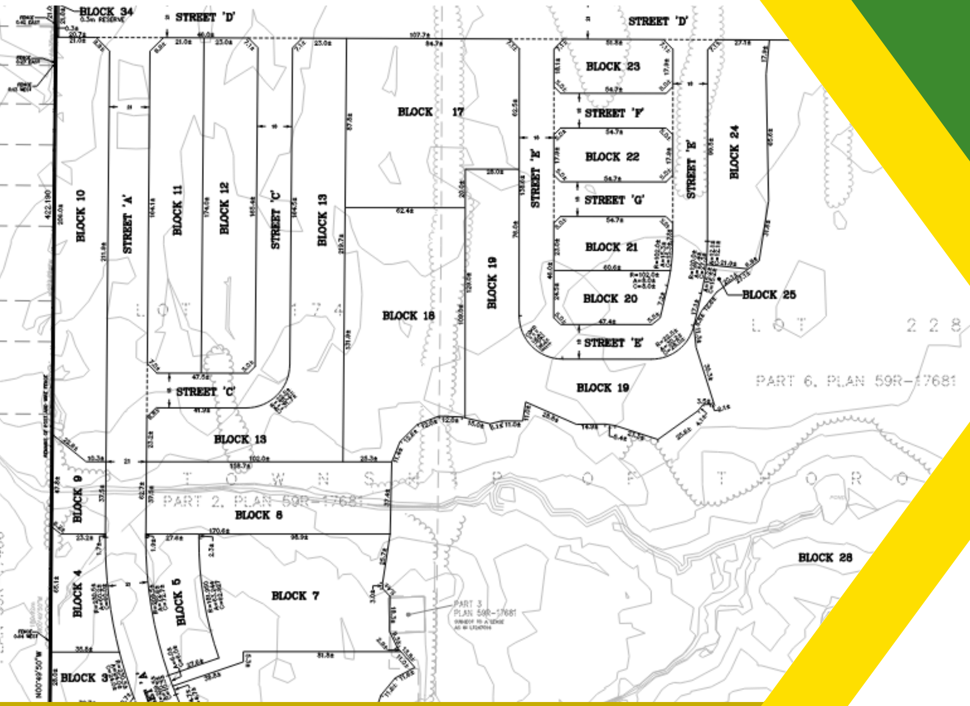
Primont (Thorold/Welland) Inc.

436 Quaker Road



Transportation Impact Study

Primont (Thorold/Welland) Inc.

436 Quaker Road, Welland

Transportation Impact Study

Prepared for:

Primont (Thorold/Welland) Inc. Homes
9130 Leslie Street, Suite 301
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Prepared by:

CGH TRANSPORTATION

628 Haines Road
Newmarket, ON L3Y 6V5

July 2024

PN: 2022-04

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Executive Summary

CGH Transportation has been retained by Primont (Thorold/Welland) Inc. to prepare a Transportation Impact Study to support the proposed residential development at 436 Quaker Road in the City of Welland. This Transportation Impact Study has been prepared to support the Draft Plan of Subdivision application. The study will include a review of existing and planned conditions, a travel demand forecast, an operational analysis, and a transportation demand management plan. As a Northwest Welland Secondary Plan Transportation Assessment report released recently has already provided a high-level review of the major intersections in the transportation network within the Northwest Welland Secondary Plan area, the focus of the operations analysis of this report will be on the site accesses. Through the Terms of Reference, the scope has been confirmed with the City.

Proposed Development:

The Primont (Thorold/Welland) Inc. Lands, consisting of 8.345 hectares of net land area, are located along the northern edge of Welland, bounded by Rice Road on the west side, First Avenue on the east side, Quaker Road on the south side, and the City of Welland boundary on the north side.

The proposed development will include 289 single-detached or townhouse dwelling units, and approximately 422 apartment units. Access to the proposed development in this application can be facilitated via the direct access on Quaker Road, the direct access on First Avenue / Cataract Road, and the connections to the adjacent development to the west.

The site statistics have been taken from preliminary block plans and will be refined through future Zoning By-law and Site Plan Approval stages during which the unit counts for each residential type may change. The proposed development is anticipated to be fully built out by 2026.

Analysis Process & Key Findings:

The study includes traffic operational analysis at the Study Area intersections for the baseline horizon of 2024, and the buildout horizon of 2026.

All Study Area intersections have not been constructed in the 2024 existing conditions, the traffic operations as at the adjacent major intersections of Rice Road and Quaker Road, and First Avenue and Quaker Road both operate with constraints during the PM peak hour, due to the high projected volumes and the current all-way stop configuration. Signals are warranted at these two intersections and all constraints will be mitigated under the signalized configuration.

The planned network improvements and recommendations from the Northwest Welland Secondary Plan Transportation Assessment report have been incorporated into the traffic analysis for 2026.

The proposed development is anticipated to generate a total of 328 AM and 431 PM two-way vehicle trips by 2026, including 214 AM and 296 PM two-way vehicle trips for the low-density housing and 114 AM and 135 PM two-way vehicle trips for the medium-density housing. The subject development's impact on the operations of Study Area intersections is relatively low, relative to the impact of the background traffic.

The initial assumption for the Quaker Road at Street A and First Avenue at Street D intersections are unsignalized with stop controls at the minor approaches. However, operational constraints are projected for the minor approaches at the Quaker Road at Street A and the First Avenue at Street D intersections. Signalization is not warranted but are required at these intersections as demonstrated in the Synchro analysis results.

The intersection of Street A and Street D is projected to operate without operational constraints. The delays and queues will be minimal under the 2026 future background and total conditions, with a significant amount of residual capacity to accommodate any potential change in travel patterns.

A preliminary transportation demand management plan including transit and active modes measures have been recommended in order to reduce reliance on single occupant vehicle trips. TDM measures will be further explored at the Site Approval stage once the site statistics and concept plan are refined. Potential cut-through traffic using the residential collector roads will be controlled with signage and traffic calming measures in the later stages of development application to restrict heavy vehicles to use only the arterial roads.

Given that the impact of the proposed development on the surrounding Study Area road network is relatively minor, compared to the other developments in the area, and can be mitigated by network and signal improvement, the proposed development application is recommended to proceed from a transportation perspective.

1 Introduction

This Transportation Impact Study (TIS) has been prepared to support the Draft Plan of Subdivision application for Primont (Thorold/Welland) Inc.'s 436 Quaker Road, Welland, Ontario. The property is bounded by Quaker Road to the south, First Avenue to the east, and the Welland-Thorold border to the north. According to the City of Welland Official Plan, the area is currently designated for Low Density Residential and Medium Density Residential land use. The subject site is greenfield.

The proposed development will include approximately 289 single-detached or townhouse dwelling units and approximately 422 medium density dwelling units. Access to the proposed development will be facilitated via direct access points on Quaker Road and First Avenue / Cataract Road. Additionally, there will be future connections to adjacent developments to the west and north.

Figure 1 illustrates the site context. Figure 2 illustrates the conceptual block plan showing the subject Primont (Thorold/Welland) Inc. development.

Figure 1: Site Context

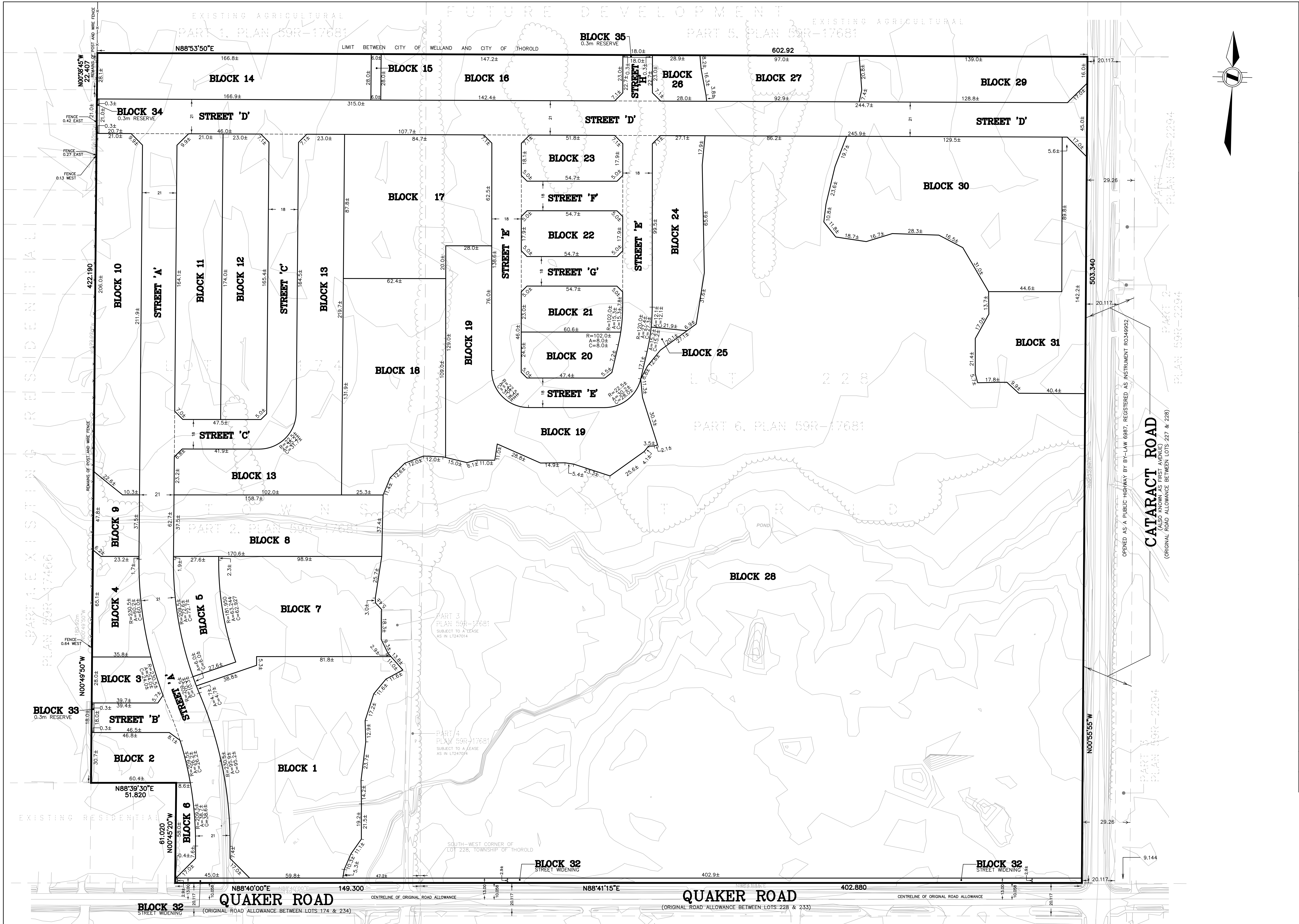


Figure 2: Block Plan

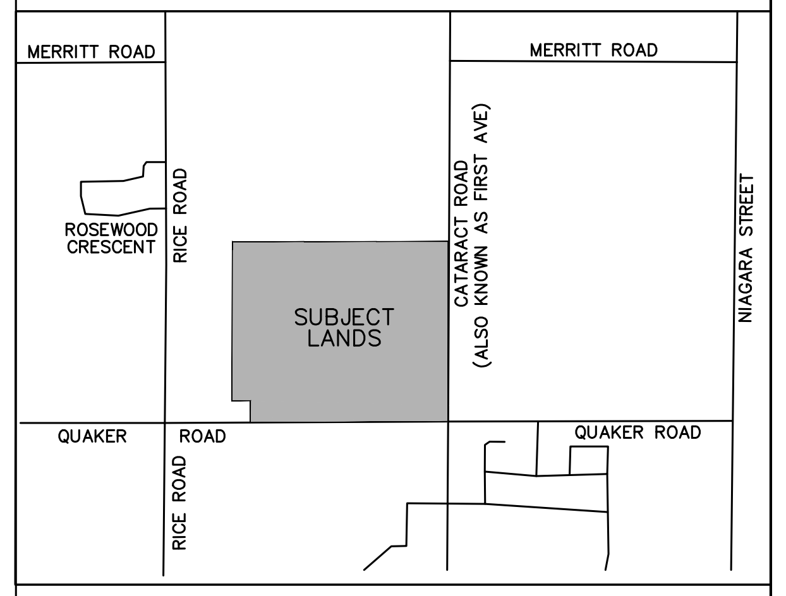
DRAFT PLAN OF SUBDIVISION

PRIMONT
(THOROLD / WELLAND) INC.

PART OF TOWNSHIP LOTS 174 AND 228,
GEOGRAPHIC TOWNSHIP OF THOROLD,
IN THE CITY OF WELLAND, REGIONAL
MUNICIPALITY OF NIAGARA

SCALE 1:1000 METRIC

20 10 0 20 40 60 metres



KEY MAP - NOT TO SCALE

INFORMATION REQUIRED

UNDER SECTION 51 (17) OF THE PLANNING ACT, R.S.O. 1990. c.P.13
AS AMENDED FEBRUARY 21, 2024

(a) - AS SHOWN
(b) - AS SHOWN
(c) - AS SHOWN
(d) - AS LISTED BELOW
(e) - AS SHOWN
(f) - AS SHOWN
(g) - AS SHOWN
(h) - MUNICIPAL WATER
(i) - CLAY LOAM
(j) - AS SHOWN
(k) - MUNICIPAL SANITARY AND STORM SEWERS
(l) - AS SHOWN

SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED ON THIS PLAN AND THEIR RELATIONSHIP TO THE ADJACENT LANDS ARE ACCURATELY AND CORRECTLY SHOWN.

SIGNED ______________________

ROB A. McLAREN, O.L.S
A.T.McLAREN LIMITED

DATE ______________

OWNER'S CERTIFICATE

I HEREBY CONSENT TO THE FILING OF THIS PLAN

SIGNED ______________________

DATE ______________

LAND USE SCHEDULE

LAND USE	LOTS/BLOCKS	UNITS	AREA
LOW DENSITY RESIDENTIAL (FREEHOLD)	BLOCKS 2-5, 10-14, 16, 19, 20-24, 26 & 29	245-275±	6.144± Ha.
LOW DENSITY RESIDENTIAL (CONDOMINIUM)	BLOCK 1	44±	1.167± Ha.
MEDIUM DENSITY RESIDENTIAL	BLOCK 30	422±	1.034± Ha.
PARK LAND	BLOCK 17		0.732± Ha.
OPEN SPACE	BLOCKS 6, 15, 25		0.101± Ha.
STORM WATER MANAGEMENT	BLOCKS 7, 18, & 31		1.882± Ha.
ENVIRONMENTAL AREA	BLOCKS 27 & 28		14.547± Ha.
CHANNEL	BLOCKS 8 & 9		0.592± Ha.
ROADS, RESERVES & WIDENINGS	STREETS A, B, C, D, E, F, G, & H AND BLOCKS 32, 33, 34 & 35		3.937± Ha.
TOTAL		711-741±	30.118± Ha.

METRIC NOTE:

DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

A.T. McLaren Limited
LEGAL AND ENGINEERING SURVEYS
69 JOHN STREET SOUTH, SUITE 230
HAMILTON, ONTARIO, L8N 2B9
PHONE (905) 527-8559 FAX (905) 527-0032

Drawn	Checked	Crew Chief	Scale	
KM	RBM	SM	1:1000	Dwg.No. 36920-DP

2 Study Area

While typically the study area of the Transportation Impact Study (TIS) would be required to include major intersections, such as the Rice Road and Quaker Road intersection and the First Avenue and Quaker Road intersection, it has been determined that a previous study has already sufficiently examined these intersections. The Northwest Welland Secondary Plan Transportation Assessment, completed by Associated Engineering in December 2023, has thoroughly examined transportation conditions in the area covered by the Northwest Welland Secondary Plan (NWWSP study). The NWWSP study area, located in the northwest quadrant of the City of Welland, is bounded to the north by the city's municipal limits, to the west by Line Avenue/Clare Avenue, and to the east by the rear property line of properties fronting onto Regional Road 50 (Niagara Street). This area encompasses our proposed development and considers other developments in the Secondary Plan area anticipated for future construction as well. The 2023 study has already conducted a comprehensive review of traffic operations at the arterial road intersections relevant to our study and provided recommendations regarding intersection configurations.

As conducting a similar study for the same intersections would be redundant, a scope reduction has been proposed to the City. Consequently, while these intersections are included for context in this study, Synchro analysis will not be performed for the Rice Road and Quaker Road intersection or the First Avenue and Quaker Road intersection. The City of Welland’s transportation staff have agreed to the proposed Study Area, which consists of the following intersections:

- Street ‘A’ at Quaker Road (Future)
- Street ‘D’ at First Avenue / Cataract Road (Future)
- Street ‘A’ at Street ‘D’ (Future)

The first two intersections are the proposed site accesses on the City’s arterials, while the last one is the intersection of the planned collector roads within the NWWSP area. The configuration of these access points will be analyzed and confirmed through this study. The connections to the west are not included in this study, as they will not serve as primary access points for this site but will mostly be used by the adjacent site with 114 units to access the collector road, Street A. The connection to the site to the north in Thorold is also not included, as it will be developed in later phases and will not be built by the future horizon of 2026. This study will examine traffic operation conditions under the assumption that all site trips will enter and exit via the two accesses on major roads. In later phases, connections will divert some traffic away from these accesses, making the conditions examined in this study more conservative at these access points. The Terms of Reference for this TIS and email correspondences have been included in Appendix A.

It has also been confirmed through the Terms of Reference that the information and conclusions from the 2023 NWWSP study will be used as the basis for this study, including the background growth rates and the ultimate intersection configurations and collector road layout, with only slight adjustments for changes in the concept plan.

3 Existing Transportation Systems

3.1 Area Road Network

Rice Road

Rice Road is a Niagara regional road with a two-lane rural cross-section within the study area. There are no active transportation facilities provided along Rice Road in this area. The Region of Niagara Official Plan designates a right-of-way of 26.2 meters. The posted speed limit is 50 km/h.

Quaker Road

Quaker Road is a City of Welland arterial road with a two-lane cross-section. Sidewalks are only provided for the segment of Quaker Road from Quaker Road Public School eastward, and there are no cycling facilities along the road. The City of Welland Official Plan protects a right-of-way of 30 meters. The general posted speed limit is 50 km/h, but it is reduced to 40 km/h in front of the school crossing.

First Avenue

First Avenue is a City of Welland arterial road with a two-lane cross-section. There are no active transportation facilities provided along First Avenue north of Quaker Road, while boulevard-separated sidewalks and dedicated bicycle lanes are provided on both sides of the road south of Quaker Road. The City of Welland Official Plan protects a right-of-way of 30 meters. The posted speed limit is 50 km/h north of Quaker Road and is reduced to 40 km/h south of Quaker Road when the school crossing sign is flashing. Trucks are not permitted on First Avenue south of Quaker Road.

3.2 Existing Intersections

Rice Road at Quaker Road

The intersection of Rice Road and Quaker Road is an unsignalized four-legged intersection controlled by all-way stop signs. Each approach consists of a single lane shared for left turns, through traffic, and right turns. There are no turn restrictions at this intersection. No pedestrian crossings are provided. Figure 3 illustrates the intersection of Rice Road at Quaker Road.

Figure 3: Rice Road at Quaker Road

Source: Google Map; Accessed May 22, 2024

First Avenue at Quaker Road

The intersection of First Avenue and Quaker Road is an unsignalized four-legged intersection controlled by all-way stop signs. Each approach consists of a shared left-turn, through, and right-turn lane, with no turn restrictions. A pedestrian crossing is provided only on the south side of the intersection. "School Zone Maximum Speed When Flashing" signs are present at the intersection for westbound traffic. Figure 4 illustrates the intersection of First Avenue and Quaker Road. Figure 4 illustrates the intersection of First Avenue at Quaker Road.

Figure 4: First Avenue at Quaker Road

Source: Google Map; Accessed May 22, 2024

3.3 Cycling and Pedestrian Facilities

Currently, limited active transportation facilities are provided in the study area.

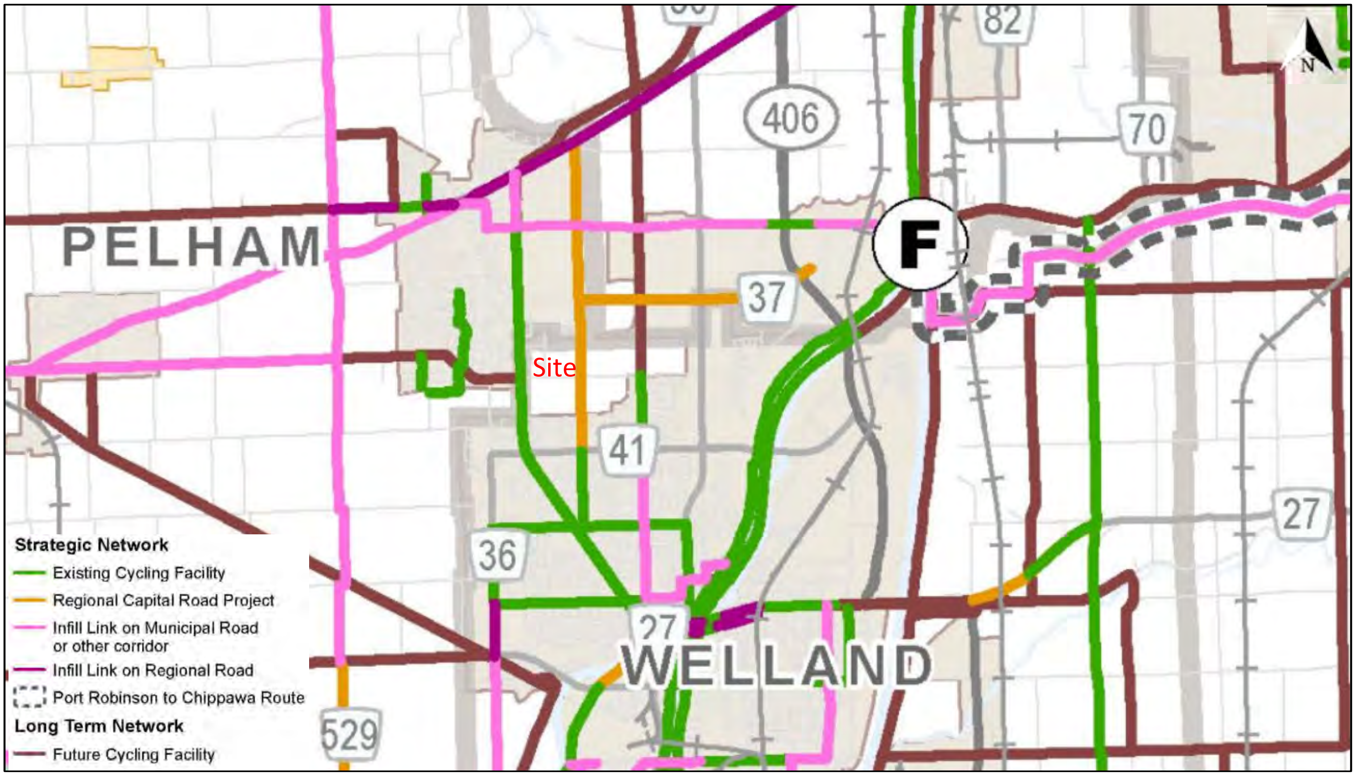
A concrete sidewalk is provided on the south side of Quaker Road from Quaker Road Public School to the intersection with Goodwillie Drive, one block east of First Avenue. The rest of Quaker Road has only gravel shoulders, which do not meet standard pedestrian facility requirements. No cycling facilities are present along Quaker Road.

Rice Road (Regional Road 54) has no active transportation facilities.

First Avenue north of Quaker Road also lacks active transportation facilities. However, First Avenue south of Quaker Road features bicycle lanes on both sides of the roadway, semi-mountable curbs at the intersections, and concrete sidewalks separated by boulevards. No cycling facilities are present on any other roads within the study area.

Figure 5 illustrates the existing and future transportation network of the Niagara Region, as excerpted from the Strategic Cycling Map. The existing cycling facilities along First Avenue are highlighted.

Figure 5: City of Welland Strategic Cycling Network



Source: Niagara Region Transportation Master Plan (2017)

3.4 Existing Transit

On January 1, 2023, the new Niagara Region Transit (NRT) consolidated all previous transit systems in the region, including Niagara Region Transit, St. Catharines Transit, Welland Transit, and Fort Erie Transit, into a single transit operator.

Route 502 Rice Road runs between the Downtown Terminal and Niagara College, mostly along Prince Charles Drive, Rice Road, and Bridlewood in the northbound direction, and along Rice Road and Willson Road in the southbound direction. This route operates every 30 minutes during daytime hours from Monday to Friday, with headways increasing to around 60 minutes during the weekend. The closest stop is located at the intersection of Rice Road and Eastwood Drive, approximately 640 meters south of Quaker Road.

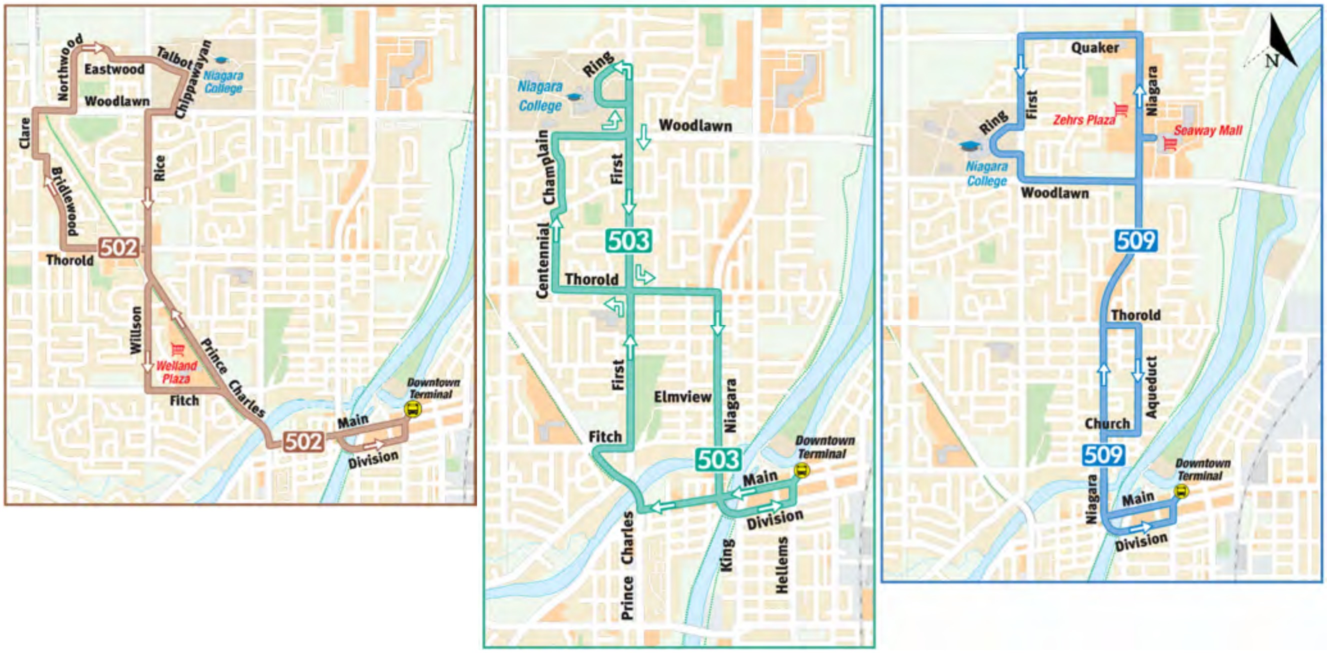
Route 503 First Avenue also runs between the Downtown Terminal and Niagara College, primarily along First Avenue, Centennial Drive, Champlain Avenue, and Niagara Street. This route operates every 30 minutes during daytime hours from Monday to Friday and every 60 minutes during the weekend. The closest stop is located at Niagara College Boulevard, approximately 850 meters south of Quaker Road.

Route 509 Niagara Street runs between the Downtown Terminal and Quaker Road. This route operates every 30 minutes during daytime hours from Monday to Friday and every 60 minutes in the evenings and during the weekend. The closest stop is along First Avenue just north of Woodlawn Road, approximately 200 meters south of Quaker Road.

Regional routes provide connections from Welland to nearby cities, including Niagara Falls and St. Catharines. Route 65 Niagara College (Welland) to Niagara Falls runs between Morrison / Dorchester Hub and Niagara College. Route 70 St. Catharines to Welland runs between St. Catharines Terminal and Welland Bus Terminal. Route 75 runs in the opposite direction of route 70. The routes all operate with a headway of 30 minutes from Monday to Friday and 60 minutes on Saturday. There are no services on Sundays.

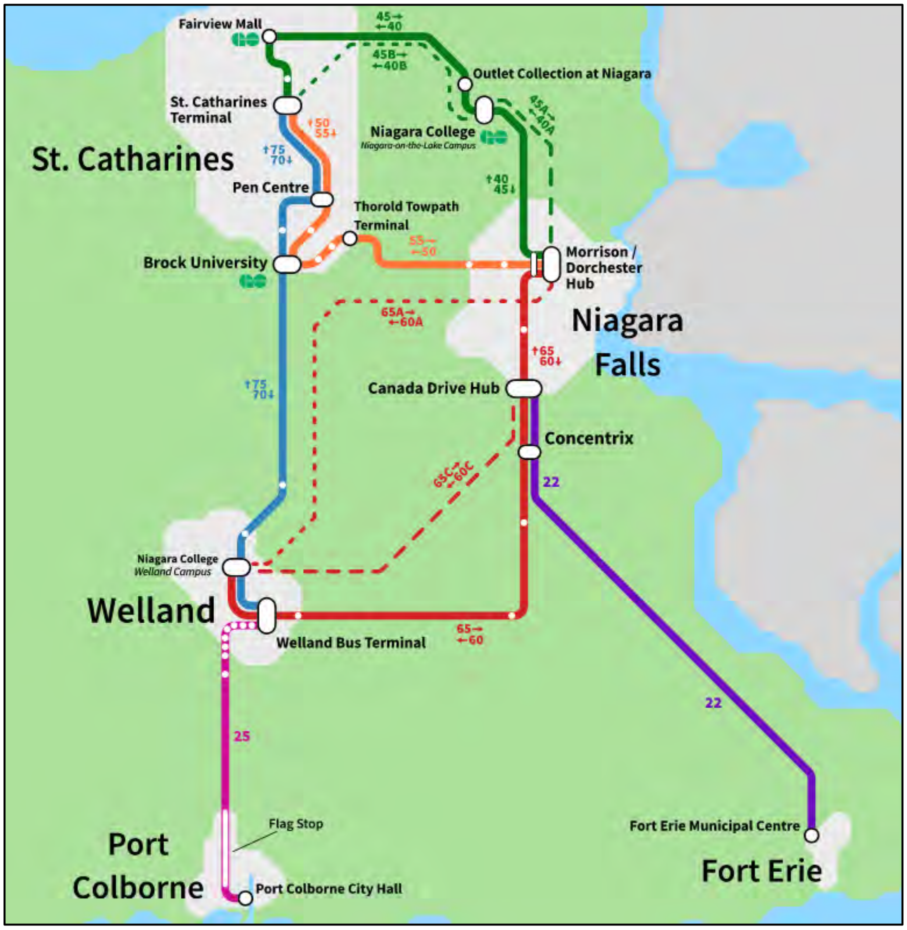
The existing Welland local routes in the Study Area are presented in Figure 6. The existing Niagara Regional route is illustrated in Figure 7.

Figure 6: Existing Welland Transit



Source: https://nrtransit.ca/routes/ Accessed: May 23, 2024

Figure 7: Existing Niagara Regional Transit



Source: https://nrtransit.ca/routes/ Accessed: May 23, 2024

4 Existing Multimodal Data and Performance Analysis

4.1 Existing Peak Hour Travel Demand

The analysis will cover the weekday AM and PM peak hours due to the development being proposed are of residential lane use. To understand the existing AM and PM peak hour traffic volumes, the same turning movement counts used by the 2023 Northwest Welland Secondary Plan Transportation Assessment, which was provided by the Regional Municipality of Niagara, dated as recent as late 2022, have been used for the two existing intersections.

Table 1 summarizes the date of the most recent turning movement counts at each existing Study Area intersection.

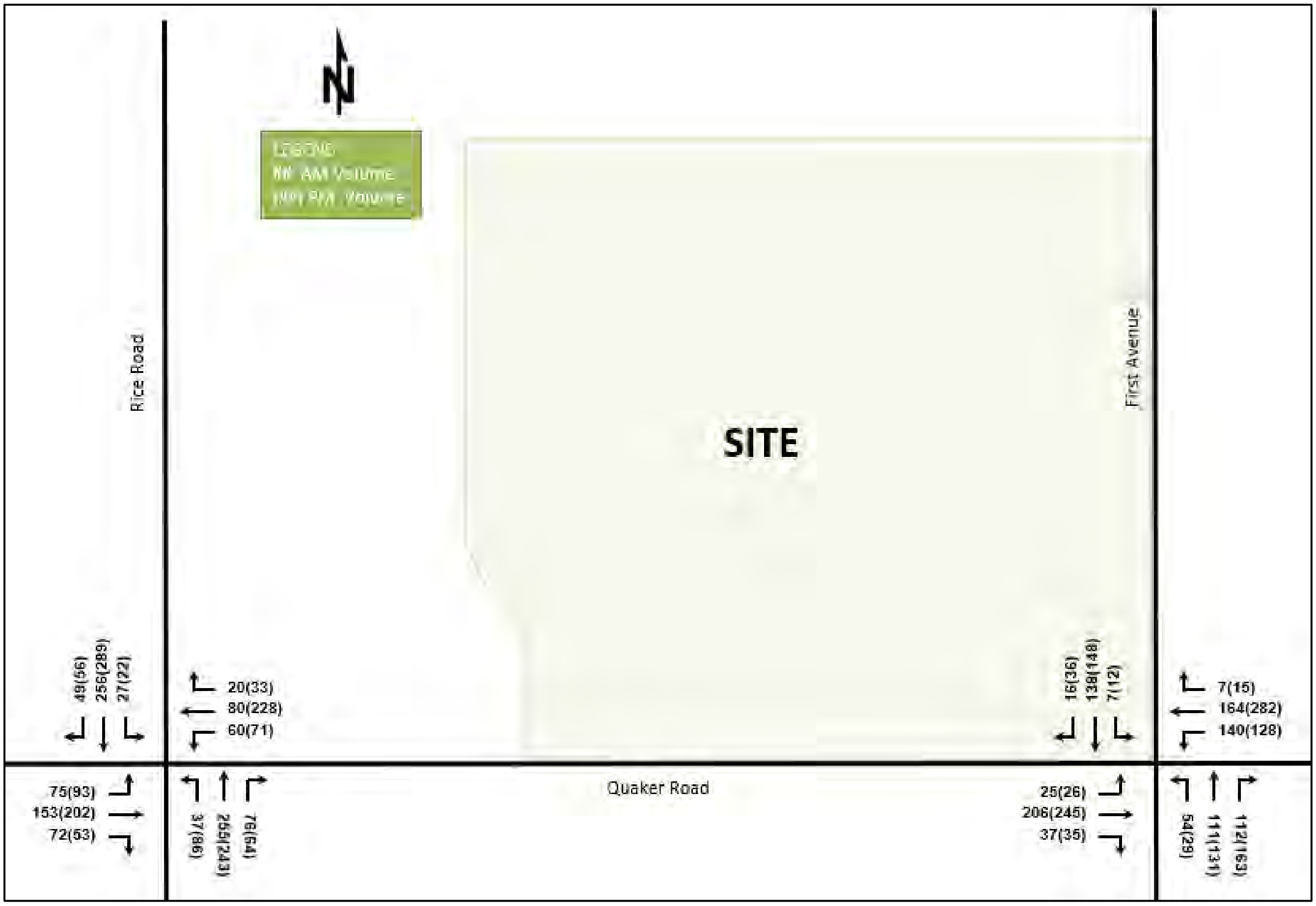
Table 1: TMC Data Dates

Data Type	Location	Count Date
Turning Movement Counts (TMC)	Rice Road at Quaker Road	Sep 14, 2022
	First Avenue at Quaker Road	Nov 2, 2022

Given that the turning movement counts were undertaken in 2022, annual compound growth rates were applied to reflect 2024 existing conditions which will be used as the base conditions for the study. Annual compound growth rates (CAGR) calculated from Niagara Region's transportation demand model were applied to the volumes at the Study Area intersections, as discussed in Section 4.4 below. The 2022 turning movement count data is included in Appendix B.

Figure 8 illustrates the 2022 traffic volumes at the Study Area intersections.

Figure 8: 2022 Existing Traffic Volumes



4.2 Background Corridor Growth

The background growth rate accounts for the increase in traffic volumes on streets within the study area due to various factors, including land use planning and significant transportation projects (e.g., overall population change in the region and improvements in public transit and active transportation systems).

