

Intersection: Niagara St & Abbey Rd

TFR File #: 2

Count date: 4-Oct-2023

Weather conditions:

Clear/Dry

Person(s) who counted:

Cam

** Non-Signalized Intersection **

Major Road: Niagara St runs N/S

North Leg Total: 1277

North Entering: 573

North Peds: 0

Peds Cross: 

Heavys 0 18

Trucks 0 6

Cars 3 546

Totals 3 570

18

6

549



Heavys 21

Trucks 2

Cars 681

Totals 704

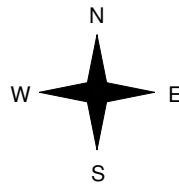
Heavys Trucks Cars Totals
0 0 13 13



Abbey Rd

Heavys Trucks Cars Totals
0 0 3 3

0 2 15 17
0 2 18



Niagara St



Peds Cross: 

West Peds: 5

West Entering: 20

West Leg Total: 33

Cars 561

Trucks 8

Heavys 18

Totals 587



Cars 10 678

Trucks 0 2

Heavys 0 21

Totals 10 701

688

2

21

Peds Cross: 

South Peds: 0

South Entering: 711

South Leg Total: 1298

Comments

Niagara St @ Abbey Rd

Afternoon Peak Diagram

Specified Period

From: 16:00:00

To: 18:00:00

One Hour Peak

From: 16:15:00

To: 17:15:00

Municipality: Welland

Site #: 0000000002

Intersection: Niagara St & Abbey Rd

TFR File #: 2

Count date: 4-Oct-2023

Weather conditions:

Clear/Dry

Person(s) who counted:

Cam

** Non-Signalized Intersection **

Major Road: Niagara St runs N/S

North Leg Total: 1931

North Entering: 1074

North Peds: 0

Peds Cross: 

Heavys	0	10	10
Trucks	0	5	5
Cars	27	1032	1059
Totals	27	1047	

10
5
1059



Heavys	9
Trucks	9
Cars	839
Totals	857

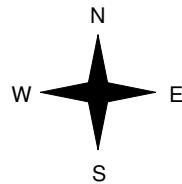
Heavys	Trucks	Cars	Totals
0	0	36	36



Niagara St



Abbey Rd



Heavys	Trucks	Cars	Totals
0	0	9	9
0	0	23	23
0	0	32	



Niagara St



Peds Cross: 

West Peds: 19

West Entering: 32

West Leg Total: 68

Cars	1055
Trucks	5
Heavys	10
Totals	1070



Cars	9	830	839
Trucks	0	9	9
Heavys	0	9	9
Totals	9	848	

Peds Cross: 

South Peds: 0

South Entering: 857

South Leg Total: 1927

Comments

Niagara St @ Aqueduct St

Morning Peak Diagram

Specified Period

From: 7:00:00

To: 9:00:00

One Hour Peak

From: 7:45:00

To: 8:45:00

Municipality: Welland

Site #: 0000000003

Intersection: Niagara St & Aqueduct St

TFR File #: 3

Count date: 4-Oct-2023

Weather conditions:

Clear/Dry

Person(s) who counted:

Cam

** Signalized Intersection **

Major Road: Niagara St runs N/S

North Leg Total: 1295

North Entering: 573

North Peds: 2

Peds Cross: $\times$

Heavys	0	17	1	18
Trucks	0	10	0	10
Cars	58	391	96	545
Totals	58	418	97	

Heavys 20

Trucks 4

Cars 698

Totals 722

East Leg Total: 258

East Entering: 150

East Peds: 2

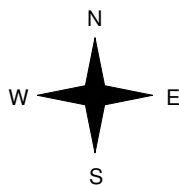
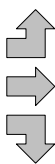
Peds Cross: $\times$

Heavys	Trucks	Cars	Totals
0	0	99	99



Driveway

Heavys	Trucks	Cars	Totals
0	0	51	51
0	0	3	3
0	0	41	41
0	0	95	



Niagara St

Cars	Trucks	Heavys	Totals
129	1	2	132
9	0	0	9
9	0	0	9
147	1	2	

Aqueduct St



Cars	Trucks	Heavys	Totals
107	0	1	108

Peds Cross: $\times$

West Peds: 4

West Entering: 95

West Leg Total: 194

Cars	441	Cars	32	518	8	558
Trucks	10	Trucks	0	3	0	3
Heavys	17	Heavys	0	18	0	18
Totals	468	Totals	32	539	8	



Peds Cross: $\times$

South Peds: 2

South Entering: 579

South Leg Total: 1047

Comments

Niagara St @ Aqueduct St

Afternoon Peak Diagram

Specified Period

From: 16:00:00

To: 18:00:00

One Hour Peak

From: 16:15:00

To: 17:15:00

Municipality: Welland

Site #: 0000000003

Intersection: Niagara St & Aqueduct St

TFR File #: 3

Count date: 4-Oct-2023

Weather conditions:

Clear/Dry

Person(s) who counted:

Cam

** Signalized Intersection **

Major Road: Niagara St runs N/S

North Leg Total: 1922

North Entering: 1066

North Peds: 2

Peds Cross: $\times$

Heavys	0	8	0	8
Trucks	0	7	0	7
Cars	44	925	82	1051
Totals	44	940	82	



Heavys	7
Trucks	9
Cars	840
Totals	856

East Leg Total: 178

East Entering: 77

East Peds: 14

Peds Cross: $\times$

Heavys	0
Trucks	0
Cars	79
Totals	79

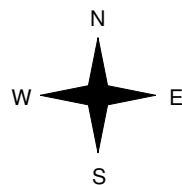
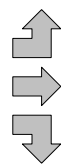


Niagara St



Driveway

Heavys	0
Trucks	0
Cars	37
Totals	37
Heavys	0
Trucks	0
Cars	1
Totals	1
Heavys	0
Trucks	0
Cars	35
Totals	35
Heavys	0
Trucks	0
Cars	73
Totals	73



Cars	63
Trucks	0
Heavys	0
Totals	63
Cars	2
Trucks	0
Heavys	0
Totals	2
Cars	12
Trucks	0
Heavys	0
Totals	12
Cars	77
Trucks	0
Heavys	0
Totals	77

Aqueduct St



Cars	101
Trucks	0
Heavys	0
Totals	101

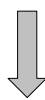
Peds Cross: $\times$

West Peds: 12

West Entering: 73

West Leg Total: 152

Cars	972
Trucks	7
Heavys	8
Totals	987
Cars	33
Trucks	0
Heavys	0
Totals	33
Cars	740
Trucks	9
Heavys	7
Totals	756
Cars	18
Trucks	0
Heavys	0
Totals	18
Cars	791
Trucks	9
Heavys	7
Totals	807



Niagara St



Peds Cross: $\times$

South Peds: 6

South Entering: 807

South Leg Total: 1794

Comments

Niagara St @ Roger Dr

Morning Peak Diagram

Specified Period

From: 7:00:00

To: 9:00:00

One Hour Peak

From: 8:00:00

To: 9:00:00

Municipality: Welland

Site #: 0000000002

Intersection: Niagara St & Roger Dr

TFR File #: 2

Count date: 23-Apr-2024

Weather conditions:

Cloudy/Dry

Person(s) who counted:

Pyramid Traffic Inc

** Non-Signalized Intersection **

Major Road: Niagara St runs N/S

North Leg Total: 1093

North Entering: 464

North Peds: 1

Peds Cross: $\times$

Heavys	2	20	0	22
Trucks	0	0	0	0
Cars	61	380	1	442
Totals	63	400	1	



Heavys 14

Trucks 0

Cars 615

Totals 629

East Leg Total: 11

East Entering: 2

East Peds: 4

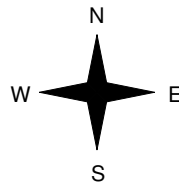
Peds Cross: $\times$

Heavys	Trucks	Cars	Totals
2	0	96	98



Roger Dr

Heavys	Trucks	Cars	Totals
0	0	16	16
0	0	0	0
1	0	30	31
1	0	46	



Niagara St

Cars	Trucks	Heavys	Totals
1	0	0	1
0	0	0	0
1	0	0	1
2	0	0	

Driveway



Cars	Trucks	Heavys	Totals
9	0	0	9

Peds Cross: $\times$

West Peds: 6

West Entering: 47

West Leg Total: 145

Cars	411	Cars	35	598	8	641
Trucks	0	Trucks	0	0	0	0
Heavys	21	Heavys	0	14	0	14
Totals	432	Totals	35	612	8	



Peds Cross: $\times$

South Peds: 0

South Entering: 655

South Leg Total: 1087

Comments

Niagara St @ Roger Dr

Afternoon Peak Diagram

Specified Period

From: 16:00:00

To: 18:00:00

One Hour Peak

From: 16:00:00

To: 17:00:00

Municipality: Welland

Site #: 0000000002

Intersection: Niagara St & Roger Dr

TFR File #: 2

Count date: 23-Apr-2024

Weather conditions:

Cloudy/Dry

Person(s) who counted:

Pyramid Traffic Inc

** Non-Signalized Intersection **

Major Road: Niagara St runs N/S

North Leg Total: 1732

North Entering: 961

North Peds: 2

Peds Cross: $\times$

	Heavys	Trucks	Cars	Totals
North	0	10	0	10
East	0	0	0	0
South	68	869	14	951
Totals	68	879	14	



	Heavys	Trucks	Cars	Totals
North	11	0	760	771
East	0	0	0	0
South	0	0	0	0
Totals	11	0	760	771

East Leg Total: 77

East Entering: 37

East Peds: 7

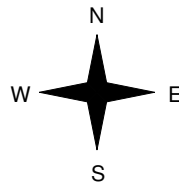
Peds Cross: $\times$

Heavys	Trucks	Cars	Totals
0	0	108	108



Roger Dr

Heavys	Trucks	Cars	Totals
0	0	21	21
0	0	3	3
0	0	36	36
0	0	60	



Niagara St

Cars	Trucks	Heavys	Totals
18	0	0	18
2	0	0	2
17	0	0	17
37	0	0	

Driveway



Cars	Trucks	Heavys	Totals
40	0	0	40

Peds Cross: $\times$

West Peds: 8

West Entering: 60

West Leg Total: 168

Cars	Trucks	Heavys	Totals
922	0	10	932
38	0	0	38
721	0	11	732
23	0	0	23
782	0	11	



Peds Cross: $\times$

South Peds: 1

South Entering: 793

South Leg Total: 1725

Comments

Niagara St @ Thorold Rd

Morning Peak Diagram

Specified Period

From: 7:00:00

To: 9:00:00

One Hour Peak

From: 7:45:00

To: 8:45:00

Municipality: Welland

Site #: 0000000004

Intersection: Niagara St & Thorold Rd

TFR File #: 4

Count date: 4-Oct-2023

Weather conditions:

Clear/Dry

Person(s) who counted:

Cam

** Signalized Intersection **

Major Road: Niagara St runs N/S

North Leg Total: 1122

North Entering: 482

North Peds: 13

Peds Cross: $\times$

Heavys	3	5	8	16
Trucks	4	3	1	8
Cars	171	230	57	458
Totals	178	238	66	

Heavys 18

Trucks 3

Cars 619

Totals 640

East Leg Total: 497

East Entering: 246

East Peds: 5

Peds Cross: $\times$

Heavys	Trucks	Cars	Totals
22	5	350	377



Thorold Rd

Heavys	Trucks	Cars	Totals
4	2	248	254
18	0	127	145
8	1	74	83
30	3	449	

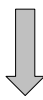
Peds Cross: $\times$

West Peds: 8

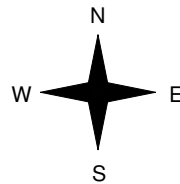
West Entering: 482

West Leg Total: 859

Cars	335	Cars	71	283	27	381
Trucks	5	Trucks	1	0	2	3
Heavys	16	Heavys	11	8	11	30
Totals	356	Totals	83	291	40	



Niagara St



Cars	Trucks	Heavys	Totals
88	1	6	95
108	0	8	116
31	1	3	35
227	2	17	

Thorold Rd



Cars	Trucks	Heavys	Totals
211	3	37	251

Peds Cross: $\times$

South Peds: 8

South Entering: 414

South Leg Total: 770

Comments

Niagara St @ Thorold Rd

Afternoon Peak Diagram

Specified Period

From: 16:00:00

To: 18:00:00

One Hour Peak

From: 16:15:00

To: 17:15:00

Municipality: Welland

Site #: 0000000004

Intersection: Niagara St & Thorold Rd

TFR File #: 4

Count date: 4-Oct-2023

Weather conditions:

Clear/Dry

Person(s) who counted:

Cam

** Signalized Intersection **

Major Road: Niagara St runs N/S

North Leg Total: 1777

North Entering: 975

North Peds: 11

Peds Cross: $\times$

Heavys	3	2	3	8
Trucks	1	3	3	7
Cars	398	478	84	960
Totals	402	483	90	

Heavys 10

Trucks 7

Cars 785

Totals 802

East Leg Total: 595

East Entering: 315

East Peds: 11

Peds Cross: $\times$

Heavys	Trucks	Cars	Totals
14	1	653	668

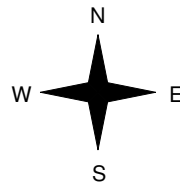


Thorold Rd

Heavys	Trucks	Cars	Totals
3	3	294	300
2	0	133	135
6	0	67	73
11	3	494	



Niagara St



Cars	Trucks	Heavys	Totals
83	3	2	88
138	0	1	139
88	0	0	88
309	3	3	



Thorold Rd

Cars	Trucks	Heavys	Totals
271	3	6	280

Peds Cross: $\times$

West Peds: 12

West Entering: 508

West Leg Total: 1176

Cars	633	Cars	117	408	54	579
Trucks	3	Trucks	0	1	0	1
Heavys	8	Heavys	10	5	1	16
Totals	644	Totals	127	414	55	



Peds Cross: $\times$

South Peds: 18

South Entering: 596

South Leg Total: 1240

Comments

Signal Code: 041050**Intersection: RR41 (WOODLAWN RD) & RR50 (NIAGARA ST)****Municipality: welland****Owner: region****Last Modified: 2023-10-27 3:14:57 PM**

Timing Parameters	NBD & SBD ADVANCE NIAGARA ST.	NBD & SBD NIAGARA ST.	WBD & EBD ADVANCE WOODLAWN RD.	EBD & WBD WOODLAWN RD.	n/a	n/a
Min Green	6	10	6	8	0	0
Walk	0	12	0	12	0	0
Ped Clearance	0	20	0	20	0	0
Vehicle Ext.	2.6	2.5	2.6	2.5	0	0
Max Green	17	50	35	35	0	0
Yellow	3	4.1	3	4.1	0	0
All Red	0	3.2	0	3.3	0	0
Offset						
Minimum Cycle			32.7	0		
Pedestrian Cycle			78.7			
Maximum Cycle			157.7	0		
Operation			FA			
Installed On:			2011-08-02			
Count Date:			2010-06-29			
FA = Fully Actuated		SA = Semi Actuated		FT = Fixed Time		
Copyright 2001 © Regional Niagara						

Signal Code: 050AQU**Intersection: RR50 (NIAGARA ST.) & AQUEDUCT ST.****Municipality: welland****Owner: region****Last Modified: 2020-07-14 12:48:24 PM**

Timing Parameters	NBD & SBD THRU NIAGARA ST.	EBD & WBD THRU MCDONALDS / AQUEDUCT ST.	n/a	n/a	n/a	n/a
Min Green	10	8	0	0	0	0
Walk	12	12	0	0	0	0
Ped Clearance	18	18	0	0	0	0
Vehicle Ext.	3	4	0	0	0	0
Max Green	45	25	0	0	0	0
Yellow	4.1	4.1	0	0	0	0
All Red	3	3	0	0	0	0

			Offset			
Minimum Cycle		32.2	0			
Pedestrian Cycle		74.2				
Maximum Cycle		84.2	0			
Operation		FA				

Installed On: 2010-06-14

Count Date: 2009-09-03

FA = Fully Actuated

SA = Semi Actuated

FT = Fixed Time

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Signal Code: 050THR**Intersection: RR50(NIAGARA ST.) & THOROLD RD.****Municipality: welland****Owner: Region****Last Modified: 2023-10-30 3:29:52 PM**

Timing Parameters	NBD & SBD ADV. NIAGARA ST.	NBD & SBD THRU NIAGARA ST.	EBD & WBD ADV THOROLD RD.	EBD & WBD THRU THOROLD RD.	n/a	n/a
Min Green	5	8	5	8	0	0
Walk	0	9	0	10	0	0
Ped Clearance	0	15	0	17	0	0
Vehicle Ext.	2.5	2.1	2.5	2.2	0	0
Max Green	12	35	12	27	0	0
Yellow	3	4.1	3	4.1	0	0
All Red	0	2.2	0	2.4	0	0

			Offset
Minimum Cycle			28.8
Pedestrian Cycle			63.8
Maximum Cycle			104.8
Operation			FA

Installed On: 2010-06-11

Count Date: 2009-04-06

FA = Fully Actuated

SA = Semi Actuated

FT = Fixed Time

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BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix C

Existing Traffic Operations

Timings

1: Niagara St. & Woodlawn Rd.

Existing AM

	↖	→	↗	↖	↖	↖	↖	↖	↖
Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations	↖	↖	↖	↖	↖	↖	↖	↖	↖
Traffic Volume (vph)	231	360	170	237	112	66	451	82	286
Future Volume (vph)	231	360	170	237	112	66	451	82	286
Lane Group Flow (vph)	251	514	185	258	122	72	761	89	454
Turn Type	pm+pt	NA	pm+pt	NA	Perm	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8		5	2	1	6
Permitted Phases	4		8		8	2		6	
Detector Phase	7	4	3	8	8	5	2	1	6
Switch Phase									
Minimum Initial (s)	6.0	8.0	6.0	8.0	8.0	6.0	10.0	6.0	10.0
Minimum Split (s)	9.0	39.4	9.0	39.4	39.4	9.0	39.3	9.0	39.3
Total Split (s)	38.0	42.4	38.0	42.4	42.4	20.0	57.3	20.0	57.3
Total Split (%)	24.1%	26.9%	24.1%	26.9%	26.9%	12.7%	36.3%	12.7%	36.3%
Yellow Time (s)	3.0	4.1	3.0	4.1	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	3.3	0.0	3.3	3.3	0.0	3.2	0.0	3.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	7.4	3.0	7.4	7.4	3.0	7.3	3.0	7.3
Lead/Lag	Lead	Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.66	0.84	0.69	0.52	0.41	0.15	0.48	0.28	0.29
Control Delay (s/veh)	46.6	71.2	49.6	64.9	13.1	15.7	26.2	17.3	22.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	46.6	71.2	49.6	64.9	13.1	15.7	26.2	17.3	22.0
Queue Length 50th (m)	60.7	79.3	42.4	39.7	0.0	8.9	73.0	11.2	37.3
Queue Length 95th (m)	76.6	95.1	55.9	52.5	18.3	19.5	110.6	23.5	59.7
Internal Link Dist (m)		245.8		240.0			194.1		161.2
Turn Bay Length (m)	111.0		87.0		132.0	97.0		133.0	
Base Capacity (vph)	437	729	409	735	375	544	1598	366	1566
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.57	0.71	0.45	0.35	0.33	0.13	0.48	0.24	0.29

Intersection Summary

Cycle Length: 157.7

Actuated Cycle Length: 157.7

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 100

Control Type: Actuated-Coordinated

Splits and Phases: 1: Niagara St. & Woodlawn Rd.

052233 418-430 Aqueduct and 650-678 Niagara Street.syn
R.J. Burnside & AssociatesSynchro 12 Report
04/04/2025 - Page 1

HCM Signalized Intersection Capacity Analysis

1: Niagara St. & Woodlawn Rd.

Existing AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	231	360	113	170	237	112	66	451	249	82	286	132
Future Volume (vph)	231	360	113	170	237	112	66	451	249	82	286	132
Ideal Flow (vphpl)	1651	1776	1535	1651	1776	1498	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00		1.00	1.00	0.98	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.96		1.00	1.00	0.85	1.00	0.95		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1537	3175		1570	3313	1265	1538	3118		1415	3033	
Flt Permitted	0.45	1.00		0.28	1.00	1.00	0.47	1.00		0.29	1.00	
Satd. Flow (perm)	725	3175		460	3313	1265	759	3118		430	3033	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	251	391	123	185	258	122	72	490	271	89	311	143
RTOR Reduction (vph)	0	19	0	0	0	104	0	35	0	0	25	0
Lane Group Flow (vph)	251	495	0	185	258	18	72	726	0	89	429	0
Confl. Peds. (#/hr)	4		2	2		4	3		9	9		3
Heavy Vehicles (%)	3%	3%	4%	1%	3%	0%	3%	3%	2%	12%	6%	8%
Turn Type	pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8		8	2			6		
Actuated Green, G (s)	51.5	29.6		42.7	23.8	23.8	87.4	79.0		89.6	80.1	
Effective Green, g (s)	51.5	29.6		42.7	23.8	23.8	87.4	79.0		89.6	80.1	
Actuated g/C Ratio	0.33	0.19		0.27	0.15	0.15	0.55	0.50		0.57	0.51	
Clearance Time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3	
Vehicle Extension (s)	2.6	2.5		2.6	2.5	2.5	2.6	2.5		2.6	2.5	
Lane Grp Cap (vph)	363	595		257	499	190	462	1561		303	1540	
v/s Ratio Prot	c0.11	c0.16		c0.09	0.08		0.01	c0.23		c0.02	0.14	
v/s Ratio Perm	0.12			0.11		0.01	0.08			0.15		
v/c Ratio	0.69	0.83		0.72	0.52	0.10	0.16	0.47		0.29	0.28	
Uniform Delay, d1	42.9	61.6		47.9	61.7	57.7	16.5	25.6		16.7	22.2	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	5.3	9.5		8.8	0.7	0.2	0.1	1.0		0.4	0.5	
Delay (s)	48.2	71.1		56.7	62.3	57.9	16.6	26.6		17.1	22.7	
Level of Service	D	E		E	E	E	B	C		B	C	
Approach Delay (s/veh)		63.6			59.5			25.7			21.8	
Approach LOS		E			E			C			C	

Intersection Summary

HCM 2000 Control Delay (s/veh)	42.7	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	157.7	Sum of lost time (s)	20.7
Intersection Capacity Utilization	77.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

052233 418-430 Aqueduct and 650-678 Niagara Street.syn
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HCM Unsignalized Intersection Capacity Analysis
3: Niagara St. & Abbey Rd.

Existing AM

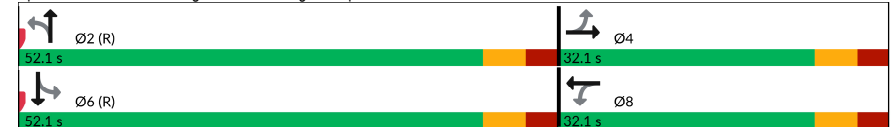
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	3	17	10	729	593	3
Future Volume (Veh/h)	3	17	10	729	593	3
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	18	11	792	645	3
Pedestrians	5					
Lane Width (m)	3.7					
Walking Speed (m/s)	1.1					
Percent Blockage	0					
Right turn flare (veh)						
Median type				TWLT	TWLT	
Median storage (veh)				2	2	
Upstream signal (m)				137	319	
pX, platoon unblocked	0.95					
vC, conflicting volume	1070	329	653			
vC1, stage 1 conf vol	652					
vC2, stage 2 conf vol	418					
vCu, unblocked vol	973	329	653			
tC, single (s)	6.8	7.1	4.1			
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.4	2.2			
p0 queue free %	99	97	99			
cM capacity (veh/h)	434	635	939			
Direction, Lane #	EB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	21	11	396	396	430	218
Volume Left	3	11	0	0	0	0
Volume Right	18	0	0	0	0	3
cSH	596	939	1700	1700	1700	1700
Volume to Capacity	0.04	0.01	0.23	0.23	0.25	0.13
Queue Length 95th (m)	0.8	0.3	0.0	0.0	0.0	0.0
Control Delay (s/veh)	11.3	8.9	0.0	0.0	0.0	0.0
Lane LOS	B	A				
Approach Delay (s/veh)	11.3	0.1			0.0	
Approach LOS	B					
Intersection Summary						
Average Delay			0.2			
Intersection Capacity Utilization			31.6%		ICU Level of Service	A
Analysis Period (min)			15			

Timings
4: Niagara St. & Parking Lot/Aqueduct St.

Existing AM

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	53	3	9	9	33	561	101	435
Future Volume (vph)	53	3	9	9	33	561	101	435
Lane Group Flow (vph)	58	50	10	159	36	619	110	538
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA
Protected Phases		4		8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	8	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	8.0	8.0	8.0	8.0	10.0	10.0	10.0	10.0
Minimum Split (s)	15.1	15.1	15.1	15.1	17.1	17.1	17.1	17.1
Total Split (s)	32.1	32.1	32.1	32.1	52.1	52.1	52.1	52.1
Total Split (%)	38.1%	38.1%	38.1%	38.1%	61.9%	61.9%	61.9%	61.9%
Yellow Time (s)	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
All-Red Time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Max	C-Max	C-Max	C-Max
v/c Ratio	0.40	0.23	0.06	0.53	0.07	0.27	0.23	0.24
Control Delay (s/veh)	40.8	13.2	30.8	13.7	5.2	5.4	6.7	5.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	40.8	13.2	30.8	13.7	5.2	5.4	6.7	5.0
Queue Length 50th (m)	8.7	0.4	1.5	1.5	1.5	15.8	5.2	12.7
Queue Length 95th (m)	18.8	9.2	5.5	17.2	5.2	27.6	14.3	22.8
Internal Link Dist (m)		33.7		300.3		252.9		113.5
Turn Bay Length (m)			20.0		90.0		100.0	
Base Capacity (vph)	324	423	358	488	526	2290	481	2226
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.18	0.12	0.03	0.33	0.07	0.27	0.23	0.24
Intersection Summary								
Cycle Length: 84.2								
Actuated Cycle Length: 84.2								
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green								
Natural Cycle: 40								
Control Type: Actuated-Coordinated								

Splits and Phases: 4: Niagara St. & Parking Lot/Aqueduct St.



HCM Signalized Intersection Capacity Analysis
4: Niagara St. & Parking Lot/Aqueduct St.

Existing AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	53	3	43	9	9	137	33	561	8	101	435	60
Future Volume (vph)	53	3	43	9	9	137	33	561	8	101	435	60
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.86		1.00	0.86		1.00	1.00		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1584	1316		1583	1293		1582	3274		1568	3172	
Flt Permitted	0.66	1.00		0.72	1.00		0.45	1.00		0.42	1.00	
Satd. Flow (perm)	1094	1316		1207	1293		752	3274		689	3172	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	58	3	47	10	10	149	36	610	9	110	473	65
RTOR Reduction (vph)	0	41	0	0	129	0	0	1	0	0	8	0
Lane Group Flow (vph)	58	9	0	10	30	0	36	618	0	110	530	0
Confl. Peds. (#/hr)	2		2	2		2	4		2	2		4
Heavy Vehicles (%)	0%	0%	0%	0%	0%	2%	0%	4%	0%	1%	6%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	11.1	11.1		11.1	11.1		58.9	58.9		58.9	58.9	
Effective Green, g (s)	11.1	11.1		11.1	11.1		58.9	58.9		58.9	58.9	
Actuated g/C Ratio	0.13	0.13		0.13	0.13		0.70	0.70		0.70	0.70	
Clearance Time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Vehicle Extension (s)	4.0	4.0		4.0	4.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	144	173		159	170		526	2290		481	2218	
v/s Ratio Prot		0.01			0.02			c0.19			0.17	
v/s Ratio Perm	c0.05			0.01			0.05			0.16		
v/c Ratio	0.40	0.05		0.06	0.17		0.07	0.27		0.23	0.24	
Uniform Delay, d1	33.5	32.0		32.0	32.5		4.0	4.7		4.5	4.6	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.5	0.2		0.2	0.7		0.3	0.3		1.1	0.3	
Delay (s)	36.0	32.1		32.2	33.1		4.2	5.0		5.6	4.8	
Level of Service	D	C		C	C		A	A		A	A	
Approach Delay (s/veh)		34.2			33.1			4.9			5.0	
Approach LOS		C			C			A			A	
Intersection Summary												
HCM 2000 Control Delay (s/veh)	10.0			HCM 2000 Level of Service				A				
HCM 2000 Volume to Capacity ratio	0.29											
Actuated Cycle Length (s)	84.2			Sum of lost time (s)				14.2				
Intersection Capacity Utilization	75.8%			ICU Level of Service				D				
Analysis Period (min)	15											
c Critical Lane Group												

Timings
5: Niagara St/Niagara St. & Thorold Rd

Existing AM

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations	↰	↱	↰	↱	↰	↱	↰	↱
Traffic Volume (vph)	259	148	36	118	85	297	67	243
Future Volume (vph)	259	148	36	118	85	297	67	243
Lane Group Flow (vph)	282	253	39	233	92	368	73	462
Turn Type	pm+pt	NA	pm+pt	NA	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8	5	2	1	6
Permitted Phases	4		8		2		6	
Detector Phase	7	4	3	8	5	2	1	6
Switch Phase								
Minimum Initial (s)	5.0	8.0	5.0	8.0	5.0	8.0	5.0	8.0
Minimum Split (s)	8.0	33.5	8.0	33.5	8.0	30.3	8.0	30.3
Total Split (s)	15.0	33.5	15.0	33.5	15.0	41.3	15.0	41.3
Total Split (%)	14.3%	32.0%	14.3%	32.0%	14.3%	39.4%	14.3%	39.4%
Yellow Time (s)	3.0	4.1	3.0	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	2.4	0.0	2.4	0.0	2.2	0.0	2.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.5	3.0	6.5	3.0	6.3	3.0	6.3
Lead/Lag	Lead	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.85	0.68	0.13	0.83	0.22	0.25	0.16	0.31
Control Delay (s/veh)	49.4	40.9	20.7	56.5	13.0	19.3	12.6	12.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	49.4	40.9	20.7	56.5	13.0	19.3	12.6	12.6
Queue Length 50th (m)	43.7	43.2	5.1	38.6	8.1	23.1	6.3	17.2
Queue Length 95th (m)	#67.0	67.6	10.7	61.2	18.1	39.6	14.9	34.1
Internal Link Dist (m)		152.6		154.0		97.6		318.5
Turn Bay Length (m)	70.0		67.0		85.0		60.0	
Base Capacity (vph)	333	377	363	372	459	1448	512	1486
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.85	0.67	0.11	0.63	0.20	0.25	0.14	0.31
Intersection Summary								
Cycle Length: 104.8								
Actuated Cycle Length: 104.8								
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green								
Natural Cycle: 80								
Control Type: Actuated-Coordinated								
# 95th percentile volume exceeds capacity, queue may be longer.								
Queue shown is maximum after two cycles.								

Splits and Phases: 5: Niagara St/Niagara St. & Thorold Rd



HCM Signalized Intersection Capacity Analysis
5: Niagara St/Niagara St. & Thorold Rd

Existing AM

	↖	→	↗	↖	←	↖	↖	↑	↗	↘	↓	↙
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖	↖		↖	↖		↖	↖		↖	↖	
Traffic Volume (vph)	259	148	85	36	118	97	85	297	41	67	243	182
Future Volume (vph)	259	148	85	36	118	97	85	297	41	67	243	182
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	0.98	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.95		1.00	0.93		1.00	0.98		1.00	0.94	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1550	1304		1423	1336		1386	3128		1386	3038	
Flt Permitted	0.38	1.00		0.60	1.00		0.45	1.00		0.53	1.00	
Satd. Flow (perm)	625	1304		902	1336		654	3128		777	3038	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	282	161	92	39	128	105	92	323	45	73	264	198
RTOR Reduction (vph)	0	19	0	0	30	0	0	9	0	0	110	0
Lane Group Flow (vph)	282	234	0	39	203	0	92	359	0	73	352	0
Confl. Peds. (#/hr)	13		8	8		13	8		5	5		8
Heavy Vehicles (%)	2%	12%	11%	11%	7%	7%	14%	3%	33%	14%	3%	4%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	35.9	28.3		25.5	20.9		53.8	46.5		52.4	45.8	
Effective Green, g (s)	35.9	28.3		25.5	20.9		53.8	46.5		52.4	45.8	
Actuated g/C Ratio	0.34	0.27		0.24	0.20		0.51	0.44		0.50	0.44	
Clearance Time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Vehicle Extension (s)	2.5	2.2		2.5	2.2		2.5	2.1		2.5	2.1	
Lane Grp Cap (vph)	320	352		242	266		386	1387		426	1327	
v/s Ratio Prot	c0.10	0.18		0.01	0.15		c0.02	0.11		0.01	c0.12	
v/s Ratio Perm	c0.20			0.03			0.11			0.07		
v/c Ratio	0.88	0.66		0.16	0.76		0.24	0.26		0.17	0.27	
Uniform Delay, d1	30.2	34.0		30.8	39.6		13.4	18.3		13.8	18.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	23.4	3.9		0.2	11.2		0.2	0.5		0.1	0.5	
Delay (s)	53.5	37.9		31.1	50.8		13.6	18.8		14.0	19.3	
Level of Service	D	D		C	D		B	B		B	B	
Approach Delay (s/veh)		46.1			48.0			17.7			18.5	
Approach LOS		D			D			B			B	
Intersection Summary												
HCM 2000 Control Delay (s/veh)		31.0			HCM 2000 Level of Service			C				
HCM 2000 Volume to Capacity ratio		0.53										
Actuated Cycle Length (s)		104.8			Sum of lost time (s)			18.8				
Intersection Capacity Utilization		77.3%			ICU Level of Service			D				
Analysis Period (min)		15										
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis
6: Niagara St. & Roger Dr.

Existing AM

	↖	↗	↖	↑	↓	↙
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↖		↖	↑	↑	
Traffic Volume (veh/h)	16	31	35	624	408	63
Future Volume (Veh/h)	16	31	35	624	408	63
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	17	34	38	678	443	68
Pedestrians	6				1	
Lane Width (m)	3.7				3.7	
Walking Speed (m/s)	1.1				1.1	
Percent Blockage	1				0	
Right turn flare (veh)						
Median type				TWLT	TWLT	
Median storage (veh)				2	2	
Upstream signal (m)				343	277	
pX, platoon unblocked						
vC, conflicting volume	899	262	517			
vC1, stage 1 conf vol	483					
vC2, stage 2 conf vol	416					
vCu, unblocked vol	899	262	517			
tC, single (s)	6.8	7.0	4.1			
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	95	96			
cM capacity (veh/h)	480	730	1053			
Direction, Lane #	EB 1	NB 1	NB 3	SB 1	SB 2	
Volume Total	51	38	339	339	295	216
Volume Left	17	38	0	0	0	0
Volume Right	34	0	0	0	0	68
cSH	622	1053	1700	1700	1700	1700
Volume to Capacity	0.08	0.04	0.20	0.20	0.17	0.13
Queue Length 95th (m)	2.0	0.9	0.0	0.0	0.0	0.0
Control Delay (s/veh)	11.3	8.5	0.0	0.0	0.0	0.0
Lane LOS	B	A				
Approach Delay (s/veh)	11.3	0.5			0.0	
Approach LOS	B					
Intersection Summary						
Average Delay			0.7			
Intersection Capacity Utilization			31.0%		ICU Level of Service	A
Analysis Period (min)			15			

Timings

1: Niagara St. & Woodlawn Rd.

Existing AM

	↖	→	↗	↖	↖	↖	↖	↖	↖
Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations	↖	↖↗	↖	↖↗	↖	↖	↖↗	↖	↖↗
Traffic Volume (vph)	271	354	353	514	163	87	512	183	614
Future Volume (vph)	271	354	353	514	163	87	512	183	614
Lane Group Flow (vph)	295	471	384	559	177	95	847	199	963
Turn Type	pm+pt	NA	pm+pt	NA	Perm	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8		5	2	1	6
Permitted Phases	4		8		8	2		6	
Detector Phase	7	4	3	8	8	5	2	1	6
Switch Phase									
Minimum Initial (s)	6.0	8.0	6.0	8.0	8.0	6.0	10.0	6.0	10.0
Minimum Split (s)	9.0	39.4	9.0	39.4	39.4	9.0	39.3	9.0	39.3
Total Split (s)	38.0	42.4	38.0	42.4	42.4	20.0	57.3	20.0	57.3
Total Split (%)	24.1%	26.9%	24.1%	26.9%	26.9%	12.7%	36.3%	12.7%	36.3%
Yellow Time (s)	3.0	4.1	3.0	4.1	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	3.3	0.0	3.3	3.3	0.0	3.2	0.0	3.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	7.4	3.0	7.4	7.4	3.0	7.3	3.0	7.3
Lead/Lag	Lead	Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.82	0.82	0.93	0.78	0.44	0.42	0.69	0.70	0.71
Control Delay (s/veh)	49.7	72.0	67.1	66.7	10.0	26.7	43.4	35.8	41.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	49.7	72.0	67.1	66.7	10.0	26.7	43.4	35.8	41.3
Queue Length 50th (m)	62.8	73.5	89.2	86.7	0.0	14.9	112.7	33.7	126.3
Queue Length 95th (m)	80.6	88.7	#140.5	108.8	21.1	28.1	147.5	#57.6	#176.1
Internal Link Dist (m)		245.8		240.0			194.1		161.2
Turn Bay Length (m)	111.0		87.0		132.0	97.0		133.0	
Base Capacity (vph)	437	722	425	743	410	291	1228	298	1357
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.68	0.65	0.90	0.75	0.43	0.33	0.69	0.67	0.71

Intersection Summary

Cycle Length: 157.7

Actuated Cycle Length: 157.7

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

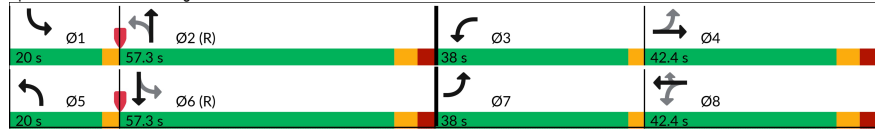
Natural Cycle: 100

Control Type: Actuated-Coordinated

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: Niagara St. & Woodlawn Rd.



052233 418-430 Aqueduct and 650-678 Niagara Street.syn

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Synchro 12 Report

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HCM Signalized Intersection Capacity Analysis

1: Niagara St. & Woodlawn Rd.

Existing AM

															
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR			
Lane Configurations															
Traffic Volume (vph)	271	354	79	353	514	163	87	512	267	183	614	272			
Future Volume (vph)	271	354	79	353	514	163	87	512	267	183	614	272			
Ideal Flow (vphpl)	1651	1776	1535	1651	1776	1498	1651	1776	1535	1651	1776	1535			
Total Lost time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3				
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	0.95		1.00	0.95				
Frpb, ped/bikes	1.00	0.99		1.00	1.00	0.96	1.00	0.99		1.00	0.99				
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00				
Frt	1.00	0.97		1.00	1.00	0.85	1.00	0.95		1.00	0.95				
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00				
Satd. Flow (prot)	1567	3199		1568	3345	1228	1569	3138		1539	3190				
Flt Permitted	0.27	1.00		0.23	1.00	1.00	0.18	1.00		0.18	1.00				
Satd. Flow (perm)	449	3199		373	3345	1228	304	3138		299	3190				
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92			
Adj. Flow (vph)	295	385	86	384	559	177	95	557	290	199	667	296			
RTOR Reduction (vph)	0	13	0	0	0	139	0	39	0	0	27	0			
Lane Group Flow (vph)	295	458	0	384	559	38	95	808	0	199	936	0			
Confl. Peds. (#/hr)	17		12	12		17	14		21	21		14			
Heavy Vehicles (%)	1%	3%	4%	1%	2%	1%	1%	2%	1%	3%	1%	1%			
Turn Type	pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA				
Protected Phases	7	4		3	8		5	2		1	6				
Permitted Phases	4			8		8	2			6					
Actuated Green, G (s)	54.9	27.8		64.0	33.9	33.9	70.0	59.7		79.0	65.7				
Effective Green, g (s)	54.9	27.8		64.0	33.9	33.9	70.0	59.7		79.0	65.7				
Actuated g/C Ratio	0.35	0.18		0.41	0.21	0.21	0.44	0.38		0.50	0.42				
Clearance Time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3				
Vehicle Extension (s)	2.6	2.5		2.6	2.5	2.5	2.6	2.5		2.6	2.5				
Lane Grp Cap (vph)	348	563		402	719	263	217	1187		277	1328				
v/s Ratio Prot	0.15	0.14		c0.20	0.17		0.03	0.26		c0.07	0.29				
v/s Ratio Perm	0.15			c0.19		0.03	0.17			c0.28					
v/c Ratio	0.85	0.81		0.96	0.78	0.14	0.44	0.68		0.72	0.70				
Uniform Delay, d1	41.9	62.5		39.2	58.3	50.2	28.0	41.0		26.5	38.0				
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00				
Incremental Delay, d2	17.0	8.6		33.2	5.1	0.2	1.1	3.2		8.2	3.2				
Delay (s)	58.8	71.0		72.4	63.4	50.3	29.1	44.2		34.6	41.1				
Level of Service	E	E		E	E	D	C	D		C	D				
Approach Delay (s/veh)		66.3			64.4			42.7			40.0				
Approach LOS		E			E			D			D				

Intersection Summary

HCM 2000 Control Delay (s/veh)

HCM 2000 Level of Service

D

Actuated Cycle Length (s)

Intersection Capacity Utilization

Analysis Period (min)

c Critical Lane Group

052233 418-430 Aqueduct and 650-678 Niagara Street.syn

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Synchro 12 Report

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HCM Unsignalized Intersection Capacity Analysis
3: Niagara St. & Abbey Rd.