As confirmed in the Terms of Reference, the same annual corridor growth rates used in the NWWSP study will be applied in this study. The NWWSP study analyzed the Niagara Region Travel Forecasting Model for the 2011 and 2031 horizons, projecting future traffic volumes based on regional population and employment growth. Table 2 summarizes the 2011 AM peak hour auto link volumes and the projected 2031 AM peak hour auto link volumes in each travel direction. The volumes between 2016 and 2031 have been compared, and annualized growth rates have been calculated for each approach, prorated to reflect an exponential growth. Following the approach of the NWWSP study, and in the absence of PM peak auto link volume projections, the same annual growth rates will be applied to the PM peak turning movement counts to establish the existing and all future conditions.

Table 2: Niagara Region Travel Forecast Model Growth Rates

Link	Start	End	Direction	2011	2026	2031	2016-2031 % Increase	2016-2031 CAGR
Rice Road	Port Robinson Road	Woodlawn Road	NB	212	511	611	188%	5.44%
			SB	189	213	221	17%	0.79%
			Two-way	401	724	832	107%	3.72%
First Avenue	Port Robinson Road	Woodlawn Road	NB	291	281	278	-4%	-0.23%
			SB	432	444	448	4%	0.18%
			Two-way	723	725	726	0%	0.02%
Quaker Road	Pelham Street	Niagara Street	EB	253	445	509	101%	3.56%
			WB	78	106	115	47%	1.96%
			Two-way	331	551	624	89%	3.22%

As shown in the table above, higher growth is projected for the number of people traveling northbound along Rice Road compared to any other road segment, while traffic volumes along First Avenue are not projected to grow significantly.

The regional model performs long-term forecasts, considering population and employment growth for each traffic zone, as well as the impact of all large-scale transportation projects planned for completion within the forecast horizons. Therefore, the projected 2031 volumes in the model include both corridor traffic growth and trips from surrounding zones, encompassing individual background developments.

The corridor traffic growth reflects the population increase in areas farther from the subject site, as accounted for by the Region. Several areas have proposed developments whose associated traffic impacts have been included in the growth rates outlined in Table 2:

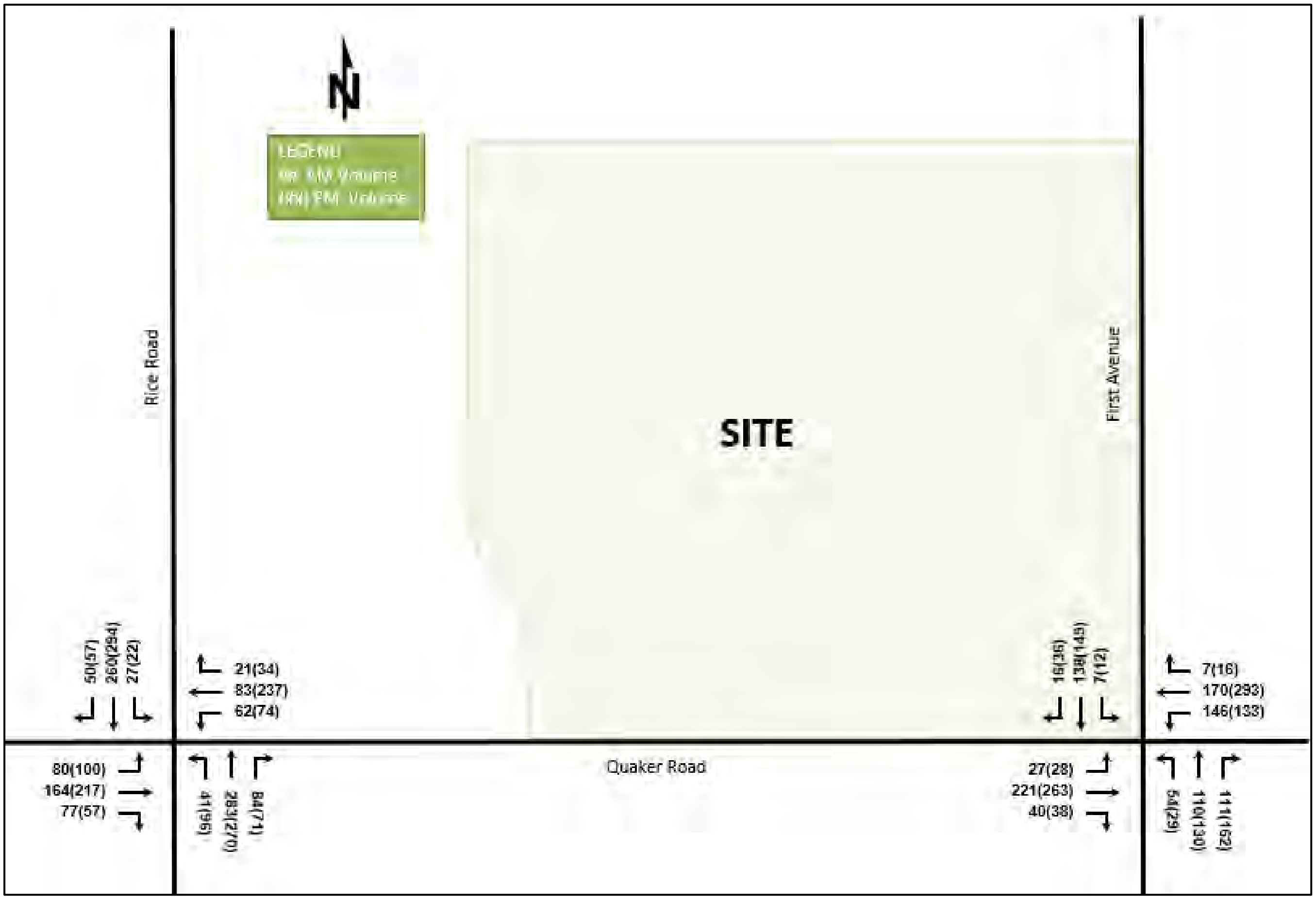
- East Fonthill Secondary Plan: Residential growth within this plan is limited to a maximum of 3,000 residents and jobs combined by 2021, 4,500 by 2026, and 5,350 by 2031. Growth within the Commercial/Employment Centre is limited to a maximum of 785 residents and jobs combined by 2021, and 1,190 by 2031. The traffic generated by these developments is anticipated to increase volumes along Rice Road.
- Port Robinson West Secondary Plan: Located north of Merritt Road and bounded by Rice Road and Cataract Road, this area is expected to generate approximately 12,500 people and jobs, including 8,500 residents, 2,400 jobs in employment areas, and 1,850 jobs in commercial areas. This traffic is anticipated to increase volumes along both Rice Road and First Avenue.

The 2026 one-way and two-way volumes have been interpolated using the CAGRs calculated. These values will be used as a reference for future travel patterns along First Avenue and Quaker Road.

4.3 2024 Existing Volumes

The compound annual growth rates were applied to the 2022 traffic volumes to reflect 2024 horizon conditions. Figure 9 illustrates the 2024 existing study area traffic volumes.

Figure 9: 2024 Existing Traffic Volumes



4.4 Operational Analysis Parameters

To understand the automobile operational characteristics of the Study Area intersections, a Synchro model has been created using Trafficware's Synchro (Version 11). For the existing conditions, the Study Area intersections have been coded based on aerial photos. Turning lane storage lengths have been rounded to the nearest five metres.

A general Peak Hour Factor (PHF) of 0.92 has been assumed for all intersections and applied to both existing and future analysis horizons, as the existing turning movement counts from the Region do not contain sufficient information to calculate peak hour factors.

The Heavy Vehicle percentage (HV %) has been calculated for each turning movement at the Study Area intersections. All Heavy Vehicle percentages calculated to be less than 2% were entered into the Synchro model as 2% in order to produce a conservative analysis. These calculations are shown in Appendix C. Pedestrian and cyclist volumes have also been taken from these counts. A pedestrian walking speed of 1.0 m/s has been assumed as design criteria for pedestrian crossing times.

According to the Niagara Region's Transportation Impact Study Guidelines, the ideal saturation flow rates as summarized in Table 3 have been used for the corresponding movements at each Study Area intersection.

Table 3: Saturation Flow Rates – City of Welland

Movement	Saturation Flow Rate (pc/h/ln)
L	1,651
T	1,776
R	1,498
LT	1,375
RT	1,535
LTR	1,630

A Lost Time Adjustment default value of 0 has been applied. All other parameters have been coded using accepted best practices and default parameters where applicable. These parameters will also be applied to the Future Background and Future Total conditions.

Level of Service (LOS) has been defined using HCM 2010 definition for LOS at signalized intersections (Table 4) and unsignalized intersections (Table 5).

Table 4: Level of Service Criteria for Signalized Intersections

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

Table 5: Level of Service Criteria for Unsignalized Intersections

Level of Service	Average Control Delay (Second/Vehicle)
A	≤10
B	>10 – 15
C	>15 – 25
D	>25 – 35
E	>35 – 50
F	>50

Criteria for critical movements and critical intersections, for both signalized and unsignalized intersections, will be considered. Movements that exceed those thresholds will be evaluated for possible operational improvements. As outlined by the Niagara Region’s Transportation Impact Study Guidelines, critical movements should be identified according to the criteria:

- At signalized intersections, movements with v/c ratio greater than 0.85 and/or LOS “E” or worse
- At unsignalized intersections, movements expected to operate at LOS “D” or worse and/or where the estimated 95th percentile queue length for an individual movement exceeds the available queuing space.
- Any site accesses where entrances or egress is anticipated to be blocked by traffic queues from an upstream/downstream intersection.
- An exclusive turning movement in which the 95th percentile queue will exceed the available storage space.
- Exclusive left-turn and right turn lanes that are inaccessible due to the length of queues in the adjacent through lanes.

The three intersections as listed in Section 2 do not exist in the 2024 horizon yet. The operational analysis will be provided for the 2026 Future Background and 2026 Future Total conditions.

5 Future Background Conditions

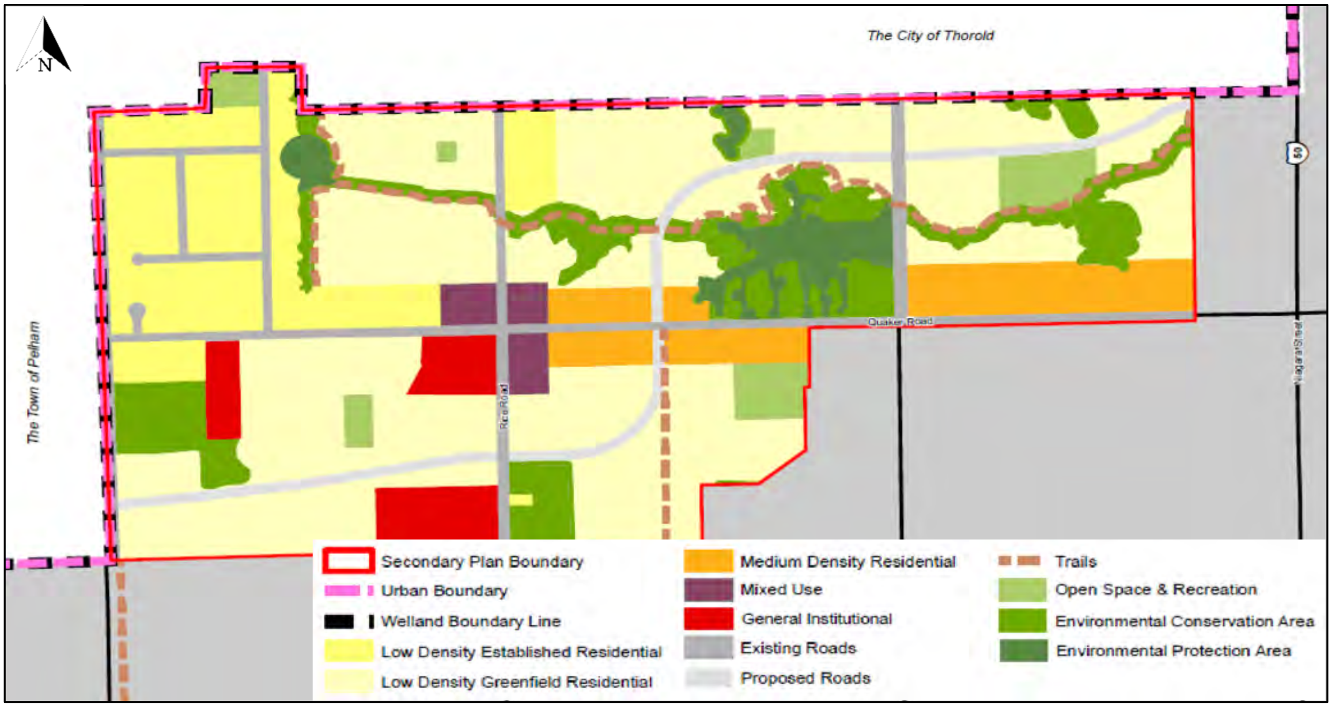
5.1 Future Analysis Horizons

The subject development is anticipated to be fully built-out and occupied in 2026. The analysis will focus on this full build-out horizon, with no further horizons included in this report. Given the relatively minor size of the development, significant growth beyond the future build-out horizon is not expected.

5.2 Future Land Use Context

The Northwest Welland Secondary Plan (NWWSP), within which this development is situated, is anticipated to generate an increase of 12,181 in population and 84 in jobs by 2033 due to all new developments in the area. Medium density development will be located along both sides of Quaker Road, with direct access to Quaker Road. Low density development will be situated along the collector roads or local roads. Mixed-use development will be positioned in the northwest, northeast, and southeast quadrants of the intersection of Quaker Road and Rice Road. Figure 10 illustrates the land use map from the Northwest Welland Secondary Plan.

Figure 10: Northwest Welland Secondary Plan



Source: Northwest Welland Secondary Plan (2021)

5.3 Planned Conditions

The capital projects planned by the Region, as well as the recommendations in the NWWSP study, have been considered in this study. Changes to road cross-sections and intersection configurations have been incorporated into the traffic models.

5.3.1 Rice Road Widening

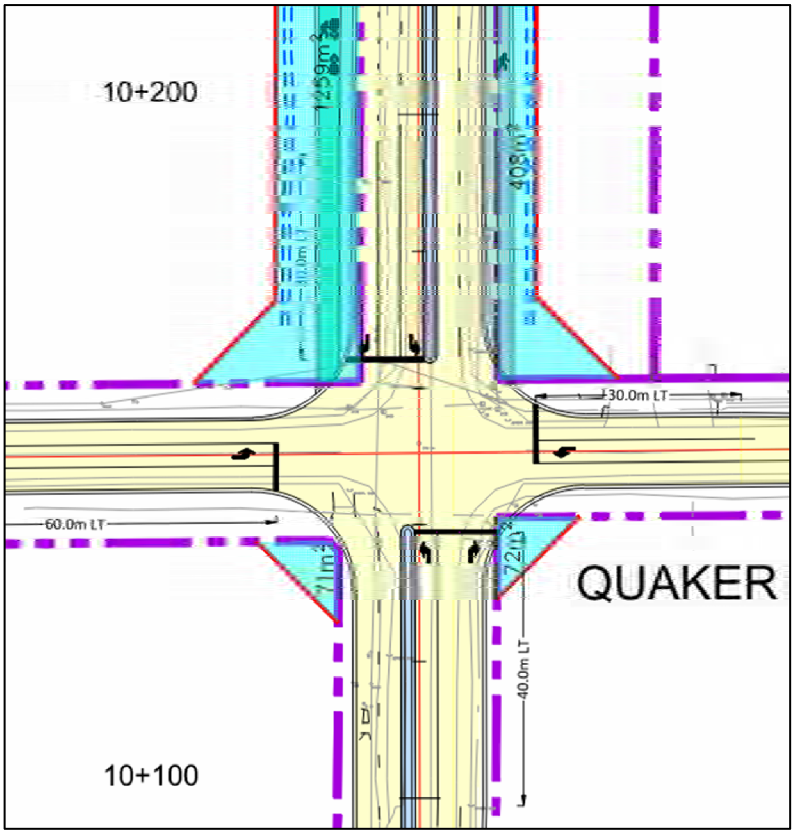
The Region plans to widen Regional Road 54 (Rice Road) to a four-lane cross-section by 2041. Rice Road will be expanded to include four 3.3-meter drive lanes with a 2.5-meter median or a 3.3-meter two-way left turn lane in the center. Boulevards and sidewalks will be added on both sides, along with a bicycle lane on the west side of the road between Merritt Road and Quaker Road. The preferred design is included in Appendix D.

5.3.2 Intersection Improvements

5.3.2.1 Rice Road at Quaker Road

Rice Road at Quaker Road will become a signalized intersection consisting of 1 dedicated left-turn lane and 1 shared through / right-turn lane for east and west approaches, 1 dedicated left-turn lane, 1 through lane, and 1 dedicated right-turn lane for north and south approaches. The preliminary design drawing showing the intersection configuration is included in Appendix D.

Figure 11: Preliminary Design for Rice Road at Quaker Road Intersection



Source: Preferred Design from Merritt Road and Rice Road Municipal Class Environmental Assessment Study

5.3.2.2 First Avenue and Quaker Road

The NWWSP study has recommended the intersection of First Avenue and Quaker Road to be signalized. Dedicated left turn lanes will be added, with 35 metres on southbound approach and 30 metres on all other approaches. Dedicated right turn lanes will also be added, with 30 metres on the eastbound approach and 40 metres on the northbound approach.

5.3.2.3 Intersection with Collectors

The NWWSP study has recommended that 30-metre left-turn lanes should be provided on:

- the eastbound and westbound approaches for Quaker Road at Street A; and
- the northbound and southbound approaches for First Avenue at Street D.

5.3.3 Active Transportation Facilities Improvements

According to the Regional Municipality of Niagara's Strategic Cycling Network Development Technical Paper (2017), First Avenue / Cataract Road was confirmed as a candidate for enhanced cyclist facilities.

As shown in Figure 5, a Regional Capital Road project has been proposed along Rice Road north of Woodlawn Road, and future cycling facilities will be provided along First Avenue north of Quaker Road.

5.3.4 Transit Improvements

In the existing conditions, route 509 only provides a short segment of services within the study area, with only Quaker Road between First Street and Regional Road 50 (Niagara Street) being serviced by Niagara Region Transit. The NWSSP has recommended that expanded transit service of this route should be considered in conjunction with the development of the subject lands.

5.4 Future Background Configurations

In the Future Background conditions, it is assumed that the southbound leg at the Quaker Road at Street A intersection, and the eastbound leg at the First Avenue at Street D intersection have not been constructed.

The Quaker Road at Street A intersection is assumed to be stop-controlled on the minor approach, as mentioned in Section 5.3.2.3. The eastbound approach will consist of one shared through / right-turn lane. The westbound approach will consist of one auxiliary left-turn lane and one through lane. The northbound approach will consist of one shared left-turn / right-turn lane.

The First Avenue at Street D intersection is also assumed to be stop-controlled on the minor approach. The northbound approach will consist of one shared through / right-turn lane. The southbound approach will consist of one auxiliary left-turn lane and one through lane. The westbound approaches consist of one shared left-turn / right-turn lane.

The 2026 Future Background intersection configuration is illustrated in Figure 12.

Figure 12: 2026 Future Background Intersection Configuration

5.5 Other Study Area Developments

The NWWSP study has assumed that the collector roads would only service low density residential development. Traffic generated by medium density and mixed-use development indicated in the preferred plan would have direct access to Quaker Road, Rice Road or First Avenue and would, therefore, have already been accounted for in the previous submission in Table 2.

The assumptions made by the NWWSP study generally work, except that it does not reflect the land use composition of the subject site at 436 Quaker Road. The proposed site is located within Block C. In the NWWSP study, a total of 800 units have been accounted for the site in the trip generation process, and the 800 units have been assumed to be single detached houses.

However, the current version of the block plan only consists of 711 to 741 units. Instead of being low-density housing, 422 of the total unit count will be apartment dwelling units located in two high-rise buildings. Therefore, to reflect a more accurate site traffic in this report, the site trip for the subject site was removed first to calculate the future background volumes of the site. The future total volumes will be re-calculated by adding the updated trip generation results (specific for 436 Quaker Road) to the future background volumes.

The NWWSP study estimated the trip generation for the Northwest Welland Secondary Plan area (broken down into Block A, B, C and D) using the ITE Trip Generation Manual and the results were summarized in Table 6. As the subject site only occupies part of Block C, the proportion of the Block C trips that were generated by the 800-unit portion were calculated, assuming it would be a linear relationship between the number of trips generated and the number of units.

Table 6: Background Developments Site Trips at Full Build-out

Land Use	Units	AM Peak Hour			PM Peak Hour		
		In	Out	Total	In	Out	Total
Block A	615	97	292	389	345	203	548
Block B	1175	175	526	701	635	372	1007
Block C	914	139	419	558	501	294	795
	800	122	367	488	439	257	696
	114	17	52	70	62	37	99
Block D	1260	187	560	747	678	397	1075
Total Trips	**3964**	**598**	**1797**	**2395**	**2159**	**1266**	**3425**

Therefore, a total of 488 AM and 696 PM trips were removed from the total volumes. The rest of the trips were all included as part of the background development trips.

5.5.1 Site Trips Removal

The removal of site trips was applied in proportion to the number of trips assigned to each inbound and outbound movement at the Quaker Road at Street A and First Avenue at Street D accesses. The trip generation for Block A, B, and D do not change.

Figure 13 illustrates the 2026 Future Total volumes interpolated using the growth rates provided in Section 4.2. Figure 14 illustrates the Future Total volumes site traffic removal.

Figure 13: 2026 Future Total – Interpolated using NWWSP Study

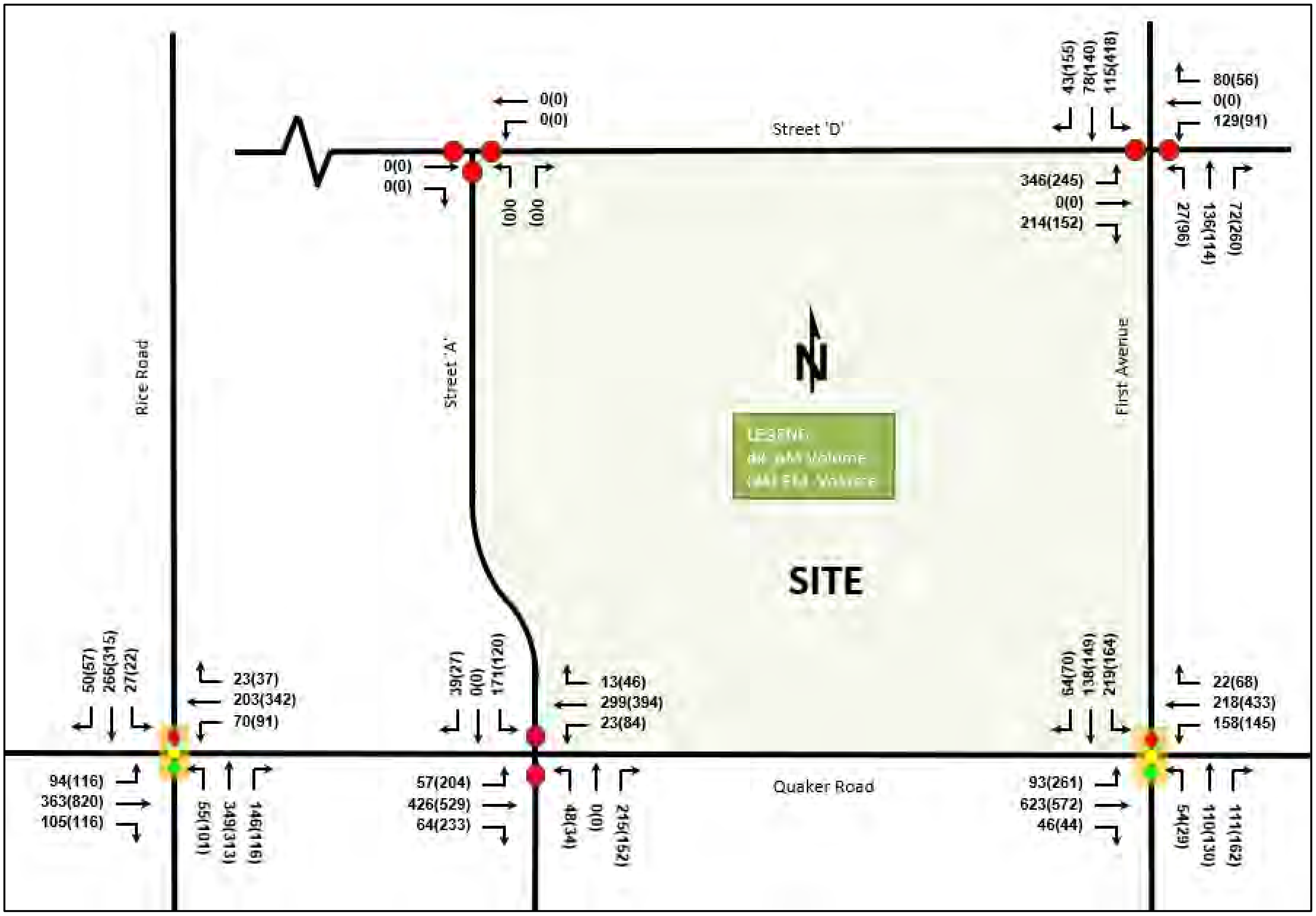
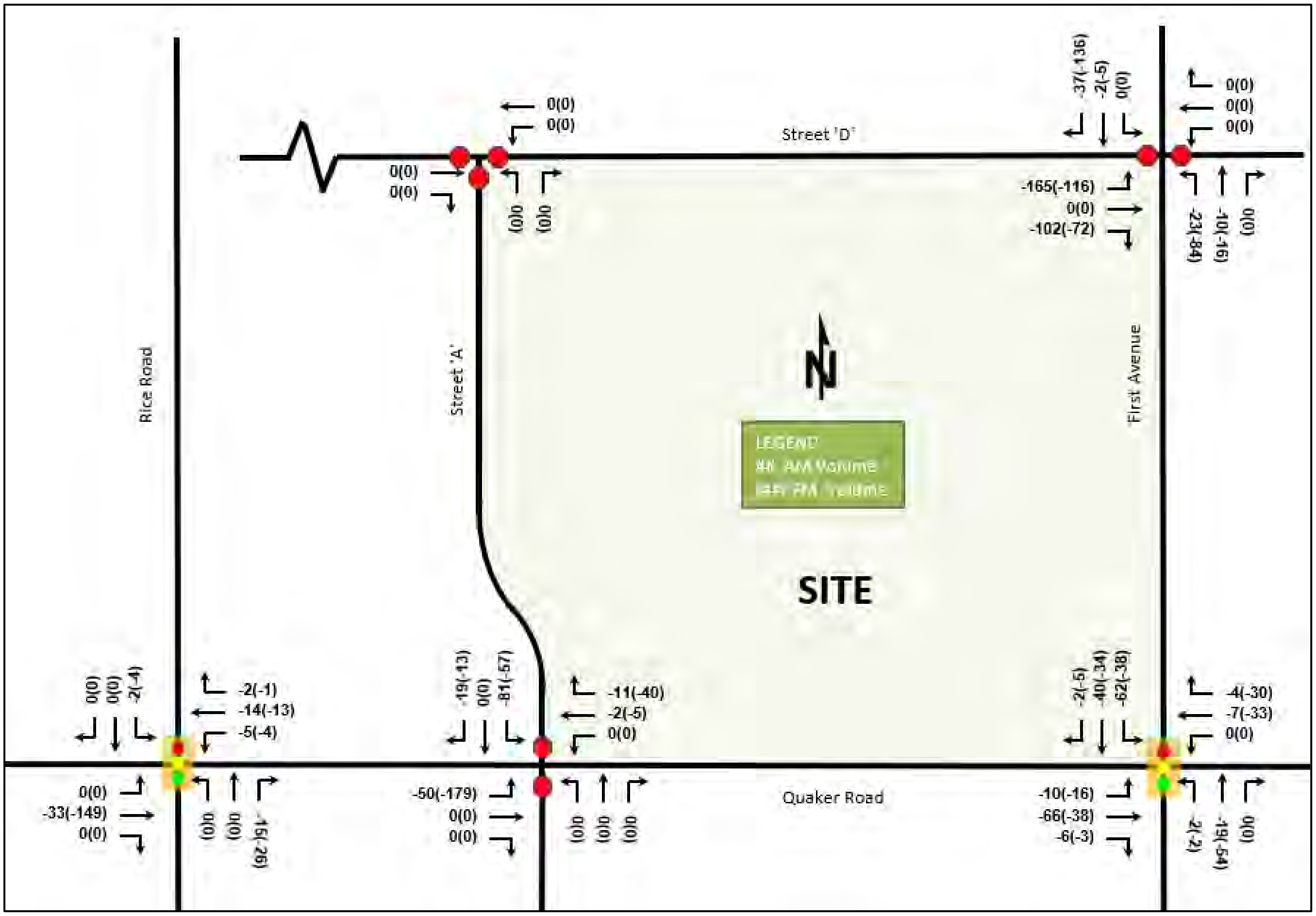


Figure 14: Site Generated Trips Removal – 436 Quaker Road



5.6 Future Background Traffic Volumes

Subtracting the site-generated traffic from the outdated 2026 Future Total traffic, the Future Background traffic volumes were projected which included the background development traffic, the background growth rate, and the existing traffic volumes. Figure 15 illustrates the updated 2026 Future Background volumes.

Figure 15: 2026 Future Background Traffic Volumes

5.7 2026 Future Background Conditions Operational Analysis

The 2026 Future Background conditions have been examined to determine the future traffic conditions without the addition of the proposed development. This will isolate the impact of the subject development on the traffic network.

Table 7 summarizes the operational analysis of 2026 Future Background conditions. Synchro worksheets have been included in Appendix E.

Table 7: 2026 Future Background Conditions Operational Analysis

Intersection	Mvmnt	AM Peak Hour				PM Peak Hour			
		LOS	V/C	Del (s)	Q (95th)	LOS	V/C	Del. (s)	Q (95th)
Quaker Road at Street A *(Unsignalized)*	EBT/R	-	0.32	0	0	-	0.49	0	0
	WBL	A	0.03	1	<1	B	0.13	2	3
	WBT	-	0.19	0	0	-	0.25	0	0
	NBL/ R	C	0.58	22	28	E	0.65	36	32
	Overall	**B**	**-**	**6**	**-**	**D**	**-**	**5**	**-**
First Avenue at Street D *(Unsignalized)*	WBL /R	C	0.41	16	15	F	0.99	125	58
	NBT/R	-	0.13	0	0	-	0.23	0	0
	SBL	A	0.09	5	2	B	0.39	8	14
	SBT/R	-	0.05	0	0	-	0.09	0	2
	Overall	**A**	**-**	**7**	**-**	**C**	**-**	**21**	**-**
Notes:	# - 95% percentile exceeds capacity m - volume for the 95th percentile queue is metered by an upstream signal								

With the addition of background traffic growth, the Study Area intersections under the improved network configurations were projected to operate with acceptable overall LOS and delays, except for the westbound approach at the First Avenue at Street D intersection during the PM peak. Critical conditions were identified at this movement due to its high left-turning volumes, which do not have sufficient time to proceed through the intersection under stop control.

6 Forecasting

6.1 Trip Generation

The block plan design is still preliminary and provides a rough estimate of the site statistics. The proposed development will contain an approximate unit count of 289 to 319 for low density blocks and an approximate unit count of 422 for high density blocks. Table 8 summarizes the unit breakdown by blocks.

Table 8: Land Use Breakdown By Blocks

Land Use	Lots / Blocks	Units
Low Density Residential	Block 2-5, 10-14, 16, 19, 20-24, 26 & 29	245-275±
Low Density Residential	Block 1	44±
Medium Density Residential	Block 30	422±

For this exercise, the trip generation has been projected using the most conservative scenario, that is, there will be 319 units of low-density housing within the development and all 319 units will be single detached homes. The plan would be subject to subsequent site plan approval processes that will further refine the plans for each block and provide more accurate unit counts. While the final development concept scale of the development may subject to changes such as the division between single detached homes and townhomes, the foregoing represents a conservative estimate of the traffic that could be generated by the subject development and the conclusions will remain valid.

Vehicle trips for the proposed development have been generated based on the ITE Trip Generation Manual 11th Edition. The appropriate trip generation rates have been selected for each of the proposed land uses. The single-family detached land use category was applied to the 319 low-density units. The Multifamily Housing (High-rise) land use category was used to estimate trips for the 422 apartment building units as they are anticipated to be around 12 storeys and any residential building higher than 10 storeys is considered a high-rise within the ITE Trip Generation Manual. The ITE vehicle trip generation rates and directional splits are summarized in Table 9.

Table 9: ITE Trip Generation Vehicle Trip Rates

Land Use	Land Use Code	Units	Peak Hour	Method	Vehicle Trip Rate	Distribution	
						In	Out
Single Family Detached	210	319	AM	Fitted Curve Equation	0.70	25%	75%
			PM		0.94	63%	37%
Multi-family High-rise	222	422	AM	Weighted Average	0.26	26%	74%
			PM		0.31	62%	38%

The vehicle trip rates calculated using the fitted curve equations have been applied to the single-family detached category because the regressions were calculated based on more than 200 studies for each and the criteria of R^2 values being greater than 0.75 were met. The weighted average rates have been used for the high-rises because the R^2 values are less than 0.75 for their fitted curves.

Using the above vehicle trip rates, the total vehicle trip generation for the developments is summarized in Table 10.

Table 10: ITE Total Vehicle Trip Generation

Block	Land Use	AM Peak Hour			PM Peak Hour		
		In	Out	Total	In	Out	Total
1, 2-5, 10-14, 16, 19, 20-24, 26 & 29	**Single Family Detached**	53	161	214	186	110	296
30	**Multifamily Housing (High-Rise)**	30	84	114	84	51	135
Total Trips		**83**	**245**	**328**	**270**	**161**	**431**

The proposed development is anticipated to generate a total of 328 AM and 431 PM two-way vehicle trips by 2026, including 214 AM and 296 PM two-way vehicle trips for the low-density housing and 114 AM and 135 PM two-way vehicle trips for the medium-density housing.

6.2 Mode Share

The site travel demand has been calculated based on the assumption that the mode share is 100% auto. The development is located within an area that is relatively rural, with limited active transportation facilities and infrequent transit services. It is anticipated that within the foreseeable future auto mode will remain the primary transportation mode of choice by the residents.

6.3 Trip Distribution

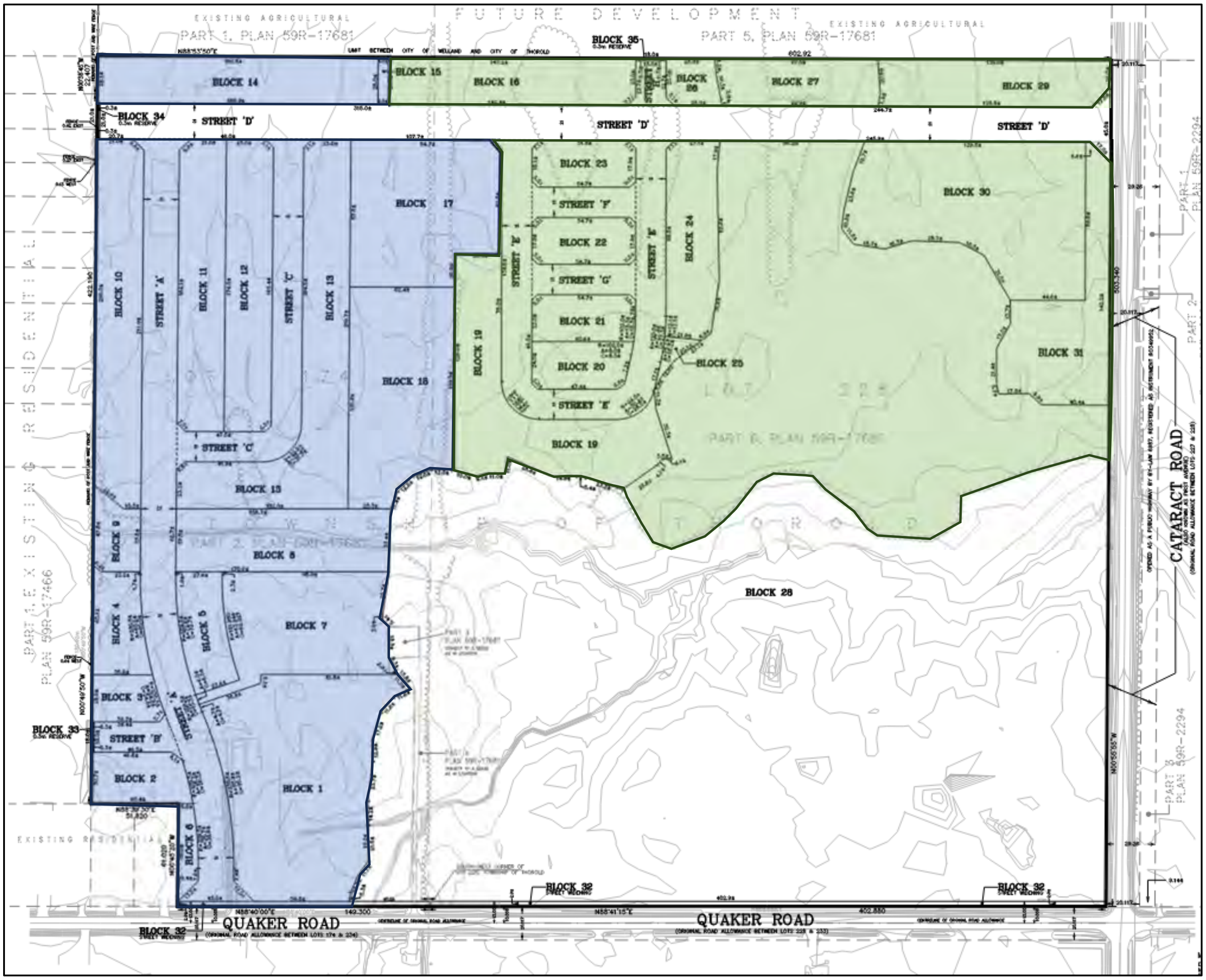
Inbound and outbound trips at the intersection of Quaker Road and Street A and First Street and Street D were distributed per the projected 2026 traffic flow on Quaker Road and First Avenue as noted in Table 2. As both accesses allow full movements, the PM peak hour trip distribution was simply the reverse of the AM peak hour trip distribution.

The percentage of the site trip distribution using each access was determined based on the following two principles:

- Vehicles are assumed to choose accesses that are closest to their residential blocks; and
- Vehicles using a particular access will travel in the same direction as their chosen route without detours.

Figure 16 illustrates the portion of the development that will primarily use the Quaker Road access (highlighted in blue) and the portion of the development that will primarily use the First Avenue access (highlighted in green).

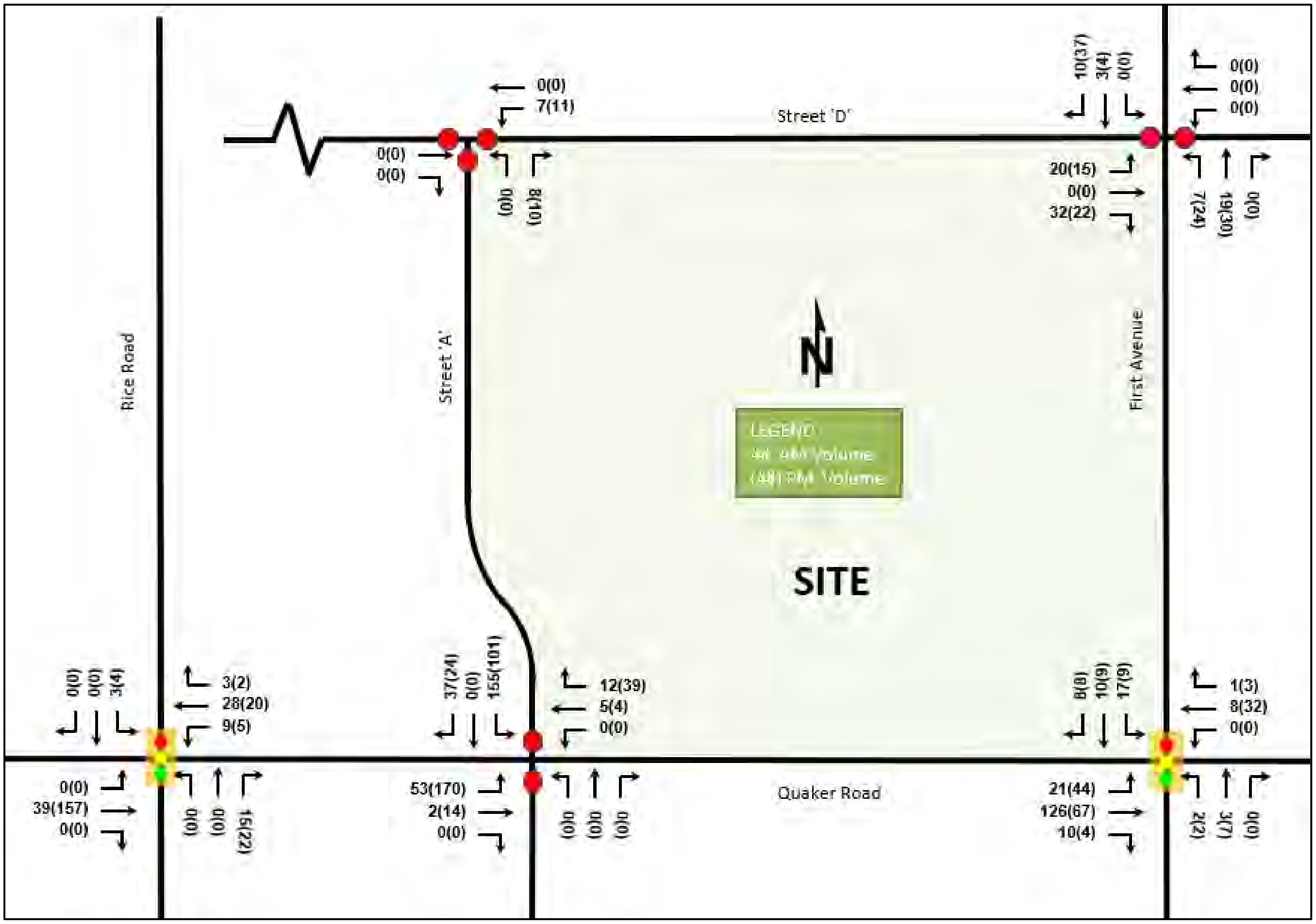
Figure 16: Trip Distribution



6.4 Trip Assignment

Using the distribution outlined above, and access to major transportation infrastructure, the trips generated by the site have been assigned to the Study Area road network. The total site trip generation is summarized in Figure 17.

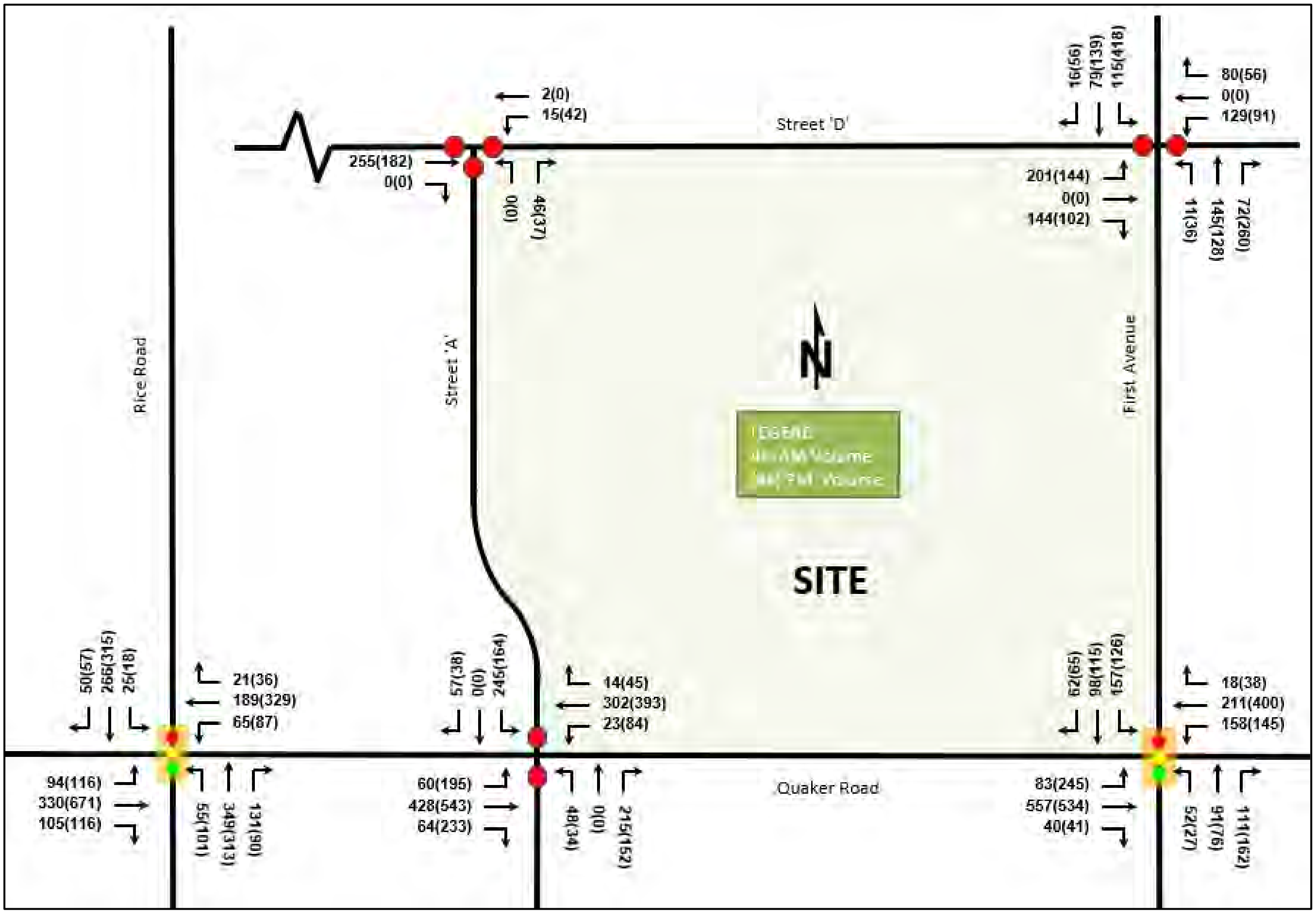
Figure 17: Total Site Trip Generation



6.5 Future Total Travel Demands

The site generated vehicle traffic has been combined with the 2026 Future Background traffic volumes to estimate the Future Total traffic volumes. Figure 18 illustrates the 2026 Future Total traffic volumes, respectively.

Figure 18: 2026 Future Total Traffic Volumes



7 Future Total Conditions

7.1 Traffic Signal Warrants

The initial assumptions for the intersections of Quaker Road at Street A and First Avenue at Street D accesses are currently operating under two-way stop control. The justification for installing traffic signals was evaluated per the Ontario Traffic Manual (OTM) Book 12 Justification 7 methodology.

The unsignalized Study Area intersections were reviewed. A summary of the traffic control signal warrant analysis for Future Total conditions can be found in Table 11. Traffic control warrant sheets are included in Appendix F.

Table 11: Future Total Signalization Warrant Summary

Intersection	Horizon	Warranted?
Quaker Road at Street A	2026 FT	No
First Avenue at Street D	2026 FT	No

7.2 All-way Stop Warrants

Given that the traffic signals were not warranted, all-way stop warrants were evaluated. As shown in Table 12, it has been found that all-way stops were warranted at both collector road – arterial road intersections. Traffic control warrant sheets are included in Appendix F.

Table 12: Future Total All-Way Stop Warrant Summary

Intersection	Horizon	Warranted?
Quaker Road at Street A	2026 FT	Yes
First Avenue at Street D	2026 FT	Yes

7.3 MTO Turn Lane Warrant Review

An MTO left turn-lane warrant analysis was undertaken at the intersections where relatively significant left turn volumes had been identified as listed in Table 13.

Table 13: Future Total Turn Lane Warrant Summary

Intersection	Movement	Warranted?
Quaker Road at Street A	NBL	No
	SBL	Yes
	EBL	Yes
	WBL	Yes
First Avenue at Street D	NBL	Yes
	SBL	Yes
	EBL	Yes
	WBL	No

Based on the estimated 2026 Future Total volumes, auxiliary left turn lanes are warranted at the major approaches at these intersections as well as the site access approaches. Left-turn lane warrant sheets are included in Appendix G.

7.4 2026 Future Total Intersection Configuration

All the road widening, and improvement projects are assumed to be completed before 2026.

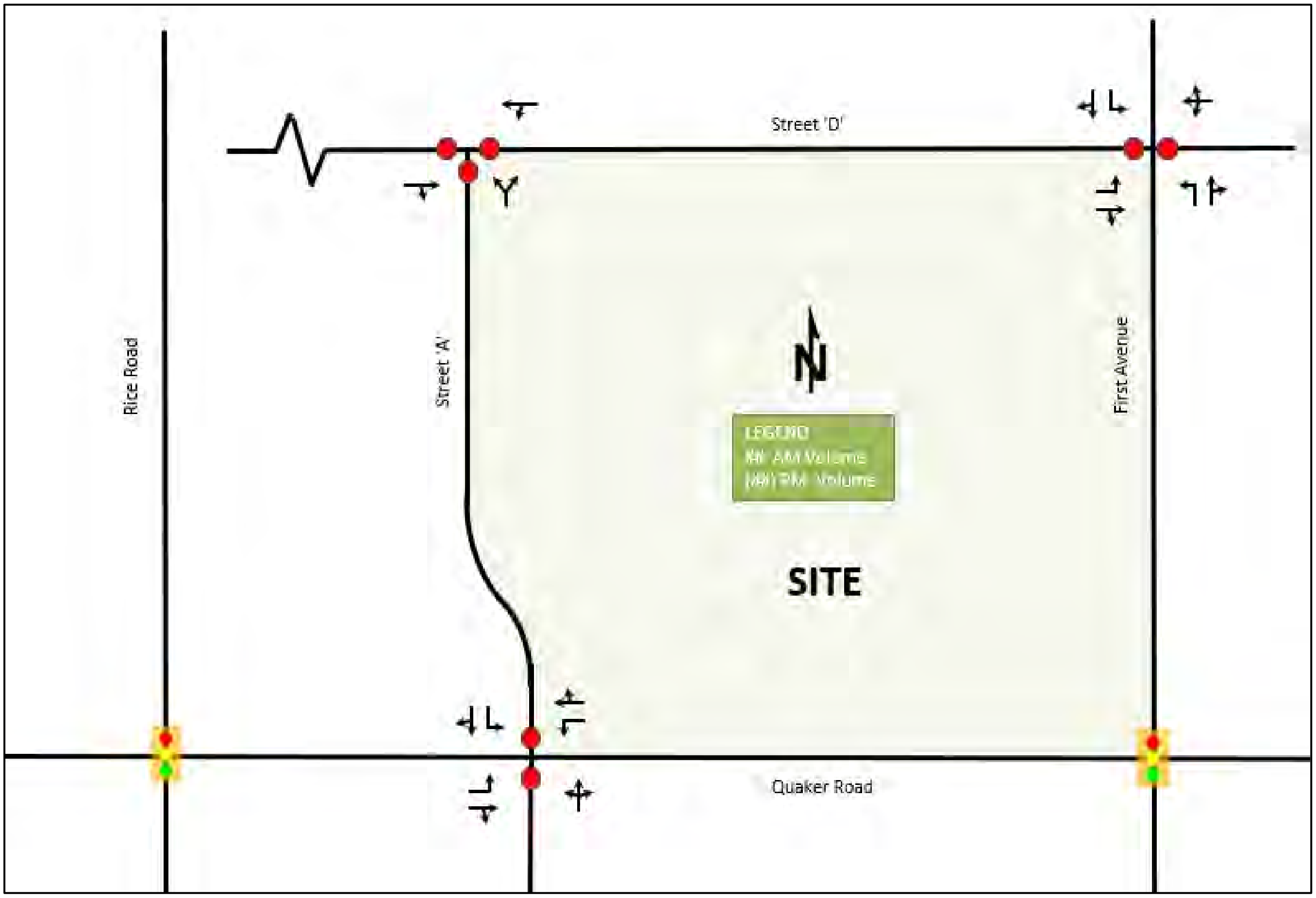
The Quaker Road at Street A intersection is assumed to be stop-controlled on the minor approaches (northbound and southbound). The eastbound and westbound approaches will consist of one auxiliary left-turn lane and one shared through / right-turn lane, as warranted in Section 7.3. The northbound approach will consist of one single shared left-turn / through / right-turn lane. The southbound approach will consist of one auxiliary left-turn lane and one shared through / right-turn lane.

The First Avenue at Street D intersection is assumed to be stop-controlled on the minor approach. The northbound and southbound approaches will consist of one auxiliary left-turn lane and one shared through / right-turn lane, as warranted in Section 7.3. The eastbound approach will consist of one auxiliary left-turn lane and one shared through / right-turn lane. The westbound approach will consist of one single shared left-turn / through / right-turn lane.

The Street A at Street D intersection is assumed to be all-way stop controlled. The eastbound approach will consist of one shared through / right-turn lane. The westbound approach will consist of one shared left-turn / through lane. The northbound approach will consist of one shared left-turn / right-turn lane.

The 2026 intersection configuration is illustrated in Figure 19.

Figure 19: 2026 Future Intersection Configuration



7.5 2026 Future Total Conditions Operational Analysis

The analysis parameters used to analyze the 2026 Future Background conditions have been carried forward as part of the analysis of 2026 Total Future conditions. The 2026 site-generated volumes have been added to the Future Background volumes and applied to the assumed 2026 road network.

Table 14 summarizes the results of the operational analysis for 2026 Future Total conditions. Synchro worksheets have been included in Appendix H.

Table 14: 2026 Future Total Conditions Operational Analysis

Intersection	**Mvmnt**	**AM Peak Hour**				**PM Peak Hour**			
		LOS	**V/C**	**Del (s)**	**Q (95th)**	**LOS**	**V/C**	**Del. (s)**	**Q (95th)**
Quaker Road at Street A *(Unsignalized)*	EBL	F	0.16	118	-	F	0.47	279	-
	EBT/R	-	1.19	-	-	-	1.71	-	-
	WBL	D	0.06	33	-	F	0.20	56	-
	WBT/R	-	0.79	-	-	-	0.99	-	-
	NBL/T/R	D	0.65	25	-	C	0.45	18	-
	SBL	C	0.67	24	-	C	0.45	17	-
	SBT/R	-	0.13	-	-	-	0.09	-	-
	Overall	**F**	**-**	**62**	-	**F**	**-**	**163**	-
	Mitigation Strategy: Signalization								
	EBL	B	0.21	15	m8	A	0.50	9	33
	EBT/R	C	0.88	30	m53	C	0.94	31	#187
	WBL	B	0.14	11	6	B	0.48	10	21
	WBT/R	B	0.56	15	45	A	0.52	9	56
	NBL	B	0.10	10	9	C	0.12	23	12
	NBT/R	B	0.19	11	7	C	0.13	23	0
	SBL	C	0.63	20	#56	D	0.68	39	#54
	SBT/R	A	0.05	10	0	C	0.03	22	0
	Overall	**B**	**0.75**	**20**	**-**	**C**	**0.86**	**23**	**-**
First Avenue at Street D *(Unsignalized)*	EBL	B	0.42	12	-	B	0.38	14	-
	EBT/R	-	0.25	-	-	-	0.23	-	-
	WBL/T/R	B	0.41	14	-	C	0.37	16	-
	NBL	B	0.02	13	-	D	0.09	31	-
	NBT/R	-	0.43	-	-	-	0.82	-	-
	SBL	B	0.25	11	-	E	0.96	45	-
	SBT/R	-	0.19	-	-	-	0.41	-	-
	Overall	**B**	**-**	**12**	**-**	**D**	**-**	**32**	**-**
	Mitigation Strategy: Signalization								
	EBL	C	0.69	25	34	D	0.74	43	#42
	EBT/R	B	0.12	16	0	C	0.09	27	0
	WBL	B	0.47	19	22	C	0.49	31	27
	WBT/R	B	0.07	16	0	C	0.05	27	0
	NBL	A	0.02	6	3	A	0.06	4	5
	NBT/R	A	0.27	8	26	A	0.36	6	19
	SBL	A	0.23	7	19	C	0.83	22	#116
	SBT/R	A	0.12	6	13	A	0.20	5	16
	Overall	**B**	**0.41**	**14**	**-**	**B**	**0.81**	**18**	**-**
Street A at Street D *(Unsignalized)*	EBT/R	A	0.31	9	-	A	0.22	8	-
	WBL/T	A	0.02	8	-	A	0.06	8	-
	NBL/R	A	0.06	7	-	A	0.04	7	-
	Overall	**A**	**-**	**9**	-	**A**	**-**	**8**	**-**
Notes:	# - 95% percentile exceeds capacity m - volume for the 95th percentile queue is metered by an upstream signal								

With the inclusion of the site access approaches into the Study Area road network as well as the addition of the site trips, the traffic operations conditions have undergone some significant changes compared to the future background conditions. Critical movements as defined by Niagara Region were identified in red.

Critical movements were identified at the eastbound and westbound movements at the Quaker Road at Street A intersection during both the AM and PM peak hours as well as the northbound movement during the AM peak hour. Critical conditions were also identified for the northbound through/right and southbound left movements at the First Avenue at Street D intersection during the PM peak hour, although the magnitude of delays was projected to be smaller and did not exceed the capacity. The potential cause to this condition was that the through volumes along the major approaches were high, and the stop signs would impact the efficiency of these through vehicles. In addition, the minor approaches were projected to experience a significant amount of left turning vehicles which also delays the through movements of the major approach.

Therefore, to mitigate the operational constraints, signalizing the intersection was proposed as the signal timing plan could optimize the green times such as all movements could achieve reasonable wait time, to allow for more vehicles to pass through the intersections. Permissive left turn phases have been added to the minor approaches. The result showed that this strategy would be highly effective in reducing critical movements. While v/c ratios at the eastbound through/right movement were still above 0.85, the overall LOS and delays improved for the intersection.

8 Development Design

8.1 Internal Roads

The internal roads of the proposed development at 436 Quaker Road consist of collector roads and local roads. The collector roads connect to arterials such as Rice Road, First Avenue and Quaker Road and extend beyond the Primont (Thorold/Welland) Inc. properties. The local roads provide direct access to the houses and connect to the collectors. Within the Study Area, the proposed widths for collector roads are 21 meters, and for local roads, 18 meters.

The City of Welland Official Plan has laid out the transportation policies protecting the rights-of-way for different road classes. Section 6.4.2.1.B has set the definitions for roadway classifications and the Section 6.4.2.1.C provides the corresponding right-of-way widths. Table 15 summarizes the definitions and functions of the Study Area road network.

Table 15: Study Area Road Network Classification

Road Hierarchy	Definition	Roads	Required ROWs (m)	Proposed ROWs (m)
Arterial Road	a divided or undivided road primarily used for traffic movement and servicing moderate to large volumes of inter-City and/or through traffic at moderate speeds	Rice Road First Avenue Quaker Road	30.0	30.0
Collector Road	an undivided road where traffic movements and land access are of equal importance and serving moderate volumes of traffic at moderate speeds	Street ‘A’ Street ‘D’	24.5	21
Local Road	an undivided road primarily used for land access and serving low volumes of traffic	Street ‘B’ Street ‘C’ Street ‘E’ Street ‘F’ Street ‘G’	20	18

From Table 15, it is found that the proposed rights-of-way for the collector roads and local roads will not meet the general minimum requirements. However, Policy 6.4.2.1.D provides the opportunity for alternative designs less than the minimum standards to be considered. It recognizes circumstances alternative road designs may be approved by the City if the following can be ensured with the proposed reduced right-of-way:

1. The planned function of the road is capable of accommodating anticipated travel demand;
2. Municipal services, including maintenance and emergency services can be delivered in a safe and efficient manner;
3. The proposed right of way is consistent with planned adjacent land uses; and,
4. The road design is consistent with the Objectives and Policies of Section 6.4 of this Plan.

The subsections below discuss how the proposed roadways meet the above four requirements.

8.1.1 Travel Demand

As illustrated in Figure 18, the projected 2031 future total volumes are moderate along Street 'A' and Street 'D', especially for the segments within the proposed development, as the local roads will divert traffic heading to and from each block. To more clearly reflect the volumes along the road segments, the AADT volumes have been estimated based on the PM peak hour intersection traffic volumes at the Quaker Road at Street 'A', First Avenue at Street 'D', and Street 'A' at Street 'D' intersections for the 2031 Future Total horizon. The rule-of-thumb calculation is to sum up the two-way PM volumes along a road segment and multiply them by 10. The results are summarized Table 16.

The TAC Geometric Design Guide for Canadian Roads (2017) was used to determine the typical right-of-way, and the typical capacity of a collector road in terms of the maximum AADT. The projected AADT volumes suggest that the volumes along the collector roads are well within the AADT range for residential collectors, which accommodates up to 8,000 AADT, even at the segments closest to the arterial roads where the volumes are the highest. As the roads are not projected to be busy, additional widths beyond the proposed 21 metres are not required to provide a buffer in case of emergencies or accidents.

Table 16: AADT Estimation

Roads	Segments	Two-way PM Peak Hour Volumes	AADTs	Road Classification	Required ROWs
Street 'A'	North of Quaker Road	442	4420	Residential Collector*	20-24 m
Street 'A'	South of Street 'D'	79	790	Residential Collector*	20-24 m
Street 'D'	East of Street 'A'	79	790	Residential Collector*	20-24 m
Street 'D'	West of First Avenue	338	3380	Residential Collector*	20-24 m
*TAC Geometric Design Guide for Canadian Roads (2017) Table 2.6.5 Characteristics of Urban Roads Residential Locals: <1,000 veh/day Residential Collectors: <8,000 veh/day					

The local road intersections have not been included in the Study Area; however, based on the unit counts along each local road segment as suggested by the site layout in the block plan, it can be estimated that a two-way PM peak hour volume of 100 (or AADT of 1,000 trips threshold) will not be exceeded. The local road anticipated to serve the largest number of units is Street 'E', which provides access to a portion of the units within Blocks 17, 18, and 23, and nearly all units within of Blocks 19, 20, 21, 22, and 24. Using the proportion of the sum of the areas of these blocks relative to the sum of the areas of the entire development, the unit counts served by Street 'E' will be approximately 107, assuming a total of 275 low-density freehold residential units will be built for the entire site. With this conservative assumption, the average PM peak hour volumes along Street 'E' will be approximately 50, equivalent to an AADT of approximately 500, assuming an equal split between the two Street 'D' at Street 'E' intersections. The low volumes along the local roads can be adequately served by the proposed local road. Besides, the typical right-of-way width for local roads is within the range of 15 to 22 metres, and the proposed 18-metre right-of-way falls within this range.

Therefore, the criterion that the planned function of the road is capable of accommodating anticipated travel demand is met.

8.1.2 Municipal Services

While the ROWs have been reduced from the required 24.5 metres, they still contain sufficient widths to accommodate maintenance vehicles such as snowplow trucks and garbage trucks, and emergency vehicles such as fire trucks.

The pavement widths provided for all collector and local roads are between 7.5 metres (excluding bike lanes) and 9.0 metres, as outlined in Table 17 and Table 18. The lane widths were compared with the recommendations in the TAC Geometric Design Guide for Canadian Roads (2017).

Section 4.2 of the TAC Geometric Design Guide for Canadian Roads (2017) provided recommendations for typical lane widths for through lanes. For urban roadways that has a 60 km/h or lower design speed, the recommended lower limit is 3.0 metres. The proposed lane width for the collector roads is 3.75 metres, which is higher than the recommended lower limit of a through lane width, and lower than the practical upper limit of 4.0 metres. The Guide also noted that a minimum lane width of 3.3m is recommended regardless of the design speed or traffic volume where buses and larger trucks are expected to regularly use a lane. Therefore, the proposed collector road width will be able to accommodate the larger trucks.

Section 5.3 of the TAC Geometric Design Guide for Canadian Roads (2017) provided recommendations for typical lane widths for shared lanes. The proposed local road will have a lane width of approximately 4.5 metres that will be shared between vehicles and bicycles. Table 5.3.7 of the Guide recommended a range between 4.3 and 4.9 metres, which allows for side-by-side operation such that a motor vehicle can pass a cyclist without encroaching into adjacent lanes. The proposed local road lane width falls within this range.

A qualitative review of the zoning by-law and access guidelines in various municipalities in Ontario was used as another reference for the minimum widths typically required for these trucks to operate without obstructions. The largest design vehicle among these is typically the fire truck, which usually has a length of 12.8 metres and a width of 2.54 metres, but the Ontario Building Code only requires a minimum fire route width of 6.0 metres.

Therefore, it can be concluded that the provided pavement widths within the Primont (Thorold/Welland) Inc. development will be sufficient to accommodate the turning movements of the largest design vehicles providing municipal services for the residential development.

8.1.3 Adjacent Land Uses

The design of the streetscapes for the collector and local roads has specifically considered the mixed low-density and medium-density residential land uses that the road network will serve. The City of Welland Urban Design Guidelines were consulted to determine the cross-sections for each collector and local road.

According to the City of Welland Urban Design Guidelines, the collector road network consists of a series of lower-order municipal streets that help provide a more complete “grid” network in Welland. As the NWWSP study has established that traffic from the medium-density residential and mixed-use blocks will connect directly to the arterials, the collectors in this context will primarily serve the low-density residential neighborhoods.

The local road network constitutes neighborhood-oriented low-order roads. The City of Welland Urban Design Guidelines emphasize the importance of designing these roads as places where social interaction is encouraged, unofficial sports can coexist with typical road functions, and active transportation is embedded as part of the streetscape culture.

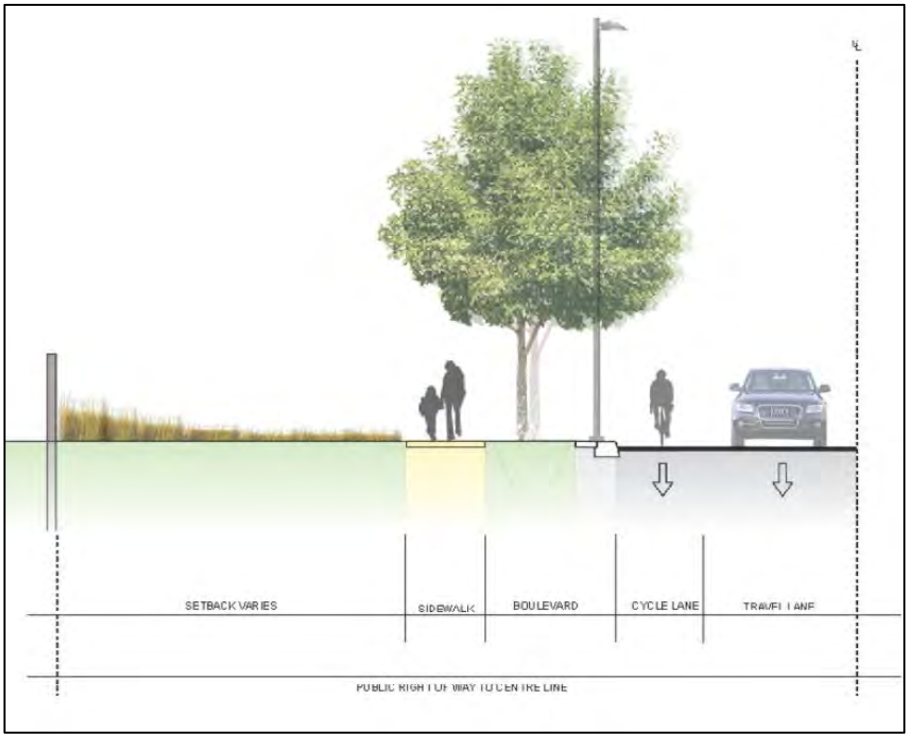
Although the widths of the collector and local roads are narrower than the City's standard rights-of-way of 24.5 metres and 20 metres, respectively, they are sufficient to include all the functions of collector roads and local roads consistent with the needs of a residential neighborhood. Efforts to improve the pedestrian environment include boulevards providing extra protection for vulnerable road users, such as the elderly and children. Dedicated 2-metre bicycle lanes are provided on both sides of collector road Street 'A' and the minor collector Street 'D', offering sufficient widths for cyclists to use the lanes safely and comfortably. In contrast, the local roads will have shared roadways for vehicles and cyclists, with the roadway width increased to 9 metres. This accommodates the mingling of all road users on local roads which are directly connected to their homes.

Table 17 provides the required right-of-way breakdown of a collector road. Figure 20 illustrates the cross-section of half of a collector road, demonstrating that the provision of a 21-metre right-of-way is sufficient to include all the functions of a collector road.

Table 17: Collector Road Right-of-Way Formation

Components	Purpose	Required Widths	Provided Widths
Setbacks	to provide a landscaped buffer between the activities of the street and adjacent land use	Not counted towards R.O.W.	NA
Public Sidewalks	to allow for appropriate pedestrian flow	1.5m to 1.8m (per side)	1.8m
Boulevards	are to be made up of low maintenance softscape including low growing grasses or lawn. Street trees will be planted in boulevards (8.0m to 12.0m on centre).	1.0m to 3.0m (per side)	2.95m
Cycle Lanes	must be incorporated into the suburban arterial streetscapes	1.5m to 2.0m (per side)	2.0m
Travel Lanes	to allow for 1 lane of traffic in each direction (2 lanes total)	3.25m to 3.75m (per lane)	3.75m
Total	-	14.5m to 21.1m	21m

Figure 20: Collector Road Cross-section



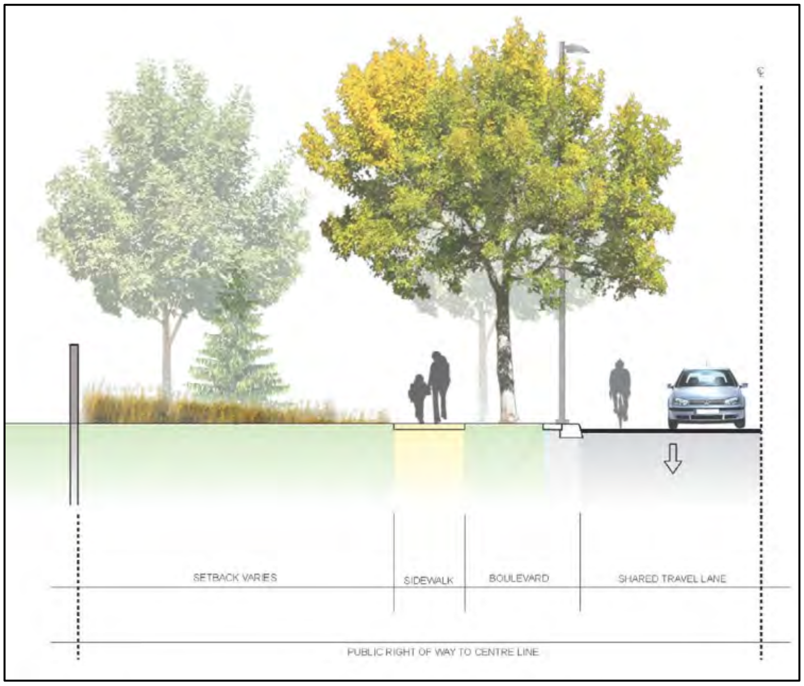
Source: City of Welland Urban Design Guidelines (2014)

According to the City of Welland Urban Design Guidelines, local roads will include the following components listed in Table 18. Figure 21 illustrates the cross-section of half of a local road, showing that the provision of an 18-metre right-of-way is sufficient to include all the functions of a local road.

Table 18: Local Road Right-of-Way Formation

Components	Purpose	Required Widths	Provided Widths
Setbacks	to provide a landscaped buffer between the activities of the street and adjacent land use.	Not counted towards R.O.W.	NA
Public Sidewalks	to allow for appropriate pedestrian flow	1.5m to 1.8m (per side)	1.8m
Boulevards	are to be made up of low maintenance softscape including low growing grasses or lawn. Street trees will be planted in boulevards (8.0m to 12.0m on centre).	1.0m to 3.0m (per side)	2.7m
Roadway	to allow for a multifunctional space that can adapt based upon local needs. This asphalt area between curbs will function as a road that provides two-way traffic, on street parking, a shared cycling network, and informal community spaces.	7.0m to 9.0m (two lanes)	9.0m
Total		12.0m to 18.6m	18m

Figure 21: Local Road Cross-section



Source: City of Welland Urban Design Guidelines (2014)

8.1.4 Planning Objectives

Although reduced ROWs have been proposed, the road design remains consistent with the Planning Objectives and Policies listed in Section 6.4 of the City of Welland Official Plan. Table 19 below summarizes how the proposed roads fulfill the applicable objectives and policies. Appendix I contains the excerpt of Section 6.4 of the City of Welland Official Plan.

Table 19: City of Welland Official Plan Planning Objectives and Policies

Planning Objectives and Policies	How the Proposed Roads Fulfill the Planning Objectives
6.4.1 Planning Objectives 6.4.1.1 To Provide a Transportation System which Supports a Variety of Modes 6.4.1.2 To Provide an Integrated Transportation System 6.4.1.3 To Create a Responsible Transportation System 6.4.1.6 To Plan for a Safe Transportation Network	• The proposed collector and local roads include sidewalks and bike lanes to encourage alternative transportation modes and reduce dependence on the automobile. • The proposed road network is consistent with the future residential land use within the Northwest Welland Secondary Plan Area. • The site layout, including the locations of the residential blocks and the collector and local roads, have been determined by balancing the network efficiency and the environmental interruption to the natural protection area. • The roads are designed to be safe and accessible. The roads will be able to accommodate all emergency response vehicles.