Existing AM

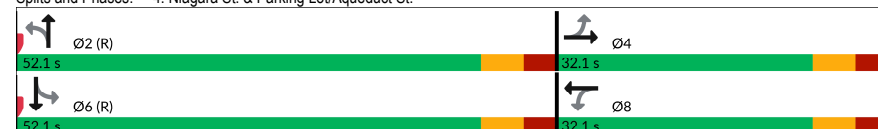
						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	9	23	9	874	1079	27
Future Volume (Veh/h)	9	23	9	874	1079	27
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	10	25	10	950	1173	29
Pedestrians	19					
Lane Width (m)	3.7					
Walking Speed (m/s)	1.1					
Percent Blockage	2					
Right turn flare (veh)						
Median type				TWLT	TWLT	
Median storage (veh)				2	2	
Upstream signal (m)				137	319	
pX, platoon unblocked	0.88	0.84	0.84			
vC, conflicting volume	1702	620	1221			
vC1, stage 1 conf vol	1207					
vC2, stage 2 conf vol	495					
vCu, unblocked vol	1108	159	877			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	96	98			
cM capacity (veh/h)	298	711	641			
Direction, Lane #	EB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	35	10	475	475	782	420
Volume Left	10	10	0	0	0	0
Volume Right	25	0	0	0	0	29
cSH	509	641	1700	1700	1700	1700
Volume to Capacity	0.07	0.02	0.28	0.28	0.46	0.25
Queue Length 95th (m)	1.7	0.4	0.0	0.0	0.0	0.0
Control Delay (s/veh)	12.6	10.7	0.0	0.0	0.0	0.0
Lane LOS	B	B				
Approach Delay (s/veh)	12.6	0.1			0.0	
Approach LOS	B					
Intersection Summary						
Average Delay			0.2			
Intersection Capacity Utilization		42.9%		ICU Level of Service		A
Analysis Period (min)		15				

Timings
4: Niagara St. & Parking Lot/Aqueduct St.

Existing AM

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	38	1	12	2	34	779	84	968
Future Volume (vph)	38	1	12	2	34	779	84	968
Lane Group Flow (vph)	41	40	13	73	37	868	91	1101
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA
Protected Phases	4		8		2		6	
Permitted Phases	4		8		2		6	
Detector Phase	4	4	8	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	8.0	8.0	8.0	8.0	10.0	10.0	10.0	10.0
Minimum Split (s)	15.1	15.1	15.1	15.1	17.1	17.1	17.1	17.1
Total Split (s)	32.1	32.1	32.1	32.1	52.1	52.1	52.1	52.1
Total Split (%)	38.1%	38.1%	38.1%	38.1%	61.9%	61.9%	61.9%	61.9%
Yellow Time (s)	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
All-Red Time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Max	C-Max	C-Max	C-Max
v/c Ratio	0.30	0.22	0.09	0.34	0.12	0.34	0.22	0.43
Control Delay (s/veh)	39.0	14.3	33.3	13.7	5.4	4.8	6.2	5.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	39.0	14.3	33.3	13.7	5.4	4.8	6.2	5.4
Queue Length 50th (m)	6.2	0.2	1.9	0.3	1.5	22.7	4.0	31.7
Queue Length 95th (m)	14.9	8.4	6.7	11.4	5.3	36.7	11.6	50.8
Internal Link Dist (m)	33.7		300.3		252.9		113.5	
Turn Bay Length (m)			20.0		90.0		100.0	
Base Capacity (vph)	350	414	360	438	311	2556	413	2549
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.12	0.10	0.04	0.17	0.12	0.34	0.22	0.43
Intersection Summary								
Cycle Length: 84.2								
Actuated Cycle Length: 84.2								
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green								
Natural Cycle: 40								
Control Type: Actuated-Coordinated								

Splits and Phases: 4: Niagara St. & Parking Lot/Aqueduct St.



HCM Signalized Intersection Capacity Analysis
4: Niagara St. & Parking Lot/Aqueduct St.

Existing AM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	38	1	36	12	2	65	34	779	19	84	968	45
Future Volume (vph)	38	1	36	12	2	65	34	779	19	84	968	45
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.98		1.00	0.99		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		0.99	1.00	
Frt	1.00	0.85		1.00	0.85		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1583	1303		1578	1308		1580	3331		1577	3320	
Flt Permitted	0.71	1.00		0.73	1.00		0.24	1.00		0.32	1.00	
Satd. Flow (perm)	1183	1303		1214	1308		406	3331		538	3320	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	41	1	39	13	2	71	37	847	21	91	1052	49
RTOR Reduction (vph)	0	35	0	0	64	0	0	1	0	0	2	0
Lane Group Flow (vph)	41	5	0	13	9	0	37	867	0	91	1099	0
Confl. Peds. (#/hr)	2		6	6		2	12		14	14		12
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	2%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	8.2	8.2		8.2	8.2		61.8	61.8		61.8	61.8	
Effective Green, g (s)	8.2	8.2		8.2	8.2		61.8	61.8		61.8	61.8	
Actuated g/C Ratio	0.10	0.10		0.10	0.10		0.73	0.73		0.73	0.73	
Clearance Time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Vehicle Extension (s)	4.0	4.0		4.0	4.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	115	126		118	127		297	2444		394	2436	
v/s Ratio Prot		0.00			0.01			0.26			c0.33	
v/s Ratio Perm	c0.03			0.01			0.09			0.17		
v/c Ratio	0.36	0.04		0.11	0.07		0.12	0.35		0.23	0.45	
Uniform Delay, d1	35.5	34.4		34.7	34.5		3.3	4.0		3.6	4.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.6	0.2		0.6	0.3		0.9	0.4		1.4	0.6	
Delay (s)	38.1	34.6		35.2	34.9		4.1	4.4		5.0	5.1	
Level of Service	D	C		D	C		A	A		A	A	
Approach Delay (s/veh)		36.4			34.9			4.4			5.1	
Approach LOS		D			C			A			A	
Intersection Summary												
HCM 2000 Control Delay (s/veh)		7.1			HCM 2000 Level of Service			A				
HCM 2000 Volume to Capacity ratio		0.44										
Actuated Cycle Length (s)		84.2			Sum of lost time (s)			14.2				
Intersection Capacity Utilization		68.3%			ICU Level of Service			C				
Analysis Period (min)		15										
c Critical Lane Group												

Timings
5: Niagara St/Niagara St. & Thorold Rd

Existing AM

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	312	140	92	145	132	431	94	503
Future Volume (vph)	312	140	92	145	132	431	94	503
Lane Group Flow (vph)	339	235	100	258	143	530	102	1001
Turn Type	pm+pt	NA	pm+pt	NA	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8	5	2	1	6
Permitted Phases	4		8		2		6	
Detector Phase	7	4	3	8	5	2	1	6
Switch Phase								
Minimum Initial (s)	5.0	8.0	5.0	8.0	5.0	8.0	5.0	8.0
Minimum Split (s)	8.0	33.5	8.0	33.5	8.0	30.3	8.0	30.3
Total Split (s)	15.0	33.5	15.0	33.5	15.0	41.3	15.0	41.3
Total Split (%)	14.3%	32.0%	14.3%	32.0%	14.3%	39.4%	14.3%	39.4%
Yellow Time (s)	3.0	4.1	3.0	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	2.4	0.0	2.4	0.0	2.2	0.0	2.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.5	3.0	6.5	3.0	6.3	3.0	6.3
Lead/Lag	Lead	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	1.06	0.65	0.28	0.84	0.59	0.38	0.25	0.72
Control Delay (s/veh)	95.3	40.9	22.4	58.6	23.5	22.7	13.9	24.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	95.3	40.9	22.4	58.6	23.5	22.7	13.9	24.9
Queue Length 50th (m)	~56.2	39.2	13.2	45.1	13.6	37.4	9.4	71.2
Queue Length 95th (m)	#88.7	64.0	22.3	70.2	27.9	59.0	19.6	#108.2
Internal Link Dist (m)		152.6		154.0		97.6		318.5
Turn Bay Length (m)	70.0		67.0		85.0		60.0	
Base Capacity (vph)	320	382	403	384	272	1402	449	1393
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.06	0.62	0.25	0.67	0.53	0.38	0.23	0.72
Intersection Summary								
Cycle Length: 104.8								
Actuated Cycle Length: 104.8								
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green								
Natural Cycle: 90								
Control Type: Actuated-Coordinated								
- Volume exceeds capacity, queue is theoretically infinite.								
Queue shown is maximum after two cycles.								
# 95th percentile volume exceeds capacity, queue may be longer.								
Queue shown is maximum after two cycles.								
Splits and Phases: 5: Niagara St/Niagara St. & Thorold Rd								
	Ø1		Ø2 (R)		Ø3		Ø4	
15 s		41.3 s		15 s		33.5 s		
	Ø5		Ø6 (R)		Ø7		Ø8	
15 s		41.3 s		15 s		33.5 s		

HCM Signalized Intersection Capacity Analysis
5: Niagara St/Niagara St. & Thorold Rd

Existing AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	312	140	76	92	145	92	132	431	57	94	503	418
Future Volume (vph)	312	140	76	92	145	92	132	431	57	94	503	418
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	0.99		1.00	0.98	
Flpb, ped/bikes	1.00	1.00		0.99	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.95		1.00	0.94		1.00	0.98		1.00	0.93	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1551	1404		1573	1407		1468	3298		1476	3083	
Flt Permitted	0.35	1.00		0.57	1.00		0.15	1.00		0.42	1.00	
Satd. Flow (perm)	567	1404		950	1407		233	3298		646	3083	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	339	152	83	100	158	100	143	468	62	102	547	454
RTOR Reduction (vph)	0	19	0	0	23	0	0	9	0	0	128	0
Lane Group Flow (vph)	339	216	0	100	235	0	143	521	0	102	873	0
Confl. Peds. (#/hr)	11		18	18		11	12		11	11		12
Heavy Vehicles (%)	2%	1%	8%	0%	1%	6%	8%	1%	2%	7%	1%	1%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	36.7	25.7		29.7	21.7		53.5	43.7		51.1	42.5	
Effective Green, g (s)	36.7	25.7		29.7	21.7		53.5	43.7		51.1	42.5	
Actuated g/C Ratio	0.35	0.25		0.28	0.21		0.51	0.42		0.49	0.41	
Clearance Time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Vehicle Extension (s)	2.5	2.2		2.5	2.2		2.5	2.1		2.5	2.1	
Lane Grp Cap (vph)	311	344		316	291		234	1375		383	1250	
v/s Ratio Prot	c0.12	0.15		0.02	0.17		c0.06	0.16		0.02	c0.28	
v/s Ratio Perm	c0.26			0.07			0.25			0.11		
v/c Ratio	1.09	0.63		0.32	0.81		0.61	0.38		0.27	0.70	
Uniform Delay, d1	31.8	35.3		28.7	39.6		16.9	21.2		14.9	25.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	77.3	2.8		0.4	14.4		4.0	0.8		0.3	3.3	
Delay (s)	109.1	38.1		29.2	54.0		20.9	22.0		15.1	29.1	
Level of Service	F	D		C	D		C	C		B	C	
Approach Delay (s/veh)		80.0			47.1			21.7			27.8	
Approach LOS		E			D			C			C	
Intersection Summary												
HCM 2000 Control Delay (s/veh)	39.9			HCM 2000 Level of Service			D					
HCM 2000 Volume to Capacity ratio	0.88											
Actuated Cycle Length (s)	104.8			Sum of lost time (s)			18.8					
Intersection Capacity Utilization	94.0%			ICU Level of Service			F					
Analysis Period (min)	15											
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis
6: Niagara St. & Roger Dr.

Existing AM

	←	↙	↘	→	↙	↘
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↙		↙	↘	↘	↙
Traffic Volume (veh/h)	21	36	38	747	897	68
Future Volume (Veh/h)	21	36	38	747	897	68
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	23	39	41	812	975	74
Pedestrians	8			1	2	
Lane Width (m)	3.7			3.7	3.7	
Walking Speed (m/s)	1.1			1.1	1.1	
Percent Blockage	1			0	0	
Right turn flare (veh)						
Median type				TWLT	TWLT	
Median storage (veh)				2	2	
Upstream signal (m)				343	277	
pX, platoon unblocked	0.92	0.91	0.91			
vC, conflicting volume	1510	534	1057			
vC1, stage 1 conf vol	1020					
vC2, stage 2 conf vol	490					
vCu, unblocked vol	1278	289	864			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3	2.2			
p0 queue free %	93	94	94			
cM capacity (veh/h)	319	644	711			
Direction, Lane #	EB 1	NB 1	NB 3	SB 1	SB 2	
Volume Total	62	41	406	406	650	399
Volume Left	23	41	0	0	0	0
Volume Right	39	0	0	0	0	74
cSH	467	711	1700	1700	1700	1700
Volume to Capacity	0.13	0.06	0.24	0.24	0.38	0.23
Queue Length 95th (m)	3.5	1.4	0.0	0.0	0.0	0.0
Control Delay (s/veh)	13.9	10.4	0.0	0.0	0.0	0.0
Lane LOS	B	B				
Approach Delay (s/veh)	13.9	0.5			0.0	
Approach LOS	B					
Intersection Summary						
Average Delay	0.7					
Intersection Capacity Utilization	46.5%			ICU Level of Service		
Analysis Period (min)	15			A		



BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix D

Background 2030 Traffic Operations

Timings
1: Niagara St. & Woodlawn Rd.

2030 Background AM

	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations	↩	↩↪	↩	↩↪	↩	↩	↩↪	↩	↩↪
Traffic Volume (vph)	243	378	179	249	118	69	474	86	301
Future Volume (vph)	243	378	179	249	118	69	474	86	301
Lane Group Flow (vph)	264	540	195	271	128	75	800	93	478
Turn Type	pm+pt	NA	pm+pt	NA	Perm	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8		5	2	1	6
Permitted Phases	4		8		8	2		6	
Detector Phase	7	4	3	8	8	5	2	1	6
Switch Phase									
Minimum Initial (s)	6.0	8.0	6.0	8.0	8.0	6.0	10.0	6.0	10.0
Minimum Split (s)	9.0	39.4	9.0	39.4	39.4	9.0	39.3	9.0	39.3
Total Split (s)	29.0	49.0	25.0	45.0	45.0	9.0	67.7	16.0	74.7
Total Split (%)	18.4%	31.1%	15.9%	28.5%	28.5%	5.7%	42.9%	10.1%	47.4%
Yellow Time (s)	3.0	4.1	3.0	4.1	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	3.3	0.0	3.3	3.3	0.0	3.2	0.0	3.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	7.4	3.0	7.4	7.4	3.0	7.3	3.0	7.3
Lead/Lag	Lead	Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.68	0.83	0.72	0.49	0.40	0.16	0.51	0.32	0.31
Control Delay (s/veh)	46.8	69.4	50.8	61.7	11.6	16.4	27.7	18.5	22.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	46.8	69.4	50.8	61.7	11.6	16.4	27.7	18.5	22.3
Queue Length 50th (m)	62.6	82.5	43.8	41.3	0.0	9.8	80.8	12.3	40.5
Queue Length 95th (m)	81.3	98.8	59.1	52.6	17.7	20.1	117.2	24.3	60.4
Internal Link Dist (m)		245.8		240.0			194.1		161.2
Turn Bay Length (m)	111.0		87.0		132.0	97.0		133.0	
Base Capacity (vph)	398	856	300	789	399	458	1563	320	1545
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.66	0.63	0.65	0.34	0.32	0.16	0.51	0.29	0.31

Intersection Summary

Cycle Length: 157.7

Actuated Cycle Length: 157.7

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 100

Control Type: Actuated-Coordinated

Splits and Phases: 1: Niagara St. & Woodlawn Rd.



HCM Signalized Intersection Capacity Analysis
1: Niagara St. & Woodlawn Rd.

2030 Background AM

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↩	↩↪		↩	↩↪	↩	↩	↩↪		↩	↩↪	
Traffic Volume (vph)	243	378	119	179	249	118	69	474	262	86	301	139
Future Volume (vph)	243	378	119	179	249	118	69	474	262	86	301	139
Ideal Flow (vphpl)	1651	1776	1535	1651	1776	1498	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00		1.00	1.00	0.98	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.96		1.00	1.00	0.85	1.00	0.95		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1537	3175		1570	3313	1265	1538	3118		1415	3032	
Flt Permitted	0.45	1.00		0.25	1.00	1.00	0.45	1.00		0.26	1.00	
Satd. Flow (perm)	724	3175		420	3313	1265	737	3118		394	3032	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	264	411	129	195	271	128	75	515	285	93	327	151
RTOR Reduction (vph)	0	21	0	0	0	107	0	40	0	0	30	0
Lane Group Flow (vph)	264	519	0	195	271	21	75	760	0	93	448	0
Confl. Peds. (#/hr)	4		2	2		4	3		9	9		3
Heavy Vehicles (%)	3%	3%	4%	1%	3%	0%	3%	3%	2%	12%	6%	8%
Turn Type	pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8		8	2			6		
Actuated Green, G (s)	53.2	31.2		45.4	26.4	26.4	85.1	77.0		88.5	78.7	
Effective Green, g (s)	53.2	31.2		45.4	26.4	26.4	85.1	77.0		88.5	78.7	
Actuated g/C Ratio	0.34	0.20		0.29	0.17	0.17	0.54	0.49		0.56	0.50	
Clearance Time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3	
Vehicle Extension (s)	2.6	2.5		2.6	2.5	2.5	2.6	2.5		2.6	2.5	
Lane Grp Cap (vph)	366	628		259	554	211	438	1522		284	1513	
v/s Ratio Prot	c0.11	c0.16		c0.09	0.08		0.01	c0.24		c0.02	0.15	
v/s Ratio Perm	0.13			0.13		0.02	0.08			0.16		
v/c Ratio	0.72	0.83		0.75	0.49	0.10	0.17	0.50		0.33	0.30	
Uniform Delay, d1	42.0	60.7		46.2	59.5	55.6	17.6	27.3		17.7	23.2	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	6.5	8.6		11.3	0.5	0.2	0.1	1.2		0.5	0.5	
Delay (s)	48.5	69.2		57.5	60.0	55.8	17.8	28.5		18.2	23.7	
Level of Service	D	E		E	E	E	B	C		B	C	
Approach Delay (s/veh)		62.4			58.3			27.6			22.8	
Approach LOS		E			E			C			C	

Intersection Summary

HCM 2000 Control Delay (s/veh)	42.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	157.7	Sum of lost time (s)	20.7
Intersection Capacity Utilization	78.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
3: Niagara St. & Abbey Rd.

2030 Background AM

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	3	17	10	805	655	3
Future Volume (Veh/h)	3	17	10	805	655	3
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	18	11	875	712	3
Pedestrians	5					
Lane Width (m)	3.7					
Walking Speed (m/s)	1.1					
Percent Blockage	0					
Right turn flare (veh)						
Median type				TWLTL	TWLTL	
Median storage (veh)				2	2	
Upstream signal (m)				137	319	
pX, platoon unblocked	0.94					
vC, conflicting volume	1178	363	720			
vC1, stage 1 conf vol	719					
vC2, stage 2 conf vol	460					
vCu, unblocked vol	1059	363	720			
tC, single (s)	6.8	7.1	4.1			
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.4	2.2			
p0 queue free %	99	97	99			
cM capacity (veh/h)	402	603	887			
Direction, Lane #	EB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	21	11	438	438	475	240
Volume Left	3	11	0	0	0	0
Volume Right	18	0	0	0	0	3
cSH	563	887	1700	1700	1700	1700
Volume to Capacity	0.04	0.01	0.26	0.26	0.28	0.14
Queue Length 95th (m)	0.9	0.3	0.0	0.0	0.0	0.0
Control Delay (s/veh)	11.6	9.1	0.0	0.0	0.0	0.0
Lane LOS	B	A				
Approach Delay (s/veh)	11.6	0.1			0.0	
Approach LOS	B					
Intersection Summary						
Average Delay			0.2			
Intersection Capacity Utilization			33.8%		ICU Level of Service	A
Analysis Period (min)			15			

Timings
4: Niagara St. & Parking Lot/Aqueduct St.

2030 Background AM

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	59	3	10	10	36	619	112	480
Future Volume (vph)	59	3	10	10	36	619	112	480
Lane Group Flow (vph)	64	54	11	175	39	683	122	594
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA
Protected Phases		4		8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	8	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	8.0	8.0	8.0	8.0	10.0	10.0	10.0	10.0
Minimum Split (s)	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1
Total Split (s)	37.1	37.1	37.1	37.1	47.1	47.1	47.1	47.1
Total Split (%)	44.1%	44.1%	44.1%	44.1%	55.9%	55.9%	55.9%	55.9%
Yellow Time (s)	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
All-Red Time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Max	C-Max	C-Max	C-Max
v/c Ratio	0.46	0.24	0.07	0.55	0.08	0.30	0.27	0.27
Control Delay (s/veh)	42.9	12.6	30.1	13.2	5.6	5.8	7.6	5.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	42.9	12.6	30.1	13.2	5.6	5.8	7.6	5.4
Queue Length 50th (m)	9.7	0.4	1.6	1.6	1.7	18.6	6.2	15.1
Queue Length 95th (m)	20.3	9.5	5.7	17.6	5.7	32.3	17.0	26.8
Internal Link Dist (m)		33.7		300.3		252.9		113.5
Turn Bay Length (m)			20.0		90.0		100.0	
Base Capacity (vph)	361	501	428	565	494	2269	448	2204
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.18	0.11	0.03	0.31	0.08	0.30	0.27	0.27

Intersection Summary

Cycle Length: 84.2
Actuated Cycle Length: 84.2
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green
Natural Cycle: 75
Control Type: Actuated-Coordinated

Splits and Phases: 4: Niagara St. & Parking Lot/Aqueduct St.



HCM Signalized Intersection Capacity Analysis
4: Niagara St. & Parking Lot/Aqueduct St.

2030 Background AM

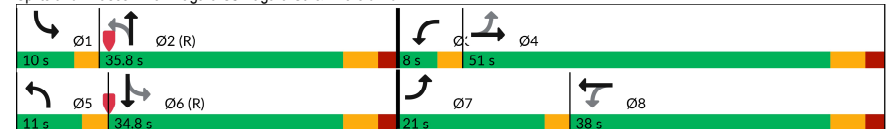
												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	59	3	47	10	10	151	36	619	9	112	480	66
Future Volume (vph)	59	3	47	10	10	151	36	619	9	112	480	66
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.86		1.00	0.86		1.00	1.00		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1584	1315		1583	1293		1582	3274		1568	3172	
Flt Permitted	0.61	1.00		0.72	1.00		0.43	1.00		0.39	1.00	
Satd. Flow (perm)	1013	1315		1203	1293		712	3274		647	3172	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	64	3	51	11	11	164	39	673	10	122	522	72
RTOR Reduction (vph)	0	44	0	0	141	0	0	1	0	0	7	0
Lane Group Flow (vph)	64	10	0	11	34	0	39	682	0	122	587	0
Confl. Peds. (#/hr)	2		2	2		2	4		2	2		4
Heavy Vehicles (%)	0%	0%	0%	0%	0%	2%	0%	4%	0%	1%	6%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	11.7	11.7		11.7	11.7		58.3	58.3		58.3	58.3	
Effective Green, g (s)	11.7	11.7		11.7	11.7		58.3	58.3		58.3	58.3	
Actuated g/C Ratio	0.14	0.14		0.14	0.14		0.69	0.69		0.69	0.69	
Clearance Time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Vehicle Extension (s)	4.0	4.0		4.0	4.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	140	182		167	179		492	2266		447	2196	
v/s Ratio Prot		0.01			0.03			c0.21			0.18	
v/s Ratio Perm	c0.06			0.01			0.05			0.19		
v/c Ratio	0.46	0.06		0.07	0.19		0.08	0.30		0.27	0.27	
Uniform Delay, d1	33.3	31.5		31.5	32.1		4.2	5.0		4.9	4.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	3.2	0.2		0.2	0.7		0.3	0.3		1.5	0.3	
Delay (s)	36.5	31.6		31.7	32.8		4.5	5.4		6.4	5.2	
Level of Service	D	C		C	C		A	A		A	A	
Approach Delay (s/veh)		34.3			32.7			5.3			5.4	
Approach LOS		C			C			A			A	
Intersection Summary												
HCM 2000 Control Delay (s/veh)	10.2			HCM 2000 Level of Service				B				
HCM 2000 Volume to Capacity ratio	0.33											
Actuated Cycle Length (s)	84.2			Sum of lost time (s)				14.2				
Intersection Capacity Utilization	76.9%			ICU Level of Service				D				
Analysis Period (min)	15											
c Critical Lane Group												

Timings
5: Niagara St/Niagara St. & Thorold Rd

2030 Background AM

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations	↰	↱	↰	↱	↰	↱	↰	↱
Traffic Volume (vph)	272	156	38	124	89	312	70	255
Future Volume (vph)	272	156	38	124	89	312	70	255
Lane Group Flow (vph)	296	267	41	246	97	386	76	485
Turn Type	pm+pt	NA	pm+pt	NA	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8	5	2	1	6
Permitted Phases	4		8		2		6	
Detector Phase	7	4	3	8	5	2	1	6
Switch Phase								
Minimum Initial (s)	5.0	8.0	5.0	8.0	5.0	8.0	5.0	8.0
Minimum Split (s)	8.0	33.5	8.0	33.5	8.0	30.3	8.0	30.3
Total Split (s)	21.0	51.0	8.0	38.0	11.0	35.8	10.0	34.8
Total Split (%)	20.0%	48.7%	7.6%	36.3%	10.5%	34.2%	9.5%	33.2%
Yellow Time (s)	3.0	4.1	3.0	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	2.4	0.0	2.4	0.0	2.2	0.0	2.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.5	3.0	6.5	3.0	6.3	3.0	6.3
Lead/Lag	Lead	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.70	0.56	0.15	0.81	0.27	0.31	0.19	0.38
Control Delay (s/veh)	29.3	27.8	17.3	53.1	18.0	24.5	17.2	17.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	29.3	27.8	17.3	53.1	18.0	24.5	17.2	17.3
Queue Length 50th (m)	40.9	39.4	4.7	40.7	10.1	28.2	7.8	23.3
Queue Length 95th (m)	52.6	57.1	9.2	61.7	23.0	46.4	18.7	42.7
Internal Link Dist (m)		152.6		154.0		97.6		318.5
Turn Bay Length (m)	70.0		67.0		85.0		60.0	
Base Capacity (vph)	426	573	277	429	364	1246	403	1289
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.69	0.47	0.15	0.57	0.27	0.31	0.19	0.38
Intersection Summary								
Cycle Length: 104.8								
Actuated Cycle Length: 104.8								
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green								
Natural Cycle: 80								
Control Type: Actuated-Coordinated								

Splits and Phases: 5: Niagara St/Niagara St. & Thorold Rd



HCM Signalized Intersection Capacity Analysis
5: Niagara St/Niagara St. & Thorold Rd

2030 Background AM

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱	↲	↰	↱	↲	↰	↱	↲	↰	↱	↲
Traffic Volume (vph)	272	156	89	38	124	102	89	312	43	70	255	191
Future Volume (vph)	272	156	89	38	124	102	89	312	43	70	255	191
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	0.98	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.95		1.00	0.93		1.00	0.98		1.00	0.94	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1550	1304		1423	1336		1387	3129		1387	3037	
Flt Permitted	0.38	1.00		0.59	1.00		0.41	1.00		0.51	1.00	
Satd. Flow (perm)	617	1304		891	1336		602	3129		739	3037	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	296	170	97	41	135	111	97	339	47	76	277	208
RTOR Reduction (vph)	0	22	0	0	31	0	0	9	0	0	112	0
Lane Group Flow (vph)	296	245	0	41	215	0	97	377	0	76	373	0
Confl. Peds. (#/hr)	13		8	8		13	8		5	5		8
Heavy Vehicles (%)	2%	12%	11%	11%	7%	7%	14%	3%	33%	14%	3%	4%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	42.9	36.9		25.4	22.4		46.8	39.7		45.4	39.0	
Effective Green, g (s)	42.9	36.9		25.4	22.4		46.8	39.7		45.4	39.0	
Actuated g/C Ratio	0.41	0.35		0.24	0.21		0.45	0.38		0.43	0.37	
Clearance Time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Vehicle Extension (s)	2.5	2.2		2.5	2.2		2.5	2.1		2.5	2.1	
Lane Grp Cap (vph)	408	459		231	285		322	1185		359	1130	
v/s Ratio Prot	c0.12	0.19		0.01	0.16		c0.02	0.12		0.01	c0.12	
v/s Ratio Perm	c0.18			0.04			0.11			0.08		
v/c Ratio	0.73	0.53		0.18	0.75		0.30	0.32		0.21	0.33	
Uniform Delay, d1	23.2	27.1		31.0	38.6		17.4	23.0		17.8	23.6	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	5.9	0.7		0.3	9.8		0.4	0.7		0.2	0.8	
Delay (s)	29.1	27.8		31.2	48.4		17.8	23.7		18.0	24.3	
Level of Service	C	C		C	D		B	C		B	C	
Approach Delay (s/veh)		28.5			46.0			22.5			23.5	
Approach LOS		C			D			C			C	
Intersection Summary												
HCM 2000 Control Delay (s/veh)		28.1			HCM 2000 Level of Service			C				
HCM 2000 Volume to Capacity ratio		0.53										
Actuated Cycle Length (s)		104.8			Sum of lost time (s)			18.8				
Intersection Capacity Utilization		78.9%			ICU Level of Service			D				
Analysis Period (min)		15										

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
6: Niagara St. & Roger Dr.

2030 Background AM

	EBL	EBR	NBL	NBT	SBT	SBR
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↰	↱	↰	↱	↱	↱
Traffic Volume (veh/h)	16	31	35	689	450	63
Future Volume (Veh/h)	16	31	35	689	450	63
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	17	34	38	749	489	68
Pedestrians	6				1	
Lane Width (m)	3.7				3.7	
Walking Speed (m/s)	1.1				1.1	
Percent Blockage	1				0	
Right turn flare (veh)						
Median type				TWLT	TWLT	
Median storage (veh)				2	2	
Upstream signal (m)				343	277	
pX, platoon unblocked						
vC, conflicting volume	981	285	563			
vC1, stage 1 conf vol	529					
vC2, stage 2 conf vol	452					
vCu, unblocked vol	981	285	563			
tC, single (s)	6.8	7.0	4.1			
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	95	96			
cM capacity (veh/h)	451	705	1013			
Direction, Lane #	EB 1	NB 1	NB 3	SB 1	SB 2	
Volume Total	51	38	375	375	326	231
Volume Left	17	38	0	0	0	0
Volume Right	34	0	0	0	0	68
cSH	594	1013	1700	1700	1700	1700
Volume to Capacity	0.09	0.04	0.22	0.22	0.19	0.14
Queue Length 95th (m)	2.1	0.9	0.0	0.0	0.0	0.0
Control Delay (s/veh)	11.6	8.7	0.0	0.0	0.0	0.0
Lane LOS	B	A				
Approach Delay (s/veh)	11.6	0.4			0.0	
Approach LOS	B					
Intersection Summary						
Average Delay			0.7			
Intersection Capacity Utilization			32.2%		ICU Level of Service	A
Analysis Period (min)			15			

Timings

1: Niagara St. & Woodlawn Rd.

2030 Background PM

	↖	→	↗	↖	↖	↖	↖	↖	↖
Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations	↖	↖↗	↖	↖↗	↖	↖	↖↗	↖	↖↗
Traffic Volume (vph)	286	374	373	543	172	92	541	193	649
Future Volume (vph)	286	374	373	543	172	92	541	193	649
Lane Group Flow (vph)	311	497	405	590	187	100	895	210	1017
Turn Type	pm+pt	NA	pm+pt	NA	Perm	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8		5	2	1	6
Permitted Phases	4		8		8	2		6	
Detector Phase	7	4	3	8	8	5	2	1	6
Switch Phase									
Minimum Initial (s)	6.0	8.0	6.0	8.0	8.0	6.0	10.0	6.0	10.0
Minimum Split (s)	9.0	39.4	9.0	39.4	39.4	9.0	39.3	9.0	39.3
Total Split (s)	30.9	39.8	39.9	48.8	48.8	11.0	56.0	22.0	67.0
Total Split (%)	19.6%	25.2%	25.3%	30.9%	30.9%	7.0%	35.5%	14.0%	42.5%
Yellow Time (s)	3.0	4.1	3.0	4.1	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	3.3	0.0	3.3	3.3	0.0	3.2	0.0	3.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	7.4	3.0	7.4	7.4	3.0	7.3	3.0	7.3
Lead/Lag	Lead	Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.87	0.85	0.95	0.73	0.43	0.53	0.78	0.78	0.75
Control Delay (s/veh)	55.7	75.1	71.2	61.0	8.9	33.9	48.9	45.5	42.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	55.7	75.1	71.2	61.0	8.9	33.9	48.9	45.5	42.7
Queue Length 50th (m)	64.5	77.9	97.7	89.7	0.0	16.4	130.8	37.5	142.2
Queue Length 95th (m)	#94.6	96.3	#154.4	109.1	20.2	29.0	#162.4	#74.2	173.0
Internal Link Dist (m)		245.8		240.0			194.1		161.2
Turn Bay Length (m)	111.0		87.0		132.0	97.0		133.0	
Base Capacity (vph)	382	669	439	878	460	192	1152	283	1351
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.81	0.74	0.92	0.67	0.41	0.52	0.78	0.74	0.75

Intersection Summary

Cycle Length: 157.7

Actuated Cycle Length: 157.7

Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

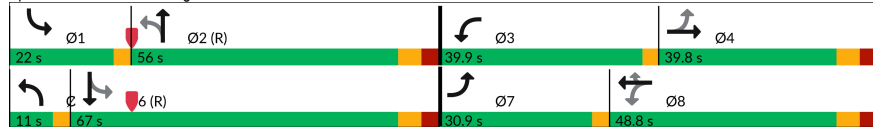
Natural Cycle: 100

Control Type: Actuated-Coordinated

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: Niagara St. & Woodlawn Rd.



052233 418-430 Aqueduct and 650-678 Niagara Street.syn

R.J. Burnside & Associates

Synchro 12 Report

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HCM Signalized Intersection Capacity Analysis

1: Niagara St. & Woodlawn Rd.

2030 Background PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			 			 			 	
Traffic Volume (vph)	286	374	83	373	543	172	92	541	282	193	649	287
Future Volume (vph)	286	374	83	373	543	172	92	541	282	193	649	287
Ideal Flow (vphpl)	1651	1776	1535	1651	1776	1498	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	1.00	0.96	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.97		1.00	1.00	0.85	1.00	0.95		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1566	3200		1569	3345	1228	1570	3137		1539	3191	
Flt Permitted	0.31	1.00		0.20	1.00	1.00	0.17	1.00		0.15	1.00	
Satd. Flow (perm)	513	3200		338	3345	1228	278	3137		236	3191	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	311	407	90	405	590	187	100	588	307	210	705	312
RTOR Reduction (vph)	0	12	0	0	0	142	0	40	0	0	30	0
Lane Group Flow (vph)	311	485	0	405	590	45	100	855	0	210	987	0
Confl. Peds. (#/hr)	17		12	12		17	14		21	21		14
Heavy Vehicles (%)	1%	3%	4%	1%	2%	1%	1%	2%	1%	3%	1%	1%
Turn Type	pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8		8	2			6		
Actuated Green, G (s)	53.5	28.2		66.3	38.0	38.0	64.3	55.8		76.7	65.2	
Effective Green, g (s)	53.5	28.2		66.3	38.0	38.0	64.3	55.8		76.7	65.2	
Actuated g/C Ratio	0.34	0.18		0.42	0.24	0.24	0.41	0.35		0.49	0.41	
Clearance Time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3	
Vehicle Extension (s)	2.6	2.5		2.6	2.5	2.5	2.6	2.5		2.6	2.5	
Lane Grp Cap (vph)	342	572		416	806	295	182	1109		262	1319	
v/s Ratio Prot	0.15	0.15		c0.22	0.18		0.03	0.27		c0.09	0.31	
v/s Ratio Perm	0.16			c0.19		0.04	0.19			c0.30		
v/c Ratio	0.91	0.85		0.97	0.73	0.15	0.55	0.77		0.80	0.75	
Uniform Delay, d1	43.5	62.7		41.7	55.2	47.2	31.6	45.3		29.5	39.3	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	26.8	11.0		36.9	3.3	0.2	2.8	5.2		15.7	3.9	
Delay (s)	70.3	73.7		78.7	58.4	47.3	34.4	50.5		45.2	43.2	
Level of Service	E	E		E	E	D	C	D		D	D	
Approach Delay (s/veh)		72.4			63.6			48.9			43.5	
Approach LOS		E			E			D			D	

Intersection Summary

HCM 2000 Control Delay (s/veh)

56.0

HCM 2000 Level of Service

E

HCM 2000 Volume to Capacity ratio

0.91

Actuated Cycle Length (s)

157.7

Sum of lost time (s)

20.7

Intersection Capacity Utilization

99.9%

ICU Level of Service

F

Analysis Period (min)

15

c Critical Lane Group

052233 418-430 Aqueduct and 650-678 Niagara Street.syn

R.J. Burnside & Associates

Synchro 12 Report

04/04/2025 - Page 2

HCM Unsignalized Intersection Capacity Analysis
3: Niagara St. & Abbey Rd.

2030 Background PM

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	9	23	9	942	1162	27
Future Volume (Veh/h)	9	23	9	942	1162	27
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	10	25	10	1024	1263	29
Pedestrians	19					
Lane Width (m)	3.7					
Walking Speed (m/s)	1.1					
Percent Blockage	2					
Right turn flare (veh)						
Median type				TWLTL	TWLTL	
Median storage (veh)				2	2	
Upstream signal (m)				137	319	
pX, platoon unblocked	0.86	0.81	0.81			
vC, conflicting volume	1829	665	1311			
vC1, stage 1 conf vol	1297					
vC2, stage 2 conf vol	532					
vCu, unblocked vol	1149	135	928			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	97	98			
cM capacity (veh/h)	274	717	597			
Direction, Lane #	EB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	35	10	512	512	842	450
Volume Left	10	10	0	0	0	0
Volume Right	25	0	0	0	0	29
cSH	490	597	1700	1700	1700	1700
Volume to Capacity	0.07	0.02	0.30	0.30	0.50	0.26
Queue Length 95th (m)	1.7	0.4	0.0	0.0	0.0	0.0
Control Delay (s/veh)	12.9	11.1	0.0	0.0	0.0	0.0
Lane LOS	B	B				
Approach Delay (s/veh)	12.9	0.1			0.0	
Approach LOS	B					
Intersection Summary						
Average Delay			0.2			
Intersection Capacity Utilization			45.3%		ICU Level of Service	A
Analysis Period (min)			15			

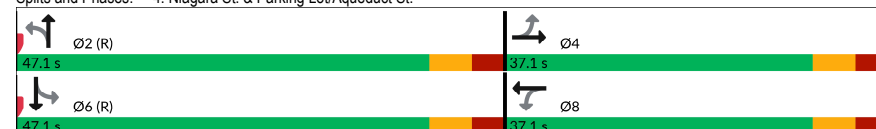
Timings

4: Niagara St. & Parking Lot/Aqueduct St.

2030 Background PM

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	41	1	13	2	37	839	90	1043
Future Volume (vph)	41	1	13	2	37	839	90	1043
Lane Group Flow (vph)	45	43	14	78	40	934	98	1186
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA
Protected Phases		4		8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	8	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	8.0	8.0	8.0	8.0	10.0	10.0	10.0	10.0
Minimum Split (s)	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1
Total Split (s)	37.1	37.1	37.1	37.1	47.1	47.1	47.1	47.1
Total Split (%)	44.1%	44.1%	44.1%	44.1%	55.9%	55.9%	55.9%	55.9%
Yellow Time (s)	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
All-Red Time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Max	C-Max	C-Max	C-Max
v/c Ratio	0.32	0.23	0.10	0.35	0.14	0.37	0.26	0.47
Control Delay (s/veh)	39.3	14.4	33.1	13.3	6.1	5.1	7.0	5.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	39.3	14.4	33.1	13.3	6.1	5.1	7.0	5.8
Queue Length 50th (m)	6.8	0.3	2.1	0.3	1.7	25.5	4.6	36.2
Queue Length 95th (m)	15.8	8.9	7.0	11.7	6.1	41.5	13.4	58.2
Internal Link Dist (m)		33.7		300.3		252.9		113.5
Turn Bay Length (m)			20.0		90.0		100.0	
Base Capacity (vph)	419	490	431	514	278	2547	380	2539
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.11	0.09	0.03	0.15	0.14	0.37	0.26	0.47
Intersection Summary								
Cycle Length: 84.2								
Actuated Cycle Length: 84.2								
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green								
Natural Cycle: 75								
Control Type: Actuated-Coordinated								

Splits and Phases: 4: Niagara St. & Parking Lot/Aqueduct St.



HCM Signalized Intersection Capacity Analysis
4: Niagara St. & Parking Lot/Aqueduct St.