Planning Objectives and Policies	How the Proposed Roads Fulfill the Planning Objectives
6.4.2 Policies 6.4.2.1 Roads 6.4.2.1.A Road Classification 6.4.2.1.B Definitions for Roadway Classifications 6.4.2.1.J Roadway Functional Principles 6.4.2.1.K Provisions for Road Design 6.4.2.1.L Truck Traffic Management	• The proposed road network within the development aligns with the definitions of the road hierarchy. • The Roadway Functional Principles are generally followed, including restricting direct access from individual properties on arterial roads, ensuring adequate intersection spacing between arterial and collector roads, discouraging the intersection of local roads with arterial roads, and controlling the number and design of driveways for multi-residential and commercial uses on collector and arterial roads. • The design of roads includes provisions for the four required components: pedestrians by way of sidewalks, bicycles and other non-motorized vehicle traffic by way of dedicated and shared bike lanes, aesthetic and noise reducing applications by way of tree planting and landscaping on the boulevards, universal access and ease of movement with minimal physical and psychological obstacles, by way of sloped curbs, etc. • The traffic calming and management measures will be proposed to reduce cut through traffic and to promote safer streets. They will be considered in detail in the subsequent stages of the development application.
6.4.2.2 Transit	• The proposed development encourages the use of public transit by including intensification within the development – the apartment buildings. • The development is located near the Niagara College Bus Terminal which provides both local and regional bus services. The Transportation Assessment for the Northwest Welland Secondary Plan has recommended that expanded transit service of route 509 should be considered in conjunction with the development of the subject lands.
6.4.2.3 Cycling	• Cycling linkages are incorporated into the design of the development in a safe and efficient manner. Bicycle parking facilities will be provided for the two 12-storey apartment buildings. • New on-street cycling routes on collector roads will be designed to buffer the effect of high traffic volumes through wide cycling lane widths.
6.4.2.4 Pedestrian	• The proposed collector and local roads are pedestrian-friendly streets. Sidewalks are provided on both sides of arterials roads, collector roads, and local roads. • Sidewalks will link directly to new transit stops if the extension of route 509 or new routes is implemented.

8.2 Accesses

The accesses on Quaker Road and First Avenue are both proposed to be signalized. Although neither of the accesses are located on a Regional road, Niagara Region’s Access Management Guidelines have been used as a reference for minimum signalized intersection spacing. Table 20 summarizes the minimum required and available distances between adjacent signalized intersections. The requirements for “main street” and “urban general” road types have been used for comparison, due to their similar typology with the purpose of Quaker Road and First Avenue within the City of Welland road network.

Table 20: Access Spacings

Intersection	Desired Spacing (m)	Minimum Spacing Required (m)	Minimum Spacing Provided (m)
Quaker Road at Street A	200 – 350 m	150 – 250 m	275 m
First Avenue at Street D	200 – 350 m	150 – 250 m	475 m
*measured from centreline to centreline			

Therefore, the spacings between the proposed signalized intersections will be sufficient to avoid negative impacts on the traffic operations of existing intersections.

8.3 Daylight Triangles

The City of Welland Municipal Standards (2013) has been consulted to evaluate the site design's compliance on daylight triangles for corner lot developments fronting onto two streets. Generally, daylight triangles should have the widths summarized in Table 21 which varies depending on the classifications of the roads forming the intersection.

Table 21: Daylight Triangles

Intersection Classification	Required Widths	Provided Widths
Local to Local	3.5 m	3.5 m
Local to Collector	5.0 m	5.0 m
Collector to Collector	7.0 m	7.0 m
Local/Collector to Arterial	12.0 m	12.0 m

The site plan has been reviewed with the above requirements. It has been found that the dimensions of provided daylight triangles at all corner lots conform with the standards.

8.4 Transportation Demand Management

The proposed development is of residential land use. For this type of development, one of the most effective Transportation Demand Management (TDM) measures addresses access and usability of transit, cycling, and pedestrian facilities.

8.4.1 Transit Improvement

As mentioned in Section 3.4, most current transit routes serve the area between Quaker Road and Woodlawn Road, south of the proposed development. This area includes established residential neighborhoods and Niagara College. It is recommended that local transit routes 502, 503, and 509 expand their networks to include Quaker Road. This expansion would serve the residents in the future Northwest Welland Secondary Plan area, providing more convenient access to transit and facilitating transfers to regional routes.

8.4.2 Active Transportation

With the redevelopment of Rice Road, bike lanes and sidewalks will be implemented on both sides of the widened roadway. As First Avenue/Cataract Road is part of the future Niagara Region Bicycle Network, improvements along First Avenue north of Quaker Road can also be expected. The collector and local streets within the proposed development are designed with sidewalks and either separated or shared cycle lanes. Consequently, the neighborhood will become more pedestrian and cyclist-friendly, offering a grid that supports active transportation users and encourages more residents to adopt non-auto modes of travel.

9 Parking and Loading Provisions

9.1 Auto Parking

Per the Comprehensive Zoning By-law No. 08-12 Section 3.22.2, the parking requirements for the proposed development have been summarized in Table 22.

Table 22: Zoning By-law Parking Requirements

Land Use	Units	Minimum Parking Rate (Required)	Parking Spaces (Required)
Detached Dwelling Two-Unit Dwelling Street Townhouse Dwelling	289 - 319	1 space per unit; one of which may be provided in an attached or detached garage	289 - 319
Apartment Dwelling	422	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*	422
*Details regarding the apartment dwellings are not known at this stage. To be conservative, all units are assumed to be larger than 50.0 m^2 in gross floor area.			

It is anticipated that one parking space will be provided within the garages for the single detached and townhome units in accordance with the Zoning By-law. No need for on-street parking is expected. A total of 538 parking spaces are proposed for the medium density use, exceeding the minimum requirements.

Table 23 summarizes the accessible parking spaces required for the apartment buildings.

Table 23: Zoning By-law Barrier Free Parking Requirements

Required Parking Spaces	Minimum Required Designated Barrier Free Parking Spaces Rate	Barrier Free Parking Spaces (Required)	Barrier Free Parking Spaces (Provided)
100 or more spaces	2 spaces plus for every additional 100 required spaces, 1 additional barrier free space shall be provided	6	6

It is anticipated that the parking provisions will meet the Zoning By-law requirements.

9.2 Bicycle Parking

The City of Welland Zoning By-law has prescribed bicycle parking requirements as shown in Table 24.

Table 24: Zoning By-law Bicycle Parking Requirements

Land Use	Units	Minimum Parking Rate (Required)	Parking Spaces (Required)
Apartment Dwelling, Multiple Dwelling, Retirement Home	422	0.25 spaces per dwelling unit	106

A total of 106 bicycle parking spaces needs to be provided for the two apartment buildings to meet the Zoning By-law requirements.

9.3 Loading

The City of Welland Zoning By-law Section 6.6 prescribes that “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." Given this, one (1) off-street loading space is to be provided for each of the two 12-storey apartment buildings. Table 25 summarizes the loading space requirements.

Table 25: Zoning By-law Loading Requirements

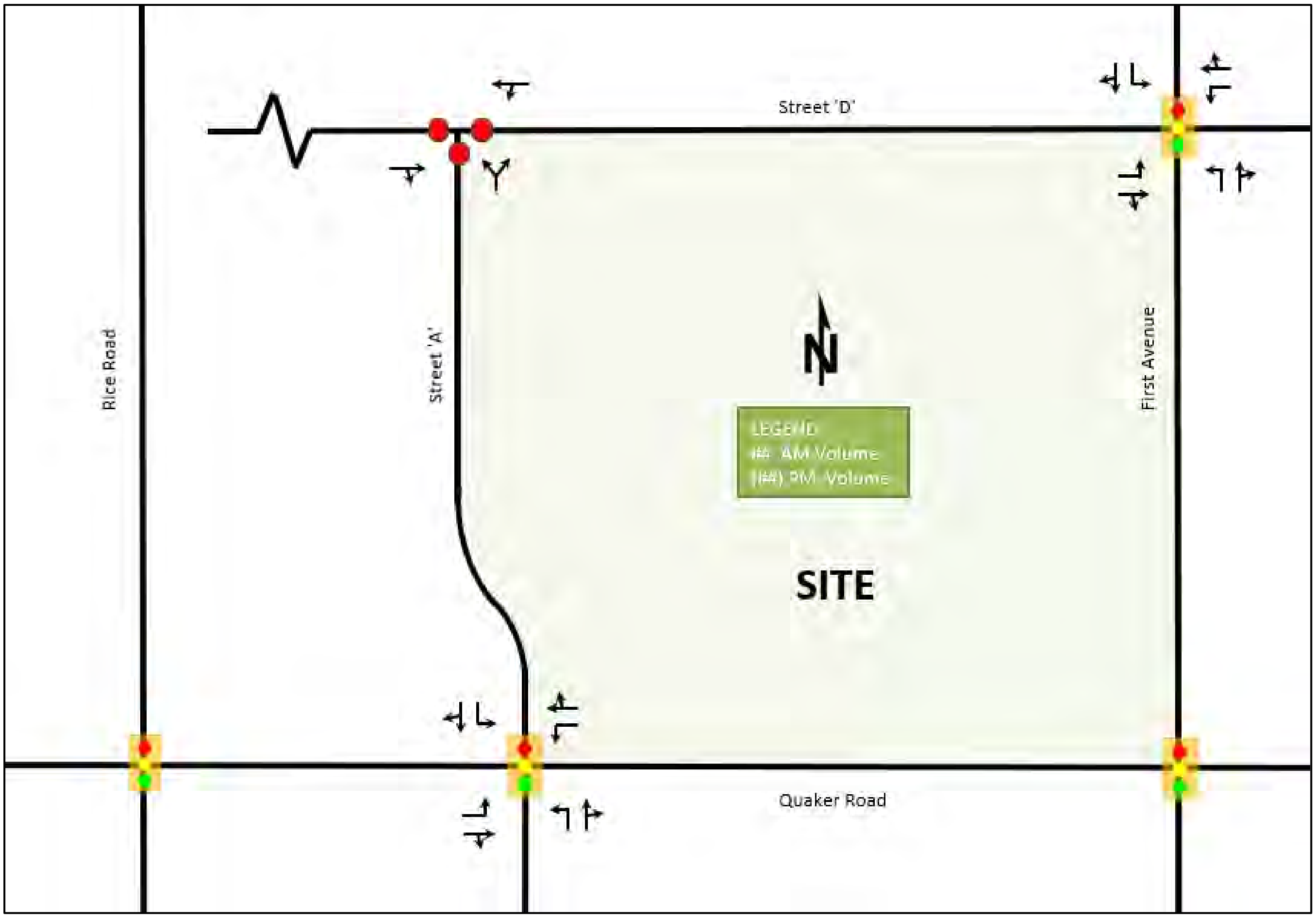
Land Use	# of Principal Buildings	Minimum Lading Space Rate (Required)	Loading Spaces (Required)	Size (m x m x m)
Apartment Dwelling, Multiple Dwelling, Retirement Home	2	1 space / principal building	2	12.0 (L) x 3.5 (W) x 4.2 (H)

It is expected that the loading spaces will be provided on the ground floor of the proposed apartment buildings in accordance with the City of Welland Zoning By-law.

10 Recommendations

It is noted that, due to the peak hour volumes along the major roads of Quaker Road and First Avenue, the intersections of Quaker Road at Street A and First Avenue at Street D are recommended to operate as signalized intersections. Dedicated left-turn lanes are recommended for all approaches as part of the signalized intersections. The recommended configurations are illustrated in Figure 22.

Figure 22: 2026 Future Total Recommended Intersection Configuration



11 Conclusions

This Transportation Impact Study has examined the trip generation, access requirements, and Study Area road network impact of the proposed Primont (Thorold/Welland) Inc. 436 Quaker Road development. The TIS has shown the following:

Introduction and Proposed Site:

- The proposed development analyzed herein is located at the northwest corner of First Avenue at Quaker Road.
- The development will include a mix of residential single detached houses, townhouses, and mid-rise apartment units. It is currently projected to contain 289 to 319 single detached homes or townhouses, and 422 apartment units. These site statistics are preliminary and will be refined in the later stages of the development application.
- The Study Area of this report is bounded by Rice Road to the west, First Avenue to the east, the Welland-Thorold boundary to the north, and Quaker Road to the south.
- The proposed development will have one full-movement access to Quaker Road, one full-movement access to the First Avenue, two connections to the future development to the west, and one connection to the to the future development in Thorold to the north.
- Anticipated completion date of the proposed development is 2026.
- A Transportation Impact Study have been completed to support a Draft Plan of Subdivision application for the proposed development.
- The appropriate scope for this study has been agreed with the City through a Terms of Reference.

Existing Conditions:

- Limited active transportation and transit facilities have been provided. Pedestrian facilities are limited to the south side Quaker Road east of the school, and both sides of First Avenue south of Quaker Road. Cycling facilities are only present along First Avenue south of Quaker Road, on both sides. Transit services are available south of the proposed development. The closest stop is approximately 200 meters south of Quaker Road.
- The turning movement counts were collected in late 2022. The existing 2024 horizon volume is based on the 2022 counts with annual growth rates applied to each approach at the Study Area intersections. Compound annual growth rates developed from the 2011 and 2031 Niagara Region travel forecast models for each road were applied to the base traffic volumes on Rice Road, Quaker Road, First Avenue.
- Based on the agreed upon scope of work, all Study Area intersections are future intersections. Therefore, no operational analysis has been conducted for existing conditions. The existing intersections have been recently analyzed through the NWWSP Transportation Assessment.

Future Background:

- The full build-out horizon of 2026 was evaluated.
- The planned road network improvements and the 2023 NWWSP report recommendations have been incorporated into the 2026 traffic models.
- The same compound annual growth rates used to calculate the 2024 horizon volumes have been used to calculate the 2026 horizon volumes.

- Apart from the subject site of 436 Quaker Road, the rest of the Northwest Welland Secondary Plan area were identified as part of the background developments that had been reflected in the annualized growth rates.
- Automobile operational analysis for the 2026 Future Background horizons indicates that the overall performance at the Study Area interactions is expected to be acceptable, except for the westbound left/right movement at the First Avenue at Street D intersection during the PM peak.

Site-generated Travel Demand Forecasting:

- An 100% auto driver mode share has been assumed for the study.
- The proposed development is anticipated to generate a total of 328 AM and 431 PM two-way vehicle trips by 2026, including 214 AM and 296 PM two-way vehicle trips for the low-density housing and 114 AM and 135 PM two-way vehicle trips for the medium-density housing.
- The distribution of site trips is estimated based on the projected 2026 AM peak hour volumes along Quaker Road and First Avenue using Niagara Region's EMME model outputs for 2011 and 2031.
- The splits of site trips between the two accesses are based on proximity from the residential lots and the accesses.

Future Total:

- All-way stops are warranted at the future Study Area intersections of Quaker Road at Street A and First Avenue at Street D, while traffic signals are not warranted. Left turn lanes are warranted at some of the approaches at the intersections and have been added to the models accordingly.
- Operational analysis shows that Quaker Road at Street A under all-way stop configurations will experience operational constraints, especially in the eastbound movements. Operational analysis projects that the First Avenue at Street D intersection will operate better than Quaker Road at Street A, but constraints are also identified on the southbound left movement.
- Signalization was examined as a mitigation strategy. Dedicated left turn lanes have been added to all approaches. These were demonstrated to be efficient as the overall LOS and delays would improve.
- The intersection of Street A and Street D was projected to operate without operational constraints. The delays and queues would be minimal under the 2026 future background and total conditions, with a significant amount of residual capacity to accommodate any potential change in travel patterns.

Block Plan Review:

- Collector roads are proposed to have a width of 21 metres throughout the Primont (Thorold/Welland) Inc. properties, which will be able to accommodate all the transportation components of a collector road cross-section.
- Local roads are proposed to have a width of 18 metres throughout the Primont (Thorold/Welland) Inc. properties, which will be able to accommodate all the transportation components of a local road cross-section.
- Policy 6.4.2.1.D of the City of Welland Official Plan permits reduced right-of-way if certain criteria are met. Evaluating the collector roads and local roads against these criteria, it is believed that the proposed reduced rights-of-way shall be permitted.
- Accesses will have sufficient spacing from the closest signalized intersections to allow for signalization.
- Potential cut-through traffic using the collector roads will be controlled with signage and traffic calming measures.

Transportation Demand Management:

- TDM measures are proposed to further encourage commuters to shift away from single occupant vehicle trips. For this development, which primarily consists of mixed-use residential land uses, the most effective measures involve access and usability of transit, cycling and pedestrian facilities.

Parking and Loading:

- A total of 319 parking spaces will be provided for the low-density residential land use and 538 parking spaces will be provided for the medium-density residential land use, both satisfying the minimum requirements.
- A total of 106 bicycle parking spaces will be required for the apartment buildings.
- Two loading space will be required for the apartment buildings.

Primont (Thorold/Welland) Inc.'s 436 Quaker Road development will have a minor impact on the Study Area road network with all the recommended network upgrades implemented. The future concept plan part of subsequent development applications will provide a good pedestrian and cycling network along with good access to transit throughout the development. It is recommended that, from a transportation perspective, the proposed development application proceed.

Prepared By:	Reviewed By:
	LICENSED PROFESSIONAL ENGINEER M. B. CROCKFORD 100152912 July 17, 2024 PROVINCE OF ONTARIO
Zhengxuan Lai, E.I.T.	Mark Crockford, P. Eng.
289-834-0646	905-251-4070
May.Lai@CGHTransportation.com	Mark.Crockford@CGHTransportation.com

Appendix A

Scope Confirmation

Technical Memorandum

To:	Taylor Meadows – City of Welland	Date:	2024-05-08
Cc:	Daniel Stummer – Primont Mark Crockford – CGH Transportation		
From:	Zhengxuan Lai	Project Number:	2022-043

Re: Primont Welland Residential Development Transportation Brief – Terms of Reference

CGH has been retained to undertake a Transportation Brief for a proposed residential development in the Town of Welland. Primont's property is bounded by Quaker Road to the south, First Avenue to the east, and the border between Welland and Thorold to the north.

The property will be developed in different phases. This application will cover all phases of the development within Welland. The proposed development will include approximately 154 single detached units, 138 townhomes of various types, and a medium-density block consisting of 422 units in total. Attachment 1 contains the preliminary block plan.

Table 1: Land Use Statistic Comparison

Phase	Location	Types	Units	Anticipated Buildout Date
1	southwest corner of the development, north of Quaker Road and south of the drainage channel	single detached homes townhomes	±75	2025
2A	north of Phase 1 and south of the Welland / Thorold boundary	single detached homes townhomes	±217	2026
2B	west of First Avenue, east of Phase 2A	Medium density	±422	2026
Total	-	-	±714	-

Access to the proposed development in this application can be facilitated via the access to Quaker Road in Phase 1 area, the access to First Avenue in Phase 2B area, the connections to the adjacent development to the west in Phase 1 and Phase 2A, and the connections to the adjacent Thorold Lands owned by the developer to the north. However, the Thorold Lands will be developed in later phases, and this study will examine the traffic operation conditions without this connection. The configuration of the access points will be analyzed and confirmed through the study. They will conform to TAC Guidelines and Welland's guidelines.

Study Context:

While typically a full Transportation Impact Study would be required for such a development, we have discovered that a study titled the *Northwest Welland Secondary Plan Transportation Assessment*, completed by Associated Engineering in December 2023, has thoroughly examined transportation conditions in the area covered by the Northwest Welland Secondary Plan (NWWSP). This study was updated from its 2020 draft version to reflect current transportation conditions, including recent traffic data and site statistics of developments in the area.

The NWWSP study area is located in the northwest quadrant of the City of Welland, bounded to the north by the city's municipal limits, to the west by Line Avenue/Clare Avenue, and to the east by the rear property line of properties fronting onto Regional Road 50 (Niagara Street). This area encompasses our proposed development and considers other developments in the Secondary Plan area anticipated for future construction as well. The proposed development is located within "Block C" in the NWWSP study and is assumed to have approximately 800 residential units. Compared to the estimated 714-unit count on the latest plan for the proposed site, the trip generation projected in the NWWSP study will be more conservative than the trip generation results with the new unit count. Additionally, the NWWSP study has a base year of 2022 and covers projections up to the future horizon of 2033, which will cover the study horizons of this study as well. Therefore, the NWWSP study has already provided a comprehensive review of traffic operations on the arterial road intersections to be included in our study, such as Rice Road at Quaker Road and Quaker Road at First Avenue, as well as the collector road intersections, and has provided recommendations regarding intersection configurations. Conducting a similar study for the same intersections would be unnecessary. A scope reduction on the TIS is proposed to the City, given the conclusions made in the NWWSP study.

The following scope of work has been prepared for review and endorsement by the City of Welland staff based on this assumption. Please let us know if you have any comments or additions. Attachment 2 includes the Northwest Welland Secondary Plan Transportation Assessment referred in the TOR.

Transportation Impact Study Requirements:

The Transportation Impact Study will be using the Regional Municipality of Niagara's *Guidelines for Traffic Impact Studies* (2012) to determine the requirements for the Transportation Impact Study. Throughout the following Terms of Reference, data and information requests are **bolded**.

Study Horizon & Peak Periods

- Base year 2024, followed by an assumed full build-out horizon of 2026.
- AM and PM peak hours will be considered.

Study Area:

- An overview of the transportation system existing conditions will be documented.
- A summary of the existing transportation planning policies within the Study Area will be identified.
- An overview of the Study Area road network will be provided including the road classification and descriptions of:
    - Rice Road
    - Quaker Road
    - First Avenue
- The following intersections will be included in the Transportation Impact Study:
    - Street 'A' at Quaker Road (Future)
    - Street 'D' at First Avenue / Cataract Road (Future)
    - Street 'A' at Street 'D' (Future) (referred to as the collector Street 'C' in the NWWSP study)

Existing Study Area Multimodal Conditions:

- Existing Turning Movement Counts will be determined for auto, heavy vehicle, pedestrian, and cycling modes, using the turning movement counts collected at the adjacent intersections in the NWWSP report. The dates of counts are listed below:
    - Rice Road at Quaker Road – Sep 14, 2022
    - First Avenue at Quaker Road – Nov 2, 2022

Proposed Development Overview:

- A description of the proposed development and any planned active mode facilities.
- Outline of land use as it relates to the development and site statistics.

Planned Infrastructure Improvements:

- The infrastructure improvements for the County's and City's arterials and intersections will follow the recommendations made in the NWWSP study, which includes:
    - Signalization of the intersection of Regional Road 54 (Rice Road) and Quaker Road with separate left turn lanes (30 metres on each approach) or a multi-lane roundabout;

  - Signalization of the intersection of First Avenue and Quaker Road with separate left turn lanes (35 metres on southbound approach and 30 metres on all other approaches) and separate right turn lanes (30 metres on the eastbound and 40 metres on the northbound approach) or a single-lane roundabout;
  - Consider the provision of either dedicated bicycle lanes (both sides) or a multi-use pathway (on one side) of Quaker Road, Regional Road 54 (Rice Road) and First Avenue, and 1.8-metre-wide sidewalks along both sides of Quaker Road, Regional Road 54 (Rice Road) and First Avenue within the NWWSP area;
  - A dedicated transit line along the entire length of Quaker Road within the NWWSP area.

Background Growth:

- The traffic growth along the Study Area corridors will follow the growth rates used in the NWWSP study.

Development Site Traffic:

- Trip generation: ITE trip generation manual 11th edition rates will be applied.
  - LUC 210 Single-Family Detached Housing for detached homes
  - LUC 215 Single-Family Attached Housing for townhouses of various types
  - LUC 222 Multi-family Housing (High-Rise) for high-rise
- Trip distribution and assignment: determined based on the existing traffic routing patterns from the TMCs and surrounding area characteristics.

Automobile Mode Performance and Analysis:

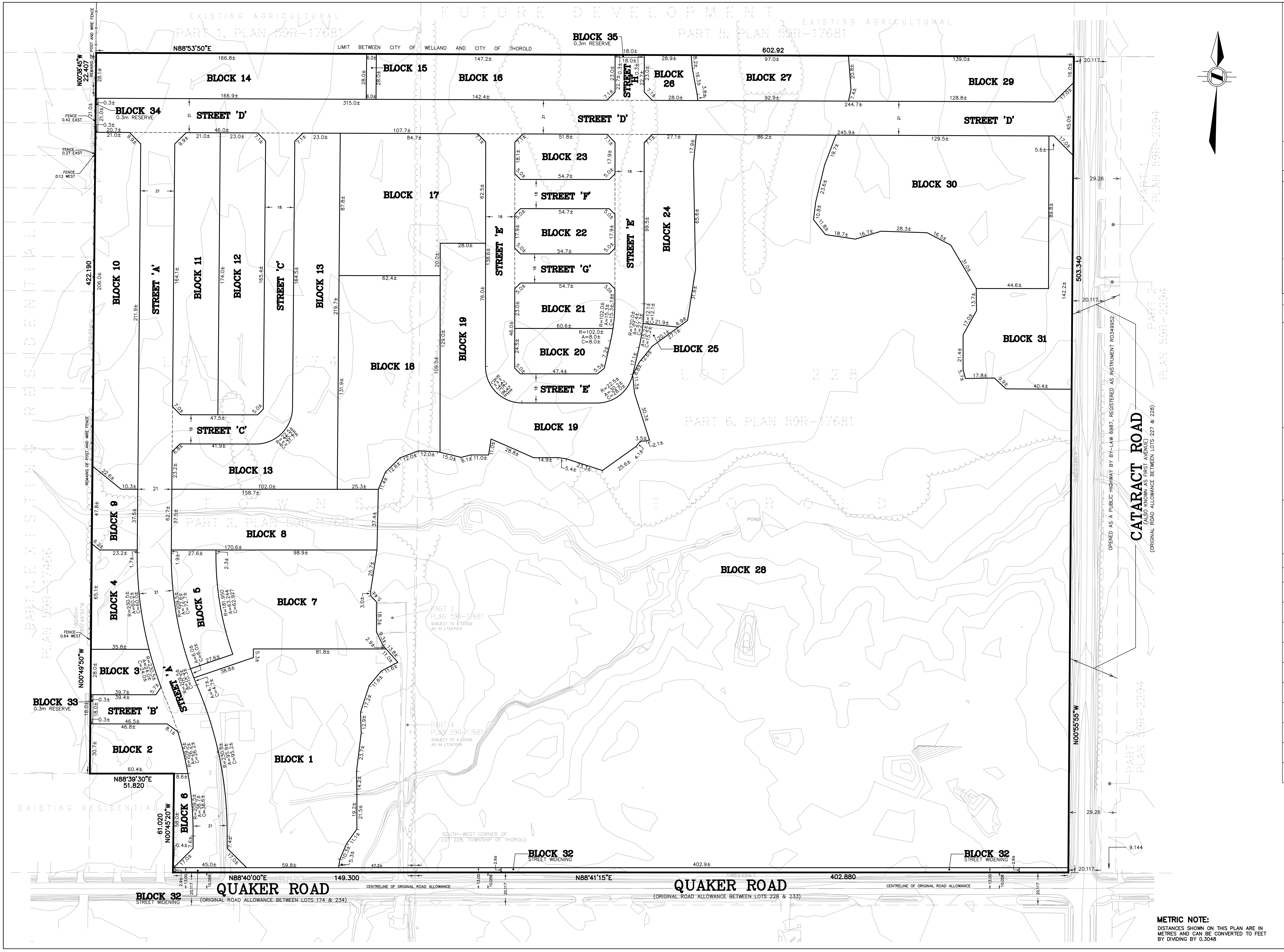
- Signal warrants and left-turn warrants will be conducted for the proposed accesses and the collector road intersection to determine their configurations.
- Traffic analysis will be performed using Synchro 11 on Study Area network intersections to determine the LOS, delay, V / C ratio and the 95th percentile queues.
  - Critical movements will be defined using intersection definitions used by Niagara's *Guidelines for Traffic Impact Studies*.
  - Heavy Vehicle % and Peak Hour Factors will be taken from the collected TMC data of the adjacent intersections. Where information is not available, a Heavy Vehicle % of 2%, and a Peak Hour Factor of 0.92 will be applied.
  - Other Synchro inputs will be based on Niagara's *Guidelines for Traffic Impact Studies*, as well as Synchro default parameters.
- Access location analysis, and concept plan circulation to be considered where necessary.
- Parking spaces for the single detached and townhome units will be provided within the garages or in front of the garages. A total of 538 parking spaces are proposed for the medium density use. The parking provision is anticipated to satisfy the City of Welland's Zoning By-law.

Recommendations, Implementation Plan, and Conclusions:

- Any recommended offsite improvements or mitigation measures, which may include physical improvements to Study Area intersections, signal timing plan optimization, pedestrian / cycling / transit amenities, safety measures etc.

Attachment 1

Preliminary Block Plan



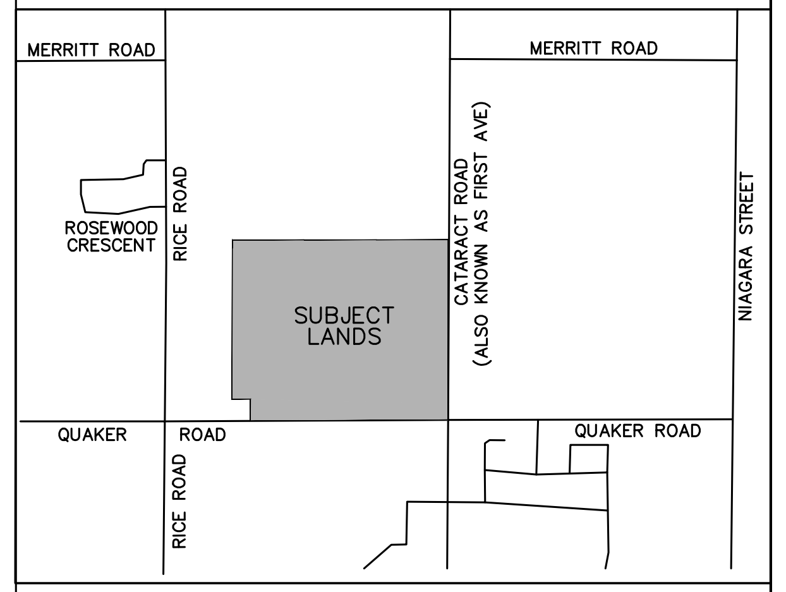
DRAFT PLAN OF SUBDIVISION

PRIMONT (THOROLD / WELLAND) INC.

PART OF TOWNSHIP LOTS 174 AND 228,
GEOGRAPHIC TOWNSHIP OF THOROLD,
IN THE CITY OF WELLAND, REGIONAL
MUNICIPALITY OF NIAGARA

SCALE 1:1000 METRIC

20 10 0 20 40 60 metres



KEY MAP - NOT TO SCALE

INFORMATION REQUIRED

UNDER SECTION 51 (17) OF THE PLANNING ACT, R.S.O. 1990. c.P.13
AS AMENDED FEBRUARY 21, 2024

(a) - AS SHOWN
(b) - AS SHOWN
(c) - AS SHOWN
(d) - AS LISTED BELOW
(e) - AS SHOWN
(f) - AS SHOWN
(g) - AS SHOWN
(h) - MUNICIPAL WATER
(i) - CLAY LOAM
(j) - AS SHOWN
(k) - MUNICIPAL SANITARY AND STORM SEWERS
(l) - AS SHOWN

SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED ON THIS PLAN AND THEIR RELATIONSHIP TO THE ADJACENT LANDS ARE ACCURATELY AND CORRECTLY SHOWN.

SIGNED ____________________

ROB A. McLAREN, O.L.S
A.T.McLAREN LIMITED

DATE ____________

OWNER'S CERTIFICATE

I HEREBY CONSENT TO THE FILING OF THIS PLAN

SIGNED ____________________

DATE ____________

LAND USE SCHEDULE

LAND USE	LOTS/BLOCKS	UNITS	AREA
LOW DENSITY RESIDENTIAL (FREEHOLD)	BLOCKS 2-5, 10-14, 16, 19, 20-24, 26 & 29	245-275±	6.144± Ha.
LOW DENSITY RESIDENTIAL (CONDOMINIUM)	BLOCK 1	44±	1.167± Ha.
MEDIUM DENSITY RESIDENTIAL	BLOCK 30	422±	1.034± Ha.
PARK LAND	BLOCK 17		0.732± Ha.
OPEN SPACE	BLOCKS 6, 15, 25		0.101± Ha.
STORM WATER MANAGEMENT	BLOCKS 7, 18, & 31		1.882± Ha.
ENVIRONMENTAL AREA	BLOCKS 27 & 28		14.547± Ha.
CHANNEL	BLOCKS 8 & 9		0.592± Ha.
ROADS, RESERVES & WIDENINGS	STREETS A, B, C, D, E, F, G, & H AND BLOCKS 32, 33, 34 & 35		3.937± Ha.
TOTAL		711-741±	30.118± Ha.

METRIC NOTE:

DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

A.T. McLaren Limited
LEGAL AND ENGINEERING SURVEYS
69 JOHN STREET SOUTH, SUITE 230
HAMILTON, ONTARIO, L8N 2B9
PHONE (905) 527-8559 FAX (905) 527-0032

Drawn	Checked	Crew Chief	Scale	
KM	RBM	SM	1:1000	Dwg.No. 36920-DP

Attachment 2

Northwest Welland Secondary Plan Transportation Assessment

CGH
TRANSPORTATION

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

REPORT

City of Welland

Northwest Welland Secondary Plan Transportation Assessment Update Preferred Plan

DECEMBER 2023

A Carbon Neutral Company

CANADA BEST MANAGED COMPANIES Platinum member

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1 INTRODUCTION

Associated Engineering (AE) was previously retained by SGL Planning and Design (SGL) to conduct a transportation assessment for the Northwest Welland Secondary Plan (NWWSP). The intended function of this report is to document the assessment of the transportation facilities within the proposed development area situated within the City of Welland's rural boundary. Because of the development of the area, it is understood that the City's urban boundary will be expanded to include these development lands.

This study was updated from the 2020 report to reflect current transportation conditions, including recent traffic data on Quaker Road at Rice Road and at First Avenue, and the revised population densities for the NWWSP.

1.1 Development Context

The NWWSP is a proposed mixed-use residential development that will provide housing for full-time residents within the City of Welland. The development area will be a community marked by sustainable transportation infrastructure through the implementation of sidewalks, cycling facilities, and/or multi-use pathways creating a unified and integrated network for all modes of transportation. The development area is comprised of approximately 190 hectares of primarily rural/agricultural designated lands. Within the project limits, there are approximately 55 hectares (or 29% of the area) of land presently developed and municipally serviced.

Situated within the northwest quadrant of the City of Welland in a currently zoned rural area, Figure 1-1 illustrates the location plan of the NWWSP. Situated to the east of the development lands, Highway 406 is accessed via Regional Road 37 (Merritt Road), Regional Road 50 (Niagara Street/Merrittville Highway), and Quaker Road. Traversing east-west to the south of the development lands is Regional Road 51 (Woodlawn Road) while Regional Road 36 (Pelham Road) traverses north-south and is located to the west of the development lands.

While single-detached residential is the predominant existing populated land use within the development lands, there are other land uses including, but not necessarily limited to: agricultural and fallow land, institutional land (Niagara Catholic District School Board, École Élémentaire Nouvel Horizon, etc.), open space and recreational land (former Welland Soccer Club), wetlands, and wooded areas. Of these non-residential land uses, agricultural lands and wooded areas are the most dominant.

Adjacent to the NWWSP development lands, the surrounding area is comprised of single-detached residential, agricultural, and fallow lands, institutional (Niagara College), open space and recreational land, and commercial. Lands to the immediate north are located within the urban boundary of the Town of Pelham (including the recent East Fonthill Secondary Plan) and City of Thorold (including the proposed Port Robinson West Secondary Plan). The East Fonthill Secondary Plan and Port Robinson West Secondary Plan are discussed further in the following section of this report.

1.2 Development Lands and Study Area

The proposed development lands are in the northwest quadrant of the City of Welland, bounded to the north by the City of Welland's municipal limits, to the west by Line Avenue/Clare Avenue, and to the east by the rear property line of those properties fronting onto Regional Road 50 (Niagara Street). The boundary of the development lands to the south is more complex which is bounded immediately north of Briarsdale Crescent, Northwood Drive, Ash Court, and the Seneca Trail before jogging to the north avoiding Rollins Drive up to Quaker Road where it continues east. Figure

1-2 illustrates the approximate location of the boundary of the development lands alongside the arterial and collector roadways within the limits.

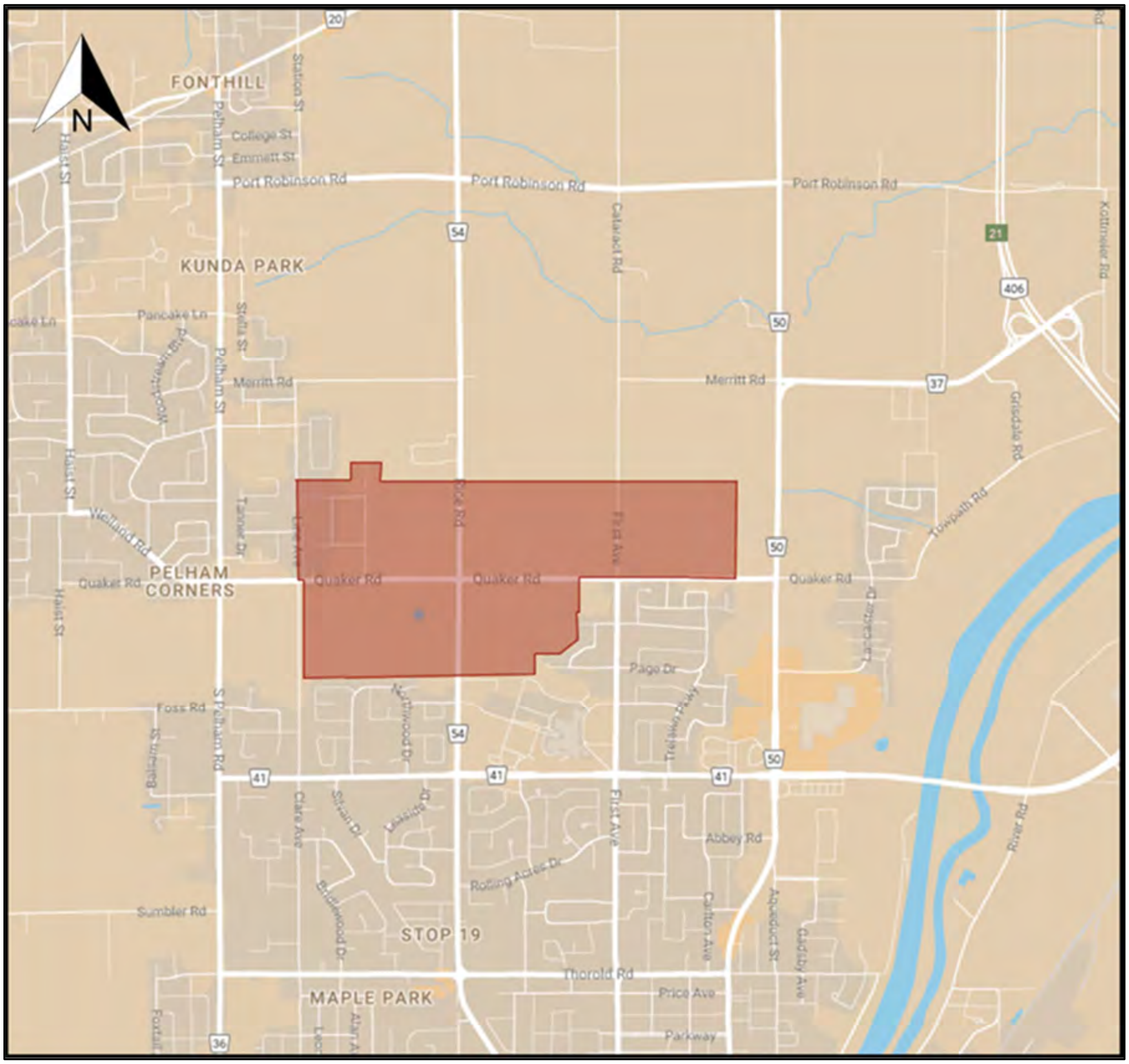

Figure 1-1: Northwest Welland Secondary Plan Location Plan

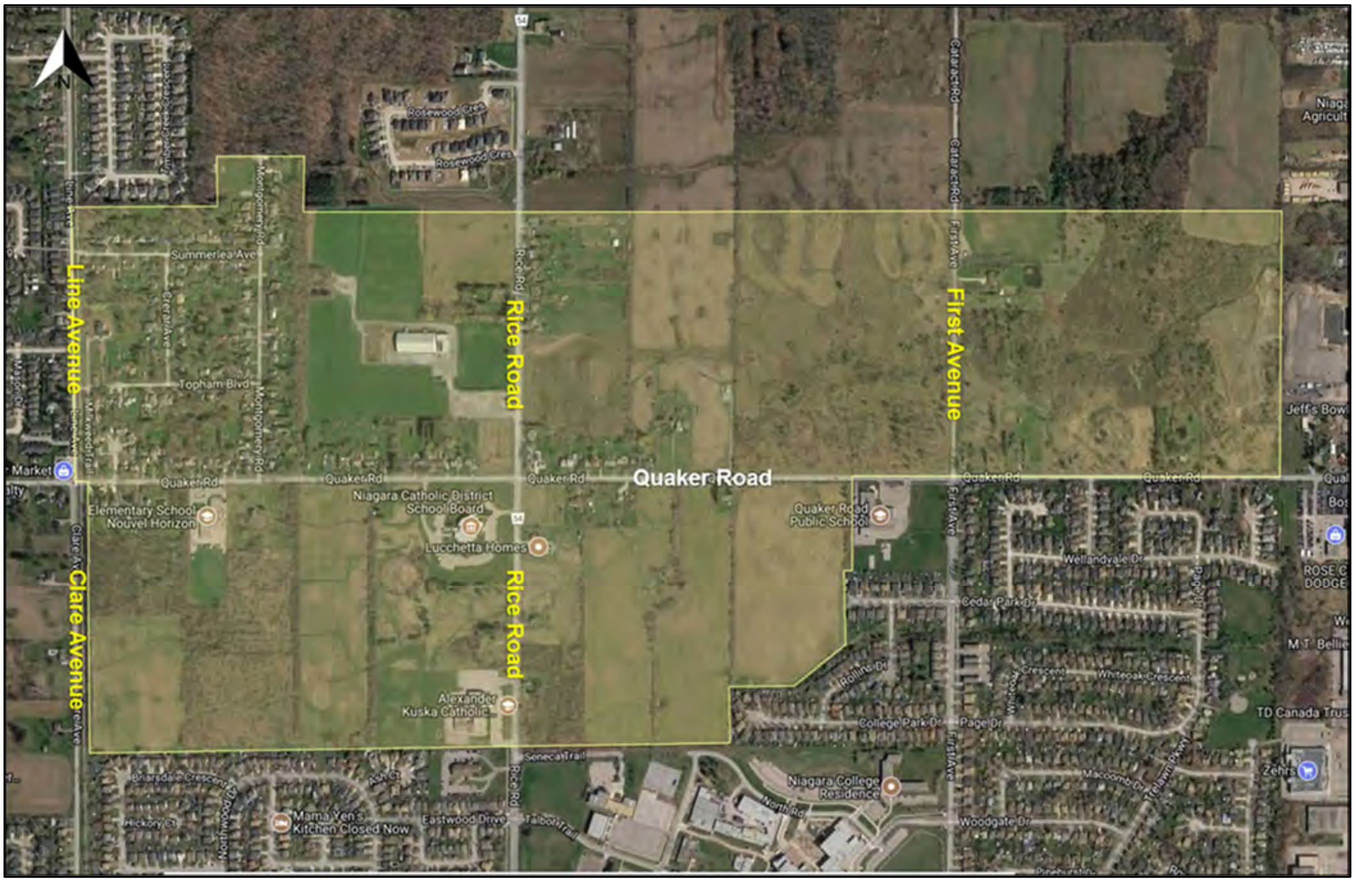

Figure 1-2: Northwest Welland Secondary Plan Development Limits

1.3 Objectives and Transportation Assessment

To effectively understand the existing and proposed state of the transportation infrastructure within the NWWSP development lands, the following objectives are set forth for the transportation assessment documented within this report:

Base Year (2022), Background Traffic Conditions

- Collect and analyze eight (8) hour turning movement counts (TMCs) and twenty-four (24) hour automated traffic recorder (ATR) data including traffic volume, vehicle classification, and observed speed for the intersections and midblock roadway sections within the study area during the weekday morning (AM) and afternoon (PM) peak hours;
- Assess traffic operations during the base year (2022) for background traffic volumes to set a benchmark for comparison to the anticipated level of service for future years before and after the full-build out of the development lands; and
- Undertake a detailed field investigation to document and review existing conditions in terms of roadway geometry, roadway cross-section, intersection control, and presence of active transportation facilities, and transit service.

Horizon Year (2033), Background Traffic Conditions

- Project base year (2022) background traffic volumes to horizon year (2033) background traffic volumes based on projected traffic conditions on key roads within the study area.

Horizon Year (2033), Development Traffic Conditions

- Determine the trip generation and trip attraction with regards to the proposed land use(s) using the Institute of Transportation Engineers Trip General Manual; and
- Determine the trip distribution of the development traffic volumes based on directional splits in the 2033 background traffic data and existing travel patterns derived from the eight (8) hour TMCs for the study area intersections.

Horizon Year (2033), Total Traffic Conditions

- Assess traffic operations during the horizon year (2033) for total traffic volumes (background plus development) and compare to the horizon year (2033) background traffic conditions to identify changes to the level of service experienced because of development-related growth within the area; and
- Assess the capabilities of the existing transportation infrastructure to accommodate all types of road users ranging from the increased vehicular volume at intersections as well as how the traffic accesses the existing road network to the presence of pedestrians and cyclists because of the sustainability-focused design of the development lands.

2 EXISTING TRANSPORTATION INFRASTRUCTURE

The following section documents the state of the existing multi-modal transportation infrastructure within the study area and assesses the performance of the subject intersections through the utilization of the existing traffic data and traffic modelling software. Furthermore, the following subsections describe and discuss the existing transportation network.

2.1 Roadway Classification

Within the development lands, the major existing roadways are Quaker Road, Regional Road 54 (Rice Road), and First Avenue. Immediately outside of the western boundary of the study area is Line Avenue/Clare Avenue. Each of the three north-south roadways (Rice Road, First Avenue, Clare Avenue) intersects Quaker Road at a four-legged intersection. It is noted that Line Avenue/Clare Avenue is marginally offset between the north and south approaches.

The twenty-four (24) hour ATR data provided by the Regional Municipality of Niagara and the City of Welland was used to determine the roadway classifications per the Transportation Association of Canada's Geometric Design Guide for Canadian Roadways, 2017. Table 2-1 summarizes the traffic volume and resulting roadway classification based on the average annual daily traffic (AADT) volumes.

Table 2-1: Existing Roadway Classification

Roadway	From/To Roadways	Year	AADT	Classification
Quaker Road	Line Avenue/Clare Avenue to Regional Road 54 (Rice Road)	2017	6,000	Rural Arterial
Quaker Road	First Avenue to Regional Road 50 (Niagara Street)	2017	9,100	Rural Arterial
Regional Road 54 (Rice Road)	Port Robinson Road to Quaker Road	2016	7,500	Rural Arterial
Regional Road 54 (Rice Road)	Quaker Road to Regional Road 41 (Woodlawn Road)	2016	7,700	Rural Arterial
First Avenue	Regional Road 37 (Merritt Road) to Quaker Road	2017	3,400	Rural Collector
First Avenue	Quaker Road to Regional Road 41 (Woodlawn Road)	2017	6,000	Urban Collector

Two (2) major regional roadways are located to the west and east of the study area: Regional Road 36 (Pelham Street) and Regional Road 50 (Niagara Street), respectively. Regional Road 36 (Pelham Street) is an arterial roadway that has an approximate AADT volume of 12,000 to 13,000 vehicles per day, while Regional Road 50 (Niagara Street) is an arterial roadway that has an approximate AADT volume of 15,000 to 18,000 vehicles per day. Line Avenue/Clare Avenue carries approximately 2,400 vehicles per day and would be considered a rural collector. Given their proximity to the development lands, traffic data was assessed since they are roadways likely to be impacted by the development traffic.

2.2 Roadway Cross-Section and Intersection Control

Within the study development lands, there are three (3) primary roadways that will be impacted because of the additional traffic generated by the NWWSP: Quaker Road, Regional Road 54 (Rice Road), and First Avenue.

Quaker Road is currently a two-lane roadway comprised of a rural cross-section bisecting east-west through the middle of the study area. Figure 2-1 illustrates the typical roadway cross-section throughout the corridor. As per the traffic data, Quaker Road operates as a rural arterial roadway with traffic volumes in the range of 6,000 to 9,000 vehicles per day. From west to east, Quaker Road intersects with Regional Road 36 (Pelham Street) under traffic signal control, Line Avenue/Clare Avenue under all-way stop control, Regional Road 54 (Rice Road) under all-way stop control, First Avenue under all-way stop control, and Regional Road 50 (Niagara Street) under traffic signal control. All minor intersections along this corridor operate under stop control for the minor roadway approaches only. Under existing conditions, Quaker Road operates with a posted regulatory speed limit of 50 kilometres per hour except for the school zones where School Zone Maximum Speed When Flashing signs are present, reducing the speed to 40 kilometres per hour. In general, Quaker Road has a relatively straight and flat alignment within the study area.

Regional Road 54 (Rice Road) is currently a two-lane roadway comprised of a rural cross-section traversing north-south through the study area. Figure 2-2 illustrates the typical roadway cross-section throughout the corridor. As per the traffic data, Regional Road 54 (Rice Road) operates as a rural arterial roadway with traffic volumes in the range of 7,500 to 7,700 vehicles per day. Under existing conditions, Regional Road 54 (Rice Road) operates with a posted regulatory speed limit of 50 kilometres per hour and 40 kilometres per hour to the north and south of Quaker Road, respectively. In general, Regional Road 54 (Rice Road) has a relatively straight and flat alignment within the study area.

First Avenue is currently a two-lane roadway comprised of a rural cross-section (north of Quaker Road) and an urban cross-section (south of Quaker Road) traversing north-south through the study area. It is noted that only the section of First Avenue north of Quaker Road is situated within the study area. Figure 2-3 illustrates the typical roadway cross-section throughout the corridor. As per the traffic data, First Avenue (north of Quaker Road) operates as a rural collector roadway with traffic volumes of approximately 3,400 vehicles per day. First Avenue (south of Quaker Road) operates as an urban collector roadway with traffic volumes of approximately 6,000 vehicles per day. Under existing conditions, First Avenue operates with a posted regulatory speed limit of 50 kilometres per hour north of Quaker Road and 40 kilometres per hour south of Quaker Road. In general, First Avenue has a relatively straight and flat alignment within the study area.

As previously indicated, the intersections of Quaker Road with Regional Road 54 (Rice Road) and First Avenue currently operate under all-way stop control. All other minor roadways within the development lands operate under stop control along the minor roadway. The signalized intersections of Quaker Road with Regional Road 36 (Pelham Street) and Regional Road 50 (Niagara Street) were included in the scope of this assessment due to their proximity to the development lands and likelihood that they will provide a link to the arterial road network. The intersection of Regional Road 50 (Niagara Street/Merrittville Highway) and Regional Road 37 (Merritt Road) is also signalized and included because of its strategic importance as a gateway intersection from Highway 406 into the northwest quadrant of Welland. Figure 2-4 illustrates the intersection control at the subject intersections within and around the development lands. Eight (8) hour TMCs and traffic signal phasing and timing plans (as applicable) were requested for each of these intersections.

Refer to Appendix A for the traffic data collected as part of this study.

Figure 2-1: Quaker Road Cross-Section (View to West at Montgomery Avenue)

Figure 2-2: Regional Road 54 (Rice Road) Cross-Section (View to South at Quaker Road)

Figure 2-3: First Avenue Cross-Section (View to North Near Quaker Road)

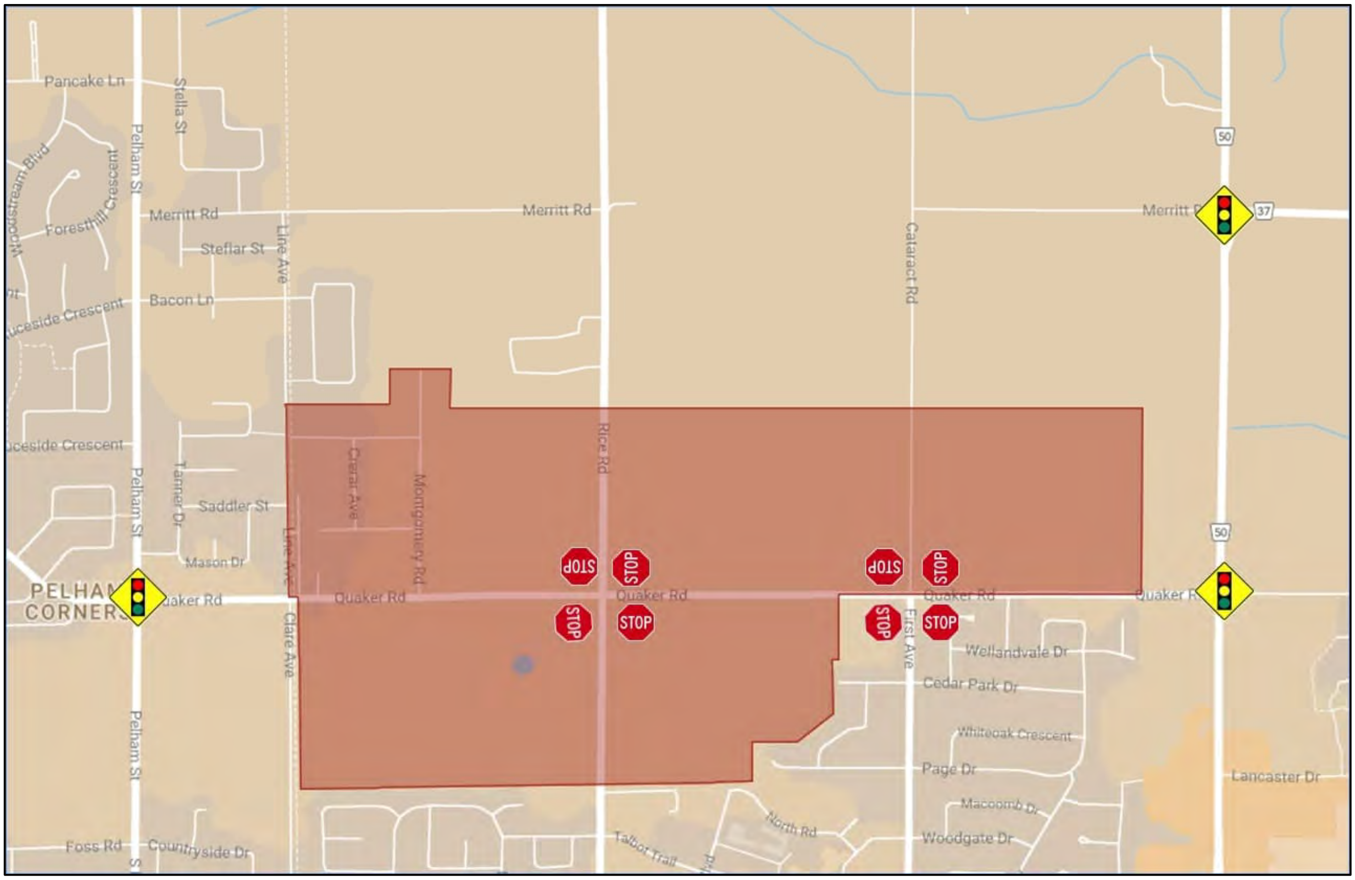

Figure 2-4: Existing Intersection Control

2.3 Active Transportation Facilities

Along Quaker Road, limited active transportation facilities are present. There is a separated segment of granular pathway on the north side of Quaker Road between Regional Road 54 (Rice Road) and 622 Quaker Road with a ladder crosswalk providing access to École Élémentaire Nouvel Horizon. No dedicated cyclist facilities have been provided along Quaker Road.

With regards to the north-south roadways within or adjacent to the development lands:

- Regional Road 54 (Rice Road) has no active transportation facilities present;
- First Avenue, north of Quaker Road, has no active transportation facilities present;
- First Avenue, south of Quaker Road has semi-mountable curbs, concrete sidewalks, and bicycle lanes on both sides of the roadway; and
- Clare Avenue/Line Avenue has semi-mountable curbs with a concrete sidewalk on the west side of the roadway north of Quaker Road, while the Steve Bauer Trail (a multi-use trail maintained by the Town of Pelham) is situated alongside the east side of the roadway.
- Niagara Street, south of Quaker Road, has concrete sidewalks on both sides of the roadway. Niagara Street, north of Merritt Road, has paved shoulders on both sides of the roadway. Pedestrian phases are present on all approaches at the Niagara Street and Quaker Road intersection.
- Pelham Street, south of Quaker Road, has a concentre sidewalk on the west side of the roadway.
- Merritt Road has no active transportation facilities present.

None of the remaining minor roadways within the development lands have sidewalks or cyclist facilities. According to the Regional Municipality of Niagara's *Strategic Cycling Network Development Technical Paper (2017)*, First Avenue/Cataract Road was confirmed as a candidate for enhanced cyclist facilities.

Opportunities exist to provide or improve active transportation facilities within the development lands to accommodate pedestrians and cyclists more effectively.

2.4 Transit Routes and Facilities

On January 1st, 2023, the new Niagara Region Transit (NRT) consolidated all previous transit systems in the Region including Niagara Region Transit, St. Catharines Transit, Welland Transit and Fort Erie Transit into one transit operator. The existing transit service within and around the development lands is depicted in Figure 2-5.

Within the NWWSP, the only sections of roadway serviced by NRT is along Quaker Road between First Avenue and Regional Road 50 (Niagara Street). NRT Route 509 Niagara St. travels between Quaker Road and the Welland Downtown Bus Terminal with important stops at Niagara College Welland Campus and Seeway Mall. The closest bus stop is located on the north side of Quaker Road, approximately 50 metres west of Niagara Street. The route offers regular service with buses arriving every 30 minutes during the daytime from Monday to Saturday, and every 60 minutes in the evenings from Monday to Saturday and all day Sunday.

There are also regional NRT bus routes that travel through the study area but no stops within the NWWSP area. Route 70/75 travels between the City of St. Catharines and the City of Welland with bus stops just outside the NWWSP area. Route 60A/65A is an express bus that travels between Niagara College Welland Campus and the Morrison-Dorchester Hub in the City of Niagara Falls.

Opportunities exist to provide or improve transit routes and facilities within the development lands to accommodate transit users more effectively.

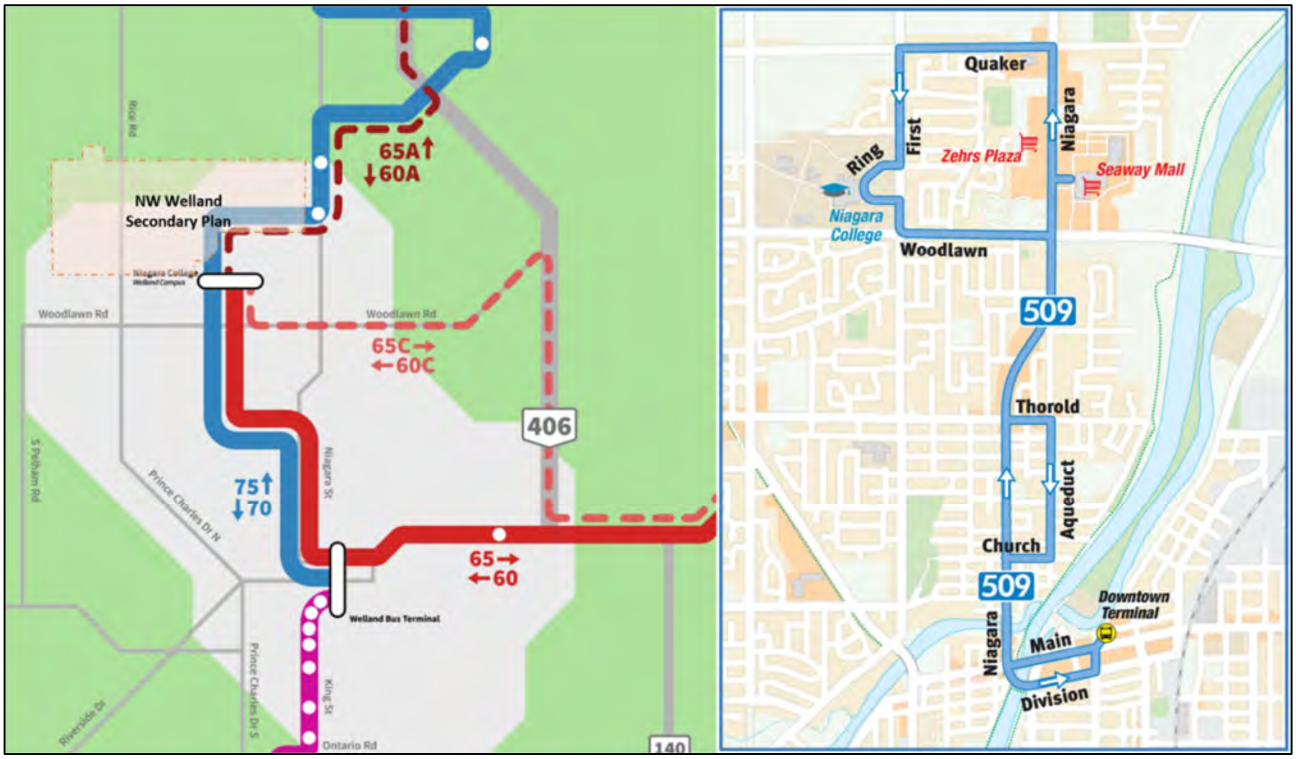

Figure 2-5: Existing Transit Routes and Facilities

2.5 Turning Movement Counts and Traffic Signal Timing Plans

The Regional Municipality of Niagara and the City of Welland provided eight (8) hour turning movement counts for each of the five (5) intersections identified within or adjacent to the development lands which may be impacted because of the NWWSP development. Table 2-2 highlights the weekday one-hour morning (AM) and afternoon (PM) peak traffic periods.

Additionally, the Regional Municipality of Niagara provided traffic signal timing plans for the signalized intersections.

Table 2-2: Existing Weekday (AM) and Afternoon (PM) Peak Traffic Periods

Intersection	AM Peak Hour	PM Peak Hour
Regional Road 50 (Rice Road) and Quaker Road	8:00 a.m. –9:00 a.m.	4:00 p.m. –5:00 p.m.
First Avenue and Quaker Road	8:00 a.m. – 9:00 a.m.	4:15 p.m. – 5:15 p.m.
Regional Road 36 (Pelham Street) and Quaker Road	8:00 a.m. – 9:00 a.m.	5:00 p.m. – 6:00 p.m.
Regional Road 50 (Niagara Street) and Quaker Road	8:00 a.m. – 9:00 a.m.	4:15 p.m. – 5:15 p.m.
Regional Road 50 (Niagara Street/Merrittville Highway) and Regional Road 37 (Merritt Road)	7:45 a.m. – 8:45 a.m.	4:30 p.m. – 5:30 p.m.

2.6 Traffic Analysis Methodology

Within the roadway network, intersections are typically the critical capacity control points. The five (5) intersections previously discussed have been analyzed to determine the existing level of service, average vehicular delay, and any capacity constraints as measured by volume-to-capacity ratios using Synchro 12 and SimTraffic 12. The capacity analysis results are based on the Highway Capacity Manual (HCM) 6th Edition methodology. All the traffic operations modelling is per the Regional Municipality of Niagara's *Guidelines for Traffic Impact Studies (2012)*.

2.7 Base Year 2022 Background Traffic Conditions

Figure 2-6 illustrates the turning movement counts during the weekday morning (AM) and afternoon (PM) peak hours used within the traffic operations assessment. From Figure 2-6, it is apparent that the heaviest traffic flows are along Regional Road 37 (Merritt Road) and Regional Road 50 (Niagara Street) stressing the importance of these corridors as connectors to the Provincial Highway Network and as a gateway into the northwest quadrant of Welland. Traffic flows are approximately balanced between the north-south and east-west movements at the subject intersections.

Level of Service (a performance measure based on delay) was calculated for each approach and movement. Level of Service is a qualitative measure of traffic flow at an intersection and is dependent upon vehicular delay and vehicle queue lengths on the various intersection approaches. The values range from a Level of Service of A (little or no delay) to Level of Service of F (congested conditions with significant delay). Appendix B provides further information on the Level of Service definitions (A through F). The Level of Service for each intersection is presented by approach and movement in Figure 2-7.

The analysis indicates that, overall, the three intersections outside of the NWWSP are all operating below capacity with an adequate Level of Service; all movements noted as being a Level of Service of B or better.

Within the NWWSP area, the intersection of Rice Road and Quaker Road is experiencing a Level of Service of F on all approaches during the PM peak. This indicates a congested state and that long delays are occurring during the PM peak hour. The delays are between 69-112 seconds (per vehicle on average). The northbound and southbound approaches are operating over capacity, while the eastbound and westbound approaches are operating near capacity. At the First Avenue and Quaker Road intersection, the Level of Service is F for the westbound approach in the PM peak, where the delay is 51.5 seconds (per vehicle on average). Appendix B provides the traffic operations assessment reports for the base year 2022 background traffic.

2.8 Traffic Control Signal Justifications

The intersections of Quaker Road with Regional Road 54 (Rice Road) and First Avenue are currently operating under all-way stop control. The justification for installing traffic signals was evaluated per the Ontario Ministry of Transportation's Ontario *Traffic Manual, Book 12: Traffic Signals (2012)*. Based on the 2022 turning movement counts provided by the City, both intersections satisfy the minimum 8-hour vehicular volumes warrant. The results, provided in Appendix C, indicate that, in the base year 2022, background traffic conditions, traffic control signals are justified for both intersections.

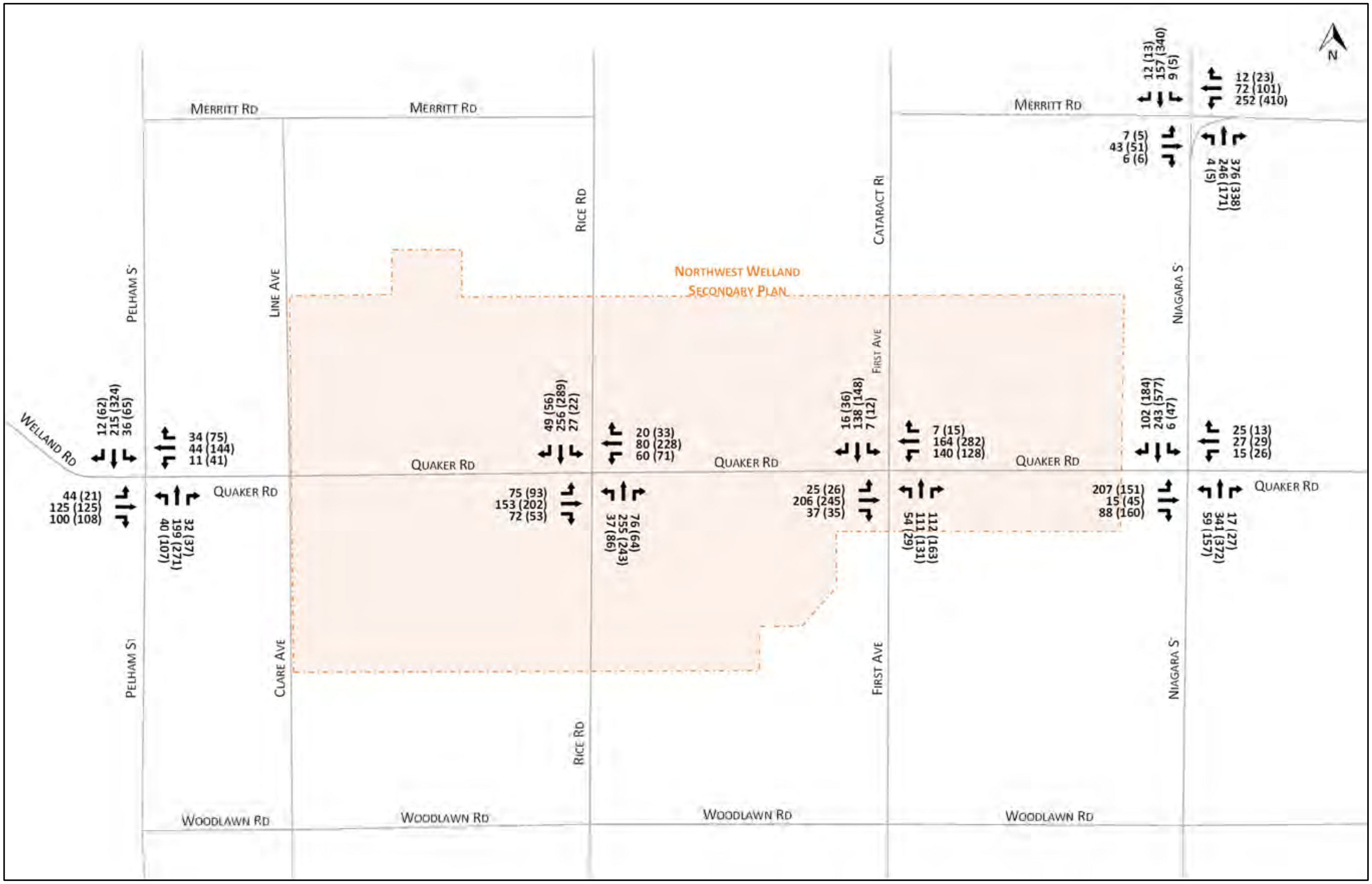

Figure 2-6: Base Year 2022 Background Traffic AM (PM) Peak Hour Turning Movement Volumes

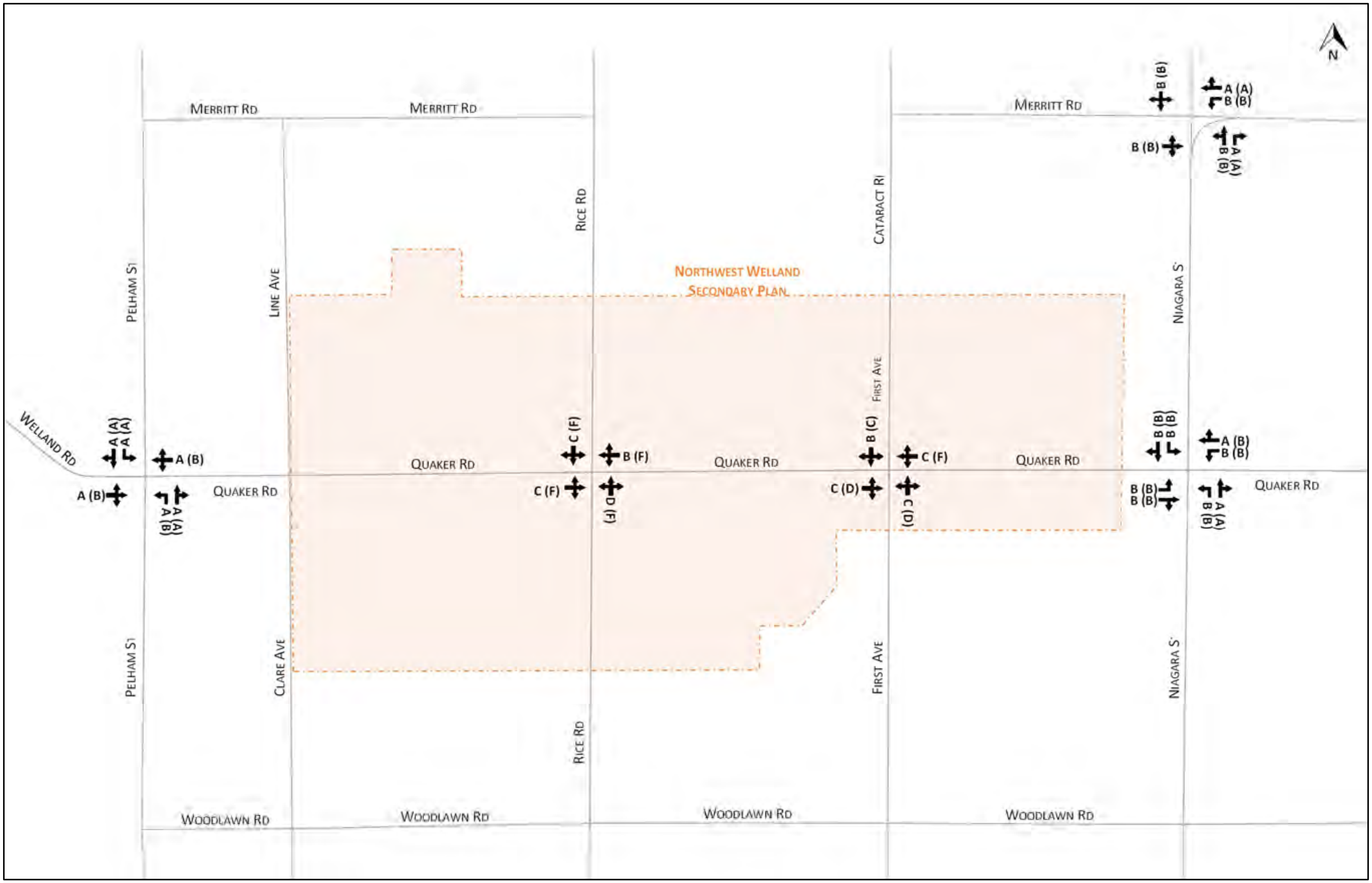

Figure 2-7: Base Year 2022 Background Traffic AM (PM) Peak Hour Levels of Service

2.9 Surrounding Development and Anticipated Impacts to Traffic

As part of the transportation assessment, the surrounding area was reviewed in terms of proposed developments and the impact of the associated traffic would have on the NWWSP.