2030 Background PM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	41	1	39	13	2	70	37	839	20	90	1043	48
Future Volume (vph)	41	1	39	13	2	70	37	839	20	90	1043	48
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.98		1.00	0.99		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		0.99	1.00	
Frt	1.00	0.85		1.00	0.85		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1583	1303		1578	1308		1581	3332		1578	3321	
Flt Permitted	0.71	1.00		0.73	1.00		0.22	1.00		0.30	1.00	
Satd. Flow (perm)	1177	1303		1211	1308		364	3332		496	3321	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	45	1	42	14	2	76	40	912	22	98	1134	52
RTOR Reduction (vph)	0	37	0	0	68	0	0	1	0	0	2	0
Lane Group Flow (vph)	45	6	0	14	10	0	40	933	0	98	1184	0
Confl. Peds. (#/hr)	2		6	6		2	12		14	14		12
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	2%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	8.5	8.5		8.5	8.5		61.5	61.5		61.5	61.5	
Effective Green, g (s)	8.5	8.5		8.5	8.5		61.5	61.5		61.5	61.5	
Actuated g/C Ratio	0.10	0.10		0.10	0.10		0.73	0.73		0.73	0.73	
Clearance Time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Vehicle Extension (s)	4.0	4.0		4.0	4.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	118	131		122	132		265	2433		362	2425	
v/s Ratio Prot		0.00			0.01			0.28			c0.36	
v/s Ratio Perm	c0.04			0.01			0.11			0.20		
v/c Ratio	0.38	0.05		0.11	0.07		0.15	0.38		0.27	0.49	
Uniform Delay, d1	35.4	34.2		34.4	34.3		3.4	4.3		3.8	4.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.8	0.2		0.6	0.3		1.2	0.5		1.8	0.7	
Delay (s)	38.2	34.4		35.0	34.6		4.6	4.7		5.6	5.5	
Level of Service	D	C		D	C		A	A		A	A	
Approach Delay (s/veh)		36.3			34.7			4.7			5.5	
Approach LOS		D			C			A			A	
Intersection Summary												
HCM 2000 Control Delay (s/veh)		7.4										
HCM 2000 Volume to Capacity ratio		0.47										
Actuated Cycle Length (s)		84.2										
Intersection Capacity Utilization		70.7%										
Analysis Period (min)		15										
c Critical Lane Group												

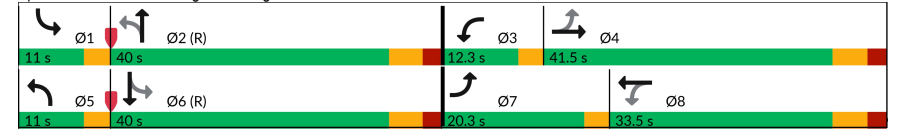
Timings

5: Niagara St/Niagara St. & Thorold Rd

2030 Background PM

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	344	155	102	160	146	476	104	555
Future Volume (vph)	344	155	102	160	146	476	104	555
Lane Group Flow (vph)	374	259	111	285	159	585	113	1105
Turn Type	pm+pt	NA	pm+pt	NA	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8	5	2	1	6
Permitted Phases	4		8		2		6	
Detector Phase	7	4	3	8	5	2	1	6
Switch Phase								
Minimum Initial (s)	5.0	8.0	5.0	8.0	5.0	8.0	5.0	8.0
Minimum Split (s)	8.0	33.5	8.0	33.5	8.0	30.3	8.0	30.3
Total Split (s)	20.3	41.5	12.3	33.5	11.0	40.0	11.0	40.0
Total Split (%)	19.4%	39.6%	11.7%	32.0%	10.5%	38.2%	10.5%	38.2%
Yellow Time (s)	3.0	4.1	3.0	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	2.4	0.0	2.4	0.0	2.2	0.0	2.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.5	3.0	6.5	3.0	6.3	3.0	6.3
Lead/Lag	Lead	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.94	0.59	0.30	0.87	0.79	0.48	0.35	0.92
Control Delay (s/veh)	55.5	32.9	19.2	60.4	50.4	27.8	19.0	40.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	55.5	32.9	19.2	60.4	50.4	27.8	19.0	40.6
Queue Length 50th (m)	52.8	39.3	12.8	49.8	18.4	49.0	12.4	98.4
Queue Length 95th (m)	#89.0	62.8	22.2	#84.9	#59.8	67.1	24.0	#144.2
Internal Link Dist (m)		152.6		154.0		97.6		318.5
Turn Bay Length (m)	70.0		67.0		85.0		60.0	
Base Capacity (vph)	398	487	387	384	201	1209	330	1201
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.94	0.53	0.29	0.74	0.79	0.48	0.34	0.92
Intersection Summary								
Cycle Length: 104.8								
Actuated Cycle Length: 104.8								
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green								
Natural Cycle: 90								
Control Type: Actuated-Coordinated								
# 95th percentile volume exceeds capacity, queue may be longer.								
Queue shown is maximum after two cycles.								

Splits and Phases: 5: Niagara St/Niagara St. & Thorold Rd



HCM Signalized Intersection Capacity Analysis
5: Niagara St/Niagara St. & Thorold Rd

2030 Background PM

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Movement												
Lane Configurations												
Traffic Volume (vph)	344	155	84	102	160	102	146	476	63	104	555	462
Future Volume (vph)	344	155	84	102	160	102	146	476	63	104	555	462
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	0.99		1.00	0.98	
Flpb, ped/bikes	1.00	1.00		0.99	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.95		1.00	0.94		1.00	0.98		1.00	0.93	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1552	1405		1572	1406		1468	3299		1477	3083	
Flt Permitted	0.31	1.00		0.60	1.00		0.10	1.00		0.37	1.00	
Satd. Flow (perm)	511	1405		992	1406		162	3299		570	3083	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	374	168	91	111	174	111	159	517	68	113	603	502
RTOR Reduction (vph)	0	20	0	0	24	0	0	9	0	0	139	0
Lane Group Flow (vph)	374	239	0	111	261	0	159	576	0	113	966	0
Confl. Peds. (#/hr)	11		18	18		11	12		11	11		12
Heavy Vehicles (%)	2%	1%	8%	0%	1%	6%	8%	1%	2%	7%	1%	1%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	43.0	31.5		31.2	22.7		48.0	38.2		44.0	36.2	
Effective Green, g (s)	43.0	31.5		31.2	22.7		48.0	38.2		44.0	36.2	
Actuated g/C Ratio	0.41	0.30		0.30	0.22		0.46	0.36		0.42	0.35	
Clearance Time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Vehicle Extension (s)	2.5	2.2		2.5	2.2		2.5	2.1		2.5	2.1	
Lane Grp Cap (vph)	381	422		342	304		196	1202		306	1064	
v/s Ratio Prot	c0.16	0.17		0.03	0.19		c0.08	0.17		0.03	c0.31	
v/s Ratio Perm	c0.24			0.07			0.30			0.13		
v/c Ratio	0.98	0.57		0.32	0.86		0.81	0.48		0.37	0.91	
Uniform Delay, d1	26.6	30.9		27.8	39.5		22.4	25.6		19.3	32.7	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	41.0	1.2		0.4	20.7		21.4	1.4		0.5	12.8	
Delay (s)	67.6	32.1		28.2	60.2		43.8	27.0		19.8	45.5	
Level of Service	E	C		C	E		D	C		B	D	
Approach Delay (s/veh)		53.1			51.3			30.6			43.1	
Approach LOS		D			D			C			D	
Intersection Summary												
HCM 2000 Control Delay (s/veh)		43.2										
HCM 2000 Volume to Capacity ratio		0.96										
Actuated Cycle Length (s)		104.8						18.8				
Intersection Capacity Utilization		101.2%										
Analysis Period (min)		15										
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis
6: Niagara St. & Roger Dr.

2030 Background PM

	EBL	EBR	NBL	NBT	SBT	SBR
Movement						
Lane Configurations						
Traffic Volume (veh/h)	21	36	38	805	966	68
Future Volume (Veh/h)	21	36	38	805	966	68
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	23	39	41	875	1050	74
Pedestrians	8			1	2	
Lane Width (m)	3.7			3.7	3.7	
Walking Speed (m/s)	1.1			1.1	1.1	
Percent Blockage	1			0	0	
Right turn flare (veh)						
Median type				TWLT	TWLT	
Median storage (veh)				2	2	
Upstream signal (m)				343	277	
pX, platoon unblocked	0.91	0.89	0.89			
vC, conflicting volume	1617	571	1132			
vC1, stage 1 conf vol	1095					
vC2, stage 2 conf vol	522					
vCu, unblocked vol	1257	262	894			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3	2.2			
p0 queue free %	92	94	94			
cM capacity (veh/h)	306	653	675			
Direction, Lane #	EB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	62	41	438	438	700	424
Volume Left	23	41	0	0	0	0
Volume Right	39	0	0	0	0	74
cSH	460	675	1700	1700	1700	1700
Volume to Capacity	0.13	0.06	0.26	0.26	0.41	0.25
Queue Length 95th (m)	3.5	1.5	0.0	0.0	0.0	0.0
Control Delay (s/veh)	14.0	10.7	0.0	0.0	0.0	0.0
Lane LOS	B	B				
Approach Delay (s/veh)	14.0	0.5			0.0	
Approach LOS	B					
Intersection Summary						
Average Delay			0.6			
Intersection Capacity Utilization			47.3%		ICU Level of Service	A
Analysis Period (min)			15			



BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix E

Background 2035 Traffic Operations

Timings
1: Niagara St. & Woodlawn Rd.

2035 Background AM

	↶	→	↷	↶	↶	↶	↶	↶	↶
Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations	↶	↶↶	↶	↶↶	↶	↶	↶↶	↶	↶↶
Traffic Volume (vph)	267	415	196	273	129	76	520	95	330
Future Volume (vph)	267	415	196	273	129	76	520	95	330
Lane Group Flow (vph)	290	592	213	297	140	83	877	103	524
Turn Type	pm+pt	NA	pm+pt	NA	Perm	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8		5	2	1	6
Permitted Phases	4		8		8	2		6	
Detector Phase	7	4	3	8	8	5	2	1	6
Switch Phase									
Minimum Initial (s)	6.0	8.0	6.0	8.0	8.0	6.0	10.0	6.0	10.0
Minimum Split (s)	9.0	39.4	9.0	39.4	39.4	9.0	39.3	9.0	39.3
Total Split (s)	30.0	48.0	26.0	44.0	44.0	9.0	67.7	16.0	74.7
Total Split (%)	19.0%	30.4%	16.5%	27.9%	27.9%	5.7%	42.9%	10.1%	47.4%
Yellow Time (s)	3.0	4.1	3.0	4.1	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	3.3	0.0	3.3	3.3	0.0	3.2	0.0	3.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	7.4	3.0	7.4	7.4	3.0	7.3	3.0	7.3
Lead/Lag	Lead	Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.72	0.85	0.77	0.50	0.41	0.20	0.59	0.40	0.35
Control Delay (s/veh)	46.3	68.7	52.0	60.1	10.8	18.9	31.9	22.1	24.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	46.3	68.7	52.0	60.1	10.8	18.9	31.9	22.1	24.6
Queue Length 50th (m)	67.6	90.9	46.7	44.9	0.0	11.5	98.0	14.6	48.4
Queue Length 95th (m)	86.7	107.6	61.9	56.3	18.3	23.1	136.7	28.0	67.5
Internal Link Dist (m)		245.8		240.0			194.1		161.2
Turn Bay Length (m)	111.0		87.0		132.0	97.0		133.0	
Base Capacity (vph)	412	835	307	768	401	413	1488	277	1486
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.70	0.71	0.69	0.39	0.35	0.20	0.59	0.37	0.35

Intersection Summary

Cycle Length: 157.7

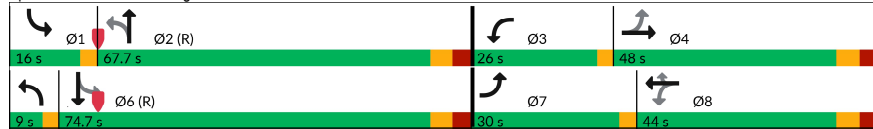
Actuated Cycle Length: 157.7

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 100

Control Type: Actuated-Coordinated

Splits and Phases: 1: Niagara St. & Woodlawn Rd.



HCM Signalized Intersection Capacity Analysis
1: Niagara St. & Woodlawn Rd.

2035 Background AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	267	415	130	196	273	129	76	520	287	95	330	152
Future Volume (vph)	267	415	130	196	273	129	76	520	287	95	330	152
Ideal Flow (vphpl)	1651	1776	1535	1651	1776	1498	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00		1.00	1.00	0.98	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.96		1.00	1.00	0.85	1.00	0.95		1.00	0.95	
Fit Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1538	3175		1570	3313	1265	1538	3119		1415	3033	
Fit Permitted	0.43	1.00		0.23	1.00	1.00	0.43	1.00		0.22	1.00	
Satd. Flow (perm)	693	3175		378	3313	1265	690	3119		327	3033	
Peak-hour factor, PHF	0.92	0.92		0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	290	451	141	213	297	140	83	565	312	103	359	165
RTOR Reduction (vph)	0	20	0	0	0	115	0	41	0	0	31	0
Lane Group Flow (vph)	290	572	0	213	297	25	83	836	0	103	493	0
Confl. Peds. (#/hr)	4		2	2		4	3		9	9		3
Heavy Vehicles (%)	3%	3%	4%	1%	3%	0%	3%	3%	2%	12%	6%	8%
Turn Type	pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8		8	2			6		
Actuated Green, G (s)	56.7	33.8		48.5	28.6	28.6	80.8	73.1		85.8	75.6	
Effective Green, g (s)	56.7	33.8		48.5	28.6	28.6	80.8	73.1		85.8	75.6	
Actuated g/C Ratio	0.36	0.21		0.31	0.18	0.18	0.51	0.46		0.54	0.48	
Clearance Time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3	
Vehicle Extension (s)	2.6	2.5		2.6	2.5	2.5	2.6	2.5		2.6	2.5	
Lane Grp Cap (vph)	383	680		266	600	229	394	1445		248	1453	
v/s Ratio Prot	c0.12	c0.18		c0.10	0.09		0.01	c0.27		c0.03	0.16	
v/s Ratio Perm	0.15			0.14		0.02	0.10			0.20		
v/c Ratio	0.76	0.84		0.80	0.50	0.11	0.21	0.58		0.42	0.34	
Uniform Delay, d1	40.1	59.4		44.5	58.1	53.9	19.9	31.0		20.1	25.5	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	8.0	9.1		15.4	0.5	0.2	0.2	1.7		0.9	0.6	
Delay (s)	48.1	68.5		60.0	58.5	54.1	20.1	32.7		21.0	26.2	
Level of Service	D	E		E	E	D	C	C		C	C	
Approach Delay (s/veh)		61.8			58.0			31.6			25.3	
Approach LOS		E			E			C			C	

Intersection Summary

HCM 2000 Control Delay (s/veh)	44.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	157.7	Sum of lost time (s)	20.7
Intersection Capacity Utilization	81.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
3: Niagara St. & Abbey Rd.

2035 Background AM

	EBL	EBR	NBL	NBT	SBT	SBR
Movement						
Lane Configurations	↔	↔	↔	↔	↔	↔
Traffic Volume (veh/h)	3	17	10	903	735	3
Future Volume (Veh/h)	3	17	10	903	735	3
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	18	11	982	799	3
Pedestrians	5					
Lane Width (m)	3.7					
Walking Speed (m/s)	1.1					
Percent Blockage	0					
Right turn flare (veh)						
Median type				TWLT	TWLT	
Median storage (veh)				2	2	
Upstream signal (m)				137	319	
pX, platoon unblocked	0.92					
vC, conflicting volume	1319	406	807			
vC1, stage 1 conf vol	806					
vC2, stage 2 conf vol	513					
vCu, unblocked vol	1171	406	807			
tC, single (s)	6.8	7.1	4.1			
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.4	2.2			
p0 queue free %	99	97	99			
cM capacity (veh/h)	364	564	823			
Direction, Lane #	EB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	21	11	491	491	533	269
Volume Left	3	11	0	0	0	0
Volume Right	18	0	0	0	0	3
cSH	523	823	1700	1700	1700	1700
Volume to Capacity	0.04	0.01	0.29	0.29	0.31	0.16
Queue Length 95th (m)	1.0	0.3	0.0	0.0	0.0	0.0
Control Delay (s/veh)	12.2	9.4	0.0	0.0	0.0	0.0
Lane LOS	B	A				
Approach Delay (s/veh)	12.2	0.1			0.0	
Approach LOS	B					
Intersection Summary						
Average Delay			0.2			
Intersection Capacity Utilization			36.7%		ICU Level of Service	A
Analysis Period (min)			15			

Timings

4: Niagara St. & Parking Lot/Aqueduct St.

2035 Background AM

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group								
Lane Configurations	↔	↔	↔	↔	↔	↔	↔	↔
Traffic Volume (vph)	66	4	11	11	41	695	125	539
Future Volume (vph)	66	4	11	11	41	695	125	539
Lane Group Flow (vph)	72	62	12	197	45	766	136	666
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA
Protected Phases		4		8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	8	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	8.0	8.0	8.0	8.0	10.0	10.0	10.0	10.0
Minimum Split (s)	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1
Total Split (s)	37.1	37.1	37.1	37.1	47.1	47.1	47.1	47.1
Total Split (%)	44.1%	44.1%	44.1%	44.1%	55.9%	55.9%	55.9%	55.9%
Yellow Time (s)	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
All-Red Time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Max	C-Max	C-Max	C-Max
v/c Ratio	0.52	0.25	0.07	0.64	0.10	0.34	0.34	0.31
Control Delay (s/veh)	45.2	11.6	28.5	21.6	6.5	6.7	9.7	6.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	45.2	11.6	28.5	21.6	6.5	6.7	9.7	6.2
Queue Length 50th (m)	10.9	0.6	1.7	9.4	2.1	22.3	7.5	18.1
Queue Length 95th (m)	21.8	9.8	5.7	27.3	7.3	41.5	22.8	34.3
Internal Link Dist (m)		33.7		300.3		252.9		113.5
Turn Bay Length (m)			20.0		90.0		100.0	
Base Capacity (vph)	326	506	425	545	452	2229	401	2167
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.22	0.12	0.03	0.36	0.10	0.34	0.34	0.31
Intersection Summary								
Cycle Length: 84.2								
Actuated Cycle Length: 84.2								
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green								
Natural Cycle: 75								
Control Type: Actuated-Coordinated								

Splits and Phases: 4: Niagara St. & Parking Lot/Aqueduct St.



HCM Signalized Intersection Capacity Analysis
4: Niagara St. & Parking Lot/Aqueduct St.

2035 Background AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	66	4	53	11	11	170	41	695	10	125	539	74
Future Volume (vph)	66	4	53	11	11	170	41	695	10	125	539	74
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.86		1.00	0.86		1.00	1.00		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1584	1317		1583	1292		1582	3274		1569	3173	
Flt Permitted	0.55	1.00		0.72	1.00		0.40	1.00		0.36	1.00	
Satd. Flow (perm)	917	1317		1194	1292		664	3274		590	3173	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	72	4	58	12	12	185	45	755	11	136	586	80
RTOR Reduction (vph)	0	49	0	0	113	0	0	1	0	0	8	0
Lane Group Flow (vph)	72	13	0	12	84	0	45	765	0	136	658	0
Confl. Peds. (#/hr)	2		2	2		2	4		2	2		4
Heavy Vehicles (%)	0%	0%	0%	0%	0%	2%	0%	4%	0%	1%	6%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	12.7	12.7		12.7	12.7		57.3	57.3		57.3	57.3	
Effective Green, g (s)	12.7	12.7		12.7	12.7		57.3	57.3		57.3	57.3	
Actuated g/C Ratio	0.15	0.15		0.15	0.15		0.68	0.68		0.68	0.68	
Clearance Time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Vehicle Extension (s)	4.0	4.0		4.0	4.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	138	198		180	194		451	2228		401	2159	
v/s Ratio Prot		0.01			0.07			c0.23			0.21	
v/s Ratio Perm	c0.08			0.01			0.07			0.23		
v/c Ratio	0.52	0.06		0.07	0.43		0.10	0.34		0.34	0.30	
Uniform Delay, d1	33.0	30.7		30.7	32.5		4.6	5.6		5.6	5.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	4.6	0.2		0.2	2.1		0.4	0.4		2.3	0.4	
Delay (s)	37.5	30.8		30.9	34.6		5.1	6.0		7.9	5.8	
Level of Service	D	C		C	C		A	A		A	A	
Approach Delay (s/veh)		34.4			34.4			6.0			6.1	
Approach LOS		C			C			A			A	
Intersection Summary												
HCM 2000 Control Delay (s/veh)	11.0			HCM 2000 Level of Service					B			
HCM 2000 Volume to Capacity ratio	0.38											
Actuated Cycle Length (s)	84.2			Sum of lost time (s)					14.2			
Intersection Capacity Utilization	78.3%			ICU Level of Service					D			
Analysis Period (min)	15											
c Critical Lane Group												

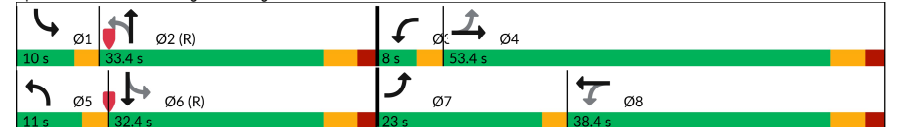
Timings

5: Niagara St/Niagara St. & Thorold Rd

2035 Background AM

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Traffic Volume (vph)	306	175	43	139	100	351	79	287
Future Volume (vph)	306	175	43	139	100	351	79	287
Lane Group Flow (vph)	333	299	47	276	109	434	86	546
Turn Type	pm+pt	NA	pm+pt	NA	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8	5	2	1	6
Permitted Phases	4		8		2		6	
Detector Phase	7	4	3	8	5	2	1	6
Switch Phase								
Minimum Initial (s)	5.0	8.0	5.0	8.0	5.0	8.0	5.0	8.0
Minimum Split (s)	8.0	33.5	8.0	33.5	8.0	30.3	8.0	30.3
Total Split (s)	23.0	53.4	8.0	38.4	11.0	33.4	10.0	32.4
Total Split (%)	21.9%	51.0%	7.6%	36.6%	10.5%	31.9%	9.5%	30.9%
Yellow Time (s)	3.0	4.1	3.0	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	2.4	0.0	2.4	0.0	2.2	0.0	2.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.5	3.0	6.5	3.0	6.3	3.0	6.3
Lead/Lag	Lead	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.74	0.58	0.16	0.84	0.37	0.39	0.24	0.49
Control Delay (s/veh)	28.5	27.0	15.8	54.3	22.3	28.4	20.4	22.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	28.5	27.0	15.8	54.3	22.3	28.4	20.4	22.1
Queue Length 50th (m)	43.5	42.7	5.0	46.3	12.5	35.2	9.7	32.1
Queue Length 95th (m)	55.4	61.2	9.4	69.5	27.0	54.3	22.0	53.0
Internal Link Dist (m)		152.6		154.0		97.6		318.5
Turn Bay Length (m)	70.0		67.0		85.0		60.0	
Base Capacity (vph)	453	603	289	434	300	1119	356	1118
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.74	0.50	0.16	0.64	0.36	0.39	0.24	0.49
Intersection Summary								
Cycle Length: 104.8								
Actuated Cycle Length: 104.8								
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green								
Natural Cycle: 80								
Control Type: Actuated-Coordinated								

Splits and Phases: 5: Niagara St/Niagara St. & Thorold Rd



HCM Signalized Intersection Capacity Analysis
5: Niagara St/Niagara St. & Thorold Rd

2035 Background AM

															
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR			
Lane Configurations															
Traffic Volume (vph)	306	175	100	43	139	115	100	351	48	79	287	215			
Future Volume (vph)	306	175	100	43	139	115	100	351	48	79	287	215			
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535			
Total Lost time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3				
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95				
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	0.98				
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00				
Frt	1.00	0.95		1.00	0.93		1.00	0.98		1.00	0.94				
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00				
Satd. Flow (prot)	1551	1304		1424	1336		1388	3132		1388	3038				
Flt Permitted	0.35	1.00		0.58	1.00		0.33	1.00		0.47	1.00				
Satd. Flow (perm)	564	1304		866	1336		488	3132		693	3038				
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92			
Adj. Flow (vph)	333	190	109	47	151	125	109	382	52	86	312	234			
RTOR Reduction (vph)	0	22	0	0	32	0	0	9	0	0	117	0			
Lane Group Flow (vph)	333	277	0	47	244	0	109	425	0	86	429	0			
Confl. Peds. (#/hr)	13		8	8		13	8		5	5		8			
Heavy Vehicles (%)	2%	12%	11%	11%	7%	7%	14%	3%	33%	14%	3%	4%			
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA				
Protected Phases	7	4		3	8		5	2		1	6				
Permitted Phases	4			8			2			6					
Actuated Green, G (s)	46.4	39.4		27.9	23.9		44.6	35.9		40.6	33.9				
Effective Green, g (s)	46.4	39.4		27.9	23.9		44.6	35.9		40.6	33.9				
Actuated g/C Ratio	0.44	0.38		0.27	0.23		0.43	0.34		0.39	0.32				
Clearance Time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3				
Vehicle Extension (s)	2.5	2.2		2.5	2.2		2.5	2.1		2.5	2.1				
Lane Grp Cap (vph)	433	490		251	304		282	1072		312	982				
v/s Ratio Prot	c0.14	0.21		0.01	0.18		c0.03	0.14		0.02	c0.14				
v/s Ratio Perm	c0.20			0.04			0.13			0.09					
v/c Ratio	0.77	0.56		0.19	0.80		0.39	0.40		0.28	0.44				
Uniform Delay, d1	21.6	25.9		29.2	38.2		19.2	26.2		21.0	27.9				
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00				
Incremental Delay, d2	7.7	1.0		0.3	13.6		0.6	1.1		0.4	1.4				
Delay (s)	29.3	26.9		29.4	51.9		19.9	27.3		21.3	29.3				
Level of Service	C	C		C	D		B	C		C	C				
Approach Delay (s/veh)		28.2			48.6			25.8			28.3				
Approach LOS		C			D			C			C				
Intersection Summary															
HCM 2000 Control Delay (s/veh)	30.7			HCM 2000 Level of Service				C							
HCM 2000 Volume to Capacity ratio	0.62														
Actuated Cycle Length (s)	104.8			Sum of lost time (s)				18.8							
Intersection Capacity Utilization	83.0%			ICU Level of Service				E							
Analysis Period (min)	15														
c Critical Lane Group															

HCM Unsignalized Intersection Capacity Analysis
6: Niagara St. & Roger Dr.

2035 Background AM

	EBL	EBR	NBL	NBT	SBT	SBR
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↰	↱	↰	↱	↱	↱
Traffic Volume (veh/h)	16	31	35	773	505	63
Future Volume (Veh/h)	16	31	35	773	505	63
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	17	34	38	840	549	68
Pedestrians	6				1	
Lane Width (m)	3.7				3.7	
Walking Speed (m/s)	1.1				1.1	
Percent Blockage	1				0	
Right turn flare (veh)						
Median type				TWLT	TWLT	
Median storage (veh)				2	2	
Upstream signal (m)				343	277	
pX, platoon unblocked	0.98					
vC, conflicting volume	1086	315	623			
vC1, stage 1 conf vol	589					
vC2, stage 2 conf vol	497					
vCu, unblocked vol	1054	315	623			
tC, single (s)	6.8	7.0	4.1			
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	95	96			
cM capacity (veh/h)	424	675	962			
Direction, Lane #	EB 1	NB 1	NB 3	SB 1	SB 2	
Volume Total	51	38	420	420	366	251
Volume Left	17	38	0	0	0	0
Volume Right	34	0	0	0	0	68
cSH	563	962	1700	1700	1700	1700
Volume to Capacity	0.09	0.04	0.25	0.25	0.22	0.15
Queue Length 95th (m)	2.3	0.9	0.0	0.0	0.0	0.0
Control Delay (s/veh)	12.0	8.9	0.0	0.0	0.0	0.0
Lane LOS	B	A				
Approach Delay (s/veh)	12.0	0.4			0.0	
Approach LOS	B					
Intersection Summary						
Average Delay	0.6					
Intersection Capacity Utilization	33.8%			ICU Level of Service		A
Analysis Period (min)	15					

Timings

1: Niagara St. & Woodlawn Rd.

2035 Background PM

	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations	↩	↩↪	↩	↩↪	↩	↩	↩↪	↩	↩↪
Traffic Volume (vph)	302	394	393	572	182	97	570	204	684
Future Volume (vph)	302	394	393	572	182	97	570	204	684
Lane Group Flow (vph)	328	524	427	622	198	105	943	222	1072
Turn Type	pm+pt	NA	pm+pt	NA	Perm	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8		5	2	1	6
Permitted Phases	4		8		8	2		6	
Detector Phase	7	4	3	8	8	5	2	1	6
Switch Phase									
Minimum Initial (s)	6.0	8.0	6.0	8.0	8.0	6.0	10.0	6.0	10.0
Minimum Split (s)	9.0	39.4	9.0	39.4	39.4	9.0	39.3	9.0	39.3
Total Split (s)	39.9	39.8	45.9	45.8	45.8	12.0	49.0	23.0	60.0
Total Split (%)	25.3%	25.2%	29.1%	29.0%	29.0%	7.6%	31.1%	14.6%	38.0%
Yellow Time (s)	3.0	4.1	3.0	4.1	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	3.3	0.0	3.3	3.3	0.0	3.2	0.0	3.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	7.4	3.0	7.4	7.4	3.0	7.3	3.0	7.3
Lead/Lag	Lead	Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.85	0.87	0.94	0.76	0.44	0.64	0.94	0.88	0.86
Control Delay (s/veh)	51.4	76.8	67.5	62.2	9.0	45.3	66.0	73.7	52.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	51.4	76.8	67.5	62.2	9.0	45.3	66.0	73.7	52.2
Queue Length 50th (m)	65.4	82.3	105.1	94.5	0.0	18.3	~165.9	52.6	164.6
Queue Length 95th (m)	91.3	102.2	#154.4	118.7	21.5	#40.1	#208.5	#107.4	#215.8
Internal Link Dist (m)		245.8		240.0			194.1		161.2
Turn Bay Length (m)	111.0		87.0		132.0	97.0		133.0	
Base Capacity (vph)	462	669	490	839	456	166	1008	257	1242
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.71	0.78	0.87	0.74	0.43	0.63	0.94	0.86	0.86

Intersection Summary

Cycle Length: 157.7

Actuated Cycle Length: 157.7

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 120

Control Type: Actuated-Coordinated

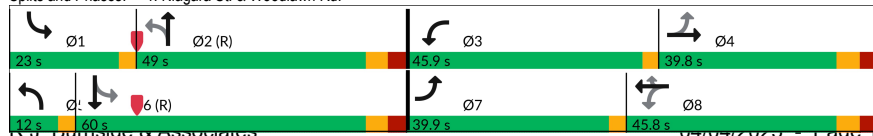
~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: Niagara St. & Woodlawn Rd.



R.J. Burnside & Associates

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HCM Signalized Intersection Capacity Analysis

1: Niagara St. & Woodlawn Rd.

2035 Background PM

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↩	↩↪		↩	↩↪	↩	↩	↩↪		↩	↩↪	
Traffic Volume (vph)	302	394	88	393	572	182	97	570	297	204	684	303
Future Volume (vph)	302	394	88	393	572	182	97	570	297	204	684	303
Ideal Flow (vphpl)	1651	1776	1535	1651	1776	1498	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	0.95		1.00	0.95	
Flpb, ped/bikes	1.00	0.99		1.00	1.00	0.96	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.97		1.00	1.00	0.85	1.00	0.95		1.00	0.95	
Fit Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1567	3198		1569	3345	1228	1570	3138		1540	3191	
Fit Permitted	0.28	1.00		0.19	1.00	1.00	0.12	1.00		0.08	1.00	
Satd. Flow (perm)	459	3198		310	3345	1228	205	3138		137	3191	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	328	428	96	427	622	198	105	620	323	222	743	329
RTOR Reduction (vph)	0	12	0	0	0	150	0	40	0	0	30	0
Lane Group Flow (vph)	328	512	0	427	622	48	105	903	0	222	1042	0
Confl. Peds. (#/hr)	17		12	12		17	14		21	21		14
Heavy Vehicles (%)	1%	3%	4%	1%	2%	1%	1%	2%	1%	3%	1%	1%
Turn Type	pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8		8	2			6		
Actuated Green, G (s)	58.0	29.0		70.5	38.5	38.5	58.2	48.6		72.5	59.9	
Effective Green, g (s)	58.0	29.0		70.5	38.5	38.5	58.2	48.6		72.5	59.9	
Actuated g/C Ratio	0.37	0.18		0.45	0.24	0.24	0.37	0.31		0.46	0.38	
Clearance Time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3	
Vehicle Extension (s)	2.6	2.5		2.6	2.5	2.5	2.6	2.5		2.6	2.5	
Lane Grp Cap (vph)	372	588		445	816	299	158	967		248	1212	
v/s Ratio Prot	0.16	0.16		c0.23	0.19		0.04	0.29		c0.12	0.33	
v/s Ratio Perm	0.16			c0.19		0.04	0.20			c0.29		
v/c Ratio	0.88	0.87		0.96	0.76	0.16	0.66	0.93		0.90	0.86	
Uniform Delay, d1	40.4	62.5		42.2	55.3	46.9	36.5	53.0		46.6	45.0	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	20.9	13.2		32.0	4.1	0.2	9.3	16.8		30.8	8.1	
Delay (s)	61.3	75.7		74.2	59.4	47.1	45.8	69.8		77.4	53.1	
Level of Service	E	E		E	E	D	D	E		E	D	
Approach Delay (s/veh)		70.1			62.5			67.4			57.3	
Approach LOS		E			E			E			E	

Intersection Summary

HCM 2000 Control Delay (s/veh)

HCM 2000 Level of Service

E

HCM 2000 Volume to Capacity ratio

0.96

Actuated Cycle Length (s)

157.7

Sum of lost time (s)

20.7

Intersection Capacity Utilization

103.5%

ICU Level of Service

G

Analysis Period (min)

15

c Critical Lane Group

052233 418-430 Aqueduct and 650-678 Niagara Street.syn

R.J. Burnside & Associates

Synchro 12 Report

04/04/2025 - Page 2

HCM Unsignalized Intersection Capacity Analysis
3: Niagara St. & Abbey Rd.

2035 Background PM

						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	9	23	9	1045	1290	27
Future Volume (Veh/h)	9	23	9	1045	1290	27
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	10	25	10	1136	1402	29
Pedestrians	19					
Lane Width (m)	3.7					
Walking Speed (m/s)	1.1					
Percent Blockage	2					
Right turn flare (veh)						
Median type				TWLTL	TWLTL	
Median storage (veh)				2	2	
Upstream signal (m)				137	319	
pX, platoon unblocked	0.83	0.78	0.78			
vC, conflicting volume	2024	735	1450			
vC1, stage 1 conf vol	1436					
vC2, stage 2 conf vol	588					
vCu, unblocked vol	1206	79	1001			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	97	98			
cM capacity (veh/h)	240	741	533			
Direction, Lane #	EB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	35	10	568	568	935	496
Volume Left	10	10	0	0	0	0
Volume Right	25	0	0	0	0	29
cSH	464	533	1700	1700	1700	1700
Volume to Capacity	0.08	0.02	0.33	0.33	0.55	0.29
Queue Length 95th (m)	1.9	0.4	0.0	0.0	0.0	0.0
Control Delay (s/veh)	13.4	11.9	0.0	0.0	0.0	0.0
Lane LOS	B	B				
Approach Delay (s/veh)	13.4	0.1			0.0	
Approach LOS	B					
Intersection Summary						
Average Delay	0.2					
Intersection Capacity Utilization	49.1%		ICU Level of Service		A	
Analysis Period (min)	15					

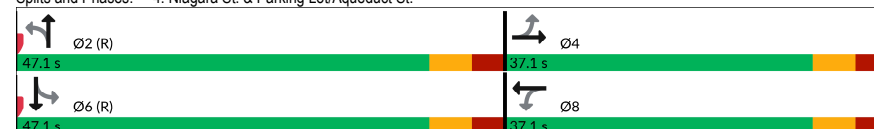
Timings

4: Niagara St. & Parking Lot/Aqueduct St.

2035 Background PM

								
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	45	1	14	2	41	931	100	1157
Future Volume (vph)	45	1	14	2	41	931	100	1157
Lane Group Flow (vph)	49	48	15	87	45	1037	109	1317
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA
Protected Phases	4		8		2		6	
Permitted Phases	4		8		2		6	
Detector Phase	4	4	8	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	8.0	8.0	8.0	8.0	10.0	10.0	10.0	10.0
Minimum Split (s)	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1
Total Split (s)	37.1	37.1	37.1	37.1	47.1	47.1	47.1	47.1
Total Split (%)	44.1%	44.1%	44.1%	44.1%	55.9%	55.9%	55.9%	55.9%
Yellow Time (s)	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
All-Red Time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Max	C-Max	C-Max	C-Max
v/c Ratio	0.34	0.26	0.10	0.41	0.19	0.41	0.33	0.52
Control Delay (s/veh)	39.6	21.5	32.9	20.6	7.4	5.5	8.7	6.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	39.6	21.5	32.9	20.6	7.4	5.5	8.7	6.5
Queue Length 50th (m)	7.4	2.9	2.2	4.3	2.0	30.1	5.6	43.6
Queue Length 95th (m)	16.8	12.0	7.2	16.3	7.5	48.8	17.2	70.1
Internal Link Dist (m)	33.7		300.3		252.9		113.5	
Turn Bay Length (m)			20.0		90.0		100.0	
Base Capacity (vph)	416	481	429	502	233	2536	332	2528
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.12	0.10	0.03	0.17	0.19	0.41	0.33	0.52
Intersection Summary								
Cycle Length: 84.2								
Actuated Cycle Length: 84.2								
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green								
Natural Cycle: 80								
Control Type: Actuated-Coordinated								

Splits and Phases: 4: Niagara St. & Parking Lot/Aqueduct St.



HCM Signalized Intersection Capacity Analysis
4: Niagara St. & Parking Lot/Aqueduct St.

2035 Background PM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	45	1	43	14	2	78	41	931	23	100	1157	54
Future Volume (vph)	45	1	43	14	2	78	41	931	23	100	1157	54
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.98		1.00	0.99		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.85		1.00	0.85		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1584	1302		1578	1307		1582	3331		1579	3320	
Flt Permitted	0.70	1.00		0.73	1.00		0.18	1.00		0.26	1.00	
Satd. Flow (perm)	1168	1302		1206	1307		306	3331		438	3320	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	49	1	47	15	2	85	45	1012	25	109	1258	59
RTOR Reduction (vph)	0	25	0	0	52	0	0	1	0	0	2	0
Lane Group Flow (vph)	49	23	0	15	35	0	45	1036	0	109	1315	0
Confl. Peds. (#/hr)	2		6	6		2	12		14	14		12
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	2%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	8.7	8.7		8.7	8.7		61.3	61.3		61.3	61.3	
Effective Green, g (s)	8.7	8.7		8.7	8.7		61.3	61.3		61.3	61.3	
Actuated g/C Ratio	0.10	0.10		0.10	0.10		0.73	0.73		0.73	0.73	
Clearance Time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Vehicle Extension (s)	4.0	4.0		4.0	4.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	120	134		124	135		222	2425		318	2417	
v/s Ratio Prot		0.02			0.03			0.31			c0.40	
v/s Ratio Perm	c0.04			0.01			0.15			0.25		
v/c Ratio	0.41	0.17		0.12	0.26		0.20	0.43		0.34	0.54	
Uniform Delay, d1	35.3	34.5		34.3	34.8		3.7	4.5		4.1	5.2	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	3.1	0.8		0.6	1.4		2.0	0.6		2.9	0.9	
Delay (s)	38.4	35.3		34.9	36.2		5.7	5.1		7.1	6.0	
Level of Service	D	D		C	D		A	A		A	A	
Approach Delay (s/veh)		36.9			36.0			5.1			6.1	
Approach LOS		D			D			A			A	
Intersection Summary												
HCM 2000 Control Delay (s/veh)		7.9										
HCM 2000 Volume to Capacity ratio		0.53										
Actuated Cycle Length (s)		84.2						14.2				
Intersection Capacity Utilization		74.5%						ICU Level of Service			D	
Analysis Period (min)		15										
c Critical Lane Group												

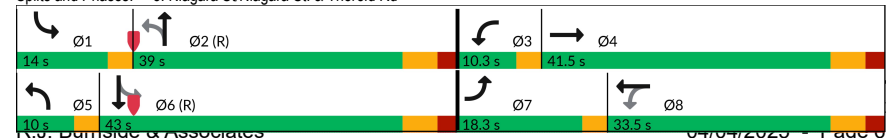
Timings

5: Niagara St/Niagara St. & Thorold Rd

2035 Background PM

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	396	178	117	184	167	547	119	638
Future Volume (vph)	396	178	117	184	167	547	119	638
Lane Group Flow (vph)	430	297	127	327	182	673	129	1269
Turn Type	Prot	NA	pm+pt	NA	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8	5	2	1	6
Permitted Phases			8		2		6	
Detector Phase	7	4	3	8	5	2	1	6
Switch Phase								
Minimum Initial (s)	5.0	8.0	5.0	8.0	5.0	8.0	5.0	8.0
Minimum Split (s)	8.0	33.5	8.0	33.5	8.0	30.3	8.0	30.3
Total Split (s)	18.3	41.5	10.3	33.5	10.0	39.0	14.0	43.0
Total Split (%)	17.5%	39.6%	9.8%	32.0%	9.5%	37.2%	13.4%	41.0%
Yellow Time (s)	3.0	4.1	3.0	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	2.4	0.0	2.4	0.0	2.2	0.0	2.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.5	3.0	6.5	3.0	6.3	3.0	6.3
Lead/Lag	Lead	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.98	0.64	0.35	0.92	0.96	0.58	0.43	1.04
Control Delay (s/veh)	83.2	34.6	20.8	66.5	84.6	30.8	20.2	64.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	83.2	34.6	20.8	66.5	84.6	30.8	20.2	64.5
Queue Length 50th (m)	45.5	45.5	14.6	58.4	~30.9	59.9	14.6	~130.7
Queue Length 95th (m)	#76.1	74.0	25.8	#106.1	#74.5	80.1	25.9	#172.3
Internal Link Dist (m)		152.6		154.0		97.6		318.5
Turn Bay Length (m)	70.0		67.0		85.0		60.0	
Base Capacity (vph)	440	487	368	384	189	1154	319	1223
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.98	0.61	0.35	0.85	0.96	0.58	0.40	1.04
Intersection Summary								
Cycle Length: 104.8								
Actuated Cycle Length: 104.8								
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green								
Natural Cycle: 120								
Control Type: Actuated-Coordinated								
- Volume exceeds capacity, queue is theoretically infinite.								
Queue shown is maximum after two cycles.								
# 95th percentile volume exceeds capacity, queue may be longer.								
Queue shown is maximum after two cycles.								