2.9.1 East Fonthill Secondary Plan

The East Fonthill Secondary Plan was included in the Town of Pelham Official Plan and adopted in 2014.

Existing lands within the East Fonthill Secondary Plan are categorized as either “greenfield” or “intensification” zones. The Land Use Plan describes scheduled land uses within the secondary plan area, and includes a mix of low, medium, and high-density residential areas, environmental protection zones, mixed-use commercial centres, and public parkland. The most dominant of these are low-density residential areas and environmental protection zones. With the implementation of the Secondary Plan, the entire area within the Secondary Plan is expected to achieve a minimum gross density of 50 persons and jobs combined per hectare.

The residential growth within the East Fonthill Secondary Plan is limited to a maximum of 3,000 residents and jobs combined by 2021, 4,500 residents and jobs combined by 2026, and 5,350 residents and jobs combined by 2031. The growth within the Commercial/Employment Centre is limited to a maximum of 785 residents and jobs combined by 2021, and a maximum of 1,190 residents and jobs combined by 2031.

It is anticipated that traffic generated by the East Fonthill Secondary Plan will result in a future increase in traffic flow along Regional Road 54 (Rice Road) through the study area.

2.9.2 West Port Robinson Secondary Plan

The West Port Robinson Secondary Plan was included in the City of Thorold Official Plan and adopted in 2016.

Existing lands within the Port Robinson West Secondary Plan are considered “greenfield”. The lands generally include a mix of low, medium, and high-density residential properties, institutional, mixed-use commercial, industrial, and environmental protection zones. The most dominant of these are low-density residential and environmental protection zones. With the implementation of the Secondary Plan, the residential areas are expected to achieve a gross density of 50 persons and jobs combined per hectare.

The Secondary Plan area is expected to generate approximately 12,500 people and jobs, divided into 8,500 people for residential areas, 2,400 jobs for employment areas, and 1,850 jobs for commercial areas. The employment area is expected to develop as a Business Park and include both light industrial uses and office uses.

It is anticipated that traffic generated by the West Port Robinson Secondary Plan will result in a future increase in traffic flow along Regional Road 50 (Niagara Street) through the study area.

2.9.3 Niagara College, Welland Campus

The Niagara College, Welland Campus is located between Regional Road 54 (Rice Road) and First Avenue on Regional Road 41 (Woodlawn Road). According to the City of Welland, they have not been made aware of any significant expansion plans at Niagara College, Welland Campus that would result in significant impacts on traffic operations within the study area.

2.9.4 Regional Road 37 (Merritt Road) Extension

In the Regional Municipality of Niagara's *Transportation Master Plan (TMP), Subarea Analysis Summary (2017)*, it was recommended that the Capital Budget 2017 include a project to construct a new connector roadway, extending Regional Road 37 (Merritt Road) between Regional Road 54 (Rice Road) and Cataract Road. The TMP indicated that design and construction of this extension is planned within the 2017-2021 phase (to be updated as part of the MCEA, Spring 2024). As of today, the design of the Merritt Road extension is currently being assessed as part of the Environmental Assessment study for Merritt Road between Rice Road and Highway 406 as discussed in the next section. This is expected to significantly impact traffic operations in the surrounding area, as the section would be a candidate to become a Regional Roadway and act to relieve Regional Road 20 of additional capacity heading towards Highway 406.

2.9.5 Merritt Road (Regional Road 37) and Rice Road (Regional Road 54) Widening

Niagara Region is undertaking a Schedule C Municipal Class Environmental Assessment, including a detailed transportation assessment for Merritt Road (Regional Road 37) and Rice Road (Regional Road 54) in Pelham, Thorold, and Welland. The study was initiated in December 2020 and three Public Information Centre sessions were conducted in 2021. The Environmental Study Report is anticipated to be completed in Spring 2024. The objectives of the study are to identify intersection improvements, provide a direct connection between Rice Road and Highway 406 via Merritt Road, and provide dedicated active transportation facilities.

The preliminary indication (to be confirmed through the MCEA) for preferred design for Rice Road between Quaker Road and Merritt Road is a four-lane cross-section with a two-way cycle track on the west side and sidewalks on both sides of the roadway with an anticipated completion date of 2041. At the Rice Road and Quaker Road intersection, left-turn lanes are recommended on all approaches with the south leg widened to four lanes to transition to the four-lane cross-section north of Quaker Road.

The preliminary indication (to be confirmed through the MCEA) for preferred design for Merritt Road between Rice Road and Merrittville Highway/Niagara Street is a two-lane cross-section with a two-way cycle track and sidewalk on the north side of the roadway. Between Merrittville Highway/Niagara Street and Grisdale Road, the preliminary preferred design is a four-lane cross-section with a two-way cycle track and sidewalk on the south side of the roadway. At the Merrittville Highway/Niagara Street and Merritt Road intersection, the potential design includes eliminating the channelized island in the southeast corner, replacing the northbound right-turn slip lane with a standard auxiliary right-turn lane, and adding separate left-turn lanes at the northbound, southbound, and eastbound approaches. The west leg is widened to four lanes to transition to the four-lane cross-section east of Merrittville Highway/Niagara Street. Pedestrian and cyclist crossings will be provided on all approaches at the intersection.

3 PREFERRED PLAN

Figure 3-1 shows the preferred plan representing the full build-out of the NWWSP. A series of collector roads have been proposed that will service low density residential development within the development. The collector roads will provide new points of access and create new intersections (based on preliminary design options): on Clare Avenue and Regional Road 54 (Rice Road) south of Quaker Road; on Quaker Road between Regional Road 54 (Rice Road) and First Avenue; and First Avenue, north of Quaker Road.

Medium density development (townhouse and condominium complexes) will be located along Quaker Road, with direct access to Quaker Road. Low density development (single family dwellings) will be located along the collector roads or local roads (not shown in the preferred land use plan). Mixed use development will be located on the northwest, northeast and southeast quadrants of the intersection of Quaker Road and Regional Road 54 (Rice Road).

Given the above, for the traffic analysis relating to the collector roads, these roads were given a name Street 'A', Street 'B', Street 'C' and Street 'D' as shown in Figure 3-2, corresponding to Blocks A through D. It has also been assumed that all medium density development will have direct access onto the existing road network (Regional Road 54 (Rice Road), Quaker Road or First Avenue). The collector roads will provide access to the low-density development (single family dwellings) except for single-family development located on the west side of Rice Road. SGL indicated the total number of single-family dwelling units located within the NWWSP.

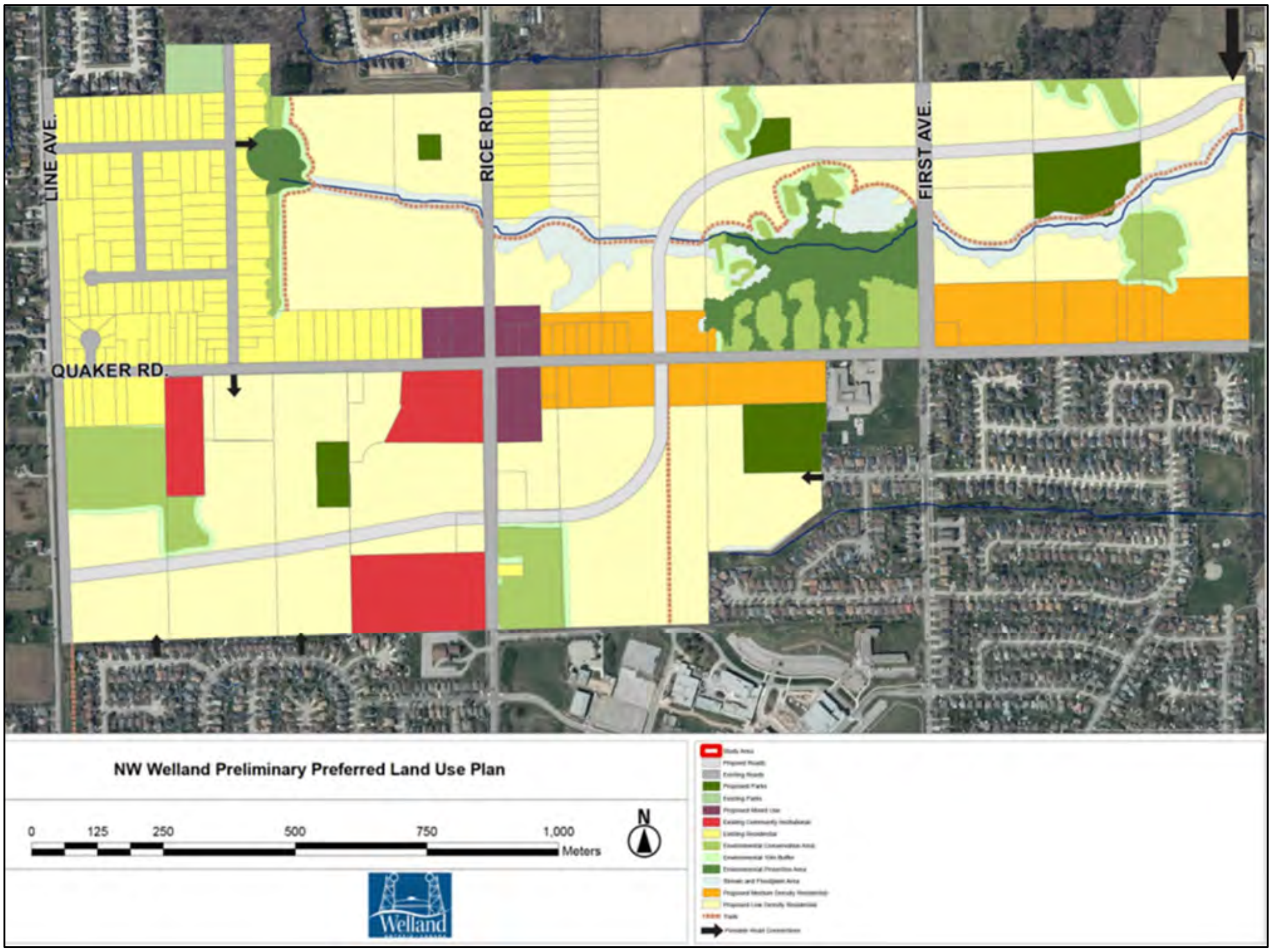

Figure 3-1: Preferred Land Use Plan

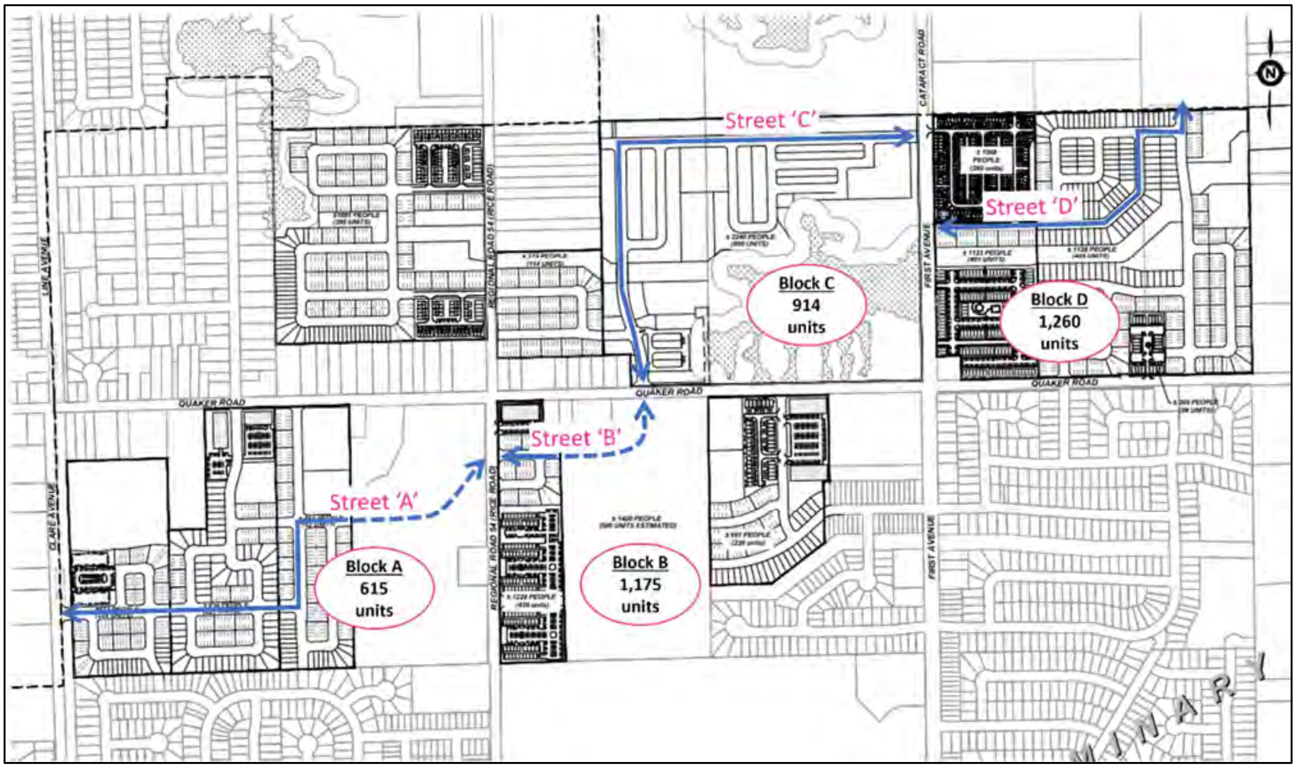

Figure 3-2: Street Names and Residential Units

4 FUTURE TRAFFIC CONDITIONS

To assess future traffic conditions in 2033, the Region of Niagara retained IBI Group to use the Niagara Region Travel Forecasting Model to forecast traffic flow along key roads in the study area. A copy of the memorandum containing the results of their analysis is provided in Appendix D. In the study area, it was presumed that there would be no changes to the cross-section of Regional Road 36 (Pelham Street), First Avenue, Regional Road 50 (Niagara Street) or Quaker Road because of area development (including the NWWSP). However, the Region is forecasting that Regional Road 54 (Rice Road) will need to be widened to a 4-lane cross-section by 2041. Also, Merritt Road would need to be widened to a 4-lane cross-section and an extension would be built between Regional Road 54 (Rice Road) and Cataract Road. The extension would also have a 4-lane cross-section.

SGL provided the Region of Niagara and their modelling consultant IBI Group with population and employment figures for the growth zones within the study area for the preferred option as previously shown in Figure 3-1. A copy of the growth zones and the corresponding population and employment growth is shown in Figure 4-1 and Table 4-1. A population increase of 12,181 is anticipated to occur by 2033 as a direct result of the new development in the NWWSP. A modest increase in employment is anticipated to occur, 84 jobs in total.

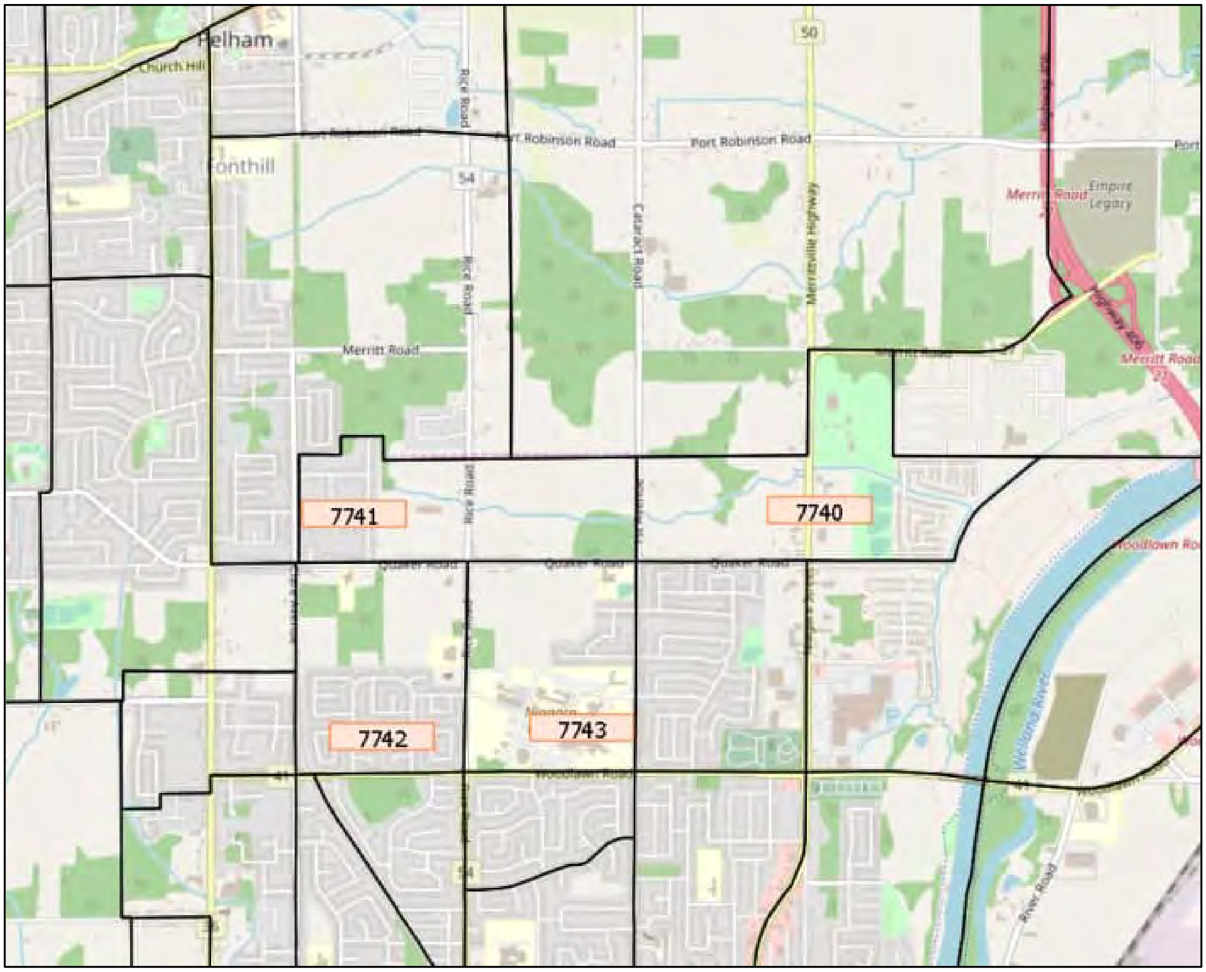

Figure 4-1: North West Welland Secondary Plan Growth Zones

Table 4-1: Population and Employment Growth

Zone	2011		2031 Base		Increase from Secondary Plan		2031 NWWSP		2011-2031 Growth	
	Total Pop.	Total Jobs	Total Pop.	Total Jobs	Pop.	Jobs	Total Pop.	Total Jobs	Total Pop.	Total Jobs
7740	1,100	379	1,151	635	3,528	0	4,679	635	325%	68%
7741	522	242	447	288	3,640	84	4,087	372	683%	54%
7742	1,148	403	982	491	1,723	0	2,705	491	136%	22%
7743	418	942	357	1,185	3,290	0	3,647	1,185	772%	26%
Total	3,187	1,966	2,937	2,598	12,181	84	15,118	2,682	374%	36%

Table 4-2 shows the change in traffic flow between 2011 and 2031 during the AM peak, as a result of the increase in population and employment within the NWWSP area, in addition to the forecasted increase in population and employment in the surrounding area, along with changes to the surrounding road network (i.e., the widening of Rice Road and Merritt Road and the extension of Merritt Road between Cataract Road and Rice Road). The following is noted in the AM peak:

- Regional Road 54 (Rice Road) between Port Robinson Road and Regional Road 41 (Woodlawn Road) will experience a significant increase in traffic flow (188% northbound; 17% southbound);
- Niagara Street between Port Robinson Road and Regional Road 41 (Woodlawn Road) will experience a significant increase in traffic (55% northbound; 34% southbound)
- Merritt Road between Pelham Street and Rice Road will experience a significant increase in traffic flow (151% eastbound; 487% westbound)
- Regional Road 37 (Merritt Road) between Cataract Road and Highway 406 will experience a significant increase in traffic flow (452% eastbound, 147% westbound);
- Quaker Road will experience a significant increase in traffic flow (101% eastbound, 47% westbound)

Increases in traffic flow show a potential order of magnitude for anticipated traffic usage. Actual usage will depend on final development characteristics, accesses and road network configuration as defined by the MCEA for Regional Road 37 (Merritt Road) and Regional Road 54 (Rice Road). Sections of Regional Road 36 (Pelham Street) and First Avenue will not experience a significant change in traffic because of the changes to the surrounding road network.

IBI Group did not provide results for the PM peak, indicating that they had less confidence in the model outputs.

Table 4-2: Traffic Growth 2011-2031

Street	Corridor	2011 AM Peak Hour Volume		2031 AM Peak Hour Volume- NWWSP		2011-2031 NWWSP Growth	
		NB/EB	SB/WB	NB/EB	SB/WB	NB/EB	SB/WB
Pelham Street	Port Robinson Road to Woodlawn Road	221	256	257	283	16%	11%
Rice Road	Port Robinson Road to Woodlawn Road	212	189	611	221	188%	17%
Cataract Road/ First Avenue	Port Robinson Road to Woodlawn Road	291	432	278	448	-4%	4%
Niagara Street	Port Robinson Road to Woodlawn Road	286	237	443	317	55%	34%
Merritt Road	Pelham Street and Rice Road	146	31	367	182	151%	487%
Merritt Road	Rice Road and Cataract Road (Extension)	-	-	867	310	-	-
Merritt Road	Cataract Road and Highway 406	214	330	1181	815	452%	147%

Street	Corridor	2011 AM Peak Hour Volume		2031 AM Peak Hour Volume- NWWSP		2011-2031 NWWSP Growth	
		NB/EB	SB/WB	NB/EB	SB/WB	NB/EB	SB/WB
Quaker Road	Pelham Street and Niagara Street	253	78	509	115	101%	47%

**Note Auto volumes have not been calibrated to local level*

5 ANALYSIS OF FUTURE TOTAL TRAFFIC CONDITIONS

Based on the above, AE developed an estimate of future traffic conditions at the five study intersections during the AM and PM peak, in addition to anticipated traffic conditions at the four new collector road intersections (AM only) because of development within the NWWSP. The following section presents the findings under horizon year conditions (with no changes to traffic control) and with any identified improvements (because of the additional traffic).

5.1 Horizon Year Conditions (2033)

Using the growth factors provided in Table 4-2, an estimate of future turning movement counts was developed for the five study intersections. For the AM peak, the 2011-2031 growth factor was applied to the 2022 turning movement counts (specific to each approach), prorated to reflect an exponential growth and the year of the count (2022). For the PM peak, as directed by the Region, the same 2011-2031 growth factor (in the AM) was applied to the 2022 turning movement counts (specific to each approach) and prorated to reflect an exponential growth and the year of the count (2022). As such, the results presented in this report for the PM peak are only meant to highlight potential future issues with capacity (by inference) and should be treated with caution.

Figure 5-1 shows the turning movement counts (AM and PM) for the five study intersections in addition to link volumes. Of note, is a heavy northbound right/westbound left traffic flow at the intersection of Regional Road 50 (Niagara Street) and Regional Road 37 (Merritt Road), and a significant increase in through traffic along Regional Road 54 (Rice Road) and Quaker Road.

5.2 Trip Generation and Distribution on Collector Roads

It was assumed that the collector roads (Street ‘A’, Street ‘B’, Street ‘C’ and Street ‘D’) would only service low density residential development. Traffic generated by medium density and mixed-use development indicated in the preferred plan would have direct access to Quaker Road, Regional Road 54 (Rice Road) or First Avenue and would, therefore, have already been accounted for in the analysis prepared by IBI Group (Table 4-2). Trip generation on the collector roads in Block A, B, C and D was estimated using the ITE Trip Generation Manual, 10th Edition for Single Family Detached Housing (Land Use Code 210) and is shown in Table 5-1. Trips generated by low density residential development on the west side of Regional Road 54 (Rice Road) north of Quaker Road would directly access Regional Road 54 (Rice Road) via a local road and is presumed to have been accounted for in the analysis prepared by IBI Group.

Table 5-1: Trip Generation - Single Family Detached Housing

Location	# Units	AM Peak		PM Peak	
		In	Out	In	Out
Block A	615	97	292	345	203
Block B	1,175	175	526	635	372
Block C	914	139	419	501	294
Block D	1,260	187	560	678	397

Inbound and outbound trips at the intersection of Regional Road 54 (Rice Road) and Street 'A'/Street 'B', Quaker Road and Street 'B'/Street 'C' and First Street and Street 'D' were distributed per the traffic flow on the major road (Regional Road 54 (Rice Road), Quaker Road and First Street) as noted in Table 4-2, with an equal amount of traffic entering and exiting Blocks A, B, C by the two proposed collector road accesses provided. At the intersection of Clare Avenue and Street 'A', a 50/50 split was presumed in the distribution of northbound/southbound traffic, reflecting AM peak hour traffic conditions based on a recent ATR count provided by the City of Welland. Traffic generation was calculated for the PM peak hour assuming the same directional flow as the AM peak hour.

Figure 5-2 shows the distribution of traffic at the four collector road intersections during the AM peak hour. Major road through movements (Quaker Road, Regional Road 54 (Rice Road) and First Avenue) were estimated at the four collector road intersections based on the traffic volumes on the downstream intersection. A growth factor was applied to northbound/southbound through movements on Clare Avenue based on AM peak hour data collected from a recent Automated Traffic Recorder count[1]. Finally, it was assumed that there would be no eastbound-westbound through traffic across Regional Road 54 (Rice Road) or First Avenue or northbound-southbound through traffic across Quaker Road.

5.3 Horizon Year Traffic Conditions (No Improvements)

Figure 5-3 shows the anticipated Level of Service at the study intersections for the 2033 horizon year with no improvements (i.e., additional auxiliary lanes or changes to traffic control). Appendix E shows the Synchro outputs for the horizon year (2033) with no improvements.

Regional Road 36 (Pelham Street) and Quaker Road

The intersection of Regional Road 36 (Pelham Street) and Quaker Road, currently signalized, is anticipated to continue to operate well below capacity, with a Level of Service of B or better, during the AM peak hour. However, during the PM peak hour, the left-turns for the eastbound, westbound, and southbound approaches will be operating near or over capacity with Level of Service E or worse. It is recommended that separate left-turn lanes are provided for the eastbound and westbound approaches, and separate right-turn lanes for the northbound and eastbound approaches. Advanced left-turn phases for the westbound and southbound left-turns, as well as increasing the cycle length are recommended.

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[1] The growth factor was 22% for northbound traffic and 16% for southbound traffic, based on the average growth for other north-south roadways in the study area as presented in the IBI Group report.

Regional Road 54 (Rice Road) and Quaker Road

The intersection of Regional Road 54 (Rice Road) and Quaker Road, currently under all-way stop control, will experience significant congestion because of the noted increase in traffic in the AM and PM peak hour. In the AM and PM peak hours, significant delay (Level of Service of F) was noted on all four approaches (ranging from 90 seconds/vehicle to 557.5 seconds/vehicle in the AM peak hour and from 200.4 seconds/vehicle to 1,090 seconds/vehicle in the PM peak hour). Based on anticipated traffic conditions, a traffic signal at this intersection plus the planned road widening to a four-lane cross-section on Regional Road 54 (Rice Road) are expected to improve traffic conditions.

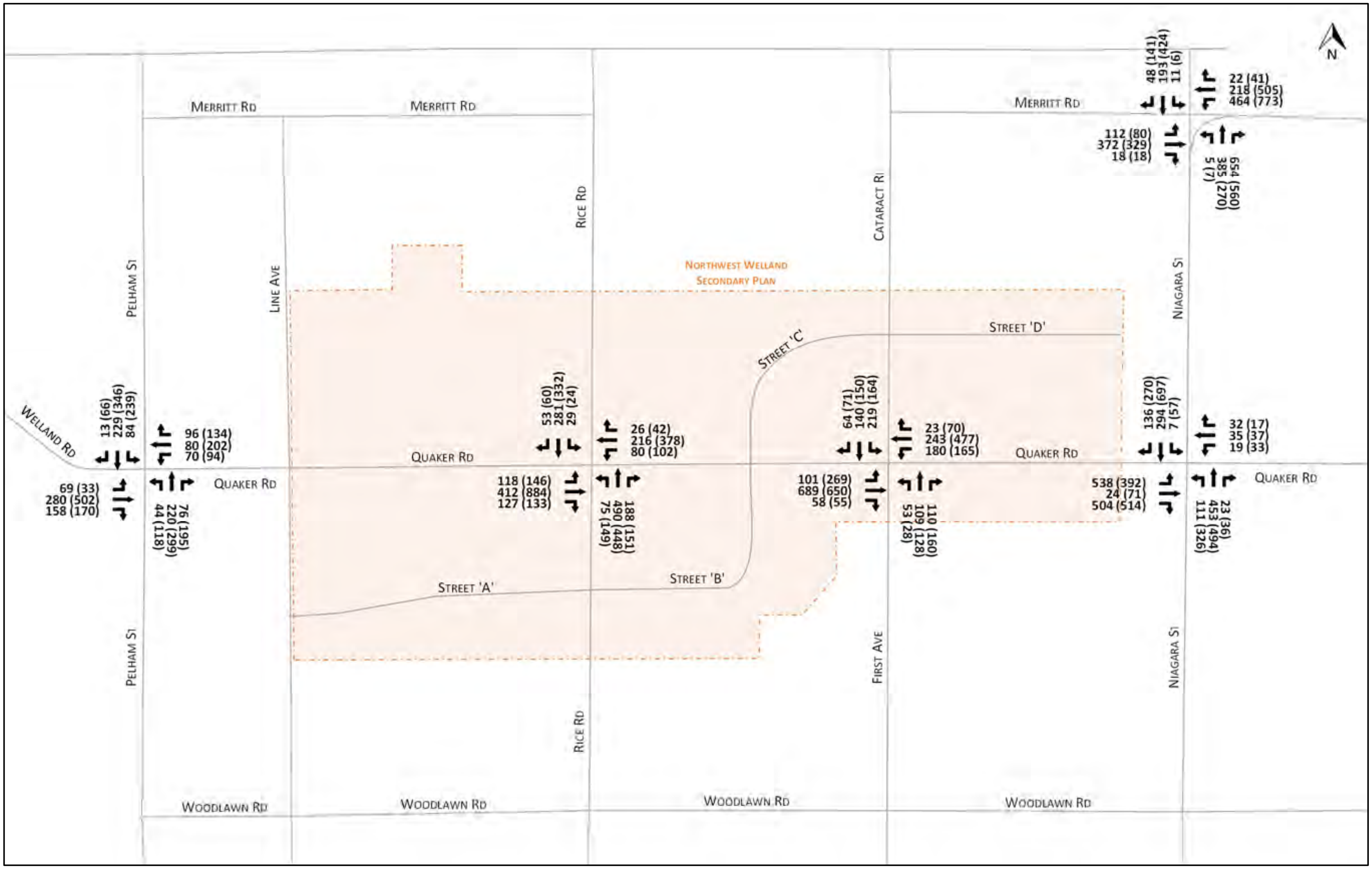


Figure 5-1: Future (2033) Peak Hour Turning Movement Volumes – Major Roads

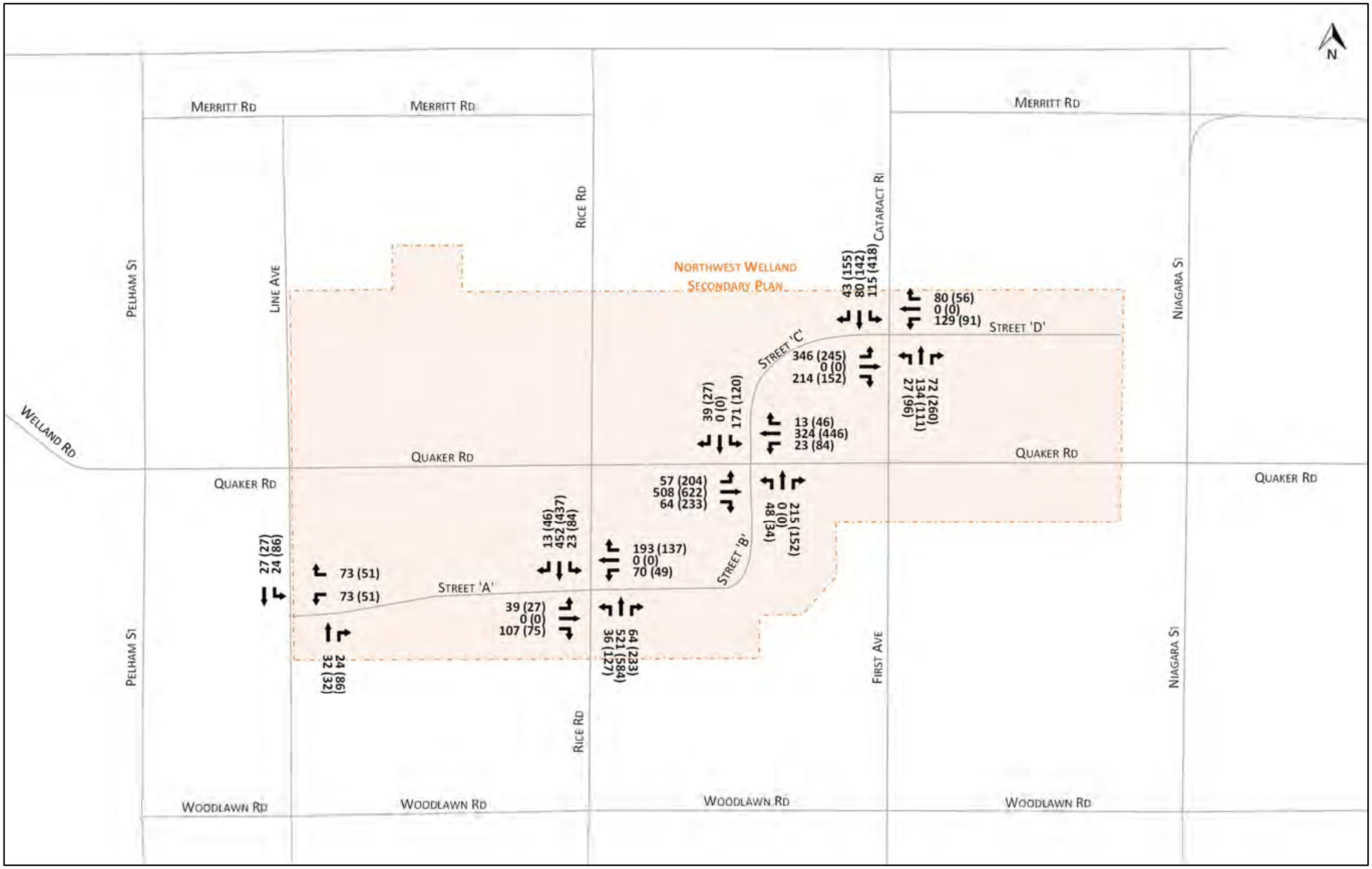


Figure 5-2: Future (2033) Peak Hour Turning Movement Volumes – Collector Roads

First Avenue/Cataract Road and Quaker Road

The intersection of First Avenue and Quaker Road, also currently under all-way stop control, will experience significant congestion because of the noted increase in traffic in the AM and PM peak hour on Quaker Road. In the AM peak hour, significant delay (Level of Service of F) was noted on all four approaches (ranging from 55 seconds/vehicle to 617.9 seconds/vehicle). In the PM peak hour, significant delay (Level of Service of F) was also noted on all four approaches (ranging from 83.2 seconds/vehicle to 805.5 seconds/vehicle). Based on anticipated traffic conditions, a traffic signal along with separate left-turn lanes on all approaches and right-turn lanes for the eastbound approach are recommended. Separate right-turn lanes may also be needed in the northbound approach to alleviate congestion during the PM peak hour.

Regional Road 50 (Niagara Street) and Quaker Road

The intersection of Regional Road 50 (Niagara Street) and Quaker Road, currently signalized, will continue to operate well below capacity in the AM peak hour, with all movements at a Level of Service of C or better, except for the eastbound through/right-turn movement, which will be operating with a v/c ratio of 0.88. at a Level of Service of D during the PM peak. In the PM peak hour, the eastbound through/right-turn movement will be operating at Level of Service of F (205.2 seconds/vehicle) and a v/c ratio of 1.36, and the northbound left-turn will be operating at Level of Service of E (56.9 seconds/vehicle) and a v/c ratio of 0.96. The eastbound left-turn will also be operating with a v/c ratio of 0.91 during the PM peak hour but the Level of Service is D (54.1 seconds/vehicle). It appears that there will continue to be sufficient storage in the eastbound left turn lane to accommodate left turn movements. A separate eastbound right-turn lane and an advanced eastbound left-turn phase are recommended to improve traffic conditions. During the PM peak hour, additional mitigation measures may include a separate southbound right-turn lane and an eastbound right-turn overlap phase with the northbound left-turn phase.

Regional Road 50 (Niagara Street) and Regional Road 37 (Merritt Road)

The intersection of Regional Road 50 (Niagara Street) and Merritt Road, currently signalized, will experience considerable delay and will be operating beyond capacity for the eastbound left-turn during the AM peak hour (Level of Service of F and a volume-to-capacity ratio of 1.04) and for the westbound left-turn during the PM peak hour (Level of Service of F and a volume-to-capacity ratio of 1.55). Storage for the westbound left turn will not be able to accommodate the anticipated traffic volume. While Merritt Road is planned to be widened to a four-lane cross section, dual westbound left-turn lanes should be considered.

Collector Road Intersections

Figure 5-4 shows the anticipated Level of Service at the collector road intersections for the 2033 horizon for the AM and PM peak hours. Based on the analysis, it was noted that all stop-controlled movements on the minor approaches except for at the Street A and Rice Road intersection would be operating beyond capacity with significant delays (Level of Service of E or worse), likely due to the relatively high amount of traffic generated by Blocks A through D. A review of the anticipated minor road traffic volumes indicates that a traffic signal or roundabout may be considered at the collector intersections.

In the AM peak, there is no evidence to suggest that a left turn lane would be warranted on the major roads to facilitate left turn movements into any of the developments at the collector road intersections, given the anticipated left turn volumes. However, in the PM peak, a review of the ITE Trip Generation Manual, 10th Edition, left turn volumes (into the residential developments) will be higher on the major roads (Regional Road 54 (Rice Road), Quaker Road and First Avenue), reflecting the higher potential of inbound trips (63% compared to 25%) according to the ITE Trip Generation Manual, 10th Edition. Furthermore, the review indicates that there is a higher amount of traffic generated during the PM peak hour for single family detached housing (Land Use Code 210). Given this, there may be a possibility for left turn lanes to be required in the future on the major approaches.

5.4 Horizon Year Traffic Conditions (with Improvements)

Based on the results of the previous assessment of traffic operations at the study intersections, the following improvements were considered, aside from the widening anticipated to occur on Regional Road 54 (Rice Road) to 4-lanes, on Merritt Road to 4-lanes and the Merritt Road extension between Regional Road 54 (Rice Road) and Cataract Road (4-lanes).

- Quaker Road and Regional Road 54 (Rice Road) – signalization and addition of left turn lanes on all four approaches;
- Quaker Road and First Avenue – signalization and addition of left turn lane on all four approaches, and right-turn lanes on the eastbound and northbound approaches;
- Regional Road 36 (Pelham Street) and Quaker Road – addition of left-turn lanes on eastbound and westbound approaches, and right-turn lanes on eastbound and northbound approaches, increase cycle length, and implement advanced left-turn phases for the westbound and southbound approaches in the PM peak;
- Regional Road 50 (Niagara Street) and Quaker Road – addition of right-turn lane on eastbound and southbound approaches, advanced left-turn phase for eastbound left-turn, and overlap phase for eastbound right-turn and northbound left-turn; and
- Regional Road 50 (Niagara Street) and Regional Road 37 (Merritt Road) – addition of a second westbound left-turn lane, implement pedestrian phases on all approaches, and exclusive westbound left turn phase.

Figure 5-5 shows the anticipated Level of Service at the study intersections for the 2033 horizon year with the indicated improvements in the AM and PM peak hours. The following was noted:

- Under signal control, the intersection of Quaker Road and Regional Road 54 (Rice Road) will operate at a Level of Service of C or better during both the AM and PM peak hour.
- Under signal control, the intersection of Quaker Road and First Avenue will operate at a Level of Service of C or better during both the AM and PM peak hour. A Level of Service of E is noted for the southbound movements in the AM peak hour.
- With the additional turn lanes and signal timing changes, the intersection of Quaker Road and Regional Road 36 (Pelham Street) will operate at a Level of Service of C or better during both the AM and PM peak hour.
- With the additional turn lanes and signal timing changes, the intersection of Quaker Road and Regional Road 50 (Niagara Street) will operate at a Level of Service of C or better during both the AM and PM peak hour.
- With the dual westbound left-turn lanes, the Level of Service for the AM and PM peak will improve to C and B respectively at the intersection of Regional Road 37 (Merritt Road) and Regional Road 50 (Niagara Street/Merrittville Highway).

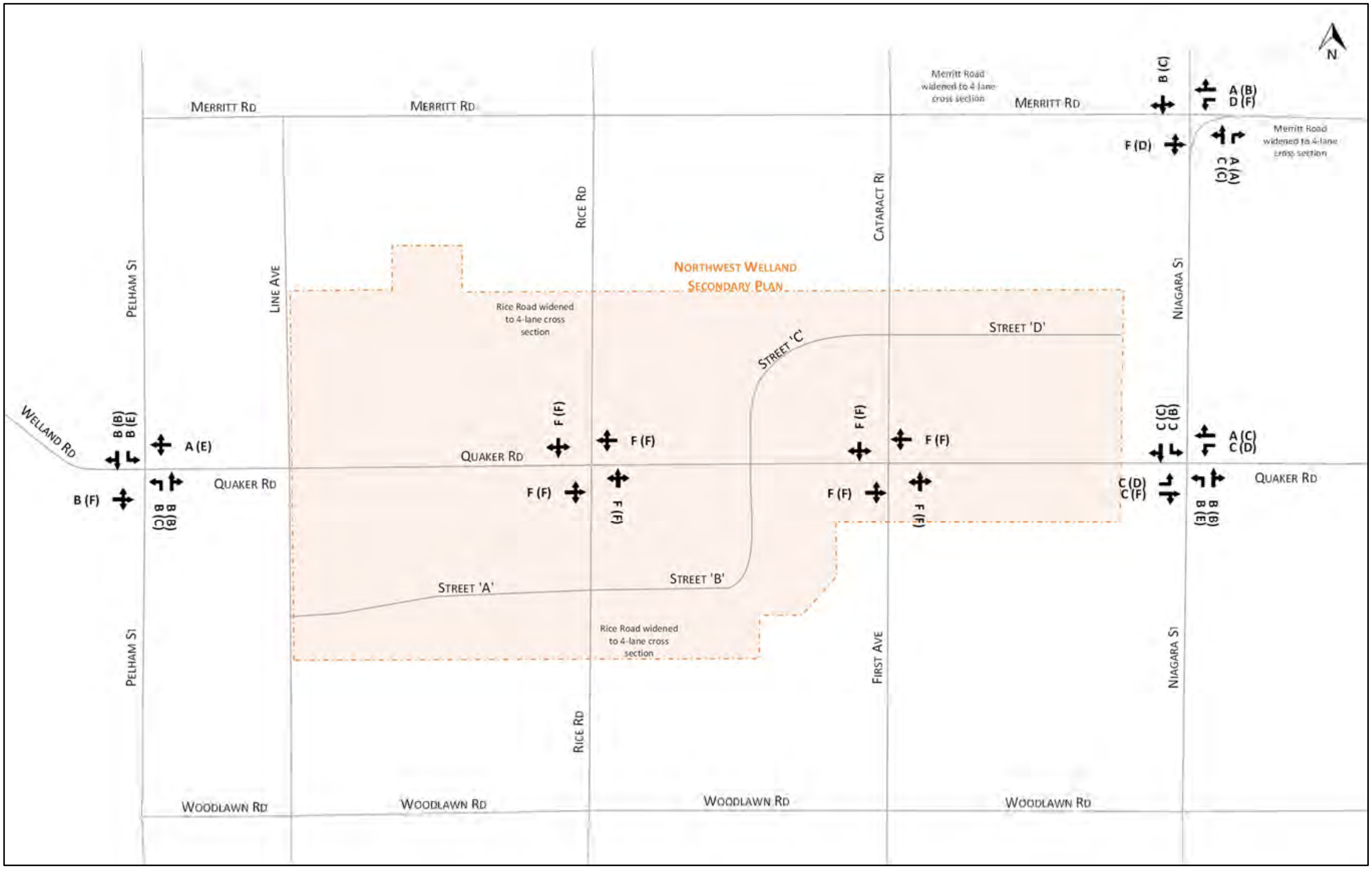


Figure 5-3: Level of Service Study Intersections (2033 Horizon Year)

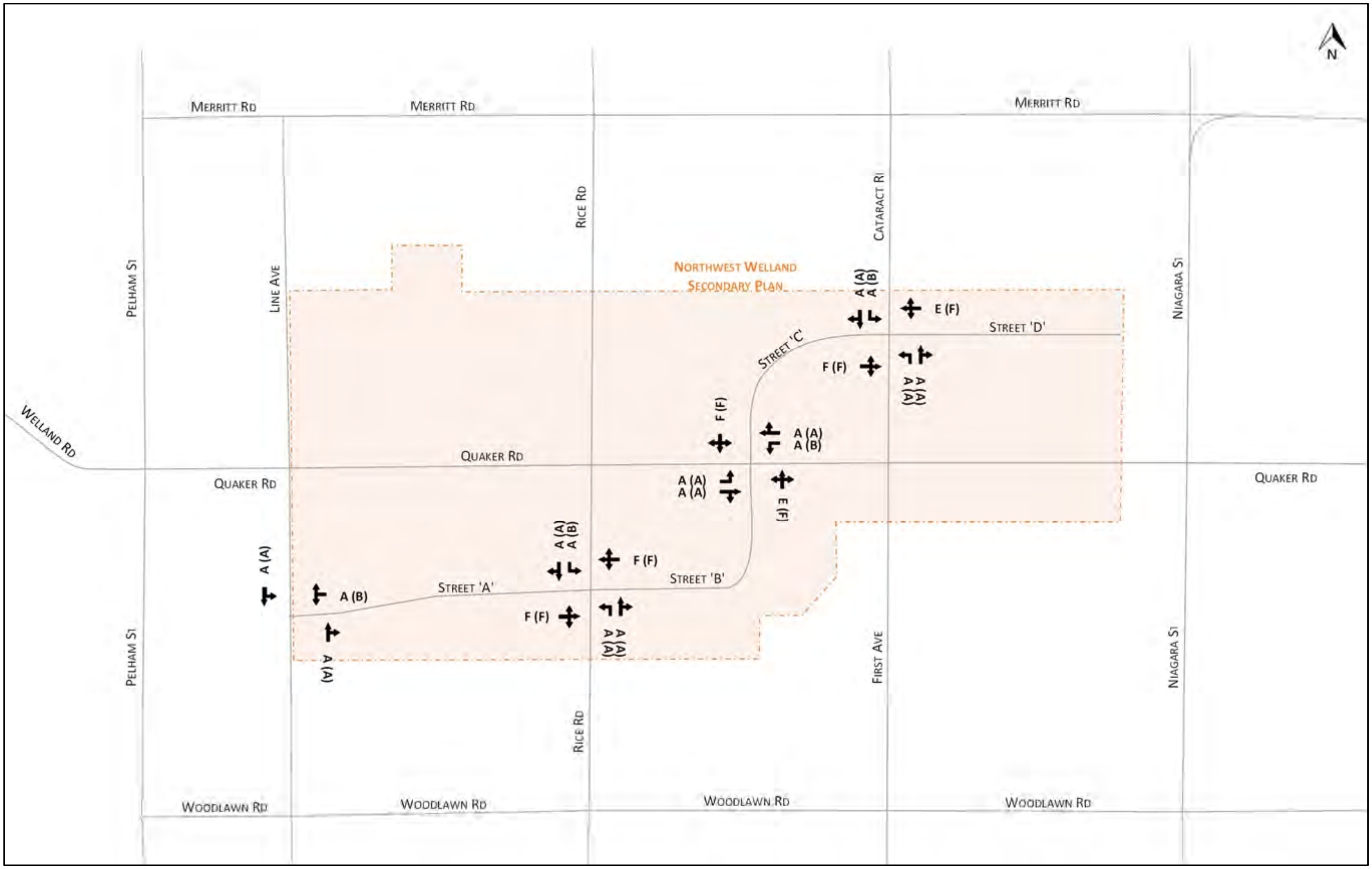


Figure 5-4: Level of Service for Collector Road Intersections (2033 Horizon Year)

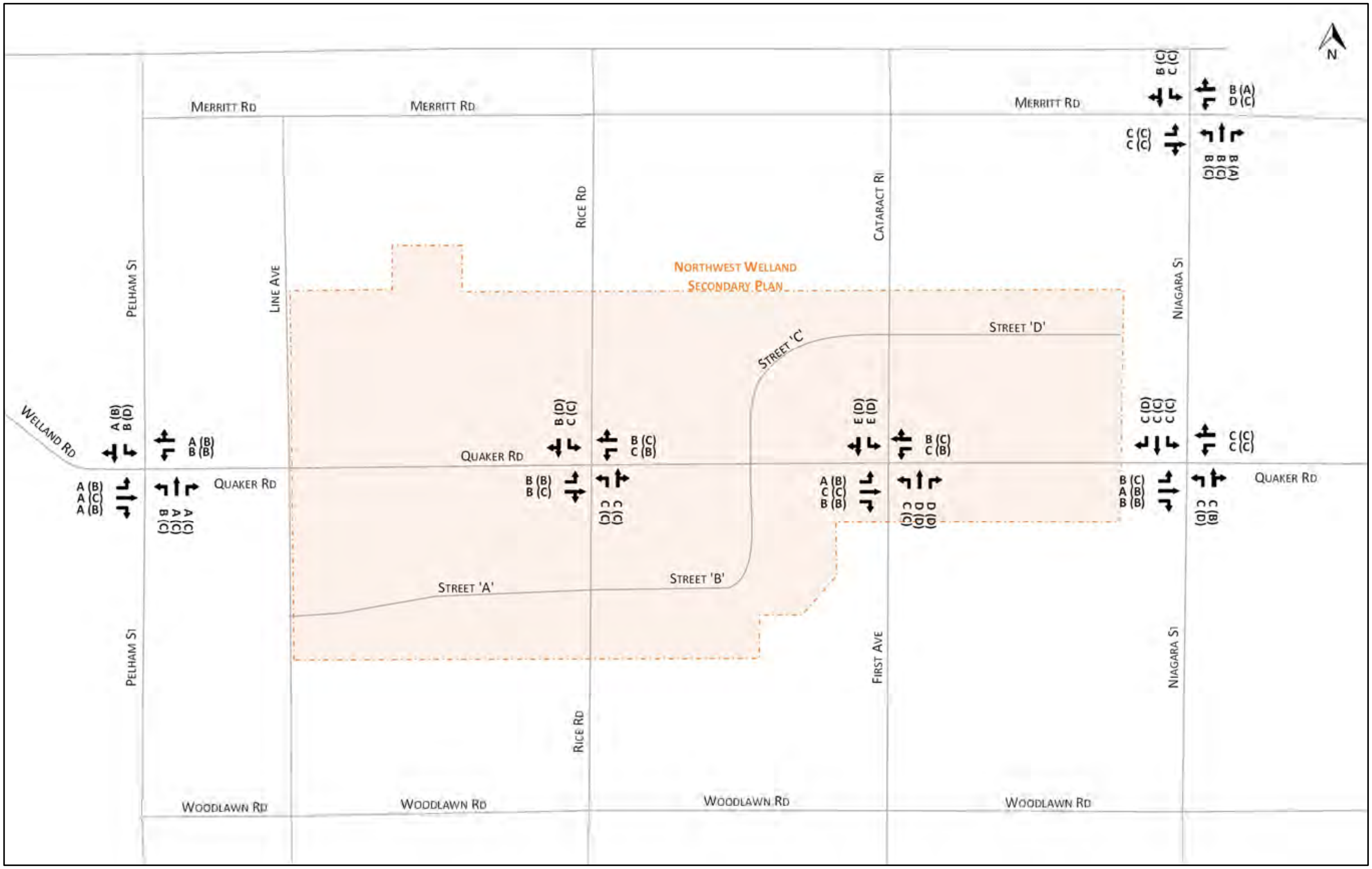


Figure 5-5: Level of Service for Study Intersections (2033 Horizon Year) with Improvements

Table 5-2 shows the recommended storage for the left turn and right-turn lanes based on the above analysis.

Table 5-2: Recommended Storage

Intersection	EBL	EBR	WBL	WBR	NBL	NBR	SBL	SBR
Quaker Road and Regional Road 50 (Rice Road)	30	N/A	30	N/A	30	N/A	30	N/A
Quaker Road and First Avenue	30	30	30	N/A	30	40	35	N/A
Quaker Road and Regional Road 36 (Pelham Street)	30	30	30	N/A	30	30	30	N/A
Quaker Road and Regional Road 50 (Niagara Street)	70	70	30	N/A	60	N/A	30	55
Regional Road 37 (Merritt Road) and Regional Road 50 (Niagara Street/Merrittville Highway)	30	N/A	55	N/A	30	60	30	N/A

Appendix F shows the Synchro outputs for the horizon year (2033) with the improvements described in this section.

Since traffic signals are warranted at the intersection of Quaker Road and Regional Road 54 (Rice Road) and the intersection of Quaker Road and First Avenue, a high-level roundabout screening and roundabout capacity analysis using Sidra were conducted. Given that Regional Road 54 (Rice Road) will have a four-lane cross section, a multi-lane roundabout is recommended for the intersection of Quaker Road and Regional Road 54 (Rice Road). A single-lane roundabout is considered for the intersection of Quaker Road and First Avenue.

Since Niagara Region does not have an established procedure for roundabout screening, AE referred to Waterloo Region's roundabout screening tool. The assessment compares the life cycle costs for the signal and roundabout scenarios. Based on the assessment, a roundabout is determined to be a feasible option since the life cycle costs of a roundabout is less than 1.5 times that of a signal.

Due to the relatively high traffic volumes in the eastbound direction, a second entry lane is needed to increase capacity. For the roundabout configuration, a Level of Service of E, and a v/c ratio of 0.86 is noted in the northbound approach at the intersection of Quaker Road and First Avenue in the PM peak hour. All other movements are anticipated to operate with Level of Service C or better during both the AM and PM peak hours. Figure 5-6 shows the anticipated Level of Service under a roundabout configuration at the two intersections for the 2033 horizon year.

Appendix G shows the roundabout screening worksheets and the Sidra outputs for the horizon year (2033).

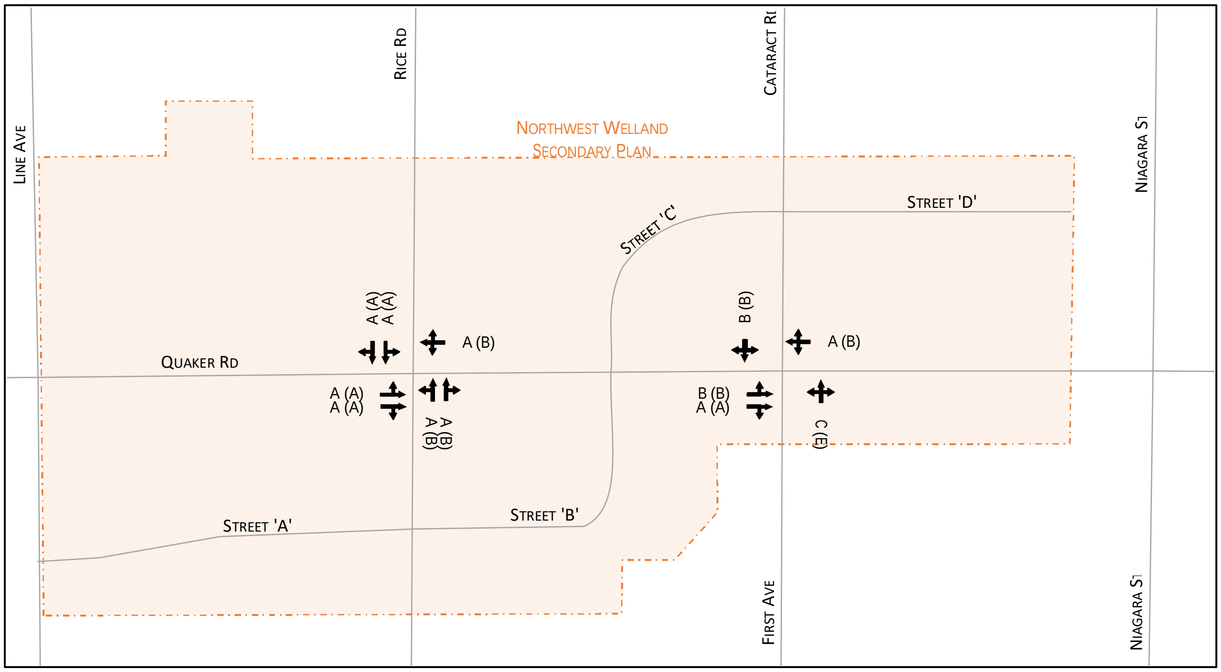


Figure 5-6: Level of Service for Roundabout Intersections (2033 Horizon Year)

6 CONCLUSIONS AND RECOMMENDATIONS

The previous sections within this report document the review of existing and future horizon year conditions from a transportation engineering perspective. The following is noted.

6.1 Existing Conditions

A review of existing conditions indicates that both Quaker Road and Regional Road 54 (Rice Road) through the study area are characterized as rural arterial roadways. First Avenue acts as a collector roadway, having an urban cross-section south of Quaker Road and a rural-cross section north of Quaker Road. Immediately west and east of the study area, Regional Road 36 (Pelham Street) and Regional Road 50 (Niagara Street) function as arterial roadways.

The two (2) major intersections within the study area are Quaker Road and Regional Road 54 (Rice Road) and Quaker Road and First Street; both of which currently operate under all-way stop control. Regional Road 36 (Pelham Street) and Quaker Road, Regional Road 50 (Niagara Street) and Quaker Road, and Regional Road 37 (Merritt) and Regional Road 50 (Niagara Street/Merrittville Highway) all operate under traffic signal control. These intersections were chosen due to the proximity to the study area and the potential for traffic generated by the development to impact traffic at these intersections.

The roadways within the study area have very limited active transportation facilities. There is a separated segment of granular pathway on the north side of Quaker Road between Regional Road 54 (Rice Road) and 622 Quaker Road with a ladder crosswalk providing access to École Élémentaire Nouvel Horizon. No dedicated cyclist facilities have been provided along Quaker Road.

With the development of the NWWSP, there is an opportunity to provide dedicated active transportation facilities for pedestrians and cyclists. According to the Regional Municipality of Niagara's *Strategic Cycling Network Development Technical Paper (2017)*, First Avenue/Cataract Road was confirmed as a candidate for enhanced cyclist facilities. Limited transit service is provided within the study area with only a short segment of Quaker Road between First Street and Regional Road 50 (Niagara Street) being serviced by Niagara Region Transit. Expanded transit service should be considered in conjunction with the development of the subject lands.

Under existing conditions, the traffic operations analysis indicates that overall, most of the study intersections are all operating below capacity with an adequate Level of Service; all movements noted as being a Level of Service of C or better. However, the intersection of Rice Road and Quaker Road is operating with LOS F during the PM peak. The westbound approach at the First Avenue and Quaker Road intersection is operating with LOS F during the PM peak. The traffic signal warrants indicate that traffic signals are justified at both intersections based on 2022 traffic data.

6.2 Future Conditions (2033 Horizon Year)

The preferred plan representing the full build-out of the NWWSP will result in a population increase of 12,181 and an increase in employment of 84 jobs. Collector roads have been proposed that will service residential development within the development. The collector roads will provide new points of access on Clare Avenue and Rice Road south of Quaker Road, on Quaker Road between Rice Road and First Avenue and First Avenue north of Quaker Road, creating new intersections and is assumed to service low density residential development within different portions of the development.

Traffic conditions were assessed for the horizon year (2033), in consideration of the anticipated development of the NWWSP, in addition to surrounding development. The Region has indicated that Regional Road 54 (Rice Road) and Merritt Road will be widened to a four-lane cross-section, and Merritt Road will be extended west to connect Regional Road 54 (Rice Road) to Cataract Road.

AE applied growth factors to the study intersections based on a memo provided by IBI Group. The memo presents growth factors between 2011-2031 indicating changes in traffic patterns during the AM peak hour because of the anticipated growth both within the NWWSP, in the surrounding area, and because of the road improvements within the study area. Several roads within the study area will see a marked increase in traffic, particularly Regional Road 54 (Rice Road) and Regional Road 37 (Merritt Road) and to a lesser degree, Quaker Road. IBI Group did not provide results for the PM peak, indicating that they had less confidence in the model outputs.

Based on the above, AE developed an estimate of future traffic conditions at the five study intersections during the AM and PM peak. The PM peak results should only be used to make general inferences about future traffic conditions. Additionally, AE developed an estimate of anticipated traffic conditions at the four new collector road intersections because of development within the NWWSP.

Under the horizon year (2033), the intersection of Regional Road 54 (Rice Road) and Quaker Road and the intersection of First Avenue and Quaker Road will experience congestion and a Level of Service of F on all approaches to the intersection.

The left-turns for the eastbound, westbound, and southbound approaches will be operating near or over capacity with Level of Service E or worse at the intersection of Pelham Street and Quaker Road. The eastbound through/right-turn movement at the intersection of Regional Road 50 (Niagara Street) and Quaker Road will operate with significant delays and beyond capacity during the PM peak hour, while the northbound left-turn and eastbound left-turn will be operating near capacity. The eastbound left turn and westbound left-turn movements at the intersection of Regional Road 50 (Niagara Street) and Regional Road 37 (Merritt Road) will operate beyond capacity.

Under the horizon year (2033), the collector road intersections are anticipated to operate with capacity issues for the stop-controlled movements on the minor approaches except at the Street A and Rice Road intersection. There may be a need for left turn lanes (on the arterial road) in the future.

Based on the results of the previous assessment of traffic operations at the study intersections, the following improvements were considered:

- Quaker Road and Regional Road 54 (Rice Road) – signalization and addition of left turn lanes on all four approaches;
- Quaker Road and First Avenue – signalization and addition of left turn lanes on all four approaches, and right-turn lanes on the eastbound and northbound approaches;
- Regional Road 36 (Pelham Street) and Quaker Road – addition of left-turn lanes on eastbound and westbound approaches, and right-turn lanes on eastbound and northbound approaches, increase cycle length, and implement advanced left-turn phases for the westbound and southbound approaches;
- Regional Road 50 (Niagara Street) and Quaker Road – addition of right-turn lane on eastbound and southbound approaches and advanced left-turn phase for the eastbound left-turn; and
- Regional Road 50 (Niagara Street) and Regional Road 37 (Merritt Street) – addition of a second westbound left-turn lane, implement pedestrian phases on all approaches, and exclusive westbound left turn phase.

Based on the review of the anticipated Level of Service, the study intersections are anticipated to operate adequately under signal control and with the improvements outlined above.

Since traffic signals are warranted at the intersection of Quaker Road and Regional Road 54 (Rice Road) and the intersection of Quaker Road and First Avenue, a high-level roundabout screening and roundabout capacity analysis were conducted. Based on the assessment, a roundabout is determined to be a feasible option since the life cycle costs of a roundabout is less than 1.5 times that of a signal. Based on the review of the anticipated Level of Service, the two intersections are anticipated to operate with better Levels of Service as a roundabout configuration compared to under signal control.

6.3 Anticipated Improvements

Based on the above, the following improvements are anticipated to be required to accommodate the level of traffic and for meeting future active transportation and transit needs because of the NWWSP. Further traffic analysis should be undertaken closer to full build-out to further evaluate the timing and extent of the improvements.

Capacity Improvements

- Signalization of the intersection of Regional Road 54 (Rice Road) and Quaker Road with separate left turn lanes (30 metres on each approach) or a multi-lane roundabout (subject to a review of adjacent utilities and property requirements);
- Signalization of the intersection of First Avenue and Quaker Road with separate left turn lanes (35 metres on southbound approach and 30 metres on all other approaches) and separate right turn lanes (30 metres on the eastbound and 40 metres on the northbound approach) or a single-lane roundabout (subject to a review of adjacent utilities and property requirements);
- Separate left-turn (30 metres on each approach) and right-turn lanes (30 metres on the northbound and eastbound approaches) at Regional Road 36 (Pelham Street) and Quaker Road, and signal timing adjustments by increasing cycle length and implementing advanced left-turn phases;
- Separate right-turn lanes (70 metres on the eastbound and 55 metres on the southbound approach) at Regional Road 50 (Niagara Street) and Quaker Road;
- Provide 30 metre left turn lanes for the collector road intersections on the major approaches:
    - Northbound/southbound Rice Road at Street ‘A’/Street ‘B’;
    - Eastbound/westbound Quaker Road at Street ‘B’/Street ‘C’; and
    - Northbound/southbound First Avenue at Street ‘C’/Street ‘D’.

Active Transportation

- Consider the provision of either dedicated bicycle lanes (both sides) or a multi-use pathway (on one side) of Quaker Road, Regional Road 54 (Rice Road) and First Avenue
- If bicycle lanes are being considered, provide 1.8 metre sidewalks along both sides of Quaker Road, Regional Road 54 (Rice Road) and First Avenue within the NWWSP area
- Provide a 1.8 metre sidewalk on one side of the collector roads (Street ‘A’, Street ‘B’, Street ‘C’ and Street ‘D’)
- Install pedestrian signals at Regional Road 54 (Rice Road) and Quaker Road, and First Avenue and Quaker Road.

Transit

- A dedicated transit line along the entire length of Quaker Road within the NWWSP area
- Consider a transit line that services the low-density residential areas on the north and south side of Quaker Road

6.4 Order of Magnitude Costs

The estimated order-of-magnitude cost for all the road works associated with the NWWSP, including all the required improvements, is approximately $22.15 million. The order-of-magnitude cost assumes the following:

- Full reconstruction of City roads within the study limits (Quaker Road and First Avenue);
- 2,800 metres of new collector road (Street ‘A’, Street ‘B’, Street ‘C’, and Street ‘D’), built to City of Welland standards for a collector road;
- 7,300 metres of new local road (not shown on preferred plan), built to City of Welland standards for a local road;
- Signalization of two intersections (Regional Road 54 (Rice Road) and Quaker Road and First Avenue and Quaker Road with auxiliary turn lanes
- Auxiliary turn lanes and signal phasing adjustments at Quaker Road and Regional Road 36 (Pelham Street), Quaker Road and Regional Road 50 (Niagara Street), and Regional Road 37 (Merritt Road) and Regional Road 50 (Niagara Street/Merrittville Highway)
- 30 metre left turn lanes on
    - Northbound/southbound Rice Road at Street ‘A’/Street ‘B’;
    - Eastbound/westbound Quaker Road at Street ‘B’/Street ‘C’; and
    - Northbound/southbound First Avenue at Street ‘C’/Street ‘D’.

There are potential construction cost savings of about $0.4 Million if roundabouts are considered at Regional Road 54 (Rice Road) and Quaker Road, and First Avenue and Quaker Road instead of signalization.

May Lai

From: Ali Khan <ali.khan@welland.ca>
Sent: May 15, 2024 3:28 PM
To: May Lai
Cc: Taylor Meadows; Mark Crockford; Samantha McCauley
Subject: RE: Primont Welland Transportation Impact Study Terms of Reference

Hi Mai,

I'm ok with the scope of work you have shared.

Regards.

CITY OF
Welland

Muhammad Ali Khan, M.A.Sc; P.Eng.
Manager, Traffic/Parking/ Bylaws
Planning and Development Services
60 East Main Street, Welland, Ontario L3B 3X4

☎ Phone: 905-735-1700 x2202
welland.ca
engagewelland.ca

From: May Lai <may.lai@cghtransportation.com>
Sent: Wednesday, May 15, 2024 3:19 PM
To: Ali Khan <ali.khan@welland.ca>
Cc: Taylor Meadows <taylor.meadows@welland.ca>; Mark Crockford <mark.crockford@cghtransportation.com>
Subject: RE: Primont Welland Transportation Impact Study Terms of Reference

Hi Ali,

I am writing to follow up with the TOR that I sent last week. Could you please review the TOR and provide feedback on the proposed scope from the City's perspective?

Best regards,

May Lai, E.I.T.
CGH Transportation Inc.
P:289-834-0646
E:May.Lai@CGHTransportation.com

From: Taylor Meadows <taylor.meadows@welland.ca>
Sent: Thursday, May 9, 2024 10:14 AM
To: May Lai <may.lai@cghtransportation.com>
Cc: Ali Khan <ali.khan@welland.ca>
Subject: FW: Primont Welland Transportation Impact Study Terms of Reference

Morning,

I have copied Ali Khan from our City's Traffic Division. Ali can assist with this TOR.

Regards,

CITY OF
Welland

Taylor Meadows
Planning Supervisor - Development
Planning Division
60 East Main Street, Welland, Ontario L3B 3X4

☎ Phone: 905-735-1700 x2246
🌐 welland.ca
🌐 engagewelland.ca

From: May Lai <may.lai@cghtransportation.com>
Sent: Thursday, May 9, 2024 8:30 AM
To: Taylor Meadows <taylor.meadows@welland.ca>
Subject: Primont Welland Transportation Impact Study Terms of Reference

Hi Taylor,

CGH has been retained by Primont to undertake a Transportation Impact Study for a proposed residential development in the City of Welland. We have prepared the attached TOR to support our proposed TIS.

It is anticipated that a scoped TIS will suffice as a transportation study has recently been conducted for the Northwest Welland Secondary Plan Area Transportation Assessment which covers the proposed development. Please let us know if City Staff have any comments or questions.

Thanks and if City Staff would like to discuss any aspect of our TOR please do not hesitate to reach out.