Splits and Phases: 5: Niagara St/Niagara St. & Thorold Rd



HCM Signalized Intersection Capacity Analysis
5: Niagara St/Niagara St. & Thorold Rd

2035 Background PM

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔
Traffic Volume (vph)	396	178	96	117	184	117	167	547	72	119	638	530
Future Volume (vph)	396	178	96	117	184	117	167	547	72	119	638	530
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Lane Util. Factor	0.97	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	0.99		1.00	0.98	
Flpb, ped/bikes	1.00	1.00		0.99	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.95		1.00	0.94		1.00	0.98		1.00	0.93	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	3016	1405		1574	1406		1468	3299		1480	3083	
Flt Permitted	0.95	1.00		0.58	1.00		0.11	1.00		0.28	1.00	
Satd. Flow (perm)	3016	1405		958	1406		170	3299		436	3083	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	430	193	104	127	200	127	182	595	78	129	693	576
RTOR Reduction (vph)	0	19	0	0	22	0	0	9	0	0	144	0
Lane Group Flow (vph)	430	278	0	127	305	0	182	664	0	129	1125	0
Confl. Peds. (#/hr)	11		18	18		11	12		11	11		12
Heavy Vehicles (%)	2%	1%	8%	0%	1%	6%	8%	1%	2%	7%	1%	1%
Turn Type	Prot	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases				8			2			6		
Actuated Green, G (s)	15.3	33.0		32.1	24.9		45.5	36.4		46.1	36.7	
Effective Green, g (s)	15.3	33.0		32.1	24.9		45.5	36.4		46.1	36.7	
Actuated g/C Ratio	0.15	0.31		0.31	0.24		0.43	0.35		0.44	0.35	
Clearance Time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Vehicle Extension (s)	2.5	2.2		2.5	2.2		2.5	2.1		2.5	2.1	
Lane Grp Cap (vph)	440	442		335	334		186	1145		285	1079	
v/s Ratio Prot	c0.14	0.20		0.03	c0.22		c0.08	0.20		0.04	c0.37	
v/s Ratio Perm				0.09			0.34			0.16		
v/c Ratio	0.98	0.63		0.38	0.91		0.98	0.58		0.45	1.04	
Uniform Delay, d1	44.6	30.7		27.4	38.9		26.4	27.9		18.7	34.1	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	36.6	2.2		0.5	27.9		59.0	2.1		0.8	39.3	
Delay (s)	81.2	32.8		28.0	66.8		85.4	30.1		19.5	73.3	
Level of Service	F	C		C	E		F	C		B	E	
Approach Delay (s/veh)		61.4			55.9			41.9			68.4	
Approach LOS		E			E			D			E	
Intersection Summary												
HCM 2000 Control Delay (s/veh)		58.7			HCM 2000 Level of Service			E				
HCM 2000 Volume to Capacity ratio		0.99										
Actuated Cycle Length (s)		104.8			Sum of lost time (s)			18.8				
Intersection Capacity Utilization		100.2%			ICU Level of Service			G				
Analysis Period (min)		15										

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
6: Niagara St. & Roger Dr.

2035 Background PM

	EBL	EBR	NBL	NBT	SBT	SBR
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↔	↔	↔	↔	↔	↔
Traffic Volume (veh/h)	21	36	38	893	1072	68
Future Volume (Veh/h)	21	36	38	893	1072	68
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	23	39	41	971	1165	74
Pedestrians	8			1	2	
Lane Width (m)	3.7			3.7	3.7	
Walking Speed (m/s)	1.1			1.1	1.1	
Percent Blockage	1			0	0	
Right turn flare (veh)						
Median type				TWLT	TWLT	
Median storage (veh)				2	2	
Upstream signal (m)				343	277	
pX, platoon unblocked	0.89	0.85	0.85			
vC, conflicting volume	1780	629	1247			
vC1, stage 1 conf vol	1210					
vC2, stage 2 conf vol	570					
vCu, unblocked vol	1278	215	941			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3	2.2			
p0 queue free %	92	94	93			
cM capacity (veh/h)	282	672	623			
Direction, Lane #	EB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	62	41	486	486	777	462
Volume Left	23	41	0	0	0	0
Volume Right	39	0	0	0	0	74
cSH	444	623	1700	1700	1700	1700
Volume to Capacity	0.14	0.07	0.29	0.29	0.46	0.27
Queue Length 95th (m)	3.7	1.6	0.0	0.0	0.0	0.0
Control Delay (s/veh)	14.4	11.2	0.0	0.0	0.0	0.0
Lane LOS	B	B				
Approach Delay (s/veh)	14.4	0.5			0.0	
Approach LOS	B					
Intersection Summary						
Average Delay			0.6			
Intersection Capacity Utilization			47.3%		ICU Level of Service	A
Analysis Period (min)			15			



BURNSIDE

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Appendix F

Total 2030 Traffic Operations

Timings

1: Niagara St. & Woodlawn Rd.

2030 Total AM

	↖	→	↗	↖	↖	↖	↑	↗	↓
Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations	↖	↖↗	↖	↖↗	↖	↖	↖↗	↖	↖↗
Traffic Volume (vph)	243	378	211	249	118	95	517	86	320
Future Volume (vph)	243	378	211	249	118	95	517	86	320
Lane Group Flow (vph)	264	553	229	271	128	103	932	93	499
Turn Type	pm+pt	NA	pm+pt	NA	Perm	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8		5	2	1	6
Permitted Phases	4		8		8	2		6	
Detector Phase	7	4	3	8	8	5	2	1	6
Switch Phase									
Minimum Initial (s)	6.0	8.0	6.0	8.0	8.0	6.0	10.0	6.0	10.0
Minimum Split (s)	9.0	39.4	9.0	39.4	39.4	9.0	39.3	9.0	39.3
Total Split (s)	27.0	45.0	28.0	46.0	46.0	10.0	69.7	15.0	74.7
Total Split (%)	17.1%	28.5%	17.8%	29.2%	29.2%	6.3%	44.2%	9.5%	47.4%
Yellow Time (s)	3.0	4.1	3.0	4.1	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	3.3	0.0	3.3	3.3	0.0	3.2	0.0	3.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	7.4	3.0	7.4	7.4	3.0	7.3	3.0	7.3
Lead/Lag	Lead	Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.66	0.85	0.79	0.43	0.37	0.24	0.61	0.39	0.34
Control Delay (s/veh)	43.8	70.2	54.0	57.2	10.3	18.7	30.3	21.6	24.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	43.8	70.2	54.0	57.2	10.3	18.7	30.3	21.6	24.4
Queue Length 50th (m)	60.7	84.2	51.1	39.8	0.0	14.3	100.8	12.9	46.1
Queue Length 95th (m)	79.0	101.6	67.4	50.7	17.0	27.3	140.1	25.2	64.4
Internal Link Dist (m)		245.8		240.0			194.1		161.2
Turn Bay Length (m)	111.0		87.0		132.0	97.0		133.0	
Base Capacity (vph)	410	776	323	810	406	435	1525	260	1489
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.64	0.71	0.71	0.33	0.32	0.24	0.61	0.36	0.34

Intersection Summary

Cycle Length: 157.7

Actuated Cycle Length: 157.7

Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

Natural Cycle: 100

Control Type: Actuated-Coordinated

Splits and Phases: 1: Niagara St. & Woodlawn Rd.

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HCM Signalized Intersection Capacity Analysis

1: Niagara St. & Woodlawn Rd.

2030 Total AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			 			 			 	
Traffic Volume (vph)	243	378	131	211	249	118	95	517	340	86	320	139
Future Volume (vph)	243	378	131	211	249	118	95	517	340	86	320	139
Ideal Flow (vphpl)	1651	1776	1535	1651	1776	1498	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	0.95		1.00	0.95	
Flrb, ped/bikes	1.00	1.00		1.00	1.00	0.98	1.00	0.99		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.96		1.00	1.00	0.85	1.00	0.94		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1537	3165		1570	3313	1265	1538	3096		1415	3040	
Flt Permitted	0.50	1.00		0.21	1.00	1.00	0.43	1.00		0.21	1.00	
Satd. Flow (perm)	805	3165		349	3313	1265	703	3096		307	3040	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	264	411	142	229	271	128	103	562	370	93	348	151
RTOR Reduction (vph)	0	23	0	0	0	103	0	61	0	0	28	0
Lane Group Flow (vph)	264	530	0	229	271	25	103	871	0	93	471	0
Confl. Peds. (#/hr)	4		2	2		4	3		9	9		3
Heavy Vehicles (%)	3%	3%	4%	1%	3%	0%	3%	3%	2%	12%	6%	8%
Turn Type	pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8		8	2			6		
Actuated Green, G (s)	53.8	31.3		51.6	30.2	30.2	83.2	74.7		85.4	75.8	
Effective Green, g (s)	53.8	31.3		51.6	30.2	30.2	83.2	74.7		85.4	75.8	
Actuated g/C Ratio	0.34	0.20		0.33	0.19	0.19	0.53	0.47		0.54	0.48	
Clearance Time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3	
Vehicle Extension (s)	2.6	2.5		2.6	2.5	2.5	2.6	2.5		2.6	2.5	
Lane Grp Cap (vph)	379	628		279	634	242	415	1466		233	1461	
v/s Ratio Prot	c0.10	c0.17		c0.11	0.08		0.01	c0.28		c0.02	0.15	
v/s Ratio Perm	0.14			0.16		0.02	0.12			0.19		
v/c Ratio	0.70	0.84		0.82	0.43	0.10	0.25	0.59		0.40	0.32	
Uniform Delay, d1	41.4	60.8		42.9	56.1	52.6	19.0	30.4		20.2	25.2	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	5.2	9.9		17.1	0.3	0.1	0.2	1.8		0.9	0.6	
Delay (s)	46.6	70.8		60.0	56.5	52.7	19.2	32.2		21.1	25.8	
Level of Service	D	E		E	E	D	B	C		C	C	
Approach Delay (s/veh)		62.9			57.0			30.9			25.0	
Approach LOS		E			E			C			C	

Intersection Summary

HCM 2000 Control Delay (s/veh) 43.6 HCM 2000 Level of Service D

HCM 2000 Volume to Capacity ratio 0.68

Actuated Cycle Length (s) 157.7 Sum of lost time (s) 20.7

Intersection Capacity Utilization 81.6% ICU Level of Service D

Analysis Period (min) 15

c Critical Lane Group

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HCM Unsignalized Intersection Capacity Analysis
2: Niagara St. & North Driveway

2030 Total AM

	←	↙	↑	↘	↗	↓
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↔		↕		↕	↕
Traffic Volume (veh/h)	8	44	944	4	18	698
Future Volume (Veh/h)	8	44	944	4	18	698
Sign Control	Stop		Free		Free	
Grade	0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	9	48	1026	4	20	759
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			TWLT		TWLT	
Median storage (veh)			2		2	
Upstream signal (m)			238		218	
pX, platoon unblocked	0.96	0.96			0.96	
vC, conflicting volume	1448	515			1030	
vC1, stage 1 conf vol	1028					
vC2, stage 2 conf vol	420					
vCu, unblocked vol	1378	421			956	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3			2.2	
p0 queue free %	97	92			97	
cM capacity (veh/h)	300	565			701	
Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	57	684	346	20	380	380
Volume Left	9	0	0	20	0	0
Volume Right	48	0	4	0	0	0
cSH	496	1700	1700	701	1700	1700
Volume to Capacity	0.11	0.40	0.20	0.03	0.22	0.22
Queue Length 95th (m)	2.9	0.0	0.0	0.7	0.0	0.0
Control Delay (s/veh)	13.2	0.0	0.0	10.3	0.0	0.0
Lane LOS	B			B		
Approach Delay (s/veh)	13.2	0.0		0.3		
Approach LOS	B					
Intersection Summary						
Average Delay			0.5			
Intersection Capacity Utilization			38.4%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
3: Niagara St. & Abbey Rd./South Driveway

2030 Total AM

	↗	→	↘	↙	←	↖	↗	↑	↘	↗	↓	↖
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕		↕	↕		↕	↕	↕	↕	↕	↕
Traffic Volume (veh/h)	3	0	17	18	0	103	10	809	8	45	663	3
Future Volume (Veh/h)	3	0	17	18	0	103	10	809	8	45	663	3
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	0	18	20	0	112	11	879	9	49	721	3
Pedestrians		5										
Lane Width (m)		3.7										
Walking Speed (m/s)		1.1										
Percent Blockage		0										
Right turn flare (veh)												
Median type								TWLT			TWLT	
Median storage (veh)								2			2	
Upstream signal (m)								137			319	
pX, platoon unblocked	0.94	0.94		0.94	0.94	0.94				0.94		
vC, conflicting volume	1399	1736	367	1382	1733	444	729			888		
vC1, stage 1 conf vol	826	826		906	906							
vC2, stage 2 conf vol	574	910		477	827							
vCu, unblocked vol	1290	1649	367	1272	1646	270	729			744		
tC, single (s)	7.5	6.5	7.1	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)	6.5	5.5		6.5	5.5							
tF (s)	3.5	4.0	3.4	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	100	97	93	100	84	99			94		
cM capacity (veh/h)	259	255	599	289	267	687	880			817		
Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3			
Volume Total	21	20	112	11	586	302	49	481	243			
Volume Left	3	20	0	11	0	0	49	0	0			
Volume Right	18	0	112	0	0	9	0	0	3			
cSH	504	289	687	880	1700	1700	817	1700	1700			
Volume to Capacity	0.04	0.07	0.16	0.01	0.34	0.18	0.06	0.28	0.14			
Queue Length 95th (m)	1.0	1.7	4.4	0.3	0.0	0.0	1.5	0.0	0.0			
Control Delay (s/veh)	12.4	18.4	11.3	9.1	0.0	0.0	9.7	0.0	0.0			
Lane LOS	B	C	B	A			A					
Approach Delay (s/veh)	12.4	12.3		0.1			0.6					
Approach LOS	B	B										
Intersection Summary												
Average Delay					1.4							
Intersection Capacity Utilization				45.0%		ICU Level of Service			A			
Analysis Period (min)				15								

Timings
4: Niagara St. & Parking Lot/Aqueduct St.

2030 Total AM

	↖	→	↗	←	↖	↑	↗	↓
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations	↖	↗	↖	↗	↖	↑	↗	↑
Traffic Volume (vph)	59	3	10	10	36	631	112	506
Future Volume (vph)	59	3	10	10	36	631	112	506
Lane Group Flow (vph)	64	54	11	175	39	696	122	622
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA
Protected Phases		4		8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	8	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	8.0	8.0	8.0	8.0	10.0	10.0	10.0	10.0
Minimum Split (s)	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1
Total Split (s)	37.1	37.1	37.1	37.1	47.1	47.1	47.1	47.1
Total Split (%)	44.1%	44.1%	44.1%	44.1%	55.9%	55.9%	55.9%	55.9%
Yellow Time (s)	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
All-Red Time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Max	C-Max	C-Max	C-Max
v/c Ratio	0.46	0.24	0.07	0.55	0.08	0.31	0.28	0.28
Control Delay (s/veh)	42.9	12.6	30.1	13.6	5.6	5.9	7.7	5.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	42.9	12.6	30.1	13.6	5.6	5.9	7.7	5.5
Queue Length 50th (m)	9.7	0.4	1.6	1.9	1.7	19.1	6.2	16.0
Queue Length 95th (m)	20.3	9.5	5.7	17.9	5.7	33.0	17.2	28.3
Internal Link Dist (m)		33.7		300.3		252.9		113.5
Turn Bay Length (m)			20.0		90.0		100.0	
Base Capacity (vph)	361	501	428	564	480	2269	442	2206
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.18	0.11	0.03	0.31	0.08	0.31	0.28	0.28

Intersection Summary

Cycle Length: 84.2

Actuated Cycle Length: 84.2

Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

Natural Cycle: 75

Control Type: Actuated-Coordinated

Splits and Phases: 4: Niagara St. & Parking Lot/Aqueduct St.



HCM Signalized Intersection Capacity Analysis
4: Niagara St. & Parking Lot/Aqueduct St.

2030 Total AM

	↖	→	↗	↖	←	↖	↗	↑	↗	↖	↓	↖
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖	↗		↖	↗		↖	↑	↗	↖	↑	↗
Traffic Volume (vph)	59	3	47	10	10	151	36	631	9	112	506	66
Future Volume (vph)	59	3	47	10	10	151	36	631	9	112	506	66
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.86		1.00	0.86		1.00	1.00		1.00	0.98	
Fit Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1584	1315		1583	1293		1582	3274		1568	3174	
Fit Permitted	0.61	1.00		0.72	1.00		0.42	1.00		0.39	1.00	
Satd. Flow (perm)	1013	1315		1203	1293		693	3274		639	3174	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	64	3	51	11	11	164	39	686	10	122	550	72
RTOR Reduction (vph)	0	44	0	0	139	0	0	1	0	0	7	0
Lane Group Flow (vph)	64	10	0	11	36	0	39	695	0	122	615	0
Confl. Peds. (#/hr)	2		2	2		2	4		2	2		4
Heavy Vehicles (%)	0%	0%	0%	0%	0%	2%	0%	4%	0%	1%	6%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	11.7	11.7		11.7	11.7		58.3	58.3		58.3	58.3	
Effective Green, g (s)	11.7	11.7		11.7	11.7		58.3	58.3		58.3	58.3	
Actuated g/C Ratio	0.14	0.14		0.14	0.14		0.69	0.69		0.69	0.69	
Clearance Time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Vehicle Extension (s)	4.0	4.0		4.0	4.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	140	182		167	179		479	2266		442	2197	
v/s Ratio Prot		0.01			0.03			c0.21			0.19	
v/s Ratio Perm	c0.06			0.01			0.06			0.19		
v/c Ratio	0.46	0.06		0.07	0.20		0.08	0.31		0.28	0.28	
Uniform Delay, d1	33.3	31.5		31.5	32.1		4.2	5.1		4.9	4.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	3.2	0.2		0.2	0.7		0.3	0.4		1.5	0.3	
Delay (s)	36.5	31.6		31.7	32.8		4.6	5.4		6.5	5.3	
Level of Service	D	C		C	C		A	A		A	A	
Approach Delay (s/veh)		34.3			32.8			5.4			5.5	
Approach LOS		C			C			A			A	

Intersection Summary

HCM 2000 Control Delay (s/veh)	10.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.33		
Actuated Cycle Length (s)	84.2	Sum of lost time (s)	14.2
Intersection Capacity Utilization	76.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Timings
5: Niagara St/Niagara St. & Thorold Rd

2030 Total AM

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	272	156	38	124	89	324	70	281
Future Volume (vph)	272	156	38	124	89	324	70	281
Lane Group Flow (vph)	296	267	41	246	97	399	76	513
Turn Type	pm+pt	NA	pm+pt	NA	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8	5	2	1	6
Permitted Phases	4		8		2		6	
Detector Phase	7	4	3	8	5	2	1	6
Switch Phase								
Minimum Initial (s)	5.0	8.0	5.0	8.0	5.0	8.0	5.0	8.0
Minimum Split (s)	8.0	33.5	8.0	33.5	8.0	30.3	8.0	30.3
Total Split (s)	21.0	51.0	8.0	38.0	11.0	35.8	10.0	34.8
Total Split (%)	20.0%	48.7%	7.6%	36.3%	10.5%	34.2%	9.5%	33.2%
Yellow Time (s)	3.0	4.1	3.0	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	2.4	0.0	2.4	0.0	2.2	0.0	2.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.5	3.0	6.5	3.0	6.3	3.0	6.3
Lead/Lag	Lead	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.70	0.56	0.15	0.81	0.28	0.32	0.19	0.40
Control Delay (s/veh)	29.3	27.8	17.3	53.1	18.1	24.7	17.2	19.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	29.3	27.8	17.3	53.1	18.1	24.7	17.2	19.0
Queue Length 50th (m)	40.9	39.4	4.7	40.7	10.1	29.2	7.8	27.6
Queue Length 95th (m)	52.6	57.1	9.2	61.7	23.0	48.0	18.7	48.5
Internal Link Dist (m)		152.6		154.0		97.6		318.5
Turn Bay Length (m)	70.0		67.0		85.0		60.0	
Base Capacity (vph)	426	573	277	429	352	1248	398	1282
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.69	0.47	0.15	0.57	0.28	0.32	0.19	0.40

Intersection Summary

Cycle Length: 104.8

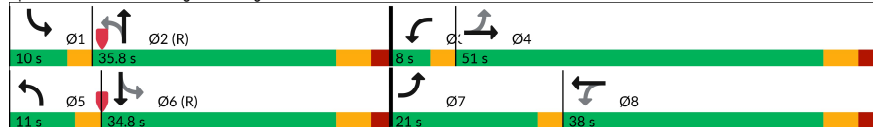
Actuated Cycle Length: 104.8

Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

Natural Cycle: 80

Control Type: Actuated-Coordinated

Splits and Phases: 5: Niagara St/Niagara St. & Thorold Rd



HCM Signalized Intersection Capacity Analysis
5: Niagara St/Niagara St. & Thorold Rd

2030 Total AM

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	272	156	89	38	124	102	89	324	43	70	281	191
Future Volume (vph)	272	156	89	38	124	102	89	324	43	70	281	191
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	0.98	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.95		1.00	0.93		1.00	0.98		1.00	0.94	
Fit Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1550	1304		1423	1336		1387	3135		1387	3052	
Fit Permitted	0.38	1.00		0.59	1.00		0.39	1.00		0.50	1.00	
Satd. Flow (perm)	617	1304		891	1336		573	3135		724	3052	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	296	170	97	41	135	111	97	352	47	76	305	208
RTOR Reduction (vph)	0	22	0	0	31	0	0	9	0	0	99	0
Lane Group Flow (vph)	296	245	0	41	215	0	97	390	0	76	414	0
Confl. Peds. (#/hr)	13		8	8		13	8		5	5		8
Heavy Vehicles (%)	2%	12%	11%	11%	7%	7%	14%	3%	33%	14%	3%	4%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	42.9	36.9		25.4	22.4		46.8	39.7		45.4	39.0	
Effective Green, g (s)	42.9	36.9		25.4	22.4		46.8	39.7		45.4	39.0	
Actuated g/C Ratio	0.41	0.35		0.24	0.21		0.45	0.38		0.43	0.37	
Clearance Time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Vehicle Extension (s)	2.5	2.2		2.5	2.2		2.5	2.1		2.5	2.1	
Lane Grp Cap (vph)	408	459		231	285		311	1187		354	1135	
v/s Ratio Prot	c0.12	0.19		0.01	0.16		c0.02	0.12		0.01	c0.14	
v/s Ratio Perm	c0.18			0.04			0.12			0.08		
v/c Ratio	0.73	0.53		0.18	0.75		0.31	0.33		0.21	0.36	
Uniform Delay, d1	23.2	27.1		31.0	38.6		17.5	23.1		17.8	23.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	5.9	0.7		0.3	9.8		0.4	0.7		0.2	0.9	
Delay (s)	29.1	27.8		31.2	48.4		17.9	23.8		18.0	24.8	
Level of Service	C	C		C	D		B	C		B	C	
Approach Delay (s/veh)		28.5			46.0			22.7			23.9	
Approach LOS		C			D			C			C	

Intersection Summary

HCM 2000 Control Delay (s/veh)	28.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	104.8	Sum of lost time (s)	18.8
Intersection Capacity Utilization	78.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis

2030 Total AM

6: Niagara St. & Roger Dr.

						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	16	31	35	701	476	63
Future Volume (Veh/h)	16	31	35	701	476	63
Sign Control	Stop		Free		Free	
Grade	0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	17	34	38	762	517	68
Pedestrians	6				1	
Lane Width (m)	3.7				3.7	
Walking Speed (m/s)	1.1				1.1	
Percent Blockage	1				0	
Right turn flare (veh)						
Median type			TWLTL		TWLTL	
Median storage (veh)			2		2	
Upstream signal (m)			343		277	
pX, platoon unblocked						
vC, conflicting volume	1015	299	591			
vC1, stage 1 conf vol	557					
vC2, stage 2 conf vol	458					
vCu, unblocked vol	1015	299	591			
tC, single (s)	6.8	7.0	4.1			
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	95	96			
cM capacity (veh/h)	439	691	989			
Direction, Lane #	EB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	51	38	381	381	345	240
Volume Left	17	38	0	0	0	0
Volume Right	34	0	0	0	0	68
cSH	580	989	1700	1700	1700	1700
Volume to Capacity	0.09	0.04	0.22	0.22	0.20	0.14
Queue Length 95th (m)	2.2	0.9	0.0	0.0	0.0	0.0
Control Delay (s/veh)	11.8	8.8	0.0	0.0	0.0	0.0
Lane LOS	B	A				
Approach Delay (s/veh)	11.8	0.4	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay	0.7					
Intersection Capacity Utilization	33.0%		ICU Level of Service		A	
Analysis Period (min)	15					

HCM Unsignalized Intersection Capacity Analysis

2: Niagara St. & North Driveway

2030 Total AM

Alternate Assignment

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↖ ↗		↖ ↗		↖ ↗	↖ ↗
Traffic Volume (veh/h)	1	44	944	4	1	715
Future Volume (Veh/h)	1	44	944	4	1	715
Sign Control	Stop		Free		Free	
Grade	0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	48	1026	4	1	777
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			TWLT		TWLT	
Median storage (veh)			2		2	
Upstream signal (m)			101			
pX, platoon unblocked	0.94	0.94			0.94	
vC, conflicting volume	1419	515			1030	
vC1, stage 1 conf vol	1028					
vC2, stage 2 conf vol	391					
vCu, unblocked vol	1320	361			908	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	92			100	
cM capacity (veh/h)	312	604			714	
Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	49	684	346	1	389	389
Volume Left	1	0	0	1	0	0
Volume Right	48	0	4	0	0	0
cSH	593	1700	1700	714	1700	1700
Volume to Capacity	0.08	0.40	0.20	0.00	0.23	0.23
Queue Length 95th (m)	2.0	0.0	0.0	0.0	0.0	0.0
Control Delay (s/veh)	11.6	0.0	0.0	10.0	0.0	0.0
Lane LOS	B			B		
Approach Delay (s/veh)	11.6	0.0		0.0		
Approach LOS	B					
Intersection Summary						
Average Delay			0.3			
Intersection Capacity Utilization			38.1%		ICU Level of Service	A
Analysis Period (min)			15			

Timings

3: Niagara St. & Abbey Rd./South Driveway

2030 Total AM

Alternate Assignment

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations		↖ ↗	↖ ↗	↖ ↗	↖ ↗	↖ ↗	↖ ↗	↖ ↗
Traffic Volume (vph)	3	0	25	0	10	809	62	656
Future Volume (vph)	3	0	25	0	10	809	62	656
Lane Group Flow (vph)	0	21	27	112	11	888	67	716
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA
Protected Phases		4		8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	8	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Total Split (s)	28.0	28.0	28.0	28.0	56.2	56.2	56.2	56.2
Total Split (%)	33.3%	33.3%	33.3%	33.3%	66.7%	66.7%	66.7%	66.7%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)		4.5	4.5	4.5	4.5	4.5	4.5	4.5
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Max	C-Max	C-Max	C-Max
v/c Ratio		0.17	0.25	0.41	0.02	0.32	0.15	0.26
Control Delay (s/veh)		19.5	40.5	6.5	2.1	2.5	3.0	2.3
Queue Delay		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)		19.5	40.5	6.5	2.1	2.5	3.0	2.3
Queue Length 50th (m)		0.3	4.1	0.0	0.3	13.7	1.7	10.3
Queue Length 95th (m)		6.6	11.5	5.5	1.3	23.7	5.3	18.3
Internal Link Dist (m)		202.9		75.4		44.8		76.5
Turn Bay Length (m)			50.0		80.0		100.0	
Base Capacity (vph)		359	342	510	528	2774	442	2748
Starvation Cap Reductn		0	0	0	0	0	0	0
Spillback Cap Reductn		0	0	0	0	0	0	0
Storage Cap Reductn		0	0	0	0	0	0	0
Reduced v/c Ratio		0.06	0.08	0.22	0.02	0.32	0.15	0.26

Intersection Summary

Cycle Length: 84.2

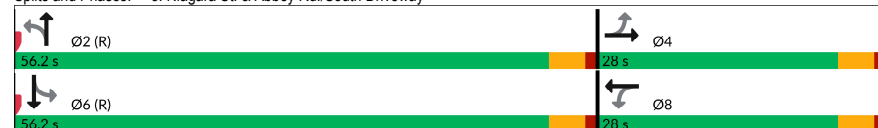
Actuated Cycle Length: 84.2

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 45

Control Type: Actuated-Coordinated

Splits and Phases: 3: Niagara St. & Abbey Rd./South Driveway



HCM Signalized Intersection Capacity Analysis
3: Niagara St. & Abbey Rd./South Driveway

2030 Total AM
Alternate Assignment

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Movement												
Lane Configurations		↔		↔	↔		↔	↔		↔	↔	
Traffic Volume (vph)	3	0	17	25	0	103	10	809	8	62	656	3
Future Volume (vph)	3	0	17	25	0	103	10	809	8	62	656	3
Ideal Flow (vphpl)	1630	1630	1630	1630	1630	1630	1651	1776	1535	1651	1776	1535
Total Lost time (s)		4.5		4.5	4.5		4.5	4.5		4.5	4.5	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt		0.88		1.00	0.85		1.00	1.00		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1312		1566	1401		1579	3308		1586	3279	
Flt Permitted		0.94		0.74	1.00		0.38	1.00		0.32	1.00	
Satd. Flow (perm)		1240		1226	1401		631	3308		528	3279	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	3	0	18	27	0	112	11	879	9	67	713	3
RTOR Reduction (vph)	0	18	0	0	103	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	3	0	27	9	0	11	888	0	67	716	0
Confl. Peds. (#/hr)							5					5
Heavy Vehicles (%)	0%	0%	12%	0%	0%	0%	0%	3%	0%	0%	4%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		6.4		6.4	6.4		68.8	68.8		68.8	68.8	
Effective Green, g (s)		6.4		6.4	6.4		68.8	68.8		68.8	68.8	
Actuated g/C Ratio		0.08		0.08	0.08		0.82	0.82		0.82	0.82	
Clearance Time (s)		4.5		4.5	4.5		4.5	4.5		4.5	4.5	
Vehicle Extension (s)		3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		94		93	106		515	2702		431	2679	
v/s Ratio Prot					0.01			c0.27			0.22	
v/s Ratio Perm		0.00		c0.02			0.02			0.13		
v/c Ratio		0.04		0.29	0.08		0.02	0.33		0.16	0.27	
Uniform Delay, d1		36.0		36.8	36.2		1.4	1.9		1.6	1.8	
Progression Factor		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.2		1.7	0.3		0.1	0.3		0.8	0.2	
Delay (s)		36.2		38.5	36.5		1.5	2.3		2.4	2.0	
Level of Service		D		D	D		A	A		A	A	
Approach Delay (s/veh)		36.2			36.9			2.2			2.1	
Approach LOS		D			D			A			A	
Intersection Summary												
HCM 2000 Control Delay (s/veh)			5.2			HCM 2000 Level of Service				A		
HCM 2000 Volume to Capacity ratio			0.33									
Actuated Cycle Length (s)			84.2			Sum of lost time (s)				9.0		
Intersection Capacity Utilization			47.1%			ICU Level of Service				A		
Analysis Period (min)			15									
c Critical Lane Group												

Timings

1: Niagara St. & Woodlawn Rd.

2030 Total PM

	↖	→	↗	↖	↗	↖	↗	↖	↗
Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations	↖	↗	↖	↗	↖	↗	↗	↖	↗
Traffic Volume (vph)	286	374	463	543	172	113	576	193	699
Future Volume (vph)	286	374	463	543	172	113	576	193	699
Lane Group Flow (vph)	311	530	503	590	187	123	1000	210	1072
Turn Type	pm+pt	NA	pm+pt	NA	Perm	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8		5	2	1	6
Permitted Phases	4		8		8	2		6	
Detector Phase	7	4	3	8	8	5	2	1	6
Switch Phase									
Minimum Initial (s)	6.0	8.0	6.0	8.0	8.0	6.0	10.0	6.0	10.0
Minimum Split (s)	9.0	39.4	9.0	39.4	39.4	9.0	39.3	9.0	39.3
Total Split (s)	36.1	39.6	45.1	48.6	48.6	10.0	52.0	21.0	63.0
Total Split (%)	22.9%	25.1%	28.6%	30.8%	30.8%	6.3%	33.0%	13.3%	39.9%
Yellow Time (s)	3.0	4.1	3.0	4.1	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	3.3	0.0	3.3	3.3	0.0	3.2	0.0	3.2
Lost Time Adjust (s)	0.0	0.0	-3.0	0.0	0.0	-2.0	-2.0	0.0	-1.0
Total Lost Time (s)	3.0	7.4	0.0	7.4	7.4	1.0	5.3	3.0	6.3
Lead/Lag	Lead	Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.78	0.88	0.96	0.61	0.38	0.72	0.97	0.92	0.88
Control Delay (s/veh)	41.1	75.9	65.0	52.0	8.0	51.5	69.4	83.2	53.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	41.1	75.9	65.0	52.0	8.0	51.5	69.4	83.2	53.9
Queue Length 50th (m)	58.3	81.5	122.2	81.8	0.0	22.1	~164.4	51.7	162.8
Queue Length 95th (m)	80.7	102.5	#189.9	109.2	20.2	#54.4	#207.4	#105.4	#202.4
Internal Link Dist (m)		245.8		240.0			194.1		161.2
Turn Bay Length (m)	111.0		87.0		132.0	97.0		133.0	
Base Capacity (vph)	478	665	533	962	486	170	1036	231	1221
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.65	0.80	0.94	0.61	0.38	0.72	0.97	0.91	0.88

Intersection Summary

Cycle Length: 157.7

Actuated Cycle Length: 157.7

Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

Natural Cycle: 110

Control Type: Actuated-Coordinated

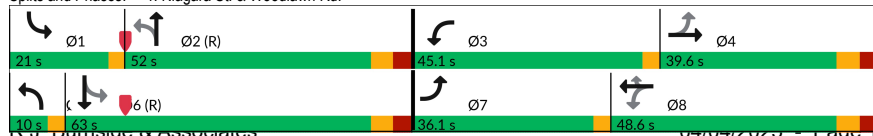
- Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: Niagara St. & Woodlawn Rd.



R.J. Burnside & Associates

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HCM Signalized Intersection Capacity Analysis

1: Niagara St. & Woodlawn Rd.

2030 Total PM

	↖	→	↗	↖	↗	↖	↗	↖	↗	↖	↗	↖	↗
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations	↖	↗		↖	↗	↖	↖	↗		↖	↗	↖	
Traffic Volume (vph)	286	374	113	463	543	172	113	576	344	193	699	287	
Future Volume (vph)	286	374	113	463	543	172	113	576	344	193	699	287	
Ideal Flow (vphpl)	1651	1776	1535	1651	1776	1498	1651	1776	1535	1651	1776	1535	
Total Lost time (s)	3.0	7.4		0.0	7.4	7.4	1.0	5.3		3.0	6.3		
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	0.95		1.00	0.95		
Flpb, ped/bikes	1.00	0.99		1.00	1.00	0.96	1.00	0.98		1.00	0.99		
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00		
Frt	1.00	0.97		1.00	1.00	0.85	1.00	0.94		1.00	0.96		
Fit Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00		
Satd. Flow (prot)	1563	3168		1568	3345	1228	1570	3119		1540	3200		
Fit Permitted	0.43	1.00		0.23	1.00	1.00	0.11	1.00		0.08	1.00		
Satd. Flow (perm)	706	3168		374	3345	1228	186	3119		128	3200		
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	
Adj. Flow (vph)	311	407	123	503	590	187	123	626	374	210	760	312	
RTOR Reduction (vph)	0	19	0	0	0	133	0	55	0	0	28	0	
Lane Group Flow (vph)	311	511	0	503	590	54	123	945	0	210	1044	0	
Confl. Peds. (#/hr)	17		12	12		17	14		21	21		14	
Heavy Vehicles (%)	1%	3%	4%	1%	2%	1%	1%	2%	1%	3%	1%	1%	
Turn Type	pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA		
Protected Phases	7	4		3	8		5	2		1	6		
Permitted Phases	4			8		8	2			6			
Actuated Green, G (s)	54.2	29.2		73.4	45.4	45.4	56.4	47.6		69.6	57.8		
Effective Green, g (s)	54.2	29.2		76.4	45.4	45.4	60.4	49.6		69.6	58.8		
Actuated g/C Ratio	0.34	0.19		0.48	0.29	0.29	0.38	0.31		0.44	0.37		
Clearance Time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3		
Vehicle Extension (s)	2.6	2.5		2.6	2.5	2.5	2.6	2.5		2.6	2.5		
Lane Grp Cap (vph)	378	586		515	962	353	166	980		226	1193		
v/s Ratio Prot	0.13	c0.16		c0.27	0.18		0.05	c0.30		c0.11	0.33		
v/s Ratio Perm	0.15			0.20		0.04	0.23			0.30			
v/c Ratio	0.82	0.87		0.98	0.61	0.15	0.74	0.96		0.93	0.88		
Uniform Delay, d1	42.4	62.4		39.3	48.6	41.8	36.2	53.2		48.8	46.0		
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00		
Incremental Delay, d2	13.3	13.4		33.4	1.0	0.1	15.6	21.3		40.3	9.1		
Delay (s)	55.7	75.8		72.6	49.6	42.0	51.8	74.5		89.0	55.2		
Level of Service	E	E		E	D	D	D	E		F	E		
Approach Delay (s/veh)		68.4			57.5			72.0			60.7		
Approach LOS		E			E			E			E		

Intersection Summary

HCM 2000 Control Delay (s/veh)

HCM 2000 Level of Service

E

HCM 2000 Volume to Capacity ratio

0.95

Actuated Cycle Length (s)

157.7

Sum of lost time (s)

18.7

Intersection Capacity Utilization

107.6%

ICU Level of Service

G

Analysis Period (min)

15

c Critical Lane Group

052233 418-430 Aqueduct and 650-678 Niagara Street.syn

R.J. Burnside & Associates

Synchro 12 Report

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HCM Unsignalized Intersection Capacity Analysis

2030 Total PM

2: Niagara St. & North Driveway

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	7	35	1034	9	51	1266
Future Volume (Veh/h)	7	35	1034	9	51	1266
Sign Control	Stop		Free		Free	
Grade	0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	8	38	1124	10	55	1376
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			TWLTL		TWLTL	
Median storage (veh)			2		2	
Upstream signal (m)			238		218	
pX, platoon unblocked	0.79	0.92			0.92	
vC, conflicting volume	1927	567			1134	
vC1, stage 1 conf vol	1129					
vC2, stage 2 conf vol	798					
vCu, unblocked vol	1191	356			972	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3			2.2	
p0 queue free %	97	94			92	
cM capacity (veh/h)	287	595			660	
Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	46	749	385	55	688	688
Volume Left	8	0	0	55	0	0
Volume Right	38	0	10	0	0	0
cSH	501	1700	1700	660	1700	1700
Volume to Capacity	0.09	0.44	0.23	0.08	0.40	0.40
Queue Length 95th (m)	2.3	0.0	0.0	2.1	0.0	0.0
Control Delay (s/veh)	12.9	0.0	0.0	10.9	0.0	0.0
Lane LOS	B		B			
Approach Delay (s/veh)	12.9	0.0		0.4		
Approach LOS	B					
Intersection Summary						
Average Delay	0.5					
Intersection Capacity Utilization	47.6%		ICU Level of Service		A	
Analysis Period (min)	15					

HCM Unsignalized Intersection Capacity Analysis

2030 Total PM

3: Niagara St. & Abbey Rd./South Driveway

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	9	0	23	14	0	83	9	951	21	119	1169	27
Future Volume (Veh/h)	9	0	23	14	0	83	9	951	21	119	1169	27
Sign Control	Stop		Stop				Free			Free		
Grade	0%		0%				0%			0%		
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	10	0	25	15	0	90	10	1034	23	129	1271	29
Pedestrians	19											
Lane Width (m)	3.7											
Walking Speed (m/s)	1.1											
Percent Blockage	2											
Right turn flare (veh)												
Median type							TWLTL		TWLTL			
Median storage (veh)							2		2			
Upstream signal (m)							137		319			
pX, platoon unblocked	0.90	0.90		0.90	0.90	0.90				0.90		
vC, conflicting volume	2190	2640	669	1984	2643	529	1319				1057	
vC1, stage 1 conf vol	1563	1563		1066	1066							
vC2, stage 2 conf vol	627	1077		919	1577							
vCu, unblocked vol	2099	2599	669	1871	2603	252	1319				840	
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1				4.1	
tC, 2 stage (s)	6.5	5.5		6.5	5.5							
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2				2.2	
p0 queue free %	89	100	94	91	100	87	98				82	
cM capacity (veh/h)	91	112	398	170	116	678	521				723	
Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3			
Volume Total	35	15	90	10	689	368	129	847	453			
Volume Left	10	15	0	10	0	0	129	0	0			
Volume Right	25	0	90	0	0	23	0	0	29			
cSH	202	170	678	521	1700	1700	723	1700	1700			
Volume to Capacity	0.17	0.09	0.13	0.02	0.41	0.22	0.18	0.50	0.27			
Queue Length 95th (m)	4.6	2.2	3.5	0.4	0.0	0.0	4.9	0.0	0.0			
Control Delay (s/veh)	26.5	28.2	11.1	12.0	0.0	0.0	11.1	0.0	0.0			
Lane LOS	D	D	B	B			B					
Approach Delay (s/veh)	26.5	13.6			0.1	1.0						
Approach LOS	D	B										
Intersection Summary												
Average Delay				1.5								
Intersection Capacity Utilization				57.8%		ICU Level of Service				B		
Analysis Period (min)	15											

Timings
4: Niagara St. & Parking Lot/Aqueduct St.

2030 Total PM

	↖	→	↗	←	↖	↑	↗	↓
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations	↖	↗	↖	↗	↖	↗	↖	↗
Traffic Volume (vph)	41	1	13	2	37	869	90	1064
Future Volume (vph)	41	1	13	2	37	869	90	1064
Lane Group Flow (vph)	45	43	14	78	40	967	98	1209
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA
Protected Phases		4		8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	8	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	8.0	8.0	8.0	8.0	10.0	10.0	10.0	10.0
Minimum Split (s)	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1
Total Split (s)	37.1	37.1	37.1	37.1	47.1	47.1	47.1	47.1
Total Split (%)	44.1%	44.1%	44.1%	44.1%	55.9%	55.9%	55.9%	55.9%
Yellow Time (s)	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
All-Red Time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Max	C-Max	C-Max	C-Max
v/c Ratio	0.32	0.23	0.10	0.36	0.15	0.38	0.27	0.48
Control Delay (s/veh)	39.3	15.8	33.1	14.8	6.2	5.1	7.2	5.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	39.3	15.8	33.1	14.8	6.2	5.1	7.2	5.9
Queue Length 50th (m)	6.8	0.7	2.1	1.0	1.7	26.7	4.7	37.3
Queue Length 95th (m)	15.8	9.4	7.0	12.4	6.1	43.4	13.7	59.8
Internal Link Dist (m)		33.7		300.3		252.9		113.5
Turn Bay Length (m)			20.0		90.0		100.0	
Base Capacity (vph)	419	488	431	511	271	2549	365	2542
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.11	0.09	0.03	0.15	0.15	0.38	0.27	0.48

Intersection Summary

Cycle Length: 84.2

Actuated Cycle Length: 84.2

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 75

Control Type: Actuated-Coordinated

Splits and Phases: 4: Niagara St. & Parking Lot/Aqueduct St.



HCM Signalized Intersection Capacity Analysis
4: Niagara St. & Parking Lot/Aqueduct St.

2030 Total PM

	↖	→	↗	↖	←	↖	↗	↑	↗	↖	↓	↖
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖	↗		↖	↗		↖	↗		↖	↗	↖
Traffic Volume (vph)	41	1	39	13	2	70	37	869	20	90	1064	48
Future Volume (vph)	41	1	39	13	2	70	37	869	20	90	1064	48
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.98		1.00	0.99		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.85		1.00	0.85		1.00	1.00		1.00	0.99	
Fit Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1583	1303		1578	1308		1581	3332		1578	3321	
Fit Permitted	0.71	1.00		0.73	1.00		0.21	1.00		0.29	1.00	
Satd. Flow (perm)	1177	1303		1211	1308		354	3332		477	3321	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	45	1	42	14	2	76	40	945	22	98	1157	52
RTOR Reduction (vph)	0	34	0	0	64	0	0	1	0	0	2	0
Lane Group Flow (vph)	45	9	0	14	14	0	40	966	0	98	1207	0
Confl. Peds. (#/hr)	2		6	6		2	12		14	14		12
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	2%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	8.5	8.5		8.5	8.5		61.5	61.5		61.5	61.5	
Effective Green, g (s)	8.5	8.5		8.5	8.5		61.5	61.5		61.5	61.5	
Actuated g/C Ratio	0.10	0.10		0.10	0.10		0.73	0.73		0.73	0.73	
Clearance Time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Vehicle Extension (s)	4.0	4.0		4.0	4.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	118	131		122	132		258	2433		348	2425	
v/s Ratio Prot		0.01			0.01			0.29			c0.36	
v/s Ratio Perm	c0.04			0.01			0.11			0.21		
v/c Ratio	0.38	0.07		0.11	0.11		0.16	0.40		0.28	0.50	
Uniform Delay, d1	35.4	34.3		34.4	34.4		3.5	4.3		3.9	4.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.8	0.3		0.6	0.5		1.3	0.5		2.0	0.7	
Delay (s)	38.2	34.6		35.0	34.9		4.7	4.8		5.9	5.5	
Level of Service	D	C		D	C		A	A		A	A	
Approach Delay (s/veh)		36.4			34.9			4.8			5.6	
Approach LOS		D			C			A			A	

Intersection Summary

HCM 2000 Control Delay (s/veh)	7.4	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	84.2	Sum of lost time (s)	14.2
Intersection Capacity Utilization	71.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Timings
5: Niagara St/Niagara St. & Thorold Rd

2030 Total PM

								
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	344	155	102	160	146	506	104	576
Future Volume (vph)	344	155	102	160	146	506	104	576
Lane Group Flow (vph)	374	259	111	285	159	618	113	1128
Turn Type	pm+pt	NA	pm+pt	NA	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8	5	2	1	6
Permitted Phases	4		8		2		6	
Detector Phase	7	4	3	8	5	2	1	6
Switch Phase								
Minimum Initial (s)	5.0	8.0	5.0	8.0	5.0	8.0	5.0	8.0
Minimum Split (s)	8.0	33.5	8.0	33.5	8.0	30.3	8.0	30.3
Total Split (s)	20.3	41.5	12.3	33.5	11.0	39.0	12.0	40.0
Total Split (%)	19.4%	39.6%	11.7%	32.0%	10.5%	37.2%	11.5%	38.2%
Yellow Time (s)	3.0	4.1	3.0	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	2.4	0.0	2.4	0.0	2.2	0.0	2.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.5	3.0	6.5	3.0	6.3	3.0	6.3
Lead/Lag	Lead	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.94	0.59	0.30	0.87	0.79	0.52	0.36	0.94
Control Delay (s/veh)	55.5	32.9	19.2	60.4	50.3	28.9	19.2	44.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	55.5	32.9	19.2	60.4	50.3	28.9	19.2	44.3
Queue Length 50th (m)	52.8	39.3	12.8	49.8	18.3	52.6	12.4	103.3
Queue Length 95th (m)	#89.0	62.8	22.2	#84.9	#60.1	72.6	24.0	#150.9
Internal Link Dist (m)		152.6		154.0		97.6		318.5
Turn Bay Length (m)	70.0		67.0		85.0		60.0	
Base Capacity (vph)	398	487	387	384	201	1196	325	1195
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.94	0.53	0.29	0.74	0.79	0.52	0.35	0.94

Intersection Summary

Cycle Length: 104.8

Actuated Cycle Length: 104.8

Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

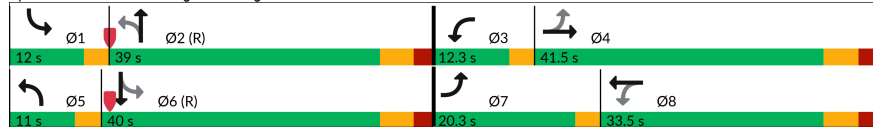
Natural Cycle: 90

Control Type: Actuated-Coordinated

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 5: Niagara St/Niagara St. & Thorold Rd



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HCM Signalized Intersection Capacity Analysis
5: Niagara St/Niagara St. & Thorold Rd

2030 Total PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	344	155	84	102	160	102	146	506	63	104	576	462
Future Volume (vph)	344	155	84	102	160	102	146	506	63	104	576	462
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	0.98	
Flpb, ped/bikes	1.00	1.00		0.99	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.95		1.00	0.94		1.00	0.98		1.00	0.93	
Fit Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1552	1405		1572	1406		1468	3303		1478	3089	
Fit Permitted	0.31	1.00		0.60	1.00		0.11	1.00		0.34	1.00	
Satd. Flow (perm)	511	1405		992	1406		164	3303		528	3089	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	374	168	91	111	174	111	159	550	68	113	626	502
RTOR Reduction (vph)	0	20	0	0	24	0	0	8	0	0	133	0
Lane Group Flow (vph)	374	239	0	111	261	0	159	610	0	113	995	0
Confl. Peds. (#/hr)	11		18	18		11	12		11	11		12
Heavy Vehicles (%)	2%	1%	8%	0%	1%	6%	8%	1%	2%	7%	1%	1%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	43.0	31.5		31.2	22.7		47.7	37.8		44.3	36.1	
Effective Green, g (s)	43.0	31.5		31.2	22.7		47.7	37.8		44.3	36.1	
Actuated g/C Ratio	0.41	0.30		0.30	0.22		0.46	0.36		0.42	0.34	
Clearance Time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Vehicle Extension (s)	2.5	2.2		2.5	2.2		2.5	2.1		2.5	2.1	
Lane Grp Cap (vph)	381	422		342	304		197	1191		297	1064	
v/s Ratio Prot	c0.16	0.17		0.03	0.19		c0.08	0.18		0.03	c0.32	
v/s Ratio Perm	c0.24			0.07			0.29			0.13		
v/c Ratio	0.98	0.57		0.32	0.86		0.81	0.51		0.38	0.94	
Uniform Delay, d1	26.6	30.9		27.8	39.5		22.7	26.3		19.2	33.2	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	41.0	1.2		0.4	20.7		20.4	1.6		0.6	15.8	
Delay (s)	67.6	32.1		28.2	60.2		43.1	27.8		19.8	49.0	
Level of Service	E	C		C	E		D	C		B	D	
Approach Delay (s/veh)		53.1			51.3			31.0			46.4	
Approach LOS		D			D			C			D	

Intersection Summary

HCM 2000 Control Delay (s/veh)	44.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	104.8	Sum of lost time (s)	18.8
Intersection Capacity Utilization	101.8%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

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HCM Unsignalized Intersection Capacity Analysis

2030 Total PM

6: Niagara St. & Roger Dr.

						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↰	↱	↰	↱	↱	↰
Traffic Volume (veh/h)	21	36	38	835	987	68
Future Volume (Veh/h)	21	36	38	835	987	68
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	23	39	41	908	1073	74
Pedestrians	8			1	2	
Lane Width (m)	3.7			3.7	3.7	
Walking Speed (m/s)	1.1			1.1	1.1	
Percent Blockage	1			0	0	
Right turn flare (veh)						
Median type				TWLT	TWLT	
Median storage (veh)				2	2	
Upstream signal (m)				343	277	
pX, platoon unblocked	0.91	0.88	0.88			
vC, conflicting volume	1656	583	1155			
vC1, stage 1 conf vol	1118					
vC2, stage 2 conf vol	538					
vCu, unblocked vol	1224	255	905			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3	2.2			
p0 queue free %	92	94	94			
cM capacity (veh/h)	303	656	664			
Direction, Lane #	EB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	62	41	454	454	715	432
Volume Left	23	41	0	0	0	0
Volume Right	39	0	0	0	0	74
cSH	458	664	1700	1700	1700	1700
Volume to Capacity	0.14	0.06	0.27	0.27	0.42	0.25
Queue Length 95th (m)	3.5	1.5	0.0	0.0	0.0	0.0
Control Delay (s/veh)	14.1	10.8	0.0	0.0	0.0	0.0
Lane LOS	B	B				
Approach Delay (s/veh)	14.1	0.5			0.0	
Approach LOS	B					
Intersection Summary						
Average Delay			0.6			
Intersection Capacity Utilization			47.3%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

2: Niagara St. & North Driveway

2030 Total PM

Alternate Assignment

	←	↖	↑	↗	↘	↓
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↖		↗		↖	↗
Traffic Volume (veh/h)	1	35	1034	9	1	1316
Future Volume (Veh/h)	1	35	1034	9	1	1316
Sign Control	Stop		Free		Free	
Grade	0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	38	1124	10	1	1430
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			TWLT		TWLT	
Median storage (veh)			2		2	
Upstream signal (m)			101			
pX, platoon unblocked	0.92	0.92			0.92	
vC, conflicting volume	1846	567			1134	
vC1, stage 1 conf vol	1129					
vC2, stage 2 conf vol	717					
vCu, unblocked vol	1748	361			976	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	94			100	
cM capacity (veh/h)	255	591			659	
Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	39	749	385	1	715	715
Volume Left	1	0	0	1	0	0
Volume Right	38	0	10	0	0	0
cSH	572	1700	1700	659	1700	1700
Volume to Capacity	0.07	0.44	0.23	0.00	0.42	0.42
Queue Length 95th (m)	1.7	0.0	0.0	0.0	0.0	0.0
Control Delay (s/veh)	11.8	0.0	0.0	10.5	0.0	0.0
Lane LOS	B			B		
Approach Delay (s/veh)	11.8	0.0		0.0		
Approach LOS	B					
Intersection Summary						
Average Delay			0.2			
Intersection Capacity Utilization			48.9%		ICU Level of Service	A
Analysis Period (min)			15			

Timings

3: Niagara St. & Abbey Rd./South Driveway

2030 Total PM

Alternate Assignment

	↖	→	↗	←	↖	↑	↗	↓
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations		↖	↗	↖	↗	↗	↖	↗
Traffic Volume (vph)	9	0	20	0	9	951	169	1163
Future Volume (vph)	9	0	20	0	9	951	169	1163
Lane Group Flow (vph)	0	35	22	90	10	1057	184	1293
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA
Protected Phases		4		8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	8	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Total Split (s)	22.5	22.5	22.5	22.5	61.7	61.7	61.7	61.7
Total Split (%)	26.7%	26.7%	26.7%	26.7%	73.3%	73.3%	73.3%	73.3%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Max	C-Max	C-Max	C-Max
v/c Ratio		0.26	0.21	0.36	0.04	0.38	0.50	0.46
Control Delay (s/veh)		23.1	40.1	5.6	2.2	2.6	8.6	3.0
Queue Delay		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)		23.1	40.1	5.6	2.2	2.6	8.6	3.0
Queue Length 50th (m)		1.5	3.4	0.0	0.2	17.0	6.7	22.9
Queue Length 95th (m)		9.8	10.0	3.8	1.2	28.3	24.8	38.2
Internal Link Dist (m)		202.9		75.4		44.8		76.5
Turn Bay Length (m)			50.0		80.0		100.0	
Base Capacity (vph)		297	258	415	278	2810	368	2834
Starvation Cap Reductn		0	0	0	0	0	0	0
Spillback Cap Reductn		0	0	0	0	0	0	0
Storage Cap Reductn		0	0	0	0	0	0	0
Reduced v/c Ratio		0.12	0.09	0.22	0.04	0.38	0.50	0.46

Intersection Summary

Cycle Length: 84.2

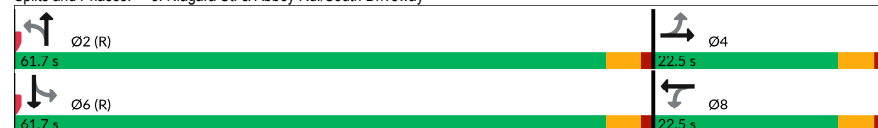
Actuated Cycle Length: 84.2

Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

Natural Cycle: 75

Control Type: Actuated-Coordinated

Splits and Phases: 3: Niagara St. & Abbey Rd./South Driveway



HCM Signalized Intersection Capacity Analysis

3: Niagara St. & Abbey Rd./South Driveway

2030 Total PM

Alternate Assignment

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	9	0	23	20	0	83	9	951	21	169	1163	27
Future Volume (vph)	9	0	23	20	0	83	9	951	21	169	1163	27
Ideal Flow (vphpl)	1630	1630	1630	1630	1630	1630	1651	1776	1535	1651	1776	1535
Total Lost time (s)		4.5		4.5	4.5		4.5	4.5		4.5	4.5	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00		0.99	1.00		1.00	1.00	
Frt		0.90		1.00	0.85		1.00	1.00		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1468		1566	1401		1576	3335		1586	3363	
Flt Permitted		0.87		0.73	1.00		0.20	1.00		0.26	1.00	
Satd. Flow (perm)		1299		1210	1401		331	3335		437	3363	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	10	0	25	22	0	90	10	1034	23	184	1264	29
RTOR Reduction (vph)	0	23	0	0	83	0	0	1	0	0	1	0
Lane Group Flow (vph)	0	12	0	22	7	0	10	1056	0	184	1292	0
Confl. Peds. (#/hr)							19					19
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	1%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		6.1		6.1	6.1		69.1	69.1		69.1	69.1	
Effective Green, g (s)		6.1		6.1	6.1		69.1	69.1		69.1	69.1	
Actuated g/C Ratio		0.07		0.07	0.07		0.82	0.82		0.82	0.82	
Clearance Time (s)		4.5		4.5	4.5		4.5	4.5		4.5	4.5	
Vehicle Extension (s)		3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		94		87	101		271	2736		358	2759	
v/s Ratio Prot					0.00			0.32				0.38
v/s Ratio Perm		0.01		c0.02			0.03			c0.42		
v/c Ratio		0.13		0.25	0.06		0.04	0.39		0.51	0.47	
Uniform Delay, d1		36.6		36.9	36.4		1.4	2.0		2.3	2.2	
Progression Factor		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.6		1.5	0.3		0.3	0.4		5.2	0.6	
Delay (s)		37.2		38.4	36.7		1.7	2.4		7.5	2.8	
Level of Service		D		D	D		A	A		A	A	
Approach Delay (s/veh)		37.2			37.0			2.4			3.4	
Approach LOS		D			D			A			A	
Intersection Summary												
HCM 2000 Control Delay (s/veh)			4.8			HCM 2000 Level of Service			A			
HCM 2000 Volume to Capacity ratio			0.49									
Actuated Cycle Length (s)			84.2			Sum of lost time (s)			9.0			
Intersection Capacity Utilization			59.8%			ICU Level of Service			B			
Analysis Period (min)			15									
c Critical Lane Group												



BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix G

Total 2035 Traffic Operations

Timings

1: Niagara St. & Woodlawn Rd.

2035 Total AM

	↖	→	↗	↖	↖	↖	↖	↖	↖
Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations	↖	↖↗	↖	↖↗	↖	↖	↖↗	↖	↖↗
Traffic Volume (vph)	267	415	228	273	129	102	563	95	349
Future Volume (vph)	267	415	228	273	129	102	563	95	349
Lane Group Flow (vph)	290	605	248	297	140	111	1009	103	544
Turn Type	pm+pt	NA	pm+pt	NA	Perm	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8		5	2	1	6
Permitted Phases	4		8		8	2		6	
Detector Phase	7	4	3	8	8	5	2	1	6
Switch Phase									
Minimum Initial (s)	6.0	8.0	6.0	8.0	8.0	6.0	10.0	6.0	10.0
Minimum Split (s)	9.0	39.4	9.0	39.4	39.4	9.0	39.3	9.0	39.3
Total Split (s)	30.0	45.0	28.0	43.0	43.0	11.0	68.7	16.0	73.7
Total Split (%)	19.0%	28.5%	17.8%	27.3%	27.3%	7.0%	43.6%	10.1%	46.7%
Yellow Time (s)	3.0	4.1	3.0	4.1	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	3.3	0.0	3.3	3.3	0.0	3.2	0.0	3.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	7.4	3.0	7.4	7.4	3.0	7.3	3.0	7.3
Lead/Lag	Lead	Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.70	0.87	0.85	0.46	0.39	0.28	0.69	0.49	0.38
Control Delay (s/veh)	43.9	71.1	61.0	57.9	10.5	20.2	35.1	25.9	26.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	43.9	71.1	61.0	57.9	10.5	20.2	35.1	25.9	26.7
Queue Length 50th (m)	65.5	92.6	54.1	43.7	0.0	16.4	121.3	15.2	54.3
Queue Length 95th (m)	87.7	112.9	81.3	56.8	18.5	29.2	160.5	27.6	72.0
Internal Link Dist (m)		245.8		240.0			194.1		161.2
Turn Bay Length (m)	111.0		87.0		132.0	97.0		133.0	
Base Capacity (vph)	425	776	319	747	393	399	1457	233	1435
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.68	0.78	0.78	0.40	0.36	0.28	0.69	0.44	0.38

Intersection Summary

Cycle Length: 157.7

Actuated Cycle Length: 157.7

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 100

Control Type: Actuated-Coordinated

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: Niagara St. & Woodlawn Rd.



052233 418-430 Aqueduct and 650-678 Niagara Street.syn

R.J. Burnside & Associates

Synchro 12 Report

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HCM Signalized Intersection Capacity Analysis

1: Niagara St. & Woodlawn Rd.

2035 Total AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			 			 			 	
Traffic Volume (vph)	267	415	142	228	273	129	102	563	365	95	349	152
Future Volume (vph)	267	415	142	228	273	129	102	563	365	95	349	152
Ideal Flow (vphpl)	1651	1776	1535	1651	1776	1498	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	0.95		1.00	0.95	
Flrb, ped/bikes	1.00	1.00		1.00	1.00	0.98	1.00	0.99		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.96		1.00	1.00	0.85	1.00	0.94		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1537	3166		1570	3313	1265	1539	3098		1416	3040	
Flt Permitted	0.44	1.00		0.20	1.00	1.00	0.41	1.00		0.16	1.00	
Satd. Flow (perm)	720	3166		322	3313	1265	657	3098		244	3040	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	290	451	154	248	297	140	111	612	397	103	379	165
RTOR Reduction (vph)	0	22	0	0	0	113	0	61	0	0	29	0
Lane Group Flow (vph)	290	583	0	248	297	27	111	948	0	103	515	0
Confl. Peds. (#/hr)	4		2	2		4	3		9	9		3
Heavy Vehicles (%)	3%	3%	4%	1%	3%	0%	3%	3%	2%	12%	6%	8%
Turn Type	pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8		8	2			6		
Actuated Green, G (s)	58.3	33.5		52.9	30.8	30.8	79.5	71.0		83.3	72.9	
Effective Green, g (s)	58.3	33.5		52.9	30.8	30.8	79.5	71.0		83.3	72.9	
Actuated g/C Ratio	0.37	0.21		0.34	0.20	0.20	0.50	0.45		0.53	0.46	
Clearance Time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3	
Vehicle Extension (s)	2.6	2.5		2.6	2.5	2.5	2.6	2.5		2.6	2.5	
Lane Grp Cap (vph)	394	672		282	647	247	378	1394		206	1405	
v/s Ratio Prot	c0.12	c0.18		c0.12	0.09		0.02	c0.31		c0.03	0.17	
v/s Ratio Perm	0.16			0.17		0.02	0.13			0.23		
v/c Ratio	0.74	0.87		0.88	0.46	0.11	0.29	0.68		0.50	0.37	
Uniform Delay, d1	38.9	60.0		42.7	56.1	52.2	21.1	34.3		22.9	27.5	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	6.7	11.3		25.1	0.4	0.1	0.3	2.7		1.5	0.7	
Delay (s)	45.6	71.3		67.8	56.5	52.3	21.4	37.0		24.4	28.2	
Level of Service	D	E		E	E	D	C	D		C	C	
Approach Delay (s/veh)		62.9			59.7			35.5			27.6	
Approach LOS		E			E			D			C	

Intersection Summary

HCM 2000 Control Delay (s/veh) 46.3 HCM 2000 Level of Service D

HCM 2000 Volume to Capacity ratio 0.75

Actuated Cycle Length (s) 157.7 Sum of lost time (s) 20.7

Intersection Capacity Utilization 86.8% ICU Level of Service E

Analysis Period (min) 15

c Critical Lane Group

052233 418-430 Aqueduct and 650-678 Niagara Street.syn

R.J. Burnside & Associates

Synchro 12 Report

04/04/2025 - Page 2

HCM Unsignalized Intersection Capacity Analysis

2035 Total AM

2: Niagara St. & North Driveway

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	8	44	1047	4	18	777
Future Volume (Veh/h)	8	44	1047	4	18	777
Sign Control	Stop		Free		Free	
Grade	0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	9	48	1138	4	20	845
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			TWLTL		TWLTL	
Median storage (veh)			2		2	
Upstream signal (m)			238		218	
pX, platoon unblocked	0.95	0.94			0.94	
vC, conflicting volume	1603	571			1142	
vC1, stage 1 conf vol	1140					
vC2, stage 2 conf vol	463					
vCu, unblocked vol	1433	414			1022	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3			2.2	
p0 queue free %	97	91			97	
cM capacity (veh/h)	273	557			645	
Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	57	759	383	20	423	423
Volume Left	9	0	0	20	0	0
Volume Right	48	0	4	0	0	0
cSH	478	1700	1700	645	1700	1700
Volume to Capacity	0.12	0.45	0.23	0.03	0.25	0.25
Queue Length 95th (m)	3.1	0.0	0.0	0.7	0.0	0.0
Control Delay (s/veh)	13.5	0.0	0.0	10.8	0.0	0.0
Lane LOS	B			B		
Approach Delay (s/veh)	13.5	0.0		0.2		
Approach LOS	B					
Intersection Summary						
Average Delay	0.5					
Intersection Capacity Utilization	41.4%		ICU Level of Service		A	
Analysis Period (min)	15					

HCM Unsignalized Intersection Capacity Analysis

2035 Total AM

3: Niagara St. & Abbey Rd./South Driveway

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	3	0	17	18	0	103	10	907	8	45	743	3
Future Volume (Veh/h)	3	0	17	18	0	103	10	907	8	45	743	3
Sign Control	Stop			Stop			Free			Free		
Grade	0%			0%			0%			0%		
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	0	18	20	0	112	11	986	9	49	808	3
Pedestrians	5											
Lane Width (m)	3.7											
Walking Speed (m/s)	1.1											
Percent Blockage	0											
Right turn flare (veh)												
Median type							TWLTL			TWLTL		
Median storage (veh)							2			2		
Upstream signal (m)							137			319		
pX, platoon unblocked	0.92	0.92		0.92	0.92	0.92				0.92		
vC, conflicting volume	1540	1930	411	1533	1927	498	816			995		
vC1, stage 1 conf vol	913	913		1013	1013							
vC2, stage 2 conf vol	627	1017		520	914							
vCu, unblocked vol	1406	1832	411	1399	1829	269	816			812		
tC, single (s)	7.5	6.5	7.1	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)	6.5	5.5		6.5	5.5							
tF (s)	3.5	4.0	3.4	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	100	97	92	100	83	99			94		
cM capacity (veh/h)	232	225	561	257	238	673	817			754		
Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3			
Volume Total	21	20	112	11	657	338	49	539	272			
Volume Left	3	20	0	11	0	0	49	0	0			
Volume Right	18	0	112	0	0	9	0	0	3			
cSH	466	257	673	817	1700	1700	754	1700	1700			
Volume to Capacity	0.05	0.08	0.17	0.01	0.39	0.20	0.06	0.32	0.16			
Queue Length 95th (m)	1.1	1.9	4.5	0.3	0.0	0.0	1.6	0.0	0.0			
Control Delay (s/veh)	13.1	20.2	11.4	9.5	0.0	0.0	10.1	0.0	0.0			
Lane LOS	B	C	B	A			B					
Approach Delay (s/veh)	13.1	12.7		0.1			0.6					
Approach LOS	B	B										
Intersection Summary												
Average Delay	1.3											
Intersection Capacity Utilization	47.9%			ICU Level of Service						A		
Analysis Period (min)	15											

Timings
4: Niagara St. & Parking Lot/Aqueduct St.

2035 Total AM

								
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	66	4	11	11	41	707	125	565
Future Volume (vph)	66	4	11	11	41	707	125	565
Lane Group Flow (vph)	72	62	12	197	45	779	136	694
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA
Protected Phases		4		8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	8	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	8.0	8.0	8.0	8.0	10.0	10.0	10.0	10.0
Minimum Split (s)	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1
Total Split (s)	37.1	37.1	37.1	37.1	47.1	47.1	47.1	47.1
Total Split (%)	44.1%	44.1%	44.1%	44.1%	55.9%	55.9%	55.9%	55.9%
Yellow Time (s)	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
All-Red Time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Max	C-Max	C-Max	C-Max
v/c Ratio	0.52	0.25	0.07	0.65	0.10	0.35	0.35	0.32
Control Delay (s/veh)	44.6	11.5	28.3	22.5	6.7	6.8	10.0	6.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	44.6	11.5	28.3	22.5	6.7	6.8	10.0	6.4
Queue Length 50th (m)	10.9	0.6	1.7	10.2	2.1	22.9	7.6	19.1
Queue Length 95th (m)	21.6	9.7	5.6	28.0	7.4	42.6	23.3	36.4
Internal Link Dist (m)		33.7		300.3		252.9		113.5
Turn Bay Length (m)			20.0		90.0		100.0	
Base Capacity (vph)	327	506	425	542	438	2224	393	2163
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.22	0.12	0.03	0.36	0.10	0.35	0.35	0.32

Intersection Summary

Cycle Length: 84.2

Actuated Cycle Length: 84.2

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 75

Control Type: Actuated-Coordinated

Splits and Phases: 4: Niagara St. & Parking Lot/Aqueduct St.



HCM Signalized Intersection Capacity Analysis
4: Niagara St. & Parking Lot/Aqueduct St.

2035 Total AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	66	4	53	11	11	170	41	707	10	125	565	74
Future Volume (vph)	66	4	53	11	11	170	41	707	10	125	565	74
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.86		1.00	0.86		1.00	1.00		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1584	1317		1583	1292		1582	3274		1569	3175	
Flt Permitted	0.55	1.00		0.72	1.00		0.39	1.00		0.35	1.00	
Satd. Flow (perm)	919	1317		1194	1292		646	3274		580	3175	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	72	4	58	12	12	185	45	768	11	136	614	80
RTOR Reduction (vph)	0	49	0	0	109	0	0	1	0	0	7	0
Lane Group Flow (vph)	72	13	0	12	88	0	45	778	0	136	687	0
Confl. Peds. (#/hr)	2		2	2		2	4		2	2		4
Heavy Vehicles (%)	0%	0%	0%	0%	0%	2%	0%	4%	0%	1%	6%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	12.8	12.8		12.8	12.8		57.2	57.2		57.2	57.2	
Effective Green, g (s)	12.8	12.8		12.8	12.8		57.2	57.2		57.2	57.2	
Actuated g/C Ratio	0.15	0.15		0.15	0.15		0.68	0.68		0.68	0.68	
Clearance Time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Vehicle Extension (s)	4.0	4.0		4.0	4.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	139	200		181	196		438	2224		394	2156	
v/s Ratio Prot		0.01			0.07			c0.24			0.22	
v/s Ratio Perm	c0.08			0.01			0.07			0.23		
v/c Ratio	0.52	0.06		0.07	0.45		0.10	0.35		0.35	0.32	
Uniform Delay, d1	32.9	30.6		30.6	32.5		4.7	5.7		5.7	5.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	4.3	0.2		0.2	2.2		0.5	0.4		2.4	0.4	
Delay (s)	37.1	30.8		30.8	34.7		5.1	6.1		8.0	5.9	
Level of Service	D	C		C	C		A	A		A	A	
Approach Delay (s/veh)		34.2			34.5			6.1			6.3	
Approach LOS		C			C			A			A	

Intersection Summary

HCM 2000 Control Delay (s/veh)	11.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	84.2	Sum of lost time (s)	14.2
Intersection Capacity Utilization	78.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Timings
5: Niagara St/Niagara St. & Thorold Rd

2035 Total AM

								
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	306	175	43	139	100	363	79	313
Future Volume (vph)	306	175	43	139	100	363	79	313
Lane Group Flow (vph)	333	299	47	276	109	447	86	574
Turn Type	pm+pt	NA	pm+pt	NA	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8	5	2	1	6
Permitted Phases	4		8		2		6	
Detector Phase	7	4	3	8	5	2	1	6
Switch Phase								
Minimum Initial (s)	5.0	8.0	5.0	8.0	5.0	8.0	5.0	8.0
Minimum Split (s)	8.0	33.5	8.0	33.5	8.0	30.3	8.0	30.3
Total Split (s)	22.0	51.0	8.0	37.0	10.0	35.8	10.0	35.8
Total Split (%)	21.0%	48.7%	7.6%	35.3%	9.5%	34.2%	9.5%	34.2%
Yellow Time (s)	3.0	4.1	3.0	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	2.4	0.0	2.4	0.0	2.2	0.0	2.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.5	3.0	6.5	3.0	6.3	3.0	6.3
Lead/Lag	Lead	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	C-Max	None	C-Max	None
v/c Ratio	0.77	0.60	0.16	0.85	0.37	0.39	0.24	0.49
Control Delay (s/veh)	31.2	28.6	16.4	56.2	21.8	27.4	19.3	21.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	31.2	28.6	16.4	56.2	21.8	27.4	19.3	21.9
Queue Length 50th (m)	44.4	43.8	5.1	46.6	12.3	35.8	9.5	35.1
Queue Length 95th (m)	58.7	64.5	10.0	71.1	25.9	54.1	21.1	55.2
Internal Link Dist (m)		152.6		154.0		97.6		318.5
Turn Bay Length (m)	70.0		67.0		85.0		60.0	
Base Capacity (vph)	436	573	286	416	293	1158	358	1163
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.76	0.52	0.16	0.66	0.37	0.39	0.24	0.49

Intersection Summary

Cycle Length: 104.8

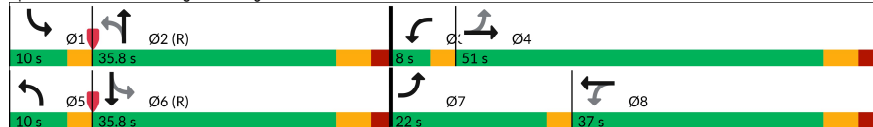
Actuated Cycle Length: 104.8

Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

Natural Cycle: 80

Control Type: Actuated-Coordinated

Splits and Phases: 5: Niagara St/Niagara St. & Thorold Rd



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HCM Signalized Intersection Capacity Analysis
5: Niagara St/Niagara St. & Thorold Rd

2035 Total AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	306	175	100	43	139	115	100	363	48	79	313	215
Future Volume (vph)	306	175	100	43	139	115	100	363	48	79	313	215
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	0.98	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.95		1.00	0.93		1.00	0.98		1.00	0.94	
Fit Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1551	1304		1424	1336		1389	3137		1388	3051	
Fit Permitted	0.34	1.00		0.58	1.00		0.33	1.00		0.46	1.00	
Satd. Flow (perm)	557	1304		866	1336		481	3137		673	3051	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	333	190	109	47	151	125	109	395	52	86	340	234
RTOR Reduction (vph)	0	22	0	0	31	0	0	9	0	0	109	0
Lane Group Flow (vph)	333	277	0	47	245	0	109	438	0	86	465	0
Confl. Peds. (#/hr)	13		8	8		13	8		5	5		8
Heavy Vehicles (%)	2%	12%	11%	11%	7%	7%	14%	3%	33%	14%	3%	4%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	45.3	38.3		27.6	23.6		45.2	37.2		42.2	35.7	
Effective Green, g (s)	45.3	38.3		27.6	23.6		45.2	37.2		42.2	35.7	
Actuated g/C Ratio	0.43	0.37		0.26	0.23		0.43	0.35		0.40	0.34	
Clearance Time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Vehicle Extension (s)	2.5	2.2		2.5	2.2		2.5	2.1		2.5	2.1	
Lane Grp Cap (vph)	418	476		249	300		276	1113		315	1039	
v/s Ratio Prot	c0.14	0.21		0.01	0.18		c0.03	0.14		0.02	c0.15	
v/s Ratio Perm	c0.20			0.04			0.14			0.09		
v/c Ratio	0.80	0.58		0.19	0.82		0.39	0.39		0.27	0.45	
Uniform Delay, d1	22.4	26.8		29.4	38.5		18.9	25.3		20.0	26.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	9.8	1.3		0.3	15.1		0.7	1.0		0.3	1.4	
Delay (s)	32.2	28.1		29.7	53.6		19.6	26.4		20.3	28.3	
Level of Service	C	C		C	D		B	C		C	C	
Approach Delay (s/veh)		30.3			50.1			25.0			27.2	
Approach LOS		C			D			C			C	

Intersection Summary

HCM 2000 Control Delay (s/veh)	31.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	104.8	Sum of lost time (s)	18.8
Intersection Capacity Utilization	83.0%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

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HCM Unsignalized Intersection Capacity Analysis

2035 Total AM

6: Niagara St. & Roger Dr.

						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	16	31	35	785	531	63
Future Volume (Veh/h)	16	31	35	785	531	63
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	17	34	38	853	577	68
Pedestrians	6				1	
Lane Width (m)	3.7				3.7	
Walking Speed (m/s)	1.1				1.1	
Percent Blockage	1				0	
Right turn flare (veh)						
Median type			TWLTL		TWLTL	
Median storage (veh)			2		2	
Upstream signal (m)			343		277	
pX, platoon unblocked	0.98					
vC, conflicting volume	1121	329	651			
vC1, stage 1 conf vol	617					
vC2, stage 2 conf vol	504					
vCu, unblocked vol	1082	329	651			
tC, single (s)	6.8	7.0	4.1			
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	95	96			
cM capacity (veh/h)	413	661	940			
Direction, Lane #	EB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	51	38	427	427	385	260
Volume Left	17	38	0	0	0	0
Volume Right	34	0	0	0	0	68
cSH	551	940	1700	1700	1700	1700
Volume to Capacity	0.09	0.04	0.25	0.25	0.23	0.15
Queue Length 95th (m)	2.3	1.0	0.0	0.0	0.0	0.0
Control Delay (s/veh)	12.2	9.0	0.0	0.0	0.0	0.0
Lane LOS	B	A				
Approach Delay (s/veh)	12.2	0.4			0.0	
Approach LOS	B					
Intersection Summary						
Average Delay	0.6					
Intersection Capacity Utilization	34.6%		ICU Level of Service		A	
Analysis Period (min)	15					

HCM Unsignalized Intersection Capacity Analysis

2: Niagara St. & North Driveway

2035 Total AM

Alternate Assignment

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	1	44	1047	4	1	794
Future Volume (Veh/h)	1	44	1047	4	1	794
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	48	1138	4	1	863
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			TWLT		TWLT	
Median storage (veh)			2		2	
Upstream signal (m)			101			
pX, platoon unblocked	0.93	0.93			0.93	
vC, conflicting volume	1574	571			1142	
vC1, stage 1 conf vol	1140					
vC2, stage 2 conf vol	434					
vCu, unblocked vol	1462	380			996	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	92			100	
cM capacity (veh/h)	277	578			651	
Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	49	759	383	1	432	432
Volume Left	1	0	0	1	0	0
Volume Right	48	0	4	0	0	0
cSH	565	1700	1700	651	1700	1700
Volume to Capacity	0.09	0.45	0.23	0.00	0.25	0.25
Queue Length 95th (m)	2.2	0.0	0.0	0.0	0.0	0.0
Control Delay (s/veh)	12.0	0.0	0.0	10.5	0.0	0.0
Lane LOS	B			B		
Approach Delay (s/veh)	12.0	0.0		0.0		
Approach LOS	B					
Intersection Summary						
Average Delay			0.3			
Intersection Capacity Utilization			41.1%		ICU Level of Service	A
Analysis Period (min)			15			

Timings

3: Niagara St. & Abbey Rd./South Driveway

2035 Total AM

Alternate Assignment

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	3	0	25	0	10	907	62	736
Future Volume (vph)	3	0	25	0	10	907	62	736
Lane Group Flow (vph)	0	21	27	112	11	995	67	803
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA
Protected Phases		4		8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	8	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Total Split (s)	27.0	27.0	27.0	27.0	57.2	57.2	57.2	57.2
Total Split (%)	32.1%	32.1%	32.1%	32.1%	67.9%	67.9%	67.9%	67.9%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)		4.5	4.5	4.5	4.5	4.5	4.5	4.5
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Max	C-Max	C-Max	C-Max
v/c Ratio		0.17	0.25	0.45	0.02	0.36	0.17	0.29
Control Delay (s/veh)		19.5	40.5	10.4	2.2	2.6	3.4	2.4
Queue Delay		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)		19.5	40.5	10.4	2.2	2.6	3.4	2.4
Queue Length 50th (m)		0.3	4.1	0.0	0.3	16.1	1.7	12.0
Queue Length 95th (m)		6.6	11.5	10.0	1.3	27.6	5.6	21.0
Internal Link Dist (m)		202.9		75.4		44.8		76.5
Turn Bay Length (m)			50.0		80.0		100.0	
Base Capacity (vph)		345	327	474	484	2776	391	2748
Starvation Cap Reductn		0	0	0	0	0	0	0
Spillback Cap Reductn		0	0	0	0	0	0	0
Storage Cap Reductn		0	0	0	0	0	0	0
Reduced v/c Ratio		0.06	0.08	0.24	0.02	0.36	0.17	0.29
Intersection Summary								
Cycle Length: 84.2								
Actuated Cycle Length: 84.2								
Offset: 72.2 (86%), Referenced to phase 2:NBT and 6:SBTL, Start of Green								
Natural Cycle: 50								
Control Type: Actuated-Coordinated								

Splits and Phases: 3: Niagara St. & Abbey Rd./South Driveway



HCM Signalized Intersection Capacity Analysis

3: Niagara St. & Abbey Rd./South Driveway

2035 Total AM

Alternate Assignment

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Movement												
Lane Configurations												
Traffic Volume (vph)	3	0	17	25	0	103	10	907	8	62	736	3
Future Volume (vph)	3	0	17	25	0	103	10	907	8	62	736	3
Ideal Flow (vphpl)	1630	1630	1630	1630	1630	1630	1651	1776	1535	1651	1776	1535
Total Lost time (s)		4.5		4.5	4.5		4.5	4.5		4.5	4.5	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt		0.88		1.00	0.85		1.00	1.00		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1312		1566	1401		1580	3309		1586	3279	
Flt Permitted		0.94		0.74	1.00		0.35	1.00		0.28	1.00	
Satd. Flow (perm)		1240		1226	1401		577	3309		468	3279	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	3	0	18	27	0	112	11	986	9	67	800	3
RTOR Reduction (vph)	0	18	0	0	103	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	3	0	27	9	0	11	995	0	67	803	0
Confl. Peds. (#/hr)							5					5
Heavy Vehicles (%)	0%	0%	12%	0%	0%	0%	0%	3%	0%	0%	4%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		6.4		6.4	6.4		68.8	68.8		68.8	68.8	
Effective Green, g (s)		6.4		6.4	6.4		68.8	68.8		68.8	68.8	
Actuated g/C Ratio		0.08		0.08	0.08		0.82	0.82		0.82	0.82	
Clearance Time (s)		4.5		4.5	4.5		4.5	4.5		4.5	4.5	
Vehicle Extension (s)		3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		94		93	106		471	2703		382	2679	
v/s Ratio Prot					0.01			c0.30			0.24	
v/s Ratio Perm		0.00		c0.02			0.02			0.14		
v/c Ratio		0.04		0.29	0.08		0.02	0.37		0.18	0.30	
Uniform Delay, d1		36.0		36.8	36.2		1.4	2.0		1.6	1.9	
Progression Factor		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.2		1.7	0.3		0.1	0.4		1.0	0.3	
Delay (s)		36.2		38.5	36.5		1.5	2.4		2.6	2.2	
Level of Service		D		D	D		A	A		A	A	
Approach Delay (s/veh)		36.2			36.9			2.4			2.2	
Approach LOS		D			D			A			A	
Intersection Summary												
HCM 2000 Control Delay (s/veh)			5.0			HCM 2000 Level of Service			A			
HCM 2000 Volume to Capacity ratio			0.36									
Actuated Cycle Length (s)			84.2			Sum of lost time (s)			9.0			
Intersection Capacity Utilization			50.0%			ICU Level of Service			A			
Analysis Period (min)			15									
c Critical Lane Group												

Timings

1: Niagara St. & Woodlawn Rd.

2035 Total PM

	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations	↩	↩↪	↩	↩↪	↩	↩	↩↪	↩	↩↪
Traffic Volume (vph)	302	394	483	572	182	118	605	204	734
Future Volume (vph)	302	394	483	572	182	118	605	204	734
Lane Group Flow (vph)	328	556	525	622	198	128	1048	222	1127
Turn Type	pm+pt	NA	pm+pt	NA	Perm	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8		5	2	1	6
Permitted Phases	4		8		8	2		6	
Detector Phase	7	4	3	8	8	5	2	1	6
Switch Phase									
Minimum Initial (s)	6.0	8.0	6.0	8.0	8.0	6.0	10.0	6.0	10.0
Minimum Split (s)	9.0	39.4	9.0	39.4	39.4	9.0	39.3	9.0	39.3
Total Split (s)	30.0	39.5	43.0	52.5	52.5	12.0	55.2	20.0	63.2
Total Split (%)	19.0%	25.0%	27.3%	33.3%	33.3%	7.6%	35.0%	12.7%	40.1%
Yellow Time (s)	3.0	4.1	3.0	4.1	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	3.3	0.0	3.3	3.3	0.0	3.2	0.0	3.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	7.4	3.0	7.4	7.4	3.0	7.3	3.0	7.3
Lead/Lag	Lead	Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	C-Max	None	C-Max	None
v/c Ratio	0.85	0.90	1.13	0.65	0.40	0.86	1.05	0.96	0.96
Control Delay (s/veh)	49.4	77.6	121.3	53.2	7.7	79.5	89.4	93.3	65.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	49.4	77.6	121.3	53.2	7.7	79.5	89.4	93.3	65.0
Queue Length 50th (m)	63.2	85.8	~166.1	90.3	0.0	25.2	~177.4	~60.9	177.5
Queue Length 95th (m)	#92.4	#109.4	#238.4	111.7	20.1	#67.7	#220.3	#115.4	#224.6
Internal Link Dist (m)		245.8		240.0			194.1		161.2
Turn Bay Length (m)	111.0		87.0		132.0	97.0		133.0	
Base Capacity (vph)	405	662	464	957	492	148	1002	231	1178
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.81	0.84	1.13	0.65	0.40	0.86	1.05	0.96	0.96

Intersection Summary

Cycle Length: 157.7

Actuated Cycle Length: 157.7

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 140

Control Type: Actuated-Coordinated

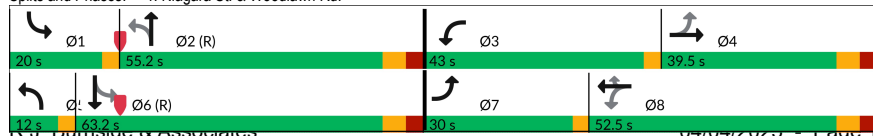
- Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: Niagara St. & Woodlawn Rd.



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HCM Signalized Intersection Capacity Analysis

1: Niagara St. & Woodlawn Rd.

2035 Total PM

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↩	↩↪		↩	↩↪	↩	↩	↩↪		↩	↩↪	
Traffic Volume (vph)	302	394	118	483	572	182	118	605	359	204	734	303
Future Volume (vph)	302	394	118	483	572	182	118	605	359	204	734	303
Ideal Flow (vphpl)	1651	1776	1535	1651	1776	1498	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	0.95		1.00	0.95	
Flpb, ped/bikes	1.00	0.99		1.00	1.00	0.96	1.00	0.98		1.00	0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.97		1.00	1.00	0.85	1.00	0.94		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1565	3169		1569	3345	1228	1570	3120		1540	3200	
Flt Permitted	0.38	1.00		0.17	1.00	1.00	0.08	1.00		0.08	1.00	
Satd. Flow (perm)	627	3169		280	3345	1228	138	3120		127	3200	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	328	428	128	525	622	198	128	658	390	222	798	329
RTOR Reduction (vph)	0	18	0	0	0	141	0	55	0	0	28	0
Lane Group Flow (vph)	328	538	0	525	622	57	128	993	0	222	1099	0
Confl. Peds. (#/hr)	17		12	12		17	14		21	21		14
Heavy Vehicles (%)	1%	3%	4%	1%	2%	1%	1%	2%	1%	3%	1%	1%
Turn Type	pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8		8	2			6		
Actuated Green, G (s)	54.9	30.0		73.0	45.1	45.1	58.2	47.9		70.0	56.7	
Effective Green, g (s)	54.9	30.0		73.0	45.1	45.1	58.2	47.9		70.0	56.7	
Actuated g/C Ratio	0.35	0.19		0.46	0.29	0.29	0.37	0.30		0.44	0.36	
Clearance Time (s)	3.0	7.4		3.0	7.4	7.4	3.0	7.3		3.0	7.3	
Vehicle Extension (s)	2.6	2.5		2.6	2.5	2.5	2.6	2.5		2.6	2.5	
Lane Grp Cap (vph)	366	602		456	956	351	144	947		227	1150	
v/s Ratio Prot	0.14	0.17		c0.29	0.19		0.06	c0.32		c0.12	0.34	
v/s Ratio Perm	0.17			c0.24		0.05	0.27			0.31		
v/c Ratio	0.90	0.89		1.15	0.65	0.16	0.89	1.05		0.98	0.96	
Uniform Delay, d1	42.9	62.3		44.6	49.4	42.1	39.1	54.9		50.4	49.3	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	23.3	15.6		90.7	1.4	0.2	43.2	42.8		52.9	17.8	
Delay (s)	66.2	77.9		135.2	50.8	42.3	82.3	97.7		103.3	67.1	
Level of Service	E	E		F	D	D	F	F		F	E	
Approach Delay (s/veh)		73.6			82.5			96.0			73.0	
Approach LOS		E			F			F			E	

Intersection Summary

HCM 2000 Control Delay (s/veh) 81.5 HCM 2000 Level of Service F

HCM 2000 Volume to Capacity ratio 1.11

Actuated Cycle Length (s) 157.7 Sum of lost time (s) 20.7

Intersection Capacity Utilization 113.2% ICU Level of Service H

Analysis Period (min) 15

c Critical Lane Group

052233 418-430 Aqueduct and 650-678 Niagara Street.syn

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Synchro 12 Report

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HCM Unsignalized Intersection Capacity Analysis

2035 Total PM

2: Niagara St. & North Driveway

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↱	↰	↱	↱
Traffic Volume (veh/h)	7	35	1139	9	51	1392
Future Volume (Veh/h)	7	35	1139	9	51	1392
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	8	38	1238	10	55	1513
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			TWLT		TWLT	
Median storage (veh)			2		2	
Upstream signal (m)			238		218	
pX, platoon unblocked	0.77	0.89			0.89	
vC, conflicting volume	2110	624			1248	
vC1, stage 1 conf vol	1243					
vC2, stage 2 conf vol	867					
vCu, unblocked vol	1231	344			1042	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3			2.2	
p0 queue free %	97	94			91	
cM capacity (veh/h)	259	589			604	
Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	46	825	423	55	757	757
Volume Left	8	0	0	55	0	0
Volume Right	38	0	10	0	0	0
cSH	482	1700	1700	604	1700	1700
Volume to Capacity	0.10	0.49	0.25	0.09	0.45	0.45
Queue Length 95th (m)	2.4	0.0	0.0	2.3	0.0	0.0
Control Delay (s/veh)	13.3	0.0	0.0	11.6	0.0	0.0
Lane LOS	B			B		
Approach Delay (s/veh)	13.3	0.0		0.4		
Approach LOS	B					
Intersection Summary						
Average Delay			0.4			
Intersection Capacity Utilization			51.2%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

2035 Total PM

3: Niagara St. & Abbey Rd./South Driveway

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱	↱	↰	↱	↱	↰	↱	↱	↰	↱	↱
Traffic Volume (veh/h)	9	0	23	14	0	83	9	1054	21	119	1297	27
Future Volume (Veh/h)	9	0	23	14	0	83	9	1054	21	119	1297	27
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	10	0	25	15	0	90	10	1146	23	129	1410	29
Pedestrians		19										
Lane Width (m)		3.7										
Walking Speed (m/s)		1.1										
Percent Blockage		2										
Right turn flare (veh)												
Median type								TWLT		TWLT		
Median storage (veh)								2		2		
Upstream signal (m)								137		319		
pX, platoon unblocked	0.93	0.93	0.89	0.93	0.93	0.88	0.89			0.88		
vC, conflicting volume	2385	2891	739	2166	2894	585	1458			1169		
vC1, stage 1 conf vol	1702	1702		1178	1178							
vC2, stage 2 conf vol	683	1189		988	1716							
vCu, unblocked vol	1804	2346	455	1569	2349	249	1265			915		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)	6.5	5.5		6.5	5.5							
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	88	100	95	92	100	86	98			81		
cM capacity (veh/h)	83	101	487	181	105	665	486			662		
Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3			
Volume Total	35	15	90	10	764	405	129	940	499			
Volume Left	10	15	0	10	0	0	129	0	0			
Volume Right	25	0	90	0	0	23	0	0	29			
cSH	204	181	665	486	1700	1700	662	1700	1700			
Volume to Capacity	0.17	0.08	0.14	0.02	0.45	0.24	0.19	0.55	0.29			
Queue Length 95th (m)	4.6	2.0	3.5	0.5	0.0	0.0	5.5	0.0	0.0			
Control Delay (s/veh)	26.2	26.6	11.3	12.6	0.0	0.0	11.8	0.0	0.0			
Lane LOS	D	D	B	B			B					
Approach Delay (s/veh)	26.2	13.5		0.1			1.0					
Approach LOS	D	B										
Intersection Summary												
Average Delay					1.4							
Intersection Capacity Utilization					61.5%			ICU Level of Service	B			
Analysis Period (min)					15							

Timings
4: Niagara St. & Parking Lot/Aqueduct St.

2035 Total PM

	↖	→	↗	↖	↖	↑	↗	↓
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations	↖	↗	↖	↗	↖	↗	↖	↗
Traffic Volume (vph)	45	1	14	2	41	961	100	1178
Future Volume (vph)	45	1	14	2	41	961	100	1178
Lane Group Flow (vph)	49	48	15	87	45	1070	109	1339
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA
Protected Phases		4		8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	8	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	8.0	8.0	8.0	8.0	10.0	10.0	10.0	10.0
Minimum Split (s)	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1
Total Split (s)	37.1	37.1	37.1	37.1	47.1	47.1	47.1	47.1
Total Split (%)	44.1%	44.1%	44.1%	44.1%	55.9%	55.9%	55.9%	55.9%
Yellow Time (s)	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
All-Red Time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Max	C-Max	C-Max	C-Max
v/c Ratio	0.34	0.26	0.10	0.42	0.20	0.42	0.34	0.53
Control Delay (s/veh)	39.6	22.4	32.9	22.3	7.6	5.6	9.1	6.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	39.6	22.4	32.9	22.3	7.6	5.6	9.1	6.6
Queue Length 50th (m)	7.4	3.2	2.2	5.0	2.0	31.5	5.6	44.9
Queue Length 95th (m)	16.8	12.4	7.2	17.1	7.6	51.1	17.7	72.3
Internal Link Dist (m)		33.7		300.3		252.9		113.5
Turn Bay Length (m)			20.0		90.0		100.0	
Base Capacity (vph)	416	480	429	499	226	2536	320	2528
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.12	0.10	0.03	0.17	0.20	0.42	0.34	0.53

Intersection Summary

Cycle Length: 84.2

Actuated Cycle Length: 84.2

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 80

Control Type: Actuated-Coordinated

Splits and Phases: 4: Niagara St. & Parking Lot/Aqueduct St.



HCM Signalized Intersection Capacity Analysis
4: Niagara St. & Parking Lot/Aqueduct St.

2035 Total PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	45	1	43	14	2	78	41	961	23	100	1178	54
Future Volume (vph)	45	1	43	14	2	78	41	961	23	100	1178	54
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.98		1.00	0.99		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.85		1.00	0.85		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1584	1302		1578	1307		1582	3332		1579	3320	
Flt Permitted	0.70	1.00		0.73	1.00		0.18	1.00		0.25	1.00	
Satd. Flow (perm)	1168	1302		1206	1307		298	3332		420	3320	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	49	1	47	15	2	85	45	1045	25	109	1280	59
RTOR Reduction (vph)	0	23	0	0	48	0	0	1	0	0	2	0
Lane Group Flow (vph)	49	25	0	15	39	0	45	1069	0	109	1337	0
Confl. Peds. (#/hr)	2		6	6		2	12		14	14		12
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	2%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	8.7	8.7		8.7	8.7		61.3	61.3		61.3	61.3	
Effective Green, g (s)	8.7	8.7		8.7	8.7		61.3	61.3		61.3	61.3	
Actuated g/C Ratio	0.10	0.10		0.10	0.10		0.73	0.73		0.73	0.73	
Clearance Time (s)	7.1	7.1		7.1	7.1		7.1	7.1		7.1	7.1	
Vehicle Extension (s)	4.0	4.0		4.0	4.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	120	134		124	135		216	2425		305	2417	
v/s Ratio Prot		0.02			0.03			0.32			c0.40	
v/s Ratio Perm	c0.04			0.01			0.15			0.26		
v/c Ratio	0.41	0.18		0.12	0.29		0.21	0.44		0.36	0.55	
Uniform Delay, d1	35.3	34.5		34.3	34.9		3.7	4.6		4.2	5.2	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	3.1	0.9		0.6	1.6		2.2	0.6		3.2	0.9	
Delay (s)	38.4	35.4		34.9	36.5		5.9	5.2		7.5	6.1	
Level of Service	D	D		C	D		A	A		A	A	
Approach Delay (s/veh)		36.9			36.3			5.2			6.2	
Approach LOS		D			D			A			A	

Intersection Summary

HCM 2000 Control Delay (s/veh)	8.0	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	84.2	Sum of lost time (s)	14.2
Intersection Capacity Utilization	75.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Timings
5: Niagara St/Niagara St. & Thorold Rd

2035 Total PM

								
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	396	178	117	184	167	577	119	659
Future Volume (vph)	396	178	117	184	167	577	119	659
Lane Group Flow (vph)	430	297	127	327	182	705	129	1292
Turn Type	pm+pt	NA	pm+pt	NA	pm+pt	NA	pm+pt	NA
Protected Phases	7	4	3	8	5	2	1	6
Permitted Phases	4		8		2		6	
Detector Phase	7	4	3	8	5	2	1	6
Switch Phase								
Minimum Initial (s)	5.0	8.0	5.0	8.0	5.0	8.0	5.0	8.0
Minimum Split (s)	8.0	33.5	8.0	33.5	8.0	30.3	8.0	30.3
Total Split (s)	23.3	42.5	14.3	33.5	10.0	36.0	12.0	38.0
Total Split (%)	22.2%	40.6%	13.6%	32.0%	9.5%	34.4%	11.5%	36.3%
Yellow Time (s)	3.0	4.1	3.0	4.1	3.0	4.1	3.0	4.1
All-Red Time (s)	0.0	2.4	0.0	2.4	0.0	2.2	0.0	2.2
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.5	3.0	6.5	3.0	6.3	3.0	6.3
Lead/Lag	Lead	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	C-Max	None	C-Max
v/c Ratio	0.99	0.59	0.32	0.92	0.96	0.69	0.53	1.21
Control Delay (s/veh)	61.8	31.2	17.3	66.5	84.1	36.1	26.8	130.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)	61.8	31.2	17.3	66.5	84.1	36.1	26.8	130.4
Queue Length 50th (m)	56.5	43.4	13.1	58.4	~30.2	67.4	16.1	~154.3
Queue Length 95th (m)	#116.0	72.8	23.3	#106.1	#73.6	88.5	28.6	#196.1
Internal Link Dist (m)		152.6		154.0		97.6		318.5
Turn Bay Length (m)	70.0		67.0		85.0		60.0	
Base Capacity (vph)	435	509	429	384	190	1026	251	1072
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.99	0.58	0.30	0.85	0.96	0.69	0.51	1.21

Intersection Summary

Cycle Length: 104.8

Actuated Cycle Length: 104.8

Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

Natural Cycle: 110

Control Type: Actuated-Coordinated

- Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 5: Niagara St/Niagara St. & Thorold Rd



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HCM Signalized Intersection Capacity Analysis
5: Niagara St/Niagara St. & Thorold Rd

2035 Total PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	396	178	96	117	184	117	167	577	72	119	659	530
Future Volume (vph)	396	178	96	117	184	117	167	577	72	119	659	530
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1776	1535	1651	1776	1535
Total Lost time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	0.98	
Flpb, ped/bikes	1.00	1.00		0.99	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.95		1.00	0.94		1.00	0.98		1.00	0.93	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1553	1405		1574	1406		1468	3302		1480	3088	
Flt Permitted	0.28	1.00		0.58	1.00		0.12	1.00		0.24	1.00	
Satd. Flow (perm)	451	1405		958	1406		191	3302		373	3088	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	430	193	104	127	200	127	182	627	78	129	716	576
RTOR Reduction (vph)	0	18	0	0	22	0	0	9	0	0	138	0
Lane Group Flow (vph)	430	279	0	127	305	0	182	696	0	129	1154	0
Confl. Peds. (#/hr)	11		18	18		11	12		11	11		12
Heavy Vehicles (%)	2%	1%	8%	0%	1%	6%	8%	1%	2%	7%	1%	1%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	48.2	35.9		34.2	24.9		41.4	32.3		40.2	31.7	
Effective Green, g (s)	48.2	35.9		34.2	24.9		41.4	32.3		40.2	31.7	
Actuated g/C Ratio	0.46	0.34		0.33	0.24		0.40	0.31		0.38	0.30	
Clearance Time (s)	3.0	6.5		3.0	6.5		3.0	6.3		3.0	6.3	
Vehicle Extension (s)	2.5	2.2		2.5	2.2		2.5	2.1		2.5	2.1	
Lane Grp Cap (vph)	420	481		367	334		186	1017		232	934	
v/s Ratio Prot	c0.20	0.20		0.03	0.22		c0.08	0.21		0.04	c0.37	
v/s Ratio Perm	c0.27			0.08			0.30			0.17		
v/c Ratio	1.02	0.58		0.35	0.91		0.98	0.68		0.56	1.24	
Uniform Delay, d1	23.2	28.3		25.9	38.9		26.2	31.8		22.7	36.6	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	50.1	1.2		0.4	27.9		59.0	3.7		2.3	115.2	
Delay (s)	73.3	29.4		26.3	66.8		85.3	35.5		25.0	151.8	
Level of Service	E	C		C	E		F	D		C	F	
Approach Delay (s/veh)		55.4			55.4			45.7			140.3	
Approach LOS		E			E			D			F	

Intersection Summary

HCM 2000 Control Delay (s/veh)	87.5	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.13		
Actuated Cycle Length (s)	104.8	Sum of lost time (s)	18.8
Intersection Capacity Utilization	113.1%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

052233 418-430 Aqueduct and 650-678 Niagara Street.syn
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Synchro 12 Report
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HCM Unsignalized Intersection Capacity Analysis

2035 Total PM

6: Niagara St. & Roger Dr.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↰	↱	↰	↱	↱	↰
Traffic Volume (veh/h)	21	36	38	923	1093	68
Future Volume (Veh/h)	21	36	38	923	1093	68
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	23	39	41	1003	1188	74
Pedestrians	8			1	2	
Lane Width (m)	3.7			3.7	3.7	
Walking Speed (m/s)	1.1			1.1	1.1	
Percent Blockage	1			0	0	
Right turn flare (veh)						
Median type				TWLT	TL	
Median storage (veh)				2	2	
Upstream signal (m)				343	277	
pX, platoon unblocked	0.89	0.84	0.84			
vC, conflicting volume	1819	640	1270			
vC1, stage 1 conf vol	1233					
vC2, stage 2 conf vol	586					
vCu, unblocked vol	1198	204	951			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3	2.2			
p0 queue free %	92	94	93			
cM capacity (veh/h)	282	677	612			
Direction, Lane #	EB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	62	41	502	502	792	470
Volume Left	23	41	0	0	0	0
Volume Right	39	0	0	0	0	74
cSH	445	612	1700	1700	1700	1700
Volume to Capacity	0.14	0.07	0.30	0.30	0.47	0.28
Queue Length 95th (m)	3.7	1.6	0.0	0.0	0.0	0.0
Control Delay (s/veh)	14.4	11.3	0.0	0.0	0.0	0.0
Lane LOS	B	B				
Approach Delay (s/veh)	14.4	0.4			0.0	
Approach LOS	B					
Intersection Summary						
Average Delay			0.6			
Intersection Capacity Utilization			47.3%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

2: Niagara St. & North Driveway

2035 Total PM

Alternate Assignment

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↖	↗	↖	↗	↖	↗
Traffic Volume (veh/h)	1	35	1139	9	1	1442
Future Volume (Veh/h)	1	35	1139	9	1	1442
Sign Control	Stop		Free		Free	
Grade	0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	38	1238	10	1	1567
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			TWLT		TWLT	
Median storage (veh)			2		2	
Upstream signal (m)			101			
pX, platoon unblocked	0.91	0.91			0.91	
vC, conflicting volume	2029	624			1248	
vC1, stage 1 conf vol	1243					
vC2, stage 2 conf vol	786					
vCu, unblocked vol	1927	376			1065	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)	5.8					
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	93			100	
cM capacity (veh/h)	225	568			599	
Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	39	825	423	1	784	784
Volume Left	1	0	0	1	0	0
Volume Right	38	0	10	0	0	0
cSH	547	1700	1700	599	1700	1700
Volume to Capacity	0.07	0.49	0.25	0.00	0.46	0.46
Queue Length 95th (m)	1.7	0.0	0.0	0.0	0.0	0.0
Control Delay (s/veh)	12.1	0.0	0.0	11.0	0.0	0.0
Lane LOS	B			B		
Approach Delay (s/veh)	12.1	0.0		0.0		
Approach LOS	B					
Intersection Summary						
Average Delay			0.2			
Intersection Capacity Utilization			52.6%		ICU Level of Service	A
Analysis Period (min)			15			

Timings

3: Niagara St. & Abbey Rd./South Driveway

2035 Total PM

Alternate Assignment

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations	↖	↗	↖	↗	↖	↗	↖	↗
Traffic Volume (vph)	9	0	20	0	9	1054	169	1291
Future Volume (vph)	9	0	20	0	9	1054	169	1291
Lane Group Flow (vph)	0	35	22	90	10	1169	184	1432
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	NA
Protected Phases		4		8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	8	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Total Split (s)	22.5	22.5	22.5	22.5	61.7	61.7	61.7	61.7
Total Split (%)	26.7%	26.7%	26.7%	26.7%	73.3%	73.3%	73.3%	73.3%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Max	C-Max	C-Max	C-Max
v/c Ratio		0.26	0.21	0.40	0.04	0.42	0.57	0.51
Control Delay (s/veh)		23.1	40.1	9.7	2.4	2.8	12.0	3.3
Queue Delay		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s/veh)		23.1	40.1	9.7	2.4	2.8	12.0	3.3
Queue Length 50th (m)		1.5	3.4	0.0	0.2	19.7	7.4	27.3
Queue Length 95th (m)		9.8	10.0	8.5	1.3	33.0	35.0	45.4
Internal Link Dist (m)		202.9		75.4		44.8		76.5
Turn Bay Length (m)			50.0		80.0		100.0	
Base Capacity (vph)		297	258	391	236	2810	323	2834
Starvation Cap Reductn		0	0	0	0	0	0	0
Spillback Cap Reductn		0	0	0	0	0	0	0
Storage Cap Reductn		0	0	0	0	0	0	0
Reduced v/c Ratio		0.12	0.09	0.23	0.04	0.42	0.57	0.51

Intersection Summary

Cycle Length: 84.2

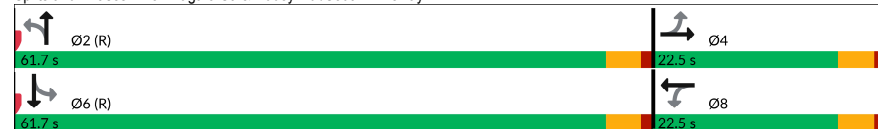
Actuated Cycle Length: 84.2

Offset: 66.2 (79%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

Natural Cycle: 80

Control Type: Actuated-Coordinated

Splits and Phases: 3: Niagara St. & Abbey Rd./South Driveway



HCM Signalized Intersection Capacity Analysis
3: Niagara St. & Abbey Rd./South Driveway

2035 Total PM
Alternate Assignment

	←	→	↙	↘	↖	↗	↙	↘	↖	↗	↙	↘
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔		↔	↔		↔	↔		↔	↔	
Traffic Volume (vph)	9	0	23	20	0	83	9	1054	21	169	1291	27
Future Volume (vph)	9	0	23	20	0	83	9	1054	21	169	1291	27
Ideal Flow (vphpl)	1630	1630	1630	1630	1630	1630	1651	1776	1535	1651	1776	1535
Total Lost time (s)		4.5		4.5	4.5		4.5	4.5		4.5	4.5	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frpb, ped/bikes		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00		0.99	1.00		1.00	1.00	
Frt		0.90		1.00	0.85		1.00	1.00		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1468		1566	1401		1578	3336		1586	3364	
Flt Permitted		0.87		0.73	1.00		0.17	1.00		0.23	1.00	
Satd. Flow (perm)		1299		1210	1401		280	3336		385	3364	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	10	0	25	22	0	90	10	1146	23	184	1403	29
RTOR Reduction (vph)	0	23	0	0	83	0	0	1	0	0	1	0
Lane Group Flow (vph)	0	12	0	22	7	0	10	1168	0	184	1431	0
Confl. Peds. (#/hr)							19					19
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	1%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		6.1		6.1	6.1		69.1	69.1		69.1	69.1	
Effective Green, g (s)		6.1		6.1	6.1		69.1	69.1		69.1	69.1	
Actuated g/C Ratio		0.07		0.07	0.07		0.82	0.82		0.82	0.82	
Clearance Time (s)		4.5		4.5	4.5		4.5	4.5		4.5	4.5	
Vehicle Extension (s)		3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		94		87	101		229	2737		315	2760	
v/s Ratio Prot					0.00			0.35				0.43
v/s Ratio Perm		0.01		c0.02			0.04			c0.48		
v/c Ratio		0.13		0.25	0.06		0.04	0.43		0.58	0.52	
Uniform Delay, d1		36.6		36.9	36.4		1.4	2.1		2.6	2.4	
Progression Factor		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.6		1.5	0.3		0.4	0.5		7.7	0.7	
Delay (s)		37.2		38.4	36.7		1.8	2.6		10.3	3.1	
Level of Service		D		D	D		A	A		B	A	
Approach Delay (s/veh)		37.2			37.0			2.6			3.9	
Approach LOS		D			D			A			A	
Intersection Summary												
HCM 2000 Control Delay (s/veh)			5.0			HCM 2000 Level of Service			A			
HCM 2000 Volume to Capacity ratio			0.56									
Actuated Cycle Length (s)			84.2			Sum of lost time (s)			9.0			
Intersection Capacity Utilization			63.4%			ICU Level of Service			B			
Analysis Period (min)			15									

c Critical Lane Group



BURNSIDE

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Appendix H

Traffic Signal Warrant Analysis

Input Sheet

Main Road	Niagara
Minor Road	Aqueduct
Direction of Main Road	North / South
Date:	2025
No. of Lanes on Main	2 or more
T-Intersection	No
Operating Environment	Urban
Scenario	Existing Traffic Volumes

Analysis Sheet

Justification 1: Minimum Vehicle Volumes						
Justification	Guidance Approach Lanes				Total	Section Percent
	1 Lanes		2 or More Lanes			
Flow Condition	FREE FLOW	RESTR. FLOW	FREE FLOW	RESTR. FLOW		
1A (All Approach Lanes)	480	720	600	900		
				x		
COMPLIANCE %					884	98%
1B (Minor Street Both Approaches)	120	170	120	170		
				x		
COMPLIANCE %						
Signal Justification 1:						

Justification 2: Delay to Cross Traffic						
Justification	Guidance Approach Lanes				Total	Section Percent
	1 lanes		2 or More lanes			
Flow Condition	FREE FLOW	RESTR. FLOW	FREE FLOW	RESTR. FLOW		
2A (Major Street Both Approaches)	480	720	600	900		
				x		
COMPLIANCE %					782	87%
2B (Traffic Crossing Major Street)	50	75	50	75		
				x		
COMPLIANCE %						
Signal Justification 2:						

Justification 3: Combination (Justification 1 and 2)	
Justification Satisfied 80% or More	
Justification 1	Minimum Vehicular Volume
Justification 2	Delay Cross Traffic

Results Sheet

Justification		Compliance	Minimum Target	Signal Justified?	
				YES	NO
1. Minimum Vehicular Volume	A. Total Volume	98%	100%		NO
	B. Crossing Volume	60%			
2. Delay to Cross Traffic	A. Main Road	87%	100%		NO
	B. Crossing Road	41%			
3. Combination	A. Justificaton 1	60%	80%		NO
	B. Justification 2	41%			

<u>Main Road</u>	Niagara
<u>Minor Road</u>	Aqueduct
<u>Direction of Main Road</u>	North / South
<u>Date:</u>	Total 2035
<u>No. of Lanes on Main</u>	2 or more
<u>T-Intersection</u>	No
<u>Operating Environment</u>	Urban
<u>Scenario</u>	Forecasted Traffic Volumes (Existing Intersection)

Justification 1: Minimum Vehicle Volumes						
Justification	Guidance Approach Lanes				Total	Section Percent
	1 Lanes		2 or More Lanes			
Flow Condition	FREE FLOW	RESTR. FLOW	FREE FLOW	RESTR. FLOW		
1A (All Approach Lanes)	480	720	600	900		
				x		
	COMPLIANCE %				1,094	122%
1B (Minor Street Both Approaches)	120	170	120	170		
				x		
	COMPLIANCE %				125	74%
Signal Justification 1:						

Justification 2: Delay to Cross Traffic						
Justification	Guidance Approach Lanes				Total	Section Percent
	1 lanes		2 or More lanes			
Flow Condition	FREE FLOW	RESTR. FLOW	FREE FLOW	RESTR. FLOW		
2A (Major Street Both Approaches)	480	720	600	900		
				x		
	COMPLIANCE %				970	108%
2B (Traffic Crossing Major Street)	50	75	50	75		
				x		
	COMPLIANCE %				53	71%
Signal Justification 2:						

Justification 3: Combination (Justification 1 and 2)	
Justification Satisfied 80% or More	
Justification 1	Minimun Vehicular Volume
Justification 2	Delay Cross Traffic

Justification		Compliance	Minimum Target	Signal Justified?	
				YES	NO
1. Minimum Vehicular Volume	A. Total Volume	122%	120%		NO
	B. Crossing Volume	74%			
2. Delay to Cross Traffic	A. Main Road	108%	120%		NO
	B. Crossing Road	71%			
3. Combination	A. Justificaton 1	74%	120%		NO
	B. Justification 2	71%			



Input Sheet

Main Road	Niagara
Minor Road	Abbey
Direction of Main Road	North / South
Date:	2025
No. of Lanes on Main	2 or more
T-Intersection	Yes
Operating Environment	Urban
Scenario	Existing Traffic Volumes

Analysis Sheet

Justification 1: Minimum Vehicle Volumes						
Justification	Guidance Approach Lanes				Total	Section Percent
	1 Lanes		2 or More Lanes			
Flow Condition	FREE FLOW	RESTR. FLOW	FREE FLOW	RESTR. FLOW		
1A (All Approach Lanes)	480	720	600	900		
				x		
COMPLIANCE %					844	94%
1B (Minor Street Both Approaches)	180	255	180	255		
				x		
COMPLIANCE %					13	5%
Signal Justification 1:						

Justification 2: Delay to Cross Traffic						
Justification	Guidance Approach Lanes				Total	Section Percent
	1 lanes		2 or More lanes			
Flow Condition	FREE FLOW	RESTR. FLOW	FREE FLOW	RESTR. FLOW		
2A (Major Street Both Approaches)	480	720	600	900		
				x		
COMPLIANCE %					831	92%
2B (Traffic Crossing Major Street)	50	75	50	75		
				x		
COMPLIANCE %					3	4%
Signal Justification 2:						

Justification 3: Combination (Justification 1 and 2)	
Justification Satisfied 80% or More	
Justification 1	Minimun Vehicular Volume
Justification 2	Delay Cross Traffic

Results Sheet

Justification		Compliance	Minimum Target	Signal Justified?	
				YES	NO
1. Minimum Vehicular Volume	A. Total Volume	94%	100%		NO
	B. Crossing Volume	5%			
2. Delay to Cross Traffic	A. Main Road	92%	100%		NO
	B. Crossing Road	4%			
3. Combination	A. Justificaton 1	5%	80%		NO
	B. Justification 2	4%			

<u>Main Road</u>	Niagara
<u>Minor Road</u>	Abbey
<u>Direction of Main Road</u>	North / South
<u>Date:</u>	Total 2035
<u>No. of Lanes on Main</u>	2 or more
<u>T-Intersection</u>	No
<u>Operating Environment</u>	Urban
<u>Scenario</u>	Forecasted Traffic Volumes (Existing Intersection)

Justification 1: Minimum Vehicle Volumes						
Justification	Guidance Approach Lanes				Total	Section Percent
	1 Lanes		2 or More Lanes			
Flow Condition	FREE FLOW	RESTR. FLOW	FREE FLOW	RESTR. FLOW		
1A (All Approach Lanes)	480	720	600	900		
				x		
	COMPLIANCE %				1,128	125%
1B (Minor Street Both Approaches)	120	170	120	170		
				x		
	COMPLIANCE %				68	40%
Signal Justification 1:						

Justification 2: Delay to Cross Traffic						
Justification	Guidance Approach Lanes				Total	Section Percent
	1 lanes		2 or More lanes			
Flow Condition	FREE FLOW	RESTR. FLOW	FREE FLOW	RESTR. FLOW		
2A (Major Street Both Approaches)	480	720	600	900		
				x		
	COMPLIANCE %				1,061	118%
2B (Traffic Crossing Major Street)	50	75	50	75		
				x		
	COMPLIANCE %				11	15%
Signal Justification 2:						

Justification 3: Combination (Justification 1 and 2)	
Justification Satisfied 80% or More	
Justification 1	Minimun Vehicular Volume
Justification 2	Delay Cross Traffic

Justification		Compliance	Minimum Target	Signal Justified?	
				YES	NO
1. Minimum Vehicular Volume	A. Total Volume	125%	120%		NO
	B. Crossing Volume	40%			
2. Delay to Cross Traffic	A. Main Road	118%	120%		NO
	B. Crossing Road	15%			
3. Combination	A. Justificaton 1	40%	120%		NO
	B. Justification 2	15%			



Input Sheet

Main Road

Minor Road

Direction of Main Road

Date:

No. of Lanes on Main

T-Intersection

Operating Environment

Scenario

Niagara

Abbey

North / South

Total 2035
Alternate Assignment

2 or more

No

Urban

Forecasted Traffic Volumes (Existing Intersection)

Analysis Sheet

Justification 1: Minimum Vehicle Volumes

Justification	Guidance Approach Lanes				Total	Section Percent
	1 Lanes		2 or More Lanes			
Flow Condition	FREE FLOW	RESTR. FLOW	FREE FLOW	RESTR. FLOW		
1A (All Approach Lanes)	480	720	600	900		
				x		
	COMPLIANCE %				1,145	127%
1B (Minor Street Both Approaches)	120	170	120	170		
				x		
	COMPLIANCE %					
Signal Justification 1:						

Justification 2: Delay to Cross Traffic

Justification	Guidance Approach Lanes				Total	Section Percent
	1 lanes		2 or More lanes			
Flow Condition	FREE FLOW	RESTR. FLOW	FREE FLOW	RESTR. FLOW		
2A (Major Street Both Approaches)	480	720	600	900		
				x		
	COMPLIANCE %				1,074	119%
2B (Traffic Crossing Major Street)	50	75	50	75		
				x		
	COMPLIANCE %					
Signal Justification 2:						

Justification 3: Combination (Justification 1 and 2)

Justification Satisfied 80% or More	
Justification 1	Minimun Vehicular Volume
Justification 2	Delay Cross Traffic

Results Sheet

Justification		Compliance	Minimum Target	Signal Justified?	
				YES	NO
1. Minimum Vehicular Volume	A. Total Volume	127%	120%		NO
	B. Crossing Volume	42%			
2. Delay to Cross Traffic	A. Main Road	119%	120%		NO
	B. Crossing Road	47%			
3. Combination	A. Justificaton 1	42%	120%		NO
	B. Justification 2	47%			



BURNSIDE

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Appendix I

Excerpts from Zoning By-law 2017-117

6.1.4 Calculation and Rounding Provisions

Where the application of any ratio in this part of the By-law results in a fraction of a parking space, barrier free space, or bicycle parking space, the minimum number of spaces required shall be increased to the next highest whole number if the fraction is greater than or equal to 0.5.

6.1.5 Cash-in-Lieu of Parking

Parking spaces, barrier free spaces and bicycle parking spaces required by this By-law for non-Residential uses shall not be required for a lot in any Mixed Use Zone if the City enters into an Agreement with the landowner respecting the payment of cash-in-lieu for some or all of the parking spaces, barrier free parking spaces, bicycle parking spaces, aisles, or driveways required, in accordance with Section 40 of the *Planning Act*, as amended.

6.1.6 Parking Space Dimensions

- a) Parking spaces may be varied in width depending on the angle measured perpendicular to the axis of the access aisle of the space provided. Where an aisle serves two different types of angled parking, which are located across from each other, the largest required access aisle shall be provided. The dimensions of parking spaces and parking space access aisles shall be in accordance with the following:
 - i) Ninety-degree (90°) parking spaces shall be 2.75 metres by 5.5 metres with a minimum 6.0 metres access aisle;
 - ii) Sixty-degree (60°) parking spaces shall be 2.6 metres by 5.5 metres with a minimum 5.5 metres access aisle;
 - iii) Forty-five-degree (45°) parking spaces shall be 2.6 metres by 5.5 metres with a minimum 4.5 metres access aisle;
 - iv) Thirty-degree (30°) parking spaces shall be 2.6 metres by 5.5 metres with a minimum 4.5 metres access aisle; and
 - v) Parallel parking spaces shall be 6.0 metres by 2.75 metres with a minimum 4.5 metres access aisle.
- b) Where a parking space is located abutting or near a wall, column or other similar surface that obstructs the opening of the doors of a parked vehicle or limits access to a parking space, the minimum width of the parking space shall be increased by 0.3 metres for each side that is obstructed.
- c) The minimum required height clearance for a covered parking space is 2.0 metres.

- ii) Where a change in use occurs that has the effect of requiring the additional spaces identified in Subsection 6.2 b).

6.3 Downtown Zones - Required Parking and Queuing Spaces

No parking and queuing spaces is required for all permitted uses and for dwelling units in buildings containing not more than three dwelling units. For buildings containing four or more dwelling units, one parking space for each dwelling unit above three units shall be required except where a dwelling unit is 50.0 m² in gross floor area or less, in which case, parking shall be provided at a rate of 0.3 spaces for each unit.

6.4 All Zones Except Downtown Zones – Required Parking and Queuing Spaces by Use

The minimum required parking and queuing spaces for permitted uses in all Zones, except Downtown Zones permitted by this By-law shall be in accordance with the following Tables.

Table 6.4.1: Residential and Accessory Residential Uses in All Zones Except Downtown Zones - Required Parking Spaces

Column 1	Column 2
Use	Required Number of Parking Spaces
Accessory Dwelling	1 additional tandem parking space
Apartment Dwelling Multiple Dwelling	1 space per unit, except where a dwelling unit is 50.0 m ² in gross floor area or less, in which case, parking shall be provided at a rate of 0.3 spaces for each such unit and no visitor parking is required
Bed and Breakfast	1 additional parking space per guest room permitted in the front yard
	Where 3 guest rooms are provided, one required parking space is not required to have direct, unobstructed access to a public street
Boarding or Lodging House	0.25 additional space per lodging unit

Column 1	Column 2
Use	Required Number of Parking Spaces
Emergency Shelter, Group Home, Residential Care Facility	1 space for each 5 persons accommodated or designed for accommodation
	Where the building is less than 350.0 m ² in gross floor area:
	i) Up to 3 in tandem parking spaces are permitted;
	ii) Two of the 3 parking spaces may be located in the driveway, and they may be located in a front yard if they are located in the laneway that leads to a required parking space;
	iii) Only one of the 3 parking spaces must have direct access to a public street or public lane by a driveway; and
	iv) Where parking is occurring in-tandem anywhere on the lot, no parking is permitted in the rear yard of the lot.
Detached Dwelling Two-Unit Dwelling Street Townhouse Dwelling	1 space per unit; one of which may be provided in an attached or detached garage
Dwelling Units on the 2nd and 3rd Floor of a 2 or 3 storey commercial building	1 space per unit
Home Day Care	No minimum required
Home Industry	No minimum required
Home Occupation	No minimum required

Column 1	Column 2
USE	Required Number of Parking Spaces
Motor Vehicle Body Shop, Motor Vehicle Dealership, Motor Vehicle Rental Establishment, Motor Vehicle Repair Establishment,	1 space per 110.0 m ² of gross floor area 25% of all required parking need not have direct, unobstructed access to a public street
Motor Vehicle Service Station	
Motor Vehicle Washing Establishment	1 space per 30.0 m ² of gross floor area
Movie Theatre	1 space per 4 seats
Office:	
i) Medical Office or Clinic	1 space per 30.0 m ² of gross floor area
ii) Other	1 space per 30.0 m ² of gross floor area
Personal Services	1 space for each 30.0 m ² of gross floor area which accommodates such use
Pet Care Establishment	1 space for each 30.0 m ² of gross floor area which accommodates such use
Place of Assembly	10 spaces per 100.0 m ² of gross floor area
Recreational Establishment	1 space per 30.0 m ² of gross floor area
Restaurant	1 space per 30.0 m ² of gross floor area
Retail or Retail Centre	1 space per 30.0 m ² of gross floor area

Column 1	Column 2
Use	Required Number of Parking Spaces
	which accommodates the remainder of the use
Other Industrial Uses Not Listed Above	1 space for each 180.0 m ² of gross floor area

6.5 Barrier Free Parking

6.5.1 Number of Barrier Free Parking Spaces

Where ten or more parking spaces are required by Section 6.3 or 6.4 for all uses on a lot, barrier free parking shall be designated and provided as part of the required parking spaces pursuant to Table 6.5.1 unless otherwise specified in the respective Zones.

Table 6.5.1: Barrier Free Parking

Column 1	Column 2
Required Parking Spaces	Minimum Required Designated Barrier Free Parking Spaces
10-50 spaces	1 space
50-100 spaces	2 spaces
100 or more spaces	2 spaces plus for every additional 100 required spaces, 1 additional barrier free space shall be provided

6.5.2 General Provisions for Barrier Free Parking Spaces

- a) Each barrier free parking space shall have a minimum width of 4.5 metres and a minimum length of 5.5 metres.
- b) Where the application of any ratio in this part of the By-law results in a fraction of a barrier free parking space being required, the minimum number of spaces required shall be increased to the next highest whole number.

6.6 Loading Spaces

Where a loading space is provided, the following regulations apply:

- a) A minimum of one off-street loading space shall be provided in conjunction with every principal building, including a mixed use building, but excluding residential buildings less than four storeys high.
- b) The minimum dimensions of a loading space are 3.5 metres in width and 12.0 metres in length, with a minimum vertical clearance of 4.2 metres.
- c) A loading space shall abut the building for which the loading space is provided.
- d) A loading space shall be setback 7.5 metres from any Residential Zone except if it is located entirely within a structure.
- e) A loading space is not permitted:
 - i) In any minimum yard or front yard except where screened from view by a visual barrier; and
 - ii) Between the main wall closest to the flankage lot line and the flankage lot line in a flankage yard; and
 - iii) In a required yard abutting a Residential Zone or an Institutional Zone and shall be screened from view by a visual barrier.

6.7 Bicycle Parking

6.7.1 Number of Required Bicycle Parking Spaces

If a lot is Zoned in a Residential, Mixed Use, Commercial, Industrial or Institutional Zone, bicycle parking shall be provided in accordance with Table 6.7.1:

Table 6.7.1: Minimum Required Bicycle Parking Spaces

Column 1	Column 2
Use	Minimum Required Bicycle Parking Spaces
Residential Uses	
Apartment Dwelling, Multiple Dwelling, Retirement Home	0.25 spaces per dwelling unit

Column 1	Column 2
Use	Minimum Required Bicycle Parking Spaces
Hotel or Motel	1 space per 1,000.0 m ² of gross floor area
Office, Retail Uses	
Office, Retail or Restaurant use with less than 3,000 m ² of gross floor area	1 space per 1,000.0 m ² of gross floor area
Office, Retail, or Restaurant use with over 3,000 m ² of gross floor area	1 space per 1,000.0 m ² of gross floor area
Institutional Uses	
School, Post-Secondary	1 space per 100.0 m ² of gross floor area
Multiple Uses on a Lot	
Where multiple uses are located on a lot in any non-Residential Zone	1 space per 1,000.0 m ² of gross floor area, plus the minimum number of parking spaces for the dwellings
Any other non-Residential Use	1 space per 1,000.0 m ² of gross floor area

6.7.2 General Provisions for Bicycle Parking Spaces

- a) Where the minimum number of bicycle parking spaces calculated in accordance with Table 6.7.1 results in a fraction, the minimum number of bicycle parking spaces shall be rounded up to the next whole number.
- b) Bicycle parking shall be located on the same lot as the use or building for which it is provided.
- c) Bicycle parking may be located within any yard, but not within a visibility triangle.
- d) A maximum of fifty percent of bicycle parking spaces may be located within a required landscaped area.
- e) Bicycle parking spaces shall be a minimum of 0.6 metres by 1.8 metres.

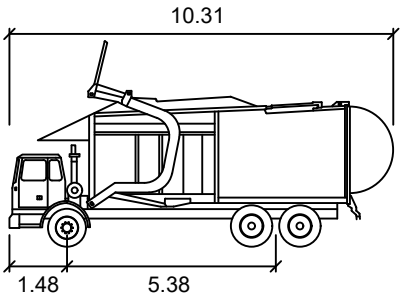
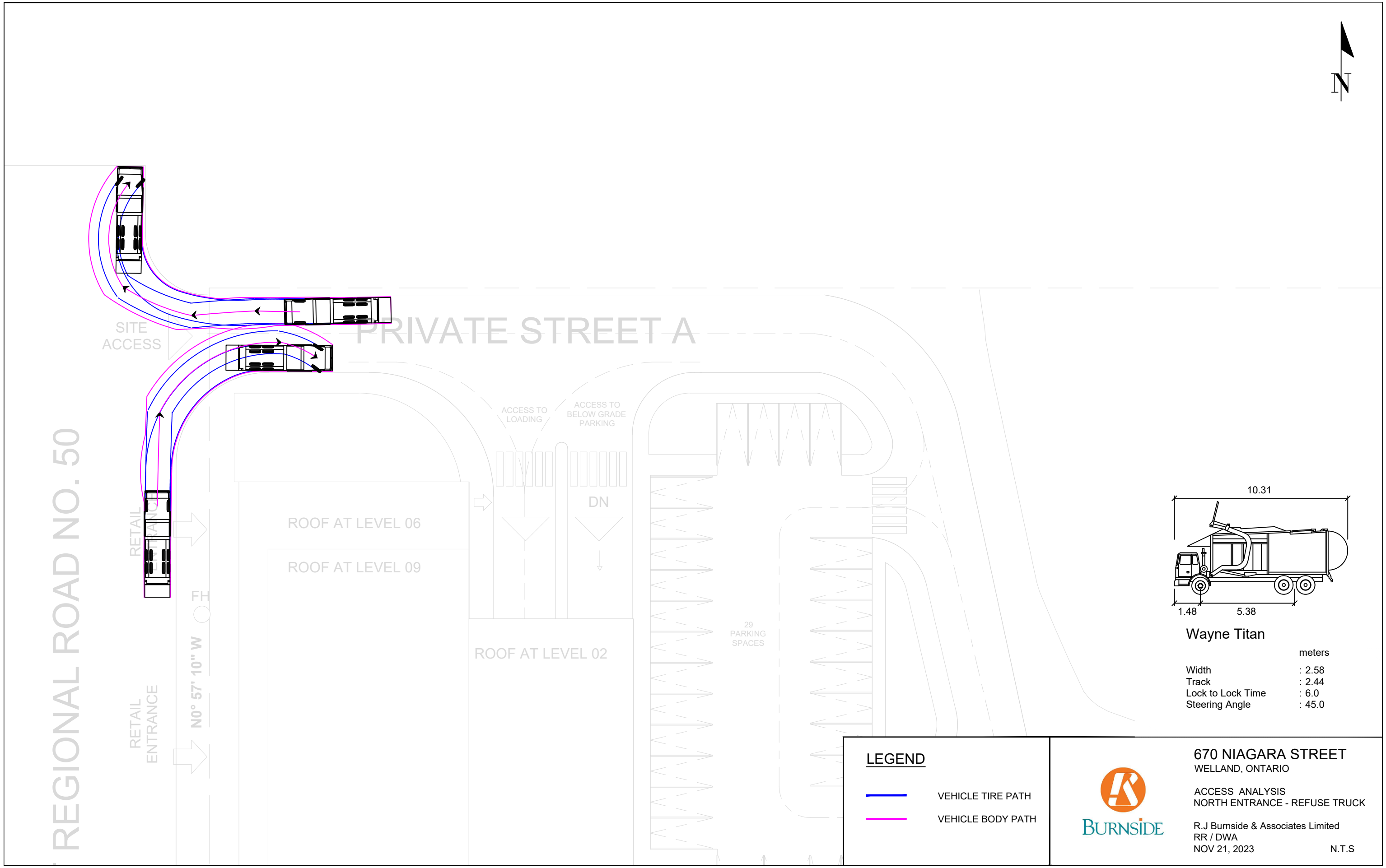


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Appendix J

AutoTurn Analysis



Wayne Titan	
	meters
Width	: 2.58
Track	: 2.44
Lock to Lock Time	: 6.0
Steering Angle	: 45.0

LEGEND

- VEHICLE TIRE PATH
- VEHICLE BODY PATH

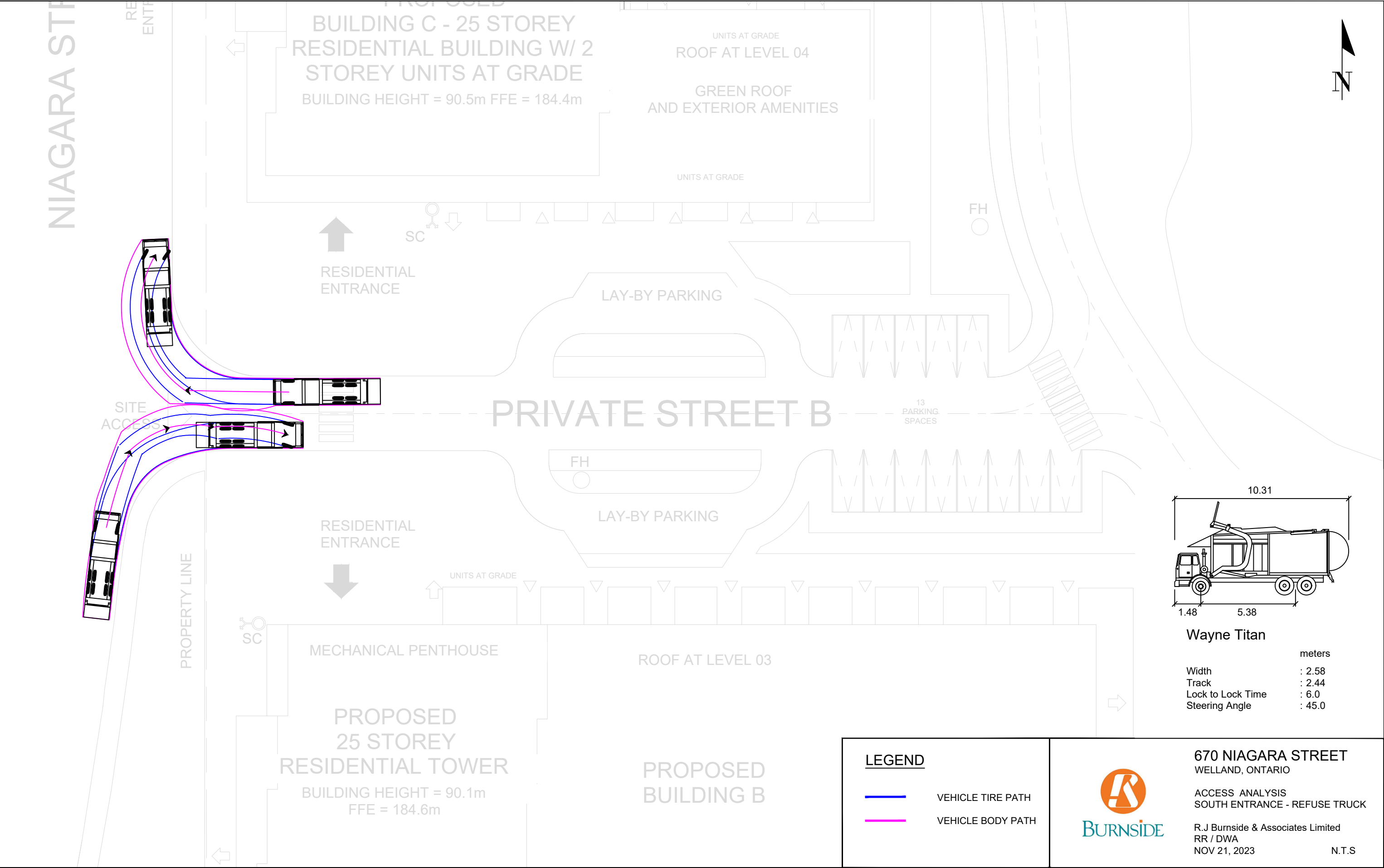


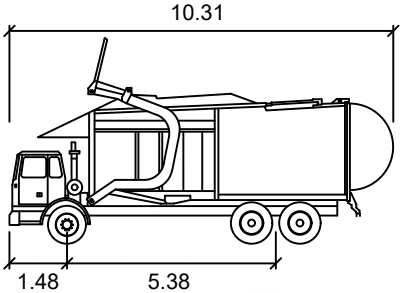
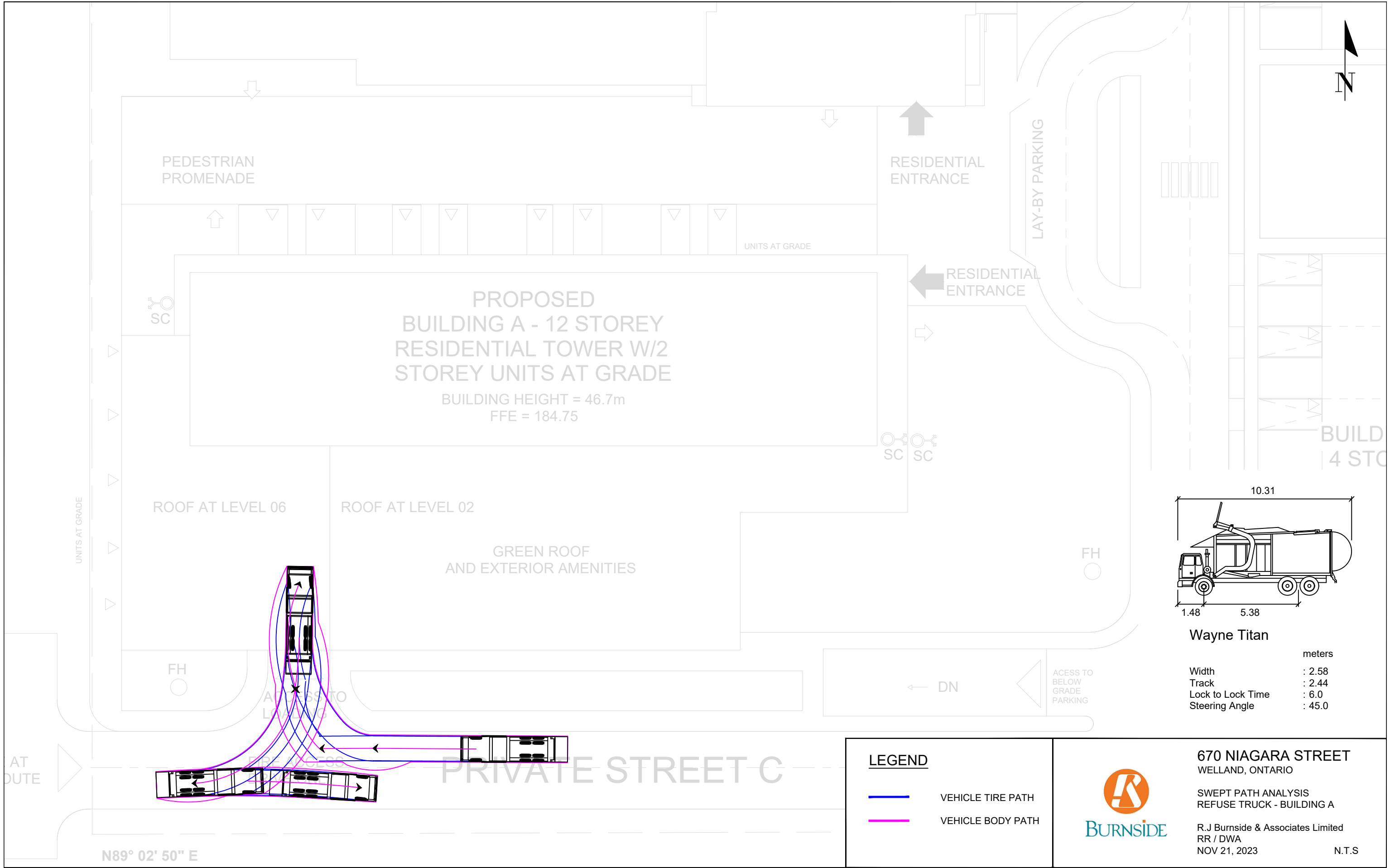
670 NIAGARA STREET
WELLAND, ONTARIO

ACCESS ANALYSIS
NORTH ENTRANCE - REFUSE TRUCK

R.J Burnside & Associates Limited
RR / DWA
NOV 21, 2023

N.T.S





Wayne Titan	
	meters
Width	: 2.58
Track	: 2.44
Lock to Lock Time	: 6.0
Steering Angle	: 45.0

LEGEND

— VEHICLE TIRE PATH

— VEHICLE BODY PATH

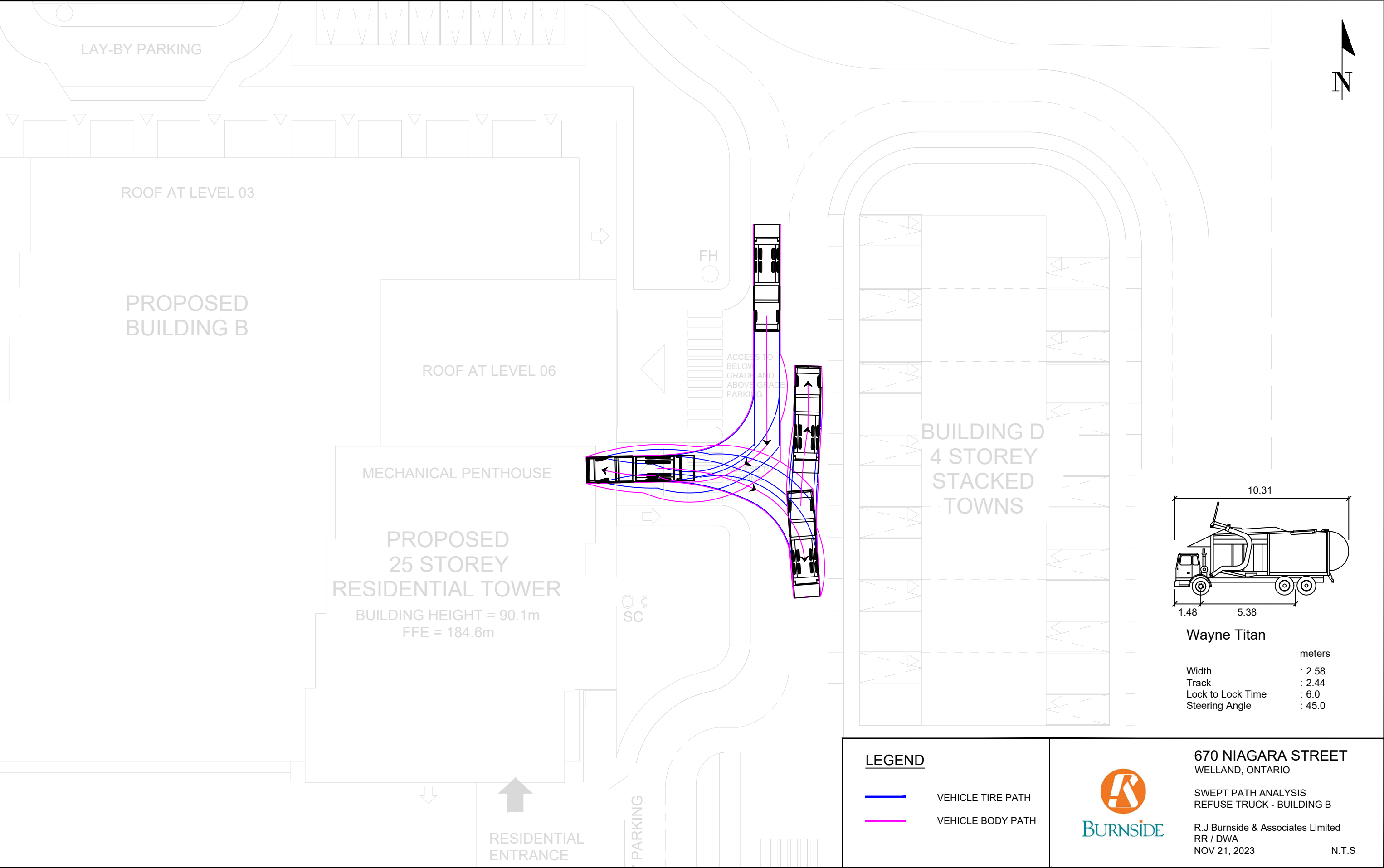


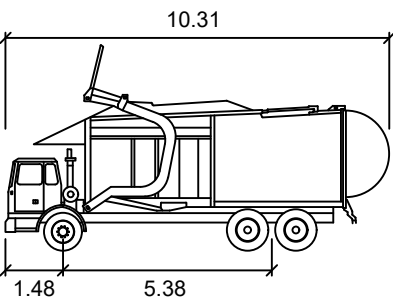
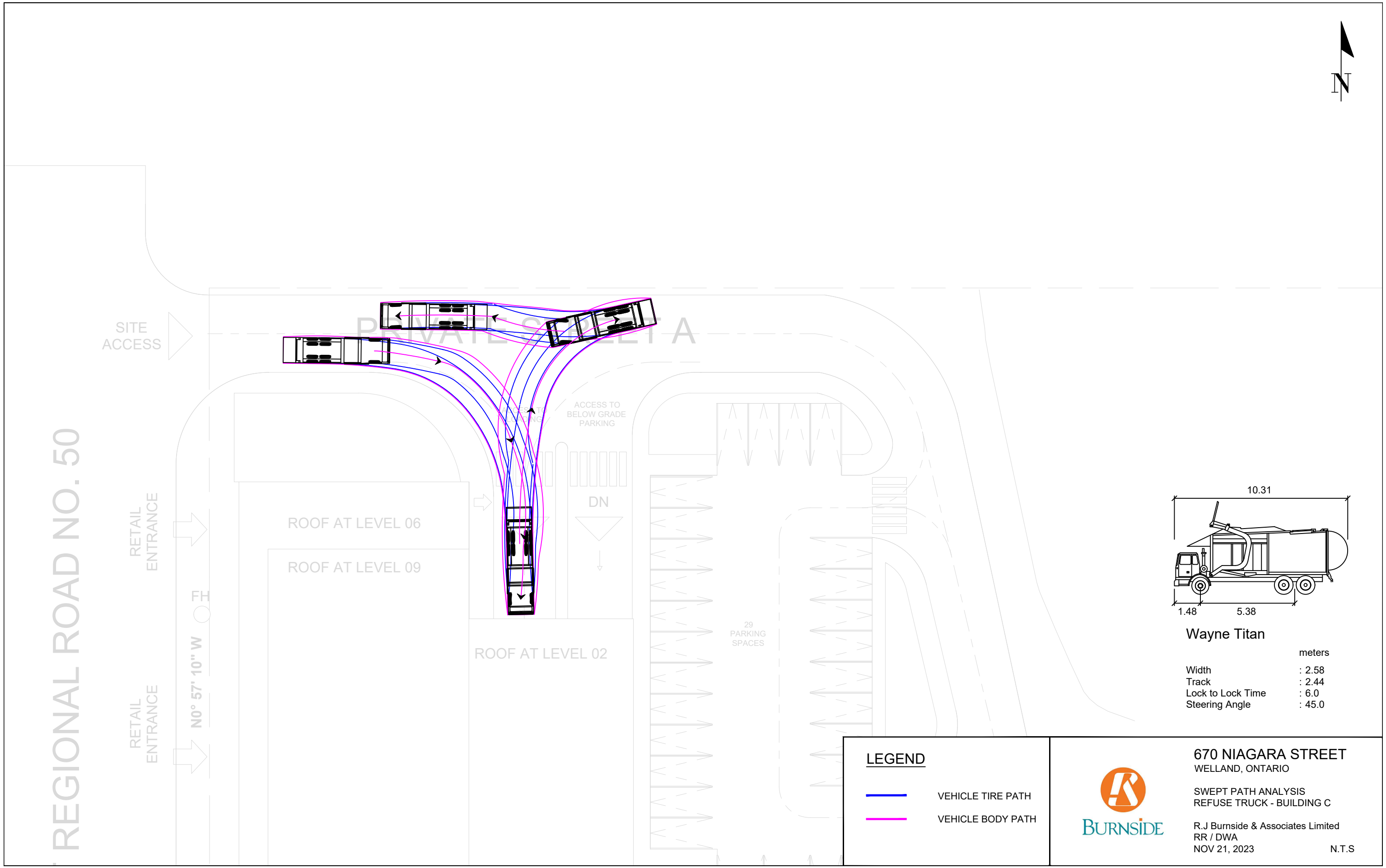
670 NIAGARA STREET
WELLAND, ONTARIO

SWEPT PATH ANALYSIS
REFUSE TRUCK - BUILDING A

R.J Burnside & Associates Limited
RR / DWA
NOV 21, 2023

N.T.S





Wayne Titan	
	meters
Width	: 2.58
Track	: 2.44
Lock to Lock Time	: 6.0
Steering Angle	: 45.0

LEGEND

- VEHICLE TIRE PATH
- VEHICLE BODY PATH

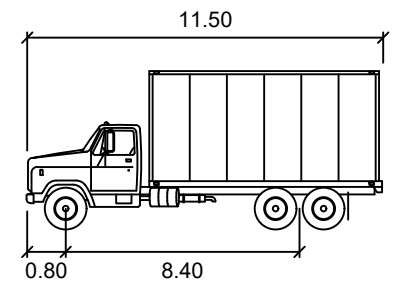
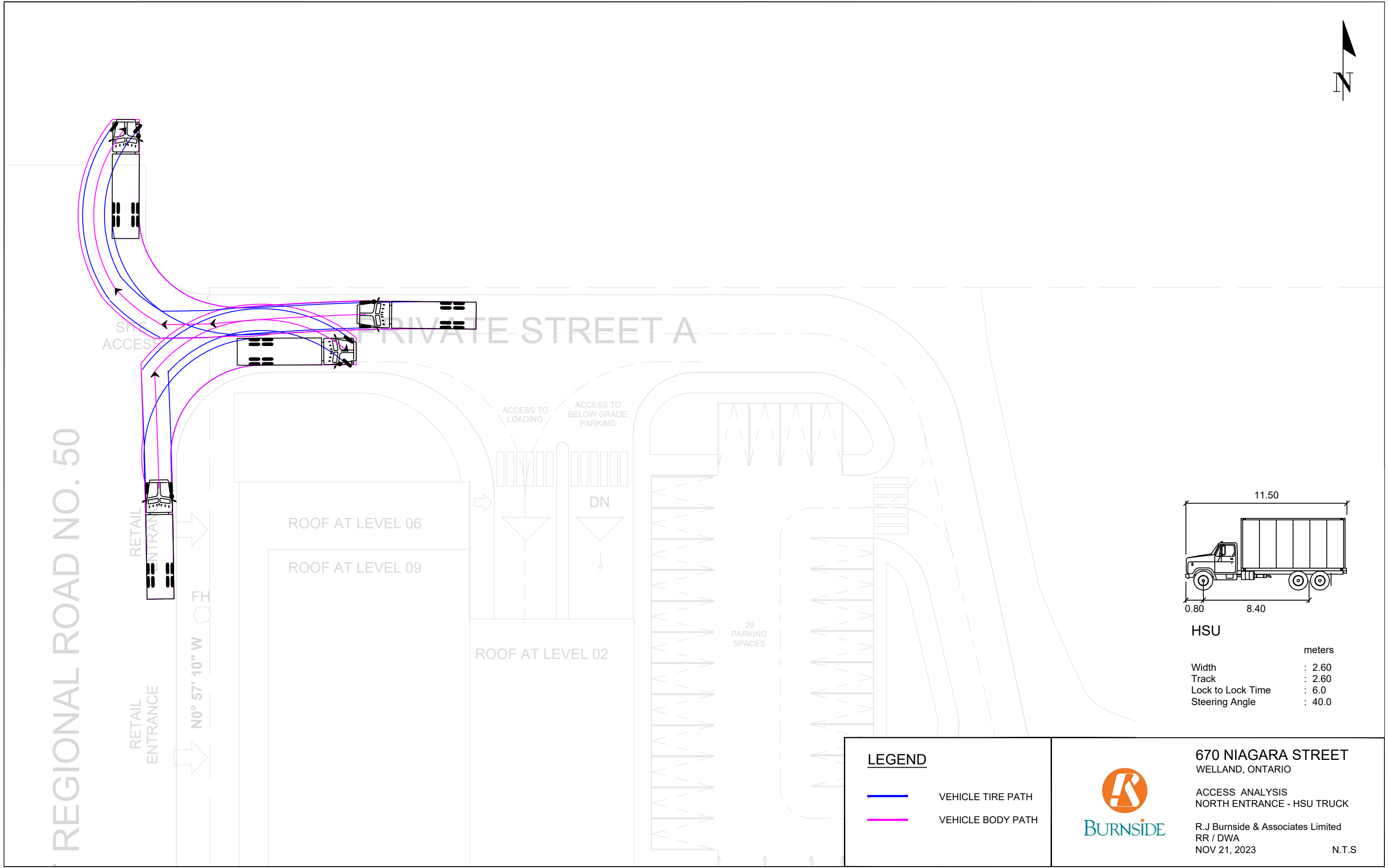


670 NIAGARA STREET
WELLAND, ONTARIO

SWEPT PATH ANALYSIS
REFUSE TRUCK - BUILDING C

R.J Burnside & Associates Limited
RR / DWA
NOV 21, 2023

N.T.S



HSU	
	meters
Width	: 2.60
Track	: 2.60
Lock to Lock Time	: 6.0
Steering Angle	: 40.0

LEGEND	
	VEHICLE TIRE PATH
	VEHICLE BODY PATH

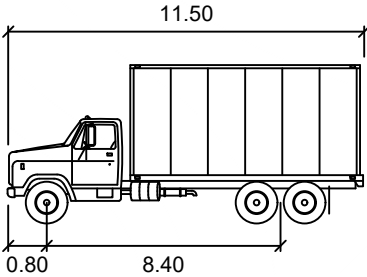
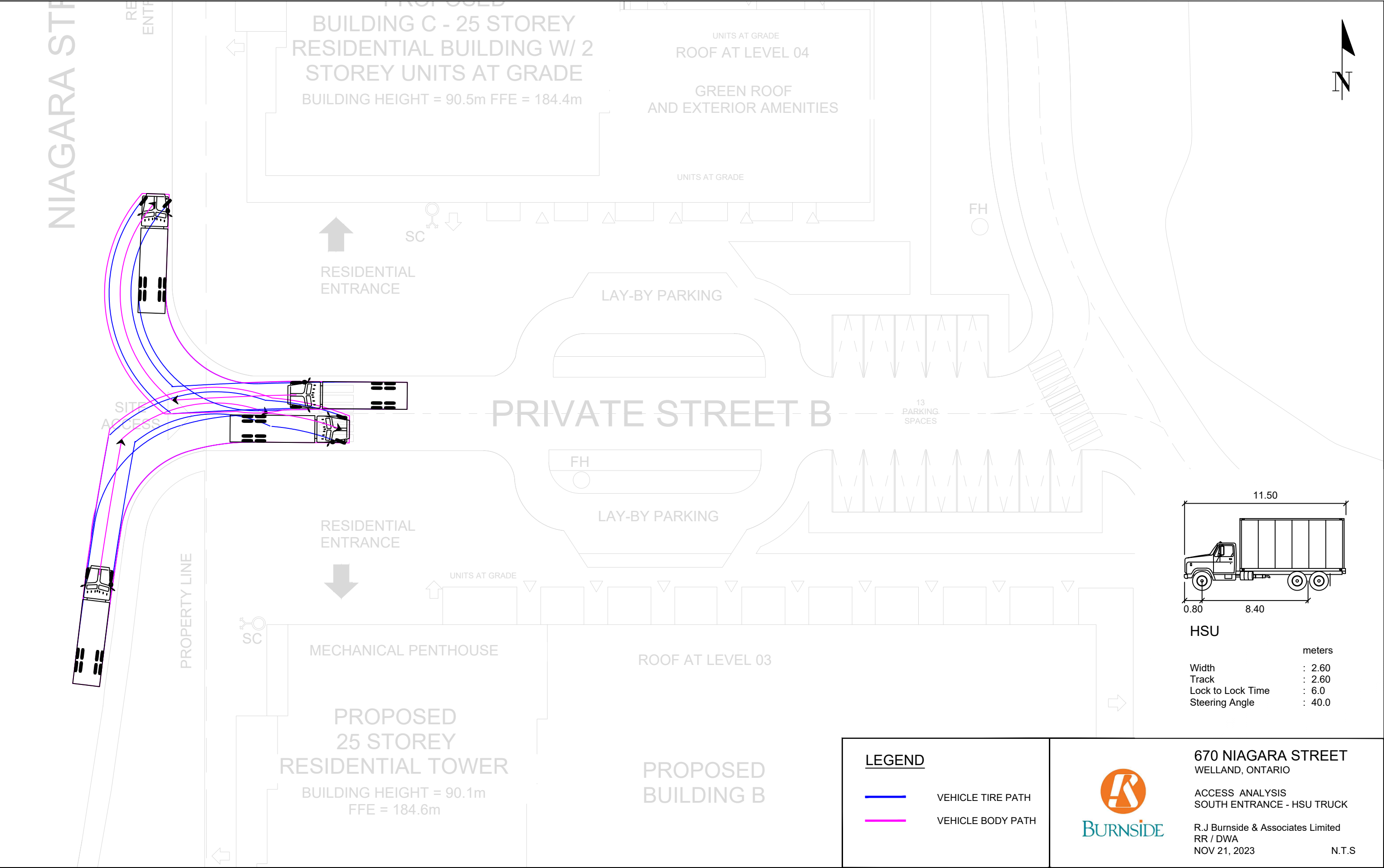


670 NIAGARA STREET
WELLAND, ONTARIO

ACCESS ANALYSIS
NORTH ENTRANCE - HSU TRUCK

R.J Burnside & Associates Limited
RR / DWA
NOV 21, 2023

N.T.S



HSU	
	meters
Width	: 2.60
Track	: 2.60
Lock to Lock Time	: 6.0
Steering Angle	: 40.0

- LEGEND**
- VEHICLE TIRE PATH
 - VEHICLE BODY PATH

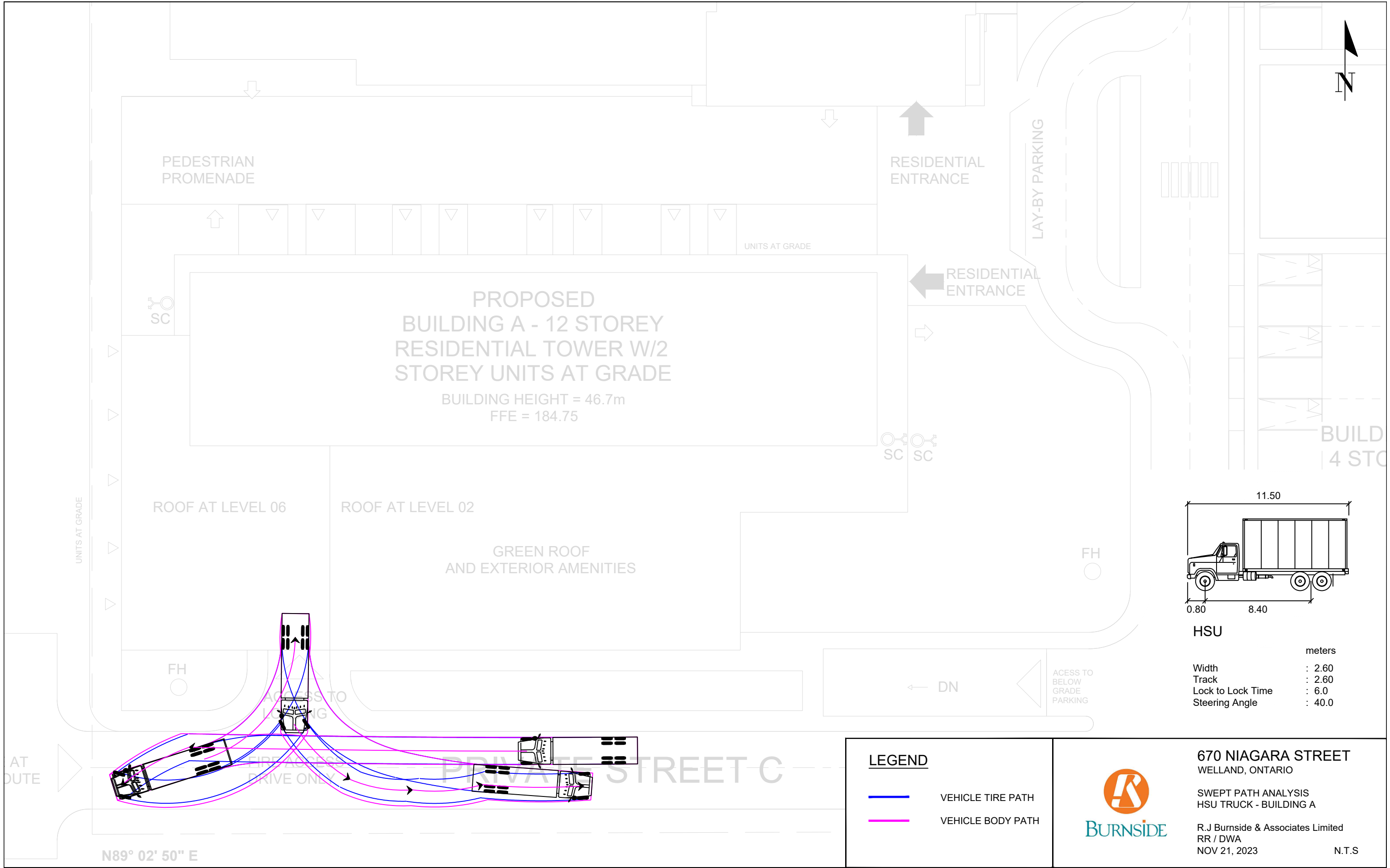


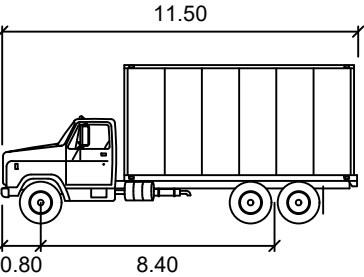
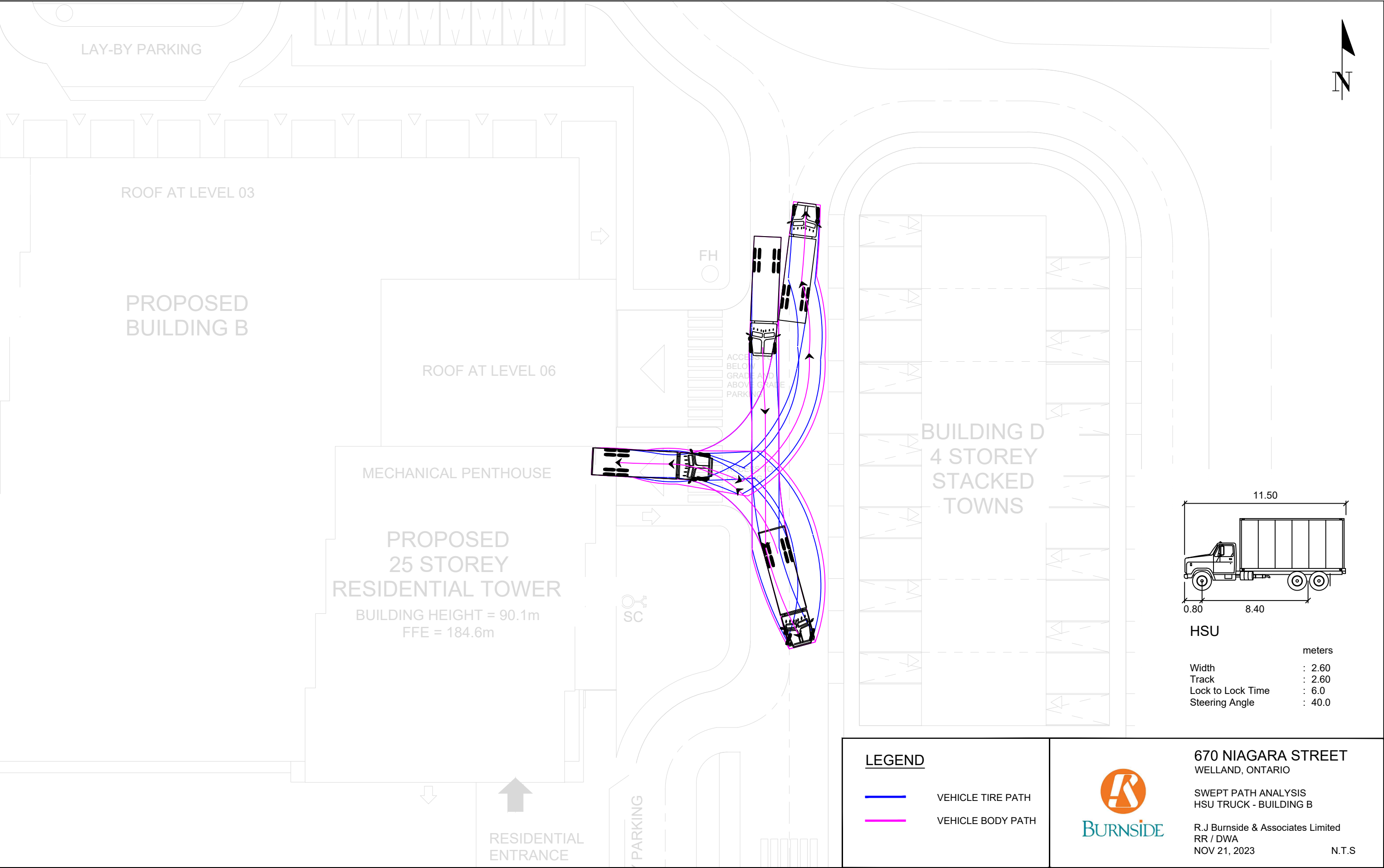
670 NIAGARA STREET
WELLAND, ONTARIO

ACCESS ANALYSIS
SOUTH ENTRANCE - HSU TRUCK

R.J Burnside & Associates Limited
RR / DWA
NOV 21, 2023

N.T.S





HSU	
	meters
Width	: 2.60
Track	: 2.60
Lock to Lock Time	: 6.0
Steering Angle	: 40.0

LEGEND

- VEHICLE TIRE PATH
- VEHICLE BODY PATH

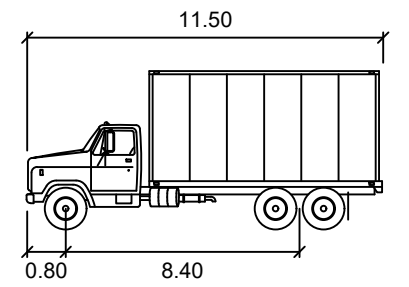
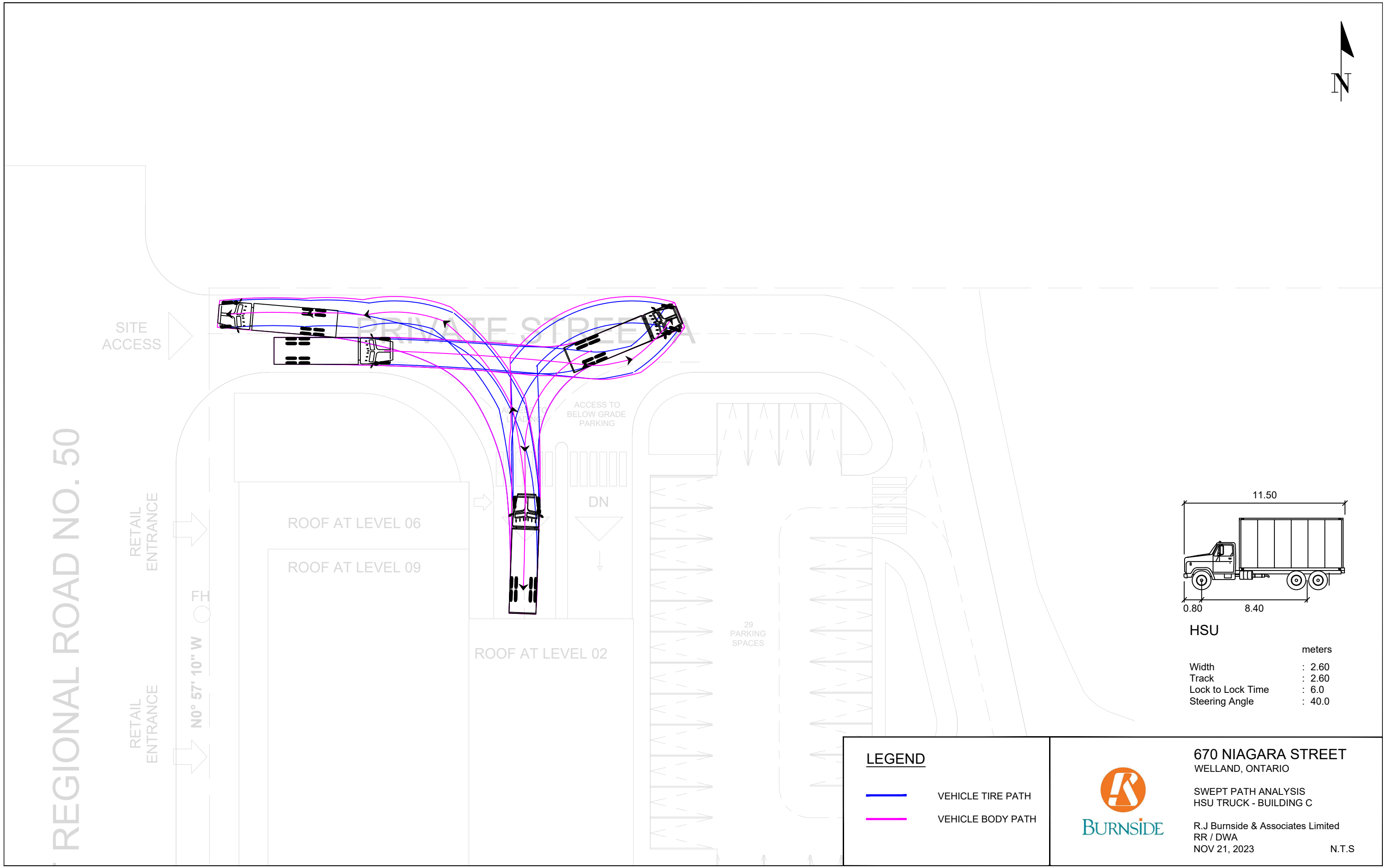


670 NIAGARA STREET
WELLAND, ONTARIO

SWEPT PATH ANALYSIS
HSU TRUCK - BUILDING B

R.J Burnside & Associates Limited
RR / DWA
NOV 21, 2023

N.T.S



HSU	
	meters
Width	: 2.60
Track	: 2.60
Lock to Lock Time	: 6.0
Steering Angle	: 40.0

LEGEND	
	VEHICLE TIRE PATH
	VEHICLE BODY PATH

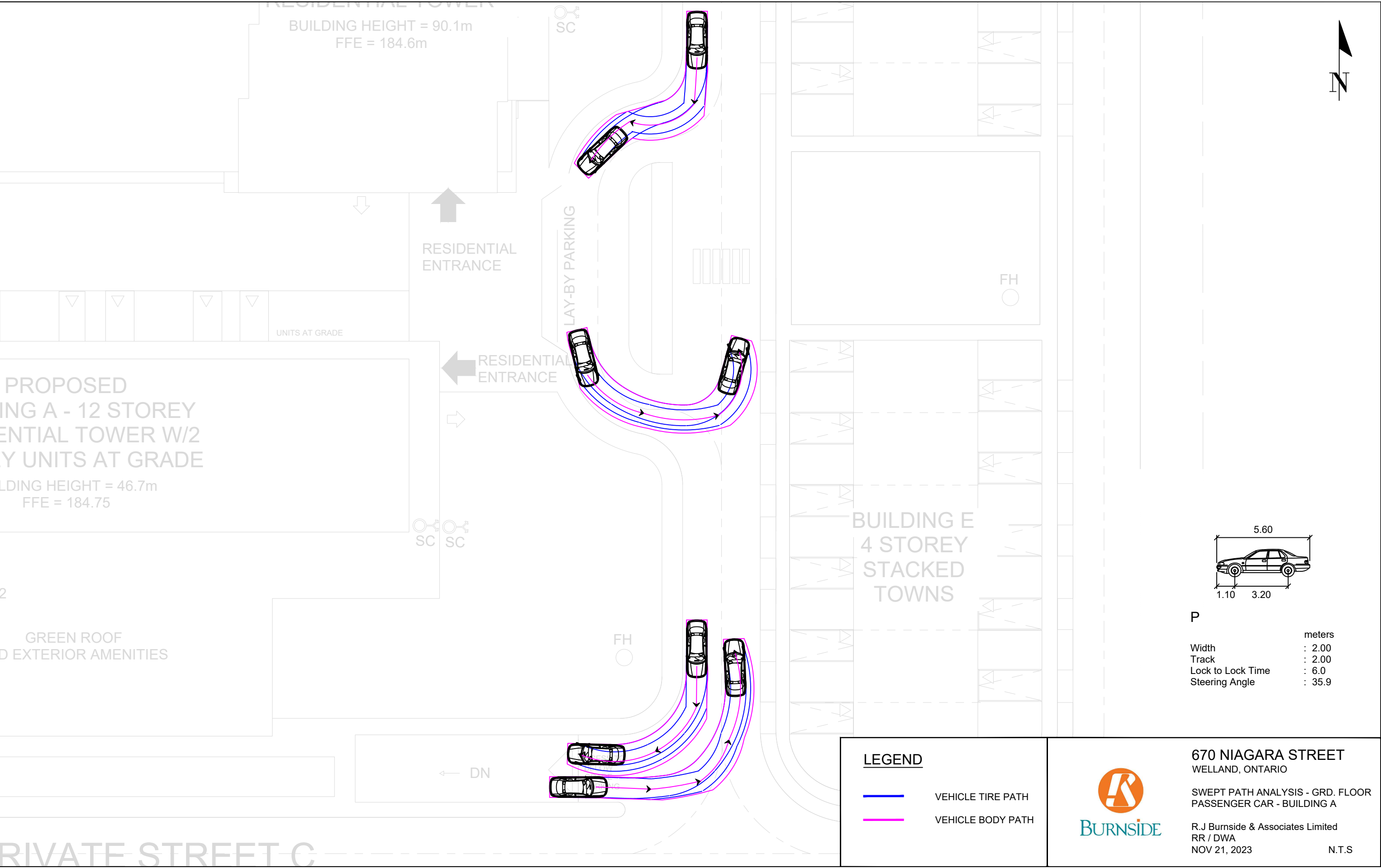


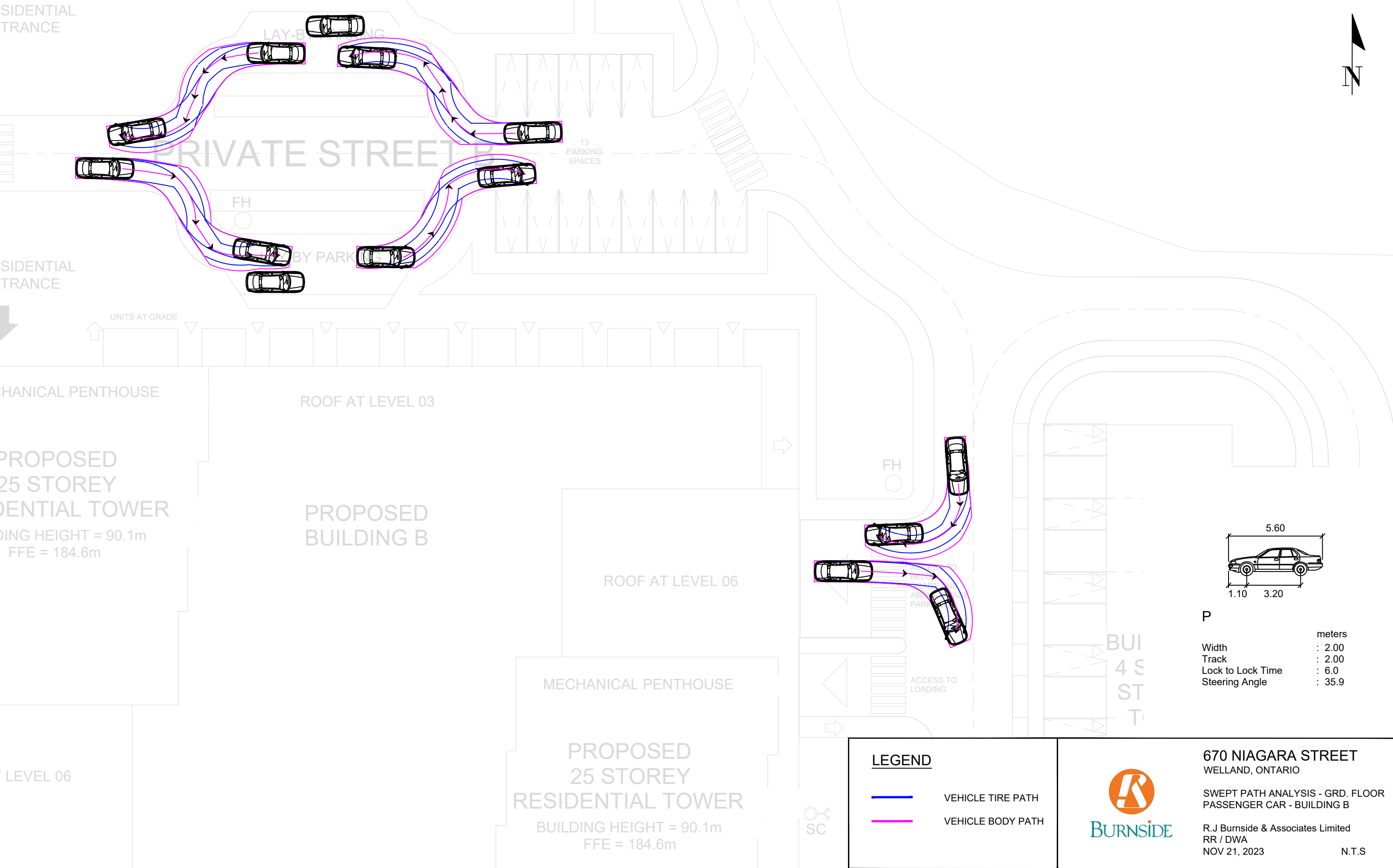
670 NIAGARA STREET
WELLAND, ONTARIO

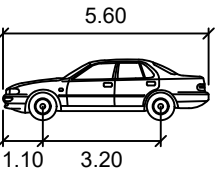
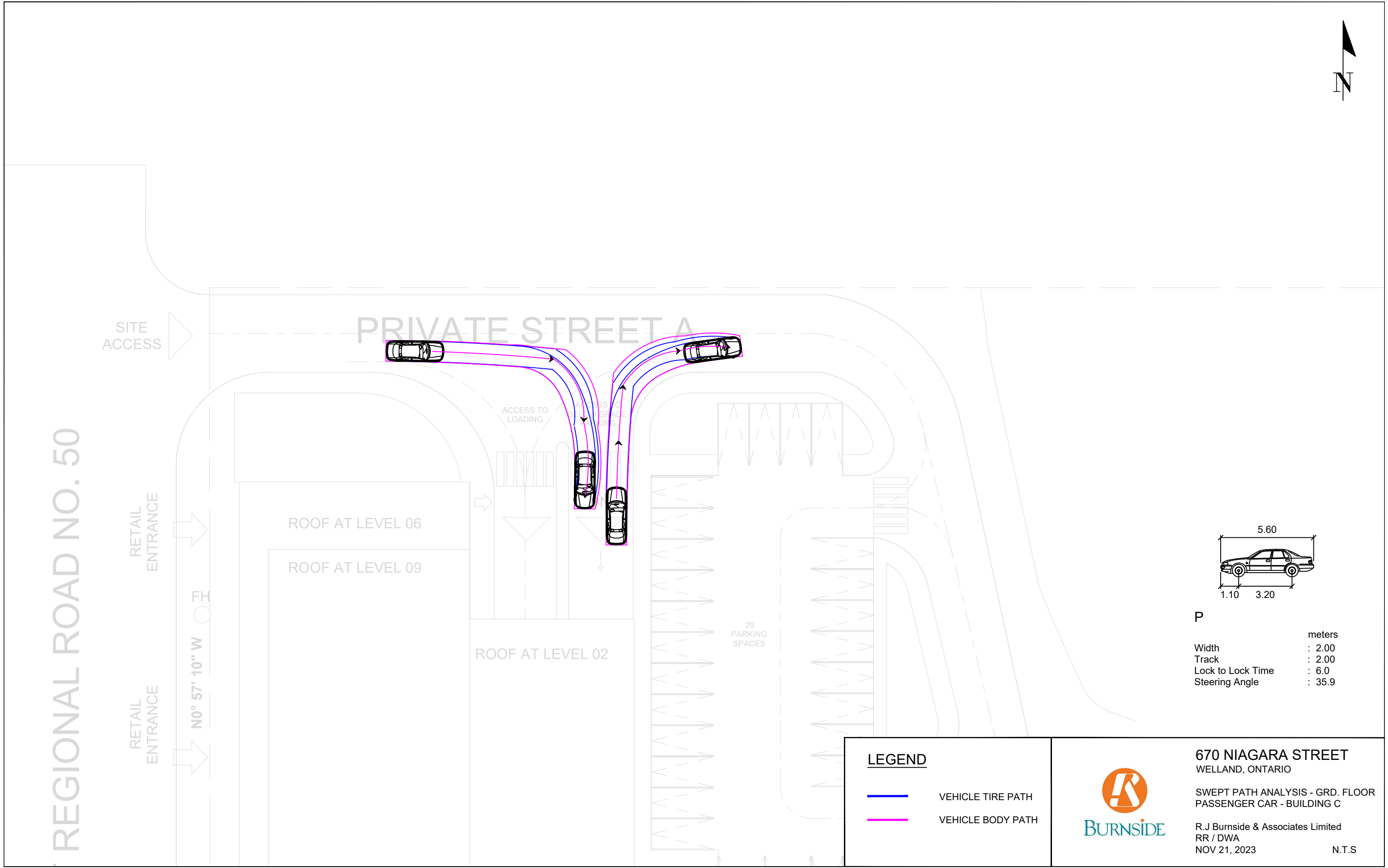
SWEPT PATH ANALYSIS
HSU TRUCK - BUILDING C

R.J Burnside & Associates Limited
RR / DWA
NOV 21, 2023

N.T.S







P	
	meters
Width	: 2.00
Track	: 2.00
Lock to Lock Time	: 6.0
Steering Angle	: 35.9

LEGEND

- VEHICLE TIRE PATH
- VEHICLE BODY PATH

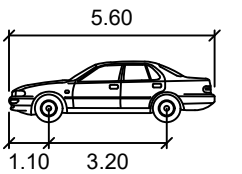
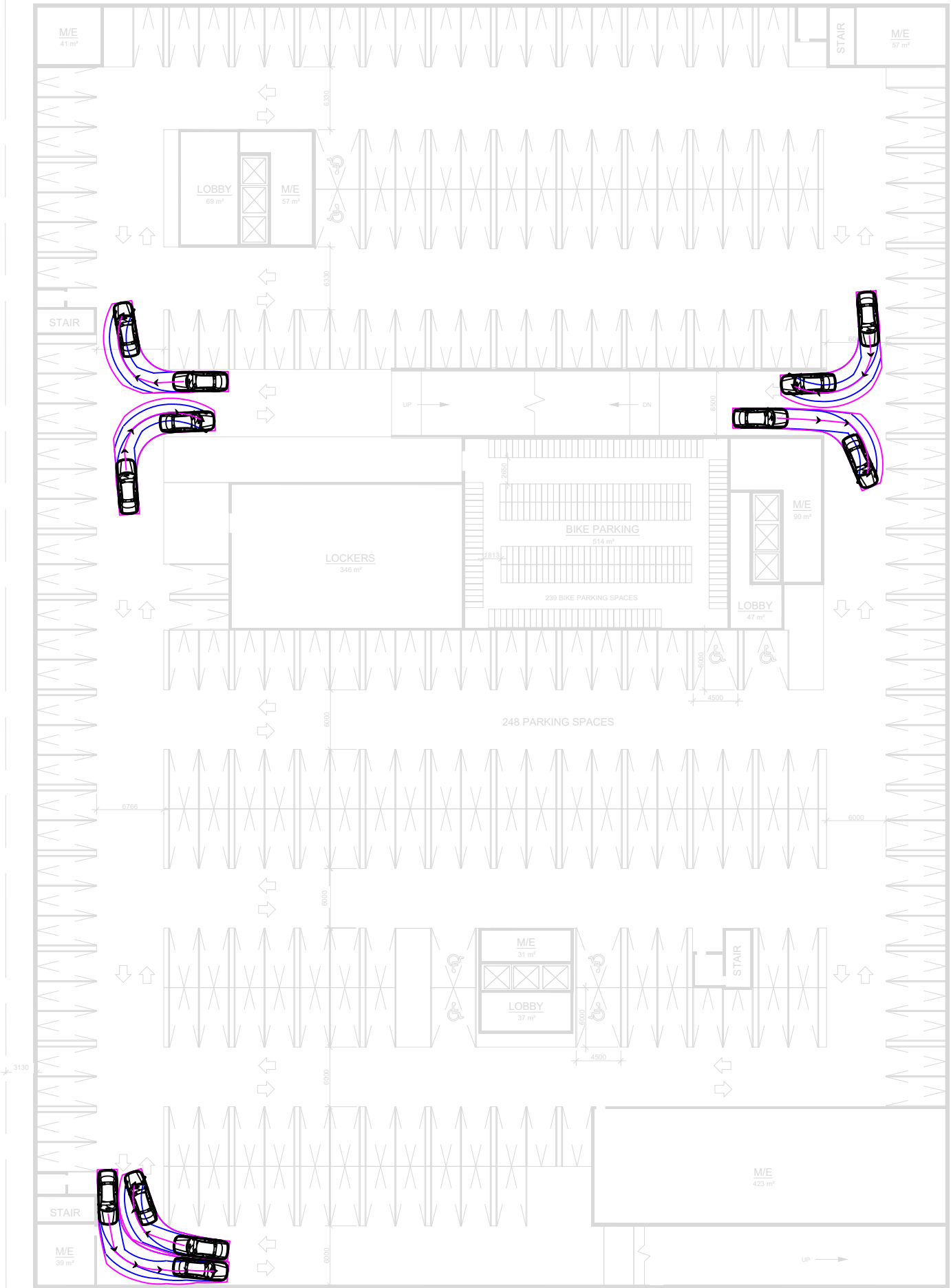


670 NIAGARA STREET
WELLAND, ONTARIO

SWEPT PATH ANALYSIS - GRD. FLOOR
PASSENGER CAR - BUILDING C

R.J Burnside & Associates Limited
RR / DWA
NOV 21, 2023

N.T.S



P

	parameters	values
Width	: 2.00	5.60
Track	: 2.00	1.10
Lock to Lock Time	: 6.0	3.20
Steering Angle	: 35.9	

LEGEND

- VEHICLE TIRE PATH
- VEHICLE BODY PATH

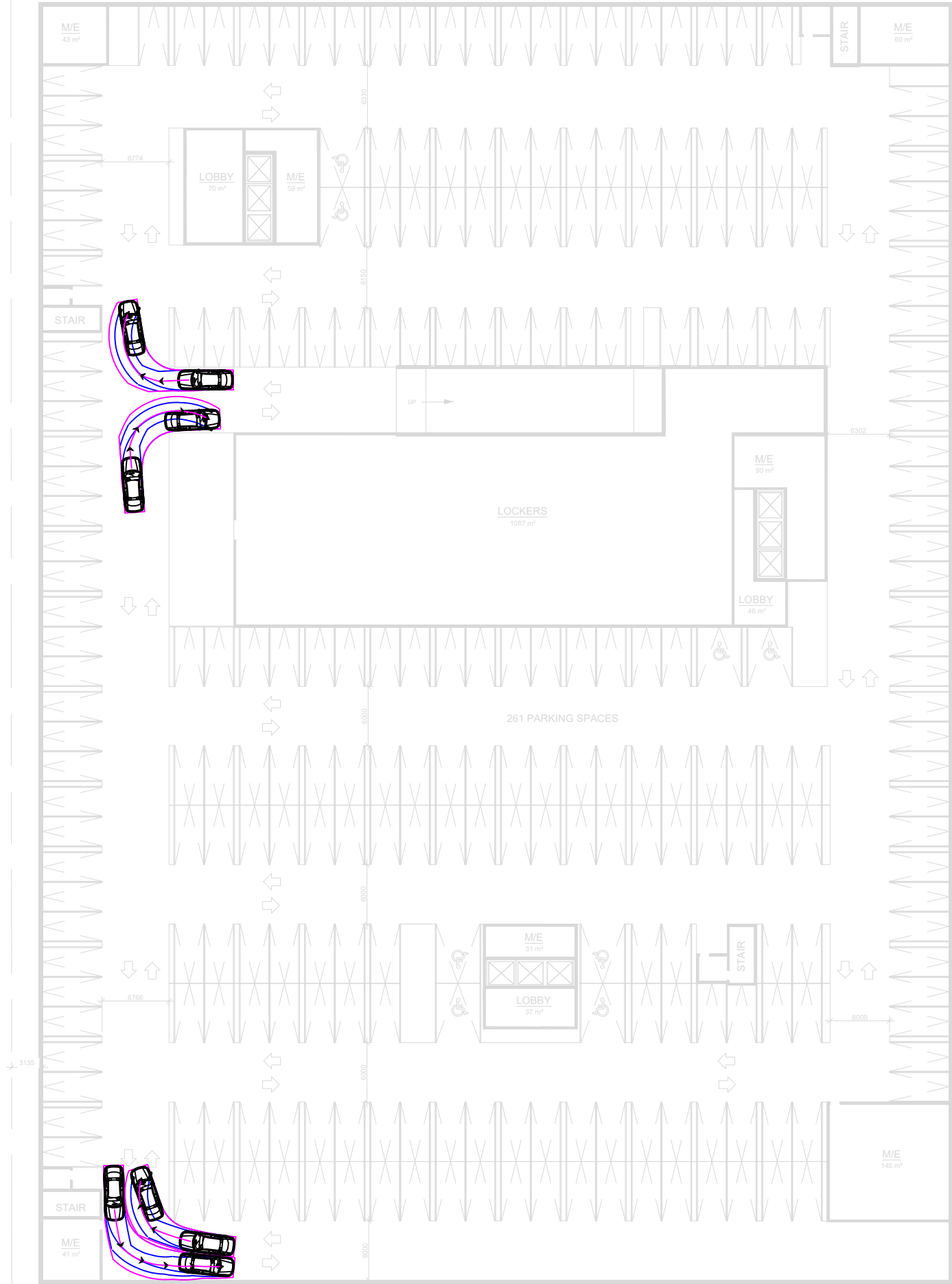


670 NIAGARA STREET
WELLAND, ONTARIO

SWEPT PATH ANALYSIS - LEVEL P1
PASSENGER CAR - BUILDING A&B

R.J Burnside & Associates Limited
RR / DWA
NOV 21, 2023

N.T.S



LEGEND

- VEHICLE TIRE PATH
- VEHICLE BODY PATH

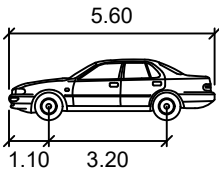


670 NIAGARA STREET
WELLAND, ONTARIO

SWEPT PATH ANALYSIS - LEVEL P2
PASSENGER CAR - BUILDING A&B

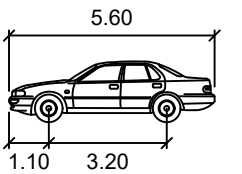
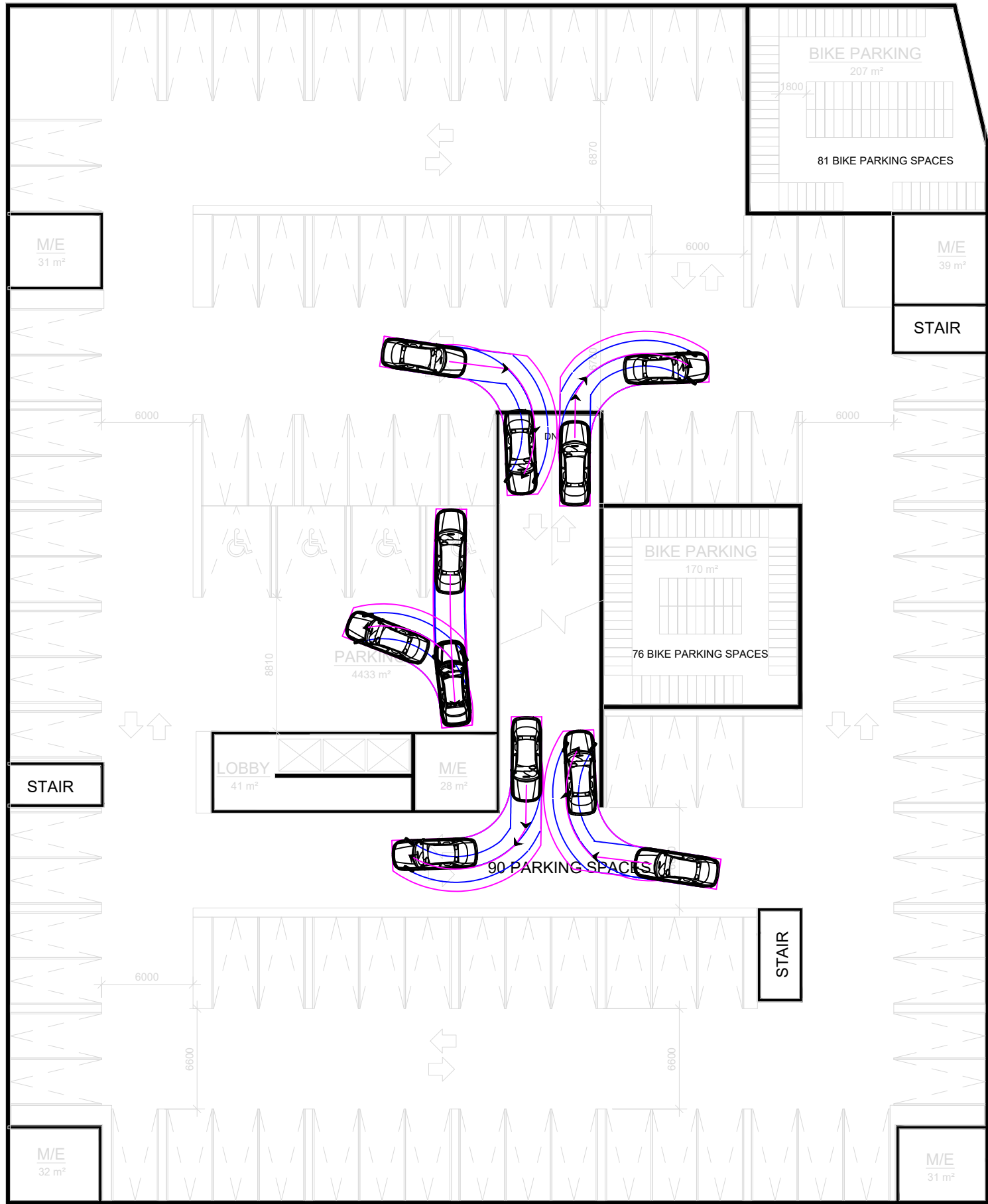
R.J Burnside & Associates Limited
RR / DWA
NOV 21, 2023

N.T.S



P

	metres
Width	: 2.00
Track	: 2.00
Lock to Lock Time	: 6.0
Steering Angle	: 35.9



P

	parameters	values
Width	2.00	2.00
Track	2.00	2.00
Lock to Lock Time	6.0	6.0
Steering Angle	35.9	35.9

- LEGEND**
- VEHICLE TIRE PATH
 - VEHICLE BODY PATH

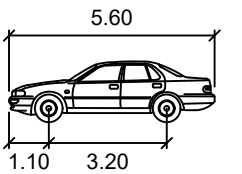
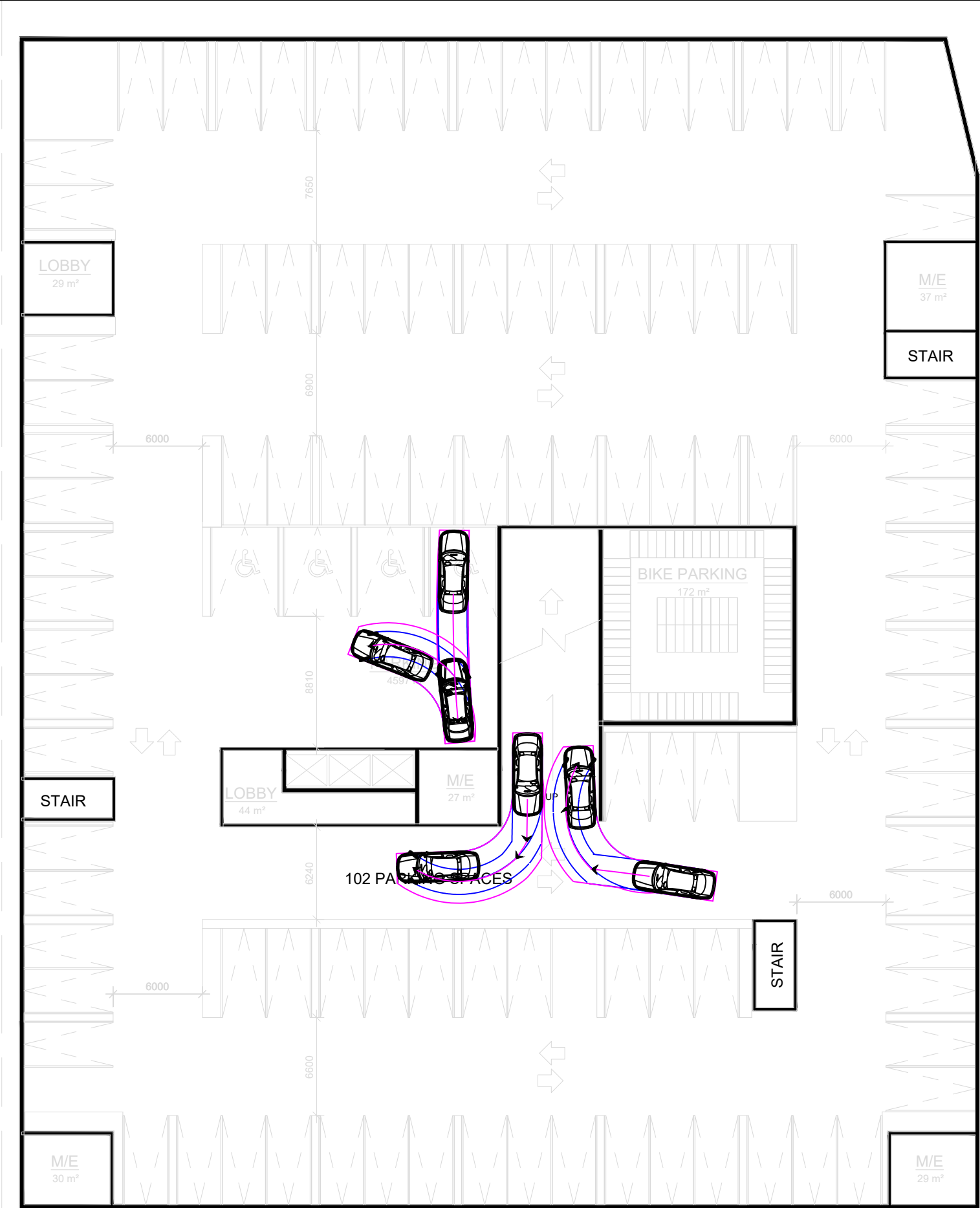


670 NIAGARA STREET
WELLAND, ONTARIO

SWEPT PATH ANALYSIS - LEVEL P1
PASSENGER CAR - BUILDING C

R.J Burnside & Associates Limited
RR / DWA
NOV 21, 2023

N.T.S



P	
Width	5.60
Track	1.10
Lock to Lock Time	3.20
Steering Angle	

LEGEND

- VEHICLE TIRE PATH
- VEHICLE BODY PATH

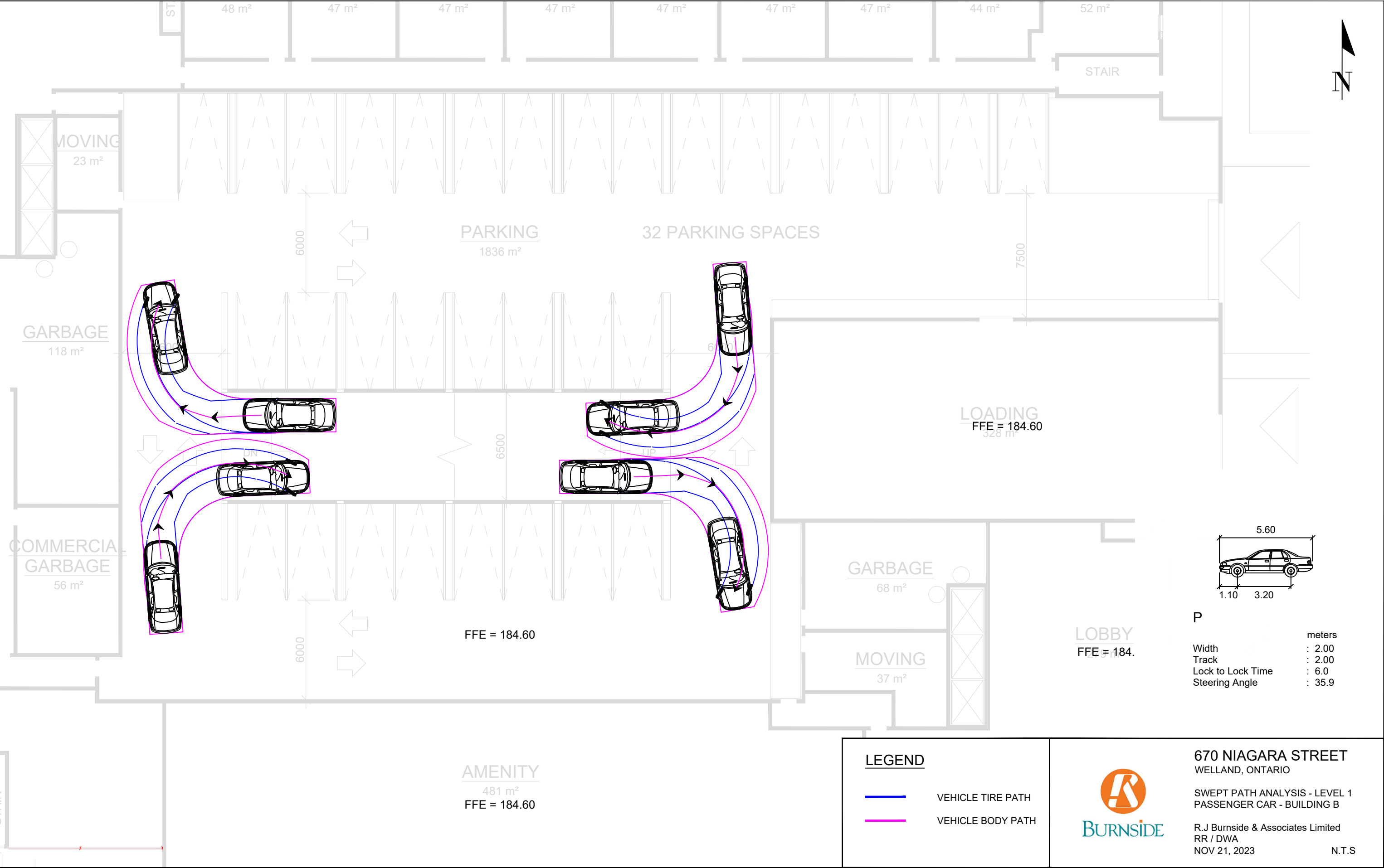


670 NIAGARA STREET
WELLAND, ONTARIO

SWEPT PATH ANALYSIS - LEVEL P2
PASSENGER CAR - BUILDING C

R.J Burnside & Associates Limited
RR / DWA
NOV 21, 2023

N.T.S



LEGEND

- VEHICLE TIRE PATH
- VEHICLE BODY PATH

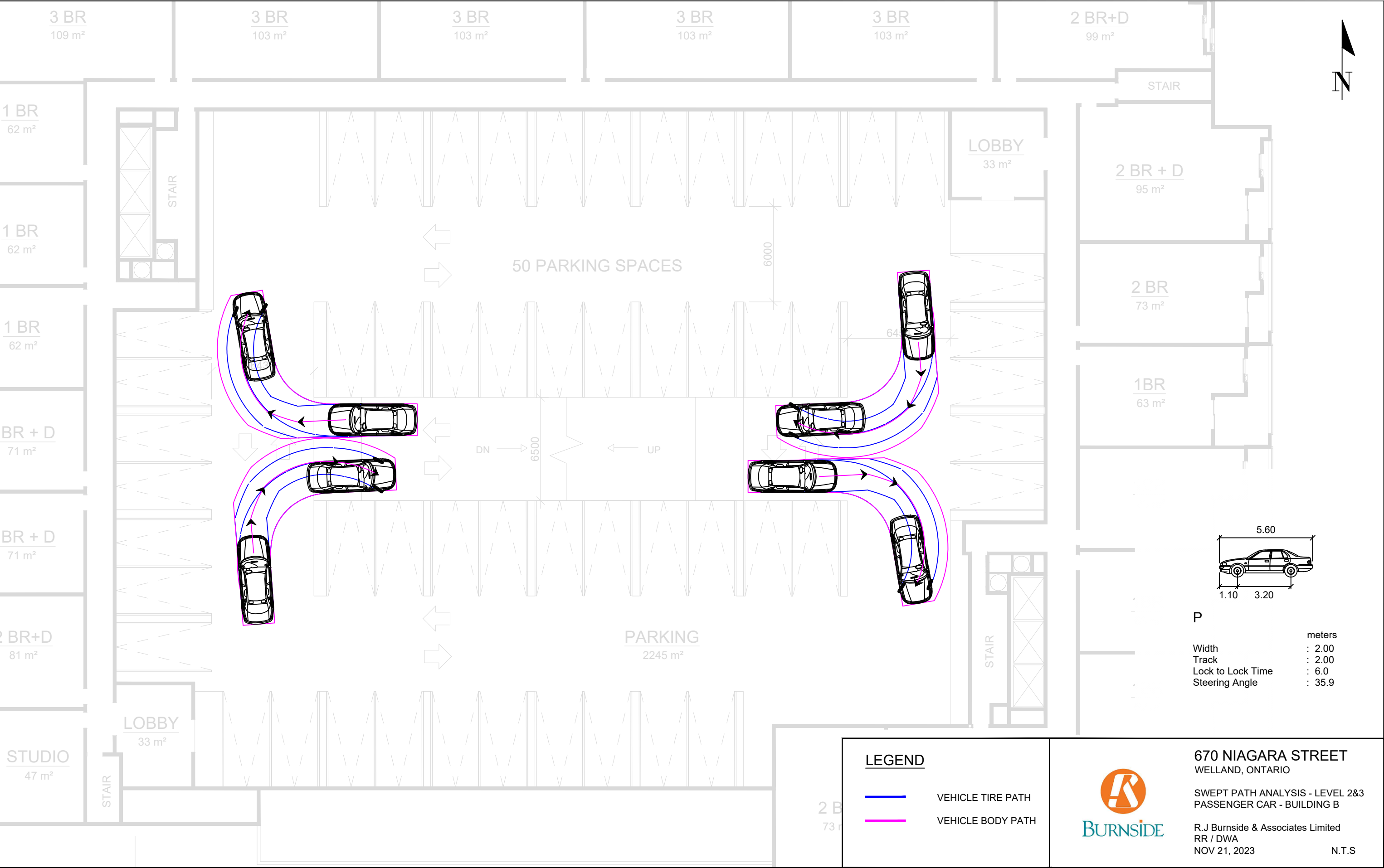


670 NIAGARA STREET
WELLAND, ONTARIO

SWEPT PATH ANALYSIS - LEVEL 1
PASSENGER CAR - BUILDING B

R.J Burnside & Associates Limited
RR / DWA
NOV 21, 2023

N.T.S





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Appendix K

Sightline Analysis



670 NIAGARA STREET
WELLAND, ONTARIO

DRIVEWAY SIGHTLINE ANALYSIS

R.J Burnside & Associates Limited
RR / DWA

SEPTEMBER 5, 2024

N.T.S