Best regards,

May Lai, E.I.T.
CGH Transportation Inc.
P:289-834-0646
E:May.Lai@CGHTransportation.com

Appendix B

Turning Movement Count Data

Quaker Rd @ First Ave

Morning Peak Diagram

Specified Period
From: 7:00:00
To: 9:00:00

One Hour Peak
From: 8:00:00
To: 9:00:00

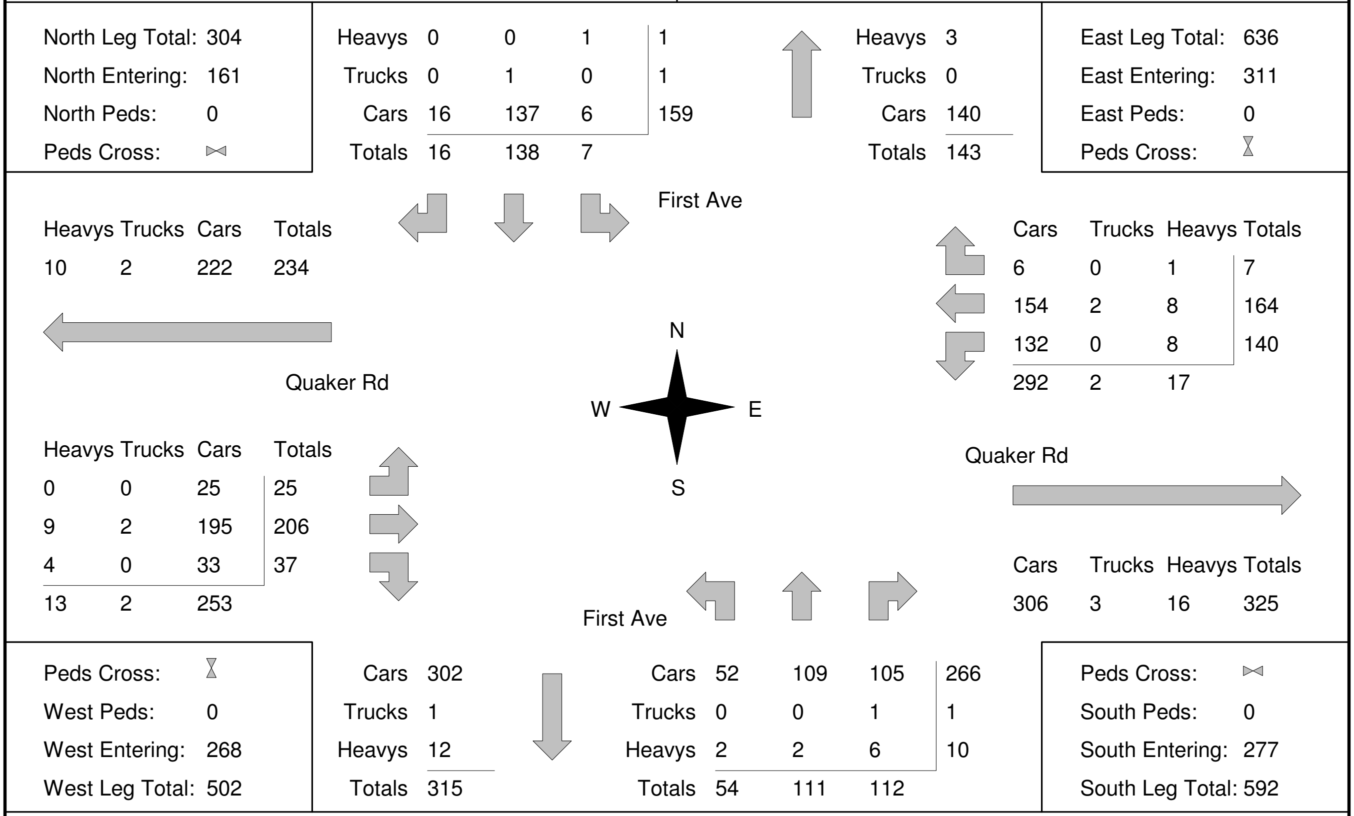
Municipality: Welland
Site #: 0000000001
Intersection: Quaker Rd & First Ave
TFR File #: 1
Count date: 2-Nov-2022

Weather conditions:
Cloudy/Dry

Person(s) who counted:
Cam

**** Non-Signalized Intersection ****

Major Road: Quaker Rd runs W/E



North Leg Total:	304
North Entering:	161
North Peds:	0
Peds Cross:	⋈

Heavys	0	0	1	1
Trucks	0	1	0	1
Cars	16	137	6	159
Totals	16	138	7	

Heavys	3
Trucks	0
Cars	140
Totals	143

East Leg Total:	636
East Entering:	311
East Peds:	0
Peds Cross:	⧗

First Ave

Heavys	Trucks	Cars	Totals
10	2	222	234

Cars	Trucks	Heavys	Totals
6	0	1	7
154	2	8	164
132	0	8	140
292	2	17	

Quaker Rd

N

W

E

S

Heavys	Trucks	Cars	Totals
0	0	25	25
9	2	195	206
4	0	33	37
13	2	253	

Quaker Rd

Cars	Trucks	Heavys	Totals
306	3	16	325

First Ave

Peds Cross:	⧗
West Peds:	0
West Entering:	268
West Leg Total:	502

Cars	302
Trucks	1
Heavys	12
Totals	315

Cars	52	109	105	266
Trucks	0	0	1	1
Heavys	2	2	6	10
Totals	54	111	112	

Peds Cross:	⋈
South Peds:	0
South Entering:	277
South Leg Total:	592

Comments

Quaker Rd @ First Ave

Afternoon Peak Diagram

Specified Period
From: 14:00:00
To: 19:00:00

One Hour Peak
From: 16:15:00
To: 17:15:00

Municipality: Welland
Site #: 0000000001
Intersection: Quaker Rd & First Ave
TFR File #: 1
Count date: 2-Nov-2022

Weather conditions:
Cloudy/Dry

Person(s) who counted:
Cam

**** Non-Signalized Intersection ****

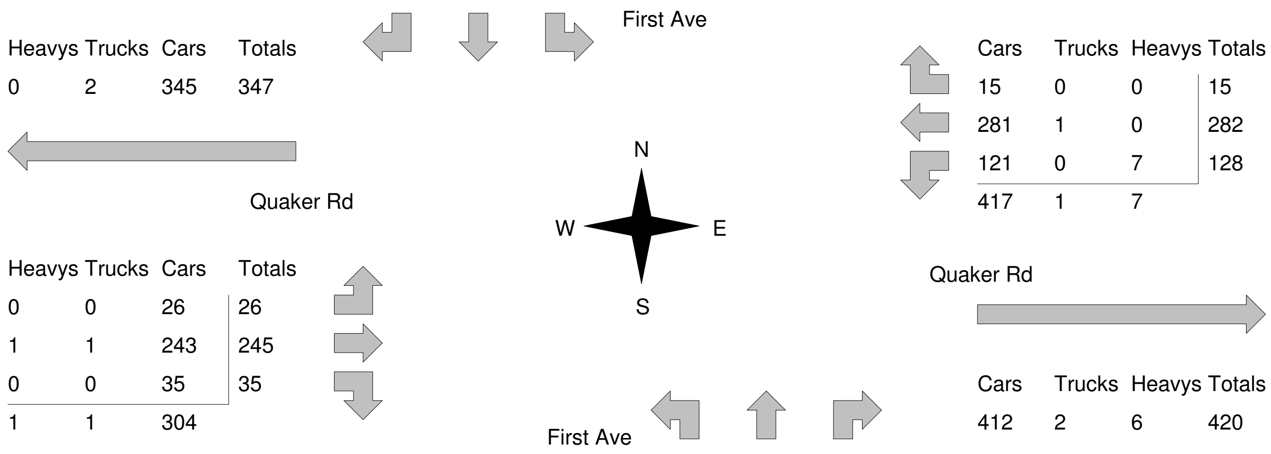
Major Road: Quaker Rd runs W/E

North Leg Total: 368
North Entering: 196
North Peds: 0
Peds Cross: ⋈

Heavys	0	0	0	0
Trucks	1	1	0	2
Cars	35	147	12	194
Totals	36	148	12	

Heavys	0
Trucks	1
Cars	171
Totals	172

East Leg Total: 845
East Entering: 425
East Peds: 0
Peds Cross: ⧗



Heavys	Trucks	Cars	Totals
0	2	345	347

Heavys	Trucks	Cars	Totals
0	0	26	26
1	1	243	245
0	0	35	35
1	1	304	

Cars	Trucks	Heavys	Totals
15	0	0	15
281	1	0	282
121	0	7	128
417	1	7	

Cars	Trucks	Heavys	Totals
412	2	6	420

Peds Cross: ⧗
West Peds: 0
West Entering: 306
West Leg Total: 653

Cars	303
Trucks	1
Heavys	7
Totals	311

Cars	29	130	157	316
Trucks	0	1	1	2
Heavys	0	0	5	5
Totals	29	131	163	

Peds Cross: ⋈
South Peds: 0
South Entering: 323
South Leg Total: 634

Comments

Quaker Rd @ Rice 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

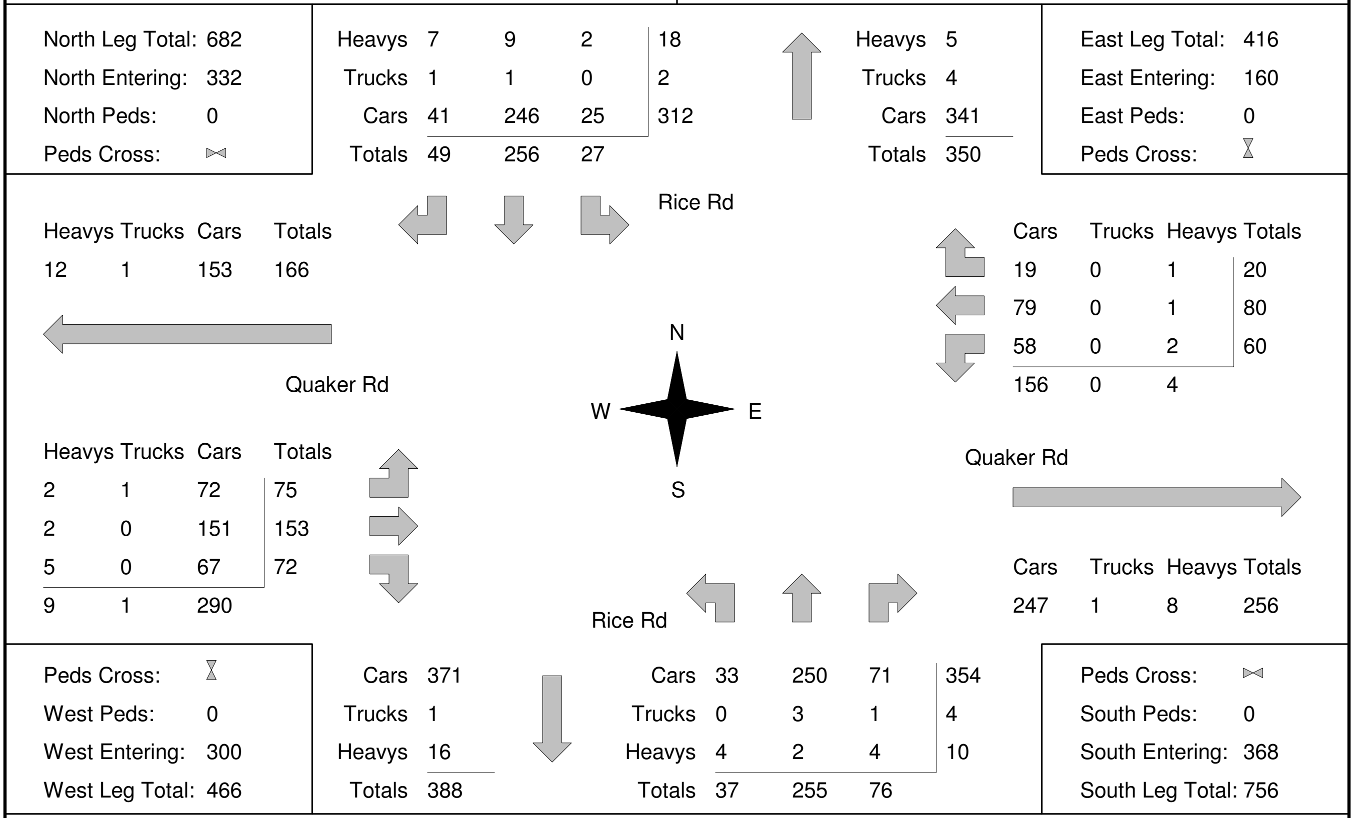
Municipality: Welland
Site #: 0000000004
Intersection: Rice Rd & Quaker Rd
TFR File #: 4
Count date: 14-Sep-2022

Weather conditions:
Clear/Dry

Person(s) who counted:
Cam

**** Non-Signalized Intersection ****

Major Road: Rice Rd runs N/S



North Leg Total: 682
North Entering: 332
North Peds: 0
Peds Cross: ⋈

Heavys	7	9	2	18
Trucks	1	1	0	2
Cars	41	246	25	312
Totals	49	256	27	

Heavys	5
Trucks	4
Cars	341
Totals	350

East Leg Total: 416
East Entering: 160
East Peds: 0
Peds Cross: ⧗

Heavys	Trucks	Cars	Totals
12	1	153	166

Cars	Trucks	Heavys	Totals
19	0	1	20
79	0	1	80
58	0	2	60
156	0	4	

Heavys	Trucks	Cars	Totals
2	1	72	75
2	0	151	153
5	0	67	72
9	1	290	

Cars	Trucks	Heavys	Totals
247	1	8	256

Peds Cross: ⧗
West Peds: 0
West Entering: 300
West Leg Total: 466

Cars	371
Trucks	1
Heavys	16
Totals	388

Cars	33	250	71	354
Trucks	0	3	1	4
Heavys	4	2	4	10
Totals	37	255	76	

Peds Cross: ⋈
South Peds: 0
South Entering: 368
South Leg Total: 756

Comments

Quaker Rd @ Rice Rd

Afternoon Peak Diagram

Specified Period
From: 15:00:00
To: 18:00:00

One Hour Peak
From: 16:00:00
To: 17:00:00

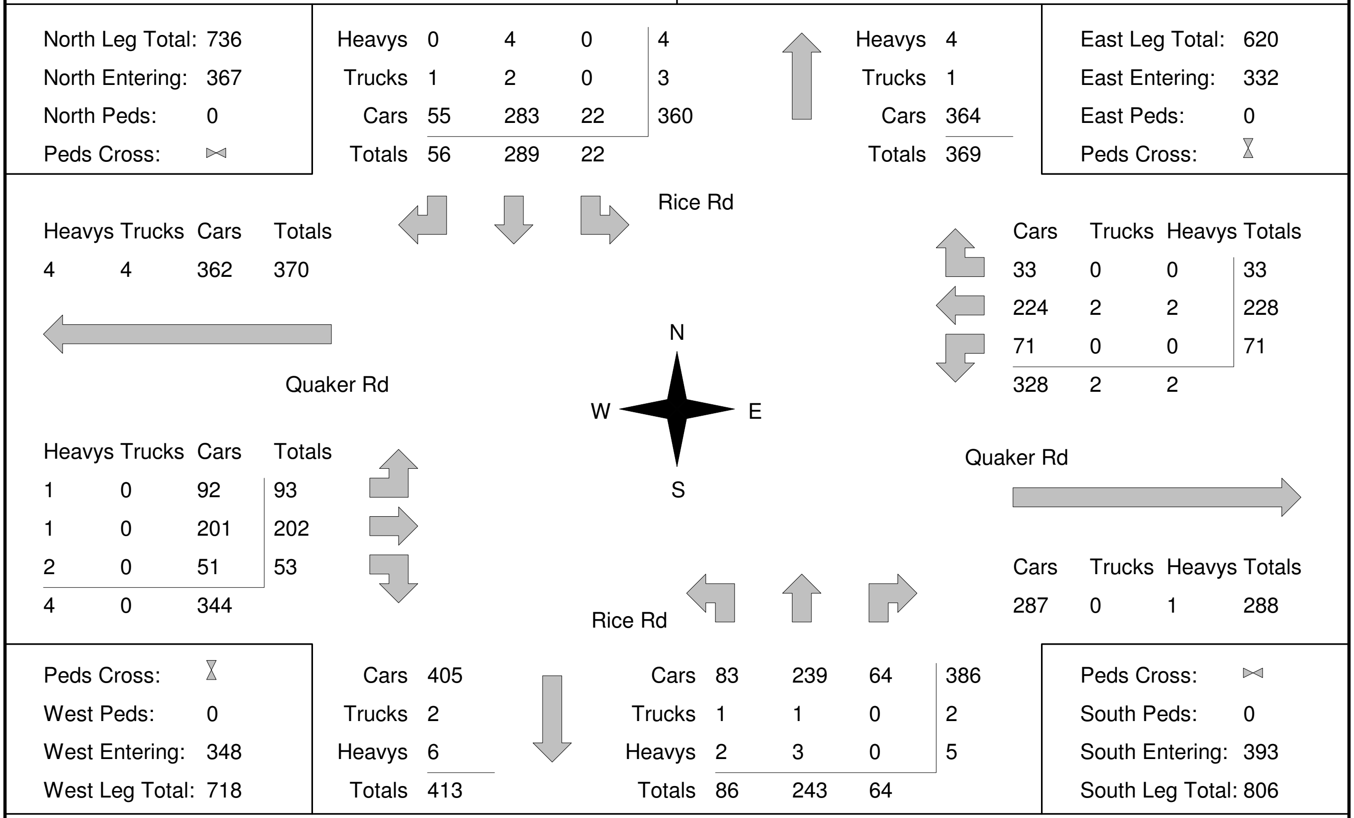
Municipality: Welland
Site #: 0000000004
Intersection: Rice Rd & Quaker Rd
TFR File #: 4
Count date: 14-Sep-2022

Weather conditions:
Clear/Dry

Person(s) who counted:
Cam

**** Non-Signalized Intersection ****

Major Road: Rice Rd runs N/S



North Leg Total: 736
North Entering: 367
North Peds: 0
Peds Cross: ⋈

Heavys	0	4	0	4
Trucks	1	2	0	3
Cars	55	283	22	360
Totals	56	289	22	

Heavys	4
Trucks	1
Cars	364
Totals	369

East Leg Total: 620
East Entering: 332
East Peds: 0
Peds Cross: ⧗

Heavys	Trucks	Cars	Totals
4	4	362	370

Cars	Trucks	Heavys	Totals
33	0	0	33
224	2	2	228
71	0	0	71
328	2	2	

Heavys	Trucks	Cars	Totals
1	0	92	93
1	0	201	202
2	0	51	53
4	0	344	

Cars	Trucks	Heavys	Totals
287	0	1	288

Peds Cross: ⧗
West Peds: 0
West Entering: 348
West Leg Total: 718

Cars	405
Trucks	2
Heavys	6
Totals	413

Cars	83	239	64	386
Trucks	1	1	0	2
Heavys	2	3	0	5
Totals	86	243	64	

Peds Cross: ⋈
South Peds: 0
South Entering: 393
South Leg Total: 806

Comments

Appendix C

Heavy Vehicle Percent Calculations

AM/PM Intersection

1 Rice Road at Quaker Road

8:00-9:00

ts after out 16:00-17:00

14-Sep-22

ts after output

	NBL	NBT	NBR	WBL	WBT	WBR	SBL	SBT	SBR	EBL	EBT	EBR
AM	4	5	5	2	1	1	2	10	8	3	2	5
PM	3	4	0	0	4	0	0	6	1	1	1	2
SAT												
	11%(3%)	2%(2%)	7%(2%)	3%(2%)	2%(2%)	5%(2%)	7%(2%)	4%(2%)	16%(2%)	4%(2%)	2%(2%)	7%(4%)

2 First Avenue at Ouaker Road

8:00-9:00

16:15-17:15

02-Nov-22

	NBL	NBT	NBR	WBL	WBT	WBR	SBL	SBT	SBR	EBL	EBT	EBR
AM	2	2	7	8	10	1	1	1	0	0	11	4
PM	0	1	6	7	1	0	0	1	1	0	2	0
SAT												
	4%(2%)	2%(2%)	6%(4%)	6%(5%)	6%(2%)	14%(2%)	14%(2%)	2%(2%)	2%(3%)	2%(2%)	5%(2%)	11%(2%)

3 Street 'A' at Quaker Road

	NBL	NBT	NBR	WBL	WBT	WBR	SBL	SBT	SBR	EBL	EBT	EBR
AM												
PM												
SAT												
	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)

4 Street 'D' at First Avenue

	NBL	NBT	NBR	WBL	WBT	WBR	SBL	SBT	SBR	EBL	EBT	EBR
AM												
PM												
SAT												
	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)

5 Street 'A' at Street 'D'

	NBL	NBT	NBR	WBL	WBT	WBR	SBL	SBT	SBR	EBL	EBT	EBR
AM												
PM												
SAT												
	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)	2%(2%)

Appendix D

Rice Road Preferred Design

Schedule ‘C’ Municipal Class Environmental Assessment for Merritt Road (Regional Road 37) and Rice Road (Regional Road 54) in the Town of Pelham, the City of Thorold and the City of Welland

APPENDIX

Q

Preferred Design

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

Maged Elmadhoon, M.Eng., P.Eng.
Manager, Transportation Planning - Public Works, Niagara Region
Phone: 905-980-6000 ext. 3583
Email: Maged.Elmadhoon@niagararegion.ca

Plotted: 2023-09-12
Last Saved: 2023-09-12

PLAN LEGEND

▬ ▪ ▪ ▬	EXISTING PROPERTY LINE	🟩	PROPOSED BIKE PATH CROSSING	▨	PROPOSED BOULEVARD	▨	PROPOSED MEDIAN
▬▬	PROPOSED PROPERTY LINE	▨	PROPOSED MULTI USE PATH	▨	PROPOSED ROAD	= = = =	PROPOSED DITCH
▨	PROPERTY TAKING	🟥	PROPOSED SIDEWALK				

PROFILE LEGEND

- - - - -	EXISTING GROUND
– – – –	PROPOSED CENTERLINE OF ROAD
– – – –	DITCH PROFILE
——	EXISTING MERRITT RD CENTERLINE

MERRITT ROAD (SEGMENT 1)

REGION OF NIAGARA

PLAN AND PROFILE

wsp

Scale 1:500
0 5 10 20

Consultant File No.
IM20103036

Drawing No.
1

Plotted: 2023-09-12
Last Saved: 2023-09-12

PLAN LEGEND

▬ ▬	EXISTING PROPERTY LINE
▬	PROPOSED PROPERTY LINE
▨	PROPERTY TAKING
🟩	PROPOSED BIKE PATH CROSSING
🟩	PROPOSED MULTI USE PATH
🟥	PROPOSED SIDEWALK
🟩	PROPOSED CYCLE TRACK
🟩	PROPOSED BOULEVARD
🟨	PROPOSED ROAD
🟦	PROPOSED MEDIAN
= = =	PROPOSED DITCH

PROFILE LEGEND

- - - -	EXISTING GROUND
- - - -	PROPOSED CENTERLINE OF ROAD
- - - -	DITCH PROFILE
──	EXISTING MERRITT RD CENTERLINE

MERRITT ROAD (SEGMENT 2)

REGION OF NIAGARA

PLAN AND PROFILE

Scale 1:500
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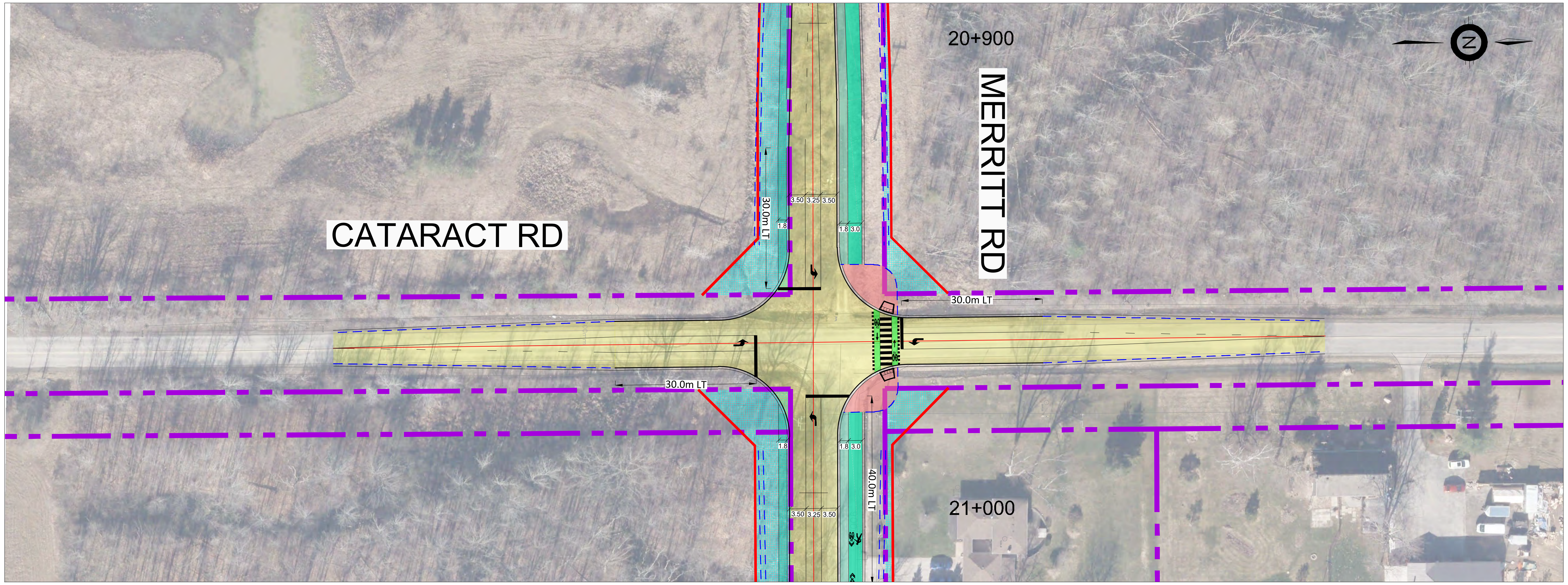
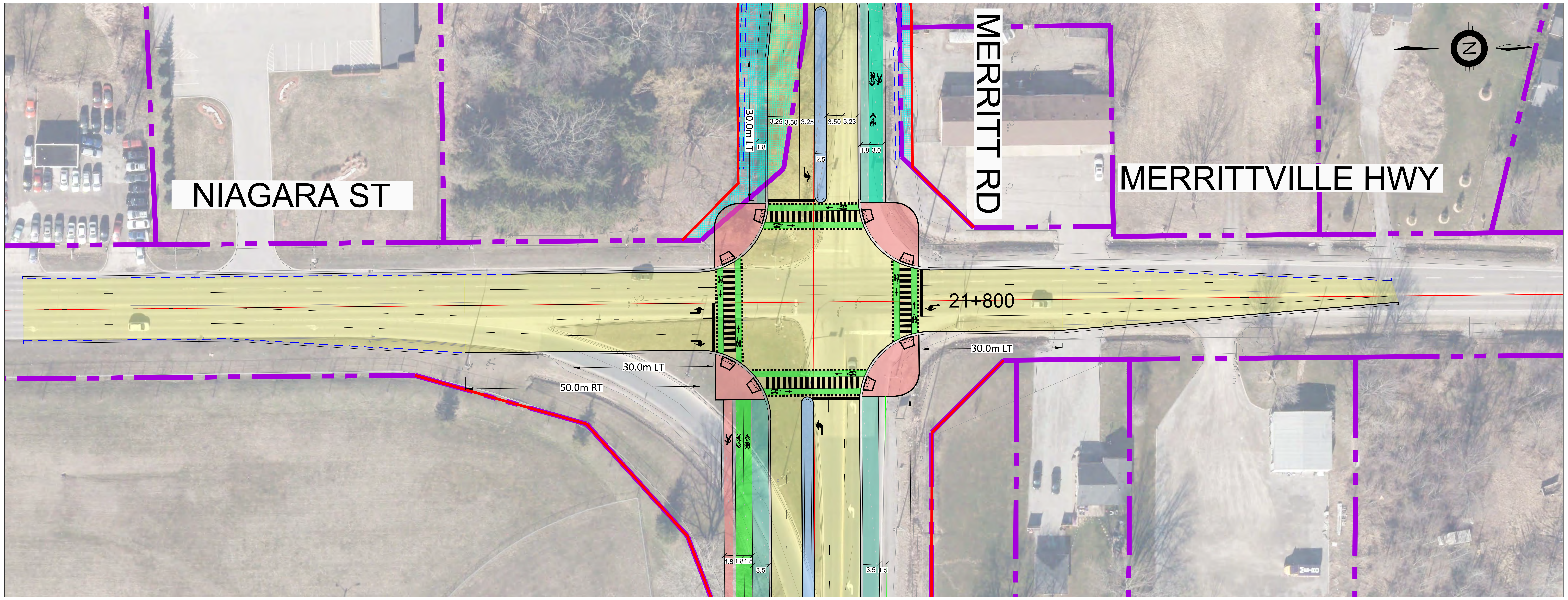
Consultant File No.
IM20103036

Drawing No.
2





PLAN LEGEND

▬ ▬	EXISTING PROPERTY LINE	🟩	PROPOSED BIKE PATH CROSSING	🟩	PROPOSED CYCLE TRACK	🟦	PROPOSED MEDIAN
▬	PROPOSED PROPERTY LINE	🟩	PROPOSED MULTI USE PATH	🟩	PROPOSED BOULEVARD	- - - -	PROPOSED DITCH
▨	PROPERTY TAKING	🟥	PROPOSED SIDEWALK	🟨	PROPOSED ROAD		

CROSSING ROAD AT MERRITT ROAD

REGION OF NIAGARA

PLAN AND PROFILE

Scale 1:500
0 5 10 20

Consultant File No.
IM20103036

Drawing No.
3

Plotted: 2023-09-12 Plotted By: zakrzewskij
Last Saved: 2023-09-12 Last Saved By: zakrzewskij

Path: S:\PLANNING DWGS\CA0002253.5346 – Merritt Road\Plan\CAD\Merritt_Rice PnP ROLL_Sections P&P.dwg

PLAN LEGEND

▬ ▪ ▪ ▬	EXISTING PROPERTY LINE	🟩	PROPOSED BIKE PATH	🟩	PROPOSED CYCLE TRACK	▭	PROPOSED MEDIAN
▬	PROPOSED PROPERTY LINE	🟩	PROPOSED MULTI USE PATH	▭	PROPOSED BOULEVARD	= = = =	PROPOSED DITCH
▨	PROPERTY TAKING	🟥	PROPOSED SIDEWALK	🟨	PROPOSED ROAD		

PROFILE LEGEND

- - - -	EXISTING GROUND
- - - -	PROPOSED CENTERLINE OF ROAD
- - - -	DITCH PROFILE
──	EXISTING MERRITT RD CENTERLINE

MERRITT ROAD (SEGMENT 3)

REGION OF NIAGARA

PLAN AND PROFILE

Scale 1:500
0 5 10 20

Consultant File No.
IM20103036

Drawing No.
4

Plotted: 2023-09-12
Last Saved: 2023-09-12

By: zakrzewskij

GRISDALE ROAD - HIGHWAY 406 / MERRITT ROAD - OPTION 6

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

EXTEND SOUTHBOUND RIGHT TURN LANE TO THE INTERSECTION

PROVIDE TRAFFIC SIGNAL

REMOVE SOUTHBOUND RIGHT TURN CHANNEL

PROVIDE CONCRETE MEDIAN

REMOVE SOUTHBOUND RAMP AND PROVIDE WESTBOUND RIGHT TURN LANE

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

RELOCATED GUIDERAIL

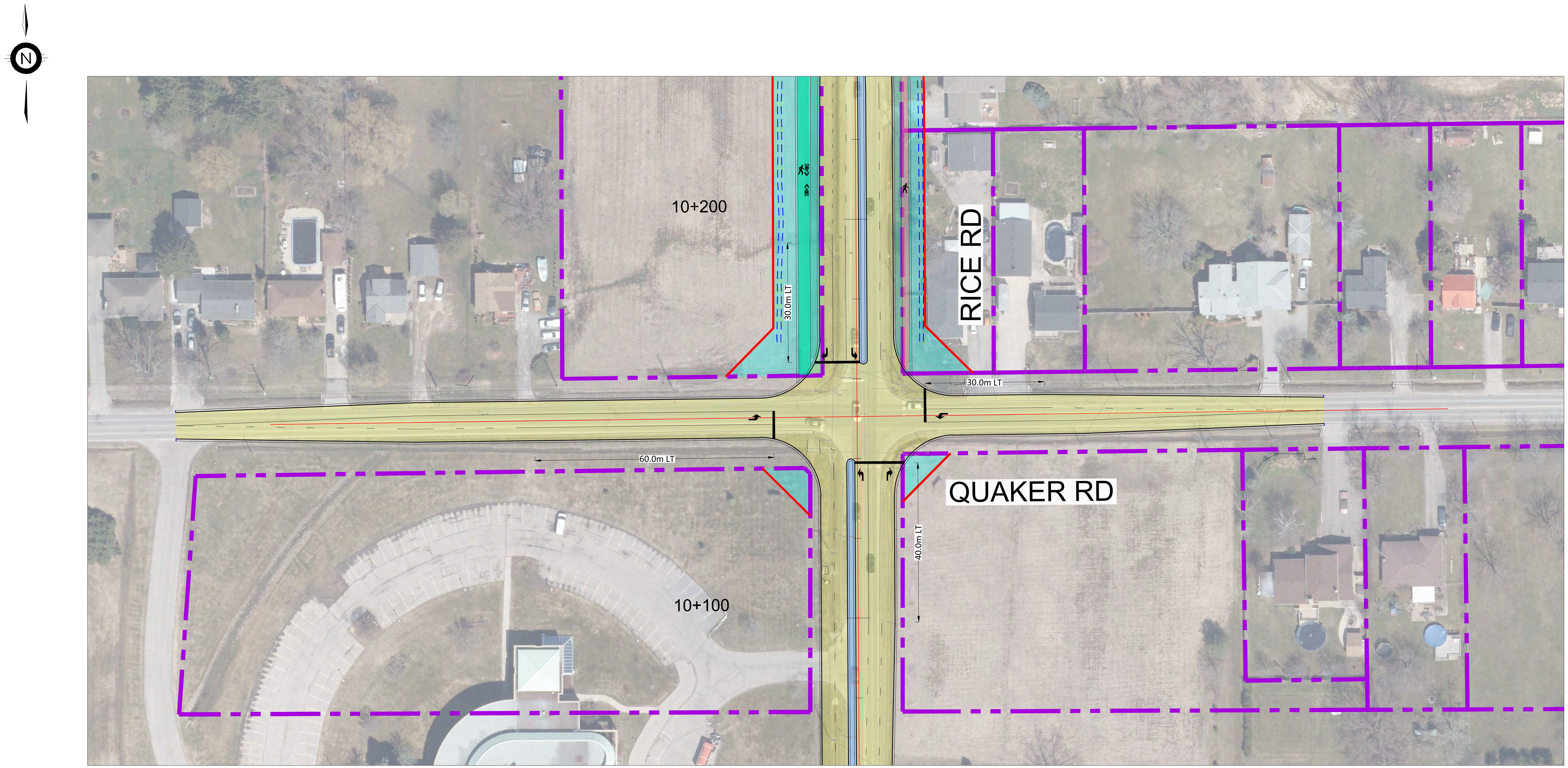
PROPOSED EDGE OF PAVEMENT

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

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

3.0m MULTI-USE PATH TO CROSS TO NORTH SIDE

RELOCATED GUIDERAIL



Path: S:\PLANNING DWGS\CA0002253.5346 – Merritt Road\Plan\CAD\Merritt_Rice PnP ROLL_Sections P&P.dwg

Plotted By: zakrzewskij
Last Saved By: zakrzewskij

Plotted: 2023-09-12
Last Saved: 2023-09-12

PLAN LEGEND

▬ ▪ ▬	EXISTING PROPERTY LINE
▬▬	PROPOSED PROPERTY LINE
▨	PROPERTY TAKING
🟩	PROPOSED BIKE PATH
🟩	PROPOSED MULTI USE PATH
🟥	PROPOSED SIDEWALK
🟩	PROPOSED CYCLE TRACK
🟩	PROPOSED BOULEVARD
🟨	PROPOSED ROAD
🟦	PROPOSED MEDIAN
= = = =	PROPOSED DITCH

MERRITT ROAD (SEGMENT 3)

REGION OF NIAGARA

PLAN AND PROFILE

wsp

Scale 1:500
0 5 10 20

Consultant File No.
IM20103036

Drawing No.
7

Plotted: 2023-09-12
Last Saved: 2023-09-12

PLAN LEGEND

▬ · ▬	EXISTING PROPERTY LINE	🟩	PROPOSED BIKE PATH CROSSING	🟩	PROPOSED BOULEVARD	🟦	PROPOSED MEDIAN
▬	PROPOSED PROPERTY LINE	🟩	PROPOSED MULTI USE PATH	🟨	PROPOSED ROAD	═ ═ ═	PROPOSED DITCH
🟦	PROPERTY TAKING	🟥	PROPOSED SIDEWALK				

MERRITT ROAD AND
RICE ROAD
REGION OF NIAGARA

PROPERTY TAKINGS PLAN

wsp

Scale 1:500
0 5 10 20

Consultant File No.
IM20103036

Drawing No.
1

Appendix E

2026 Future Background Conditions Synchro Worksheets

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↱		↰	↑	↰↱	
Traffic Volume (vph)	426	64	23	297	48	215
Future Volume (vph)	426	64	23	297	48	215
Ideal Flow (vphpl)	1535	1535	1651	1535	1630	1630
Storage Length (m)		0.0	30.0		0.0	0.0
Storage Lanes		0	1		1	0
Taper Length (m)			15.0		15.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	0.982				0.890	
Flt Protected			0.950		0.991	
Satd. Flow (prot)	1461	0	1521	1488	1394	0
Flt Permitted			0.950		0.991	
Satd. Flow (perm)	1461	0	1521	1488	1394	0
Link Speed (k/h)	50			50	50	
Link Distance (m)	281.2			541.7	127.4	
Travel Time (s)	20.2			39.0	9.2	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	473	71	26	330	53	239
Shared Lane Traffic (%)						
Lane Group Flow (vph)	544	0	26	330	292	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	3.5			3.5	3.5	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	3.0			3.0	3.0	
Two way Left Turn Lane						
Headway Factor	1.33	1.33	1.21	1.33	1.23	1.23
Turning Speed (k/h)		15	25		25	15
Sign Control	Free			Free	Stop	

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 57.8% ICU Level of Service B

Analysis Period (min) 15

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↱		↰	↑	↰↱	
Traffic Volume (veh/h)	426	64	23	297	48	215
Future Volume (Veh/h)	426	64	23	297	48	215
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	473	71	26	330	53	239
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)	281					
pX, platoon unblocked			0.91		0.91	0.91
vC, conflicting volume			544		890	508
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			445		828	406
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		82	59
cM capacity (veh/h)			1011		301	584

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	544	26	330	292
Volume Left	0	26	0	53
Volume Right	71	0	0	239
cSH	1700	1011	1700	499
Volume to Capacity	0.32	0.03	0.19	0.58
Queue Length 95th (m)	0.0	0.6	0.0	28.1
Control Delay (s)	0.0	8.7	0.0	21.9
Lane LOS		A		C
Approach Delay (s)	0.0	0.6		21.9
Approach LOS				C

Intersection Summary			
Average Delay	5.5		
Intersection Capacity Utilization	57.8%	ICU Level of Service	B
Analysis Period (min)	15		

4: First Avenue & Street D

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↱		↱		↰	↑
Traffic Volume (vph)	129	80	126	72	115	76
Future Volume (vph)	129	80	126	72	115	76
Ideal Flow (vphpl)	1630	1630	1535	1535	1651	1535
Storage Length (m)	0.0	0.0		0.0	30.0	
Storage Lanes	1	0		0	1	
Taper Length (m)	15.0				15.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	0.948		0.951			
Flt Protected	0.970				0.950	
Satd. Flow (prot)	1453	0	1415	0	1521	1488
Flt Permitted	0.970				0.950	
Satd. Flow (perm)	1453	0	1415	0	1521	1488
Link Speed (k/h)	50		50			50
Link Distance (m)	127.1		476.7			399.8
Travel Time (s)	9.2		34.3			28.8
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	143	89	140	80	128	84
Shared Lane Traffic (%)						
Lane Group Flow (vph)	232	0	220	0	128	84
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Right	Left	Left
Median Width(m)	3.5		3.5			3.5
Link Offset(m)	0.0		0.0			0.0
Crosswalk Width(m)	3.0		3.0			3.0
Two way Left Turn Lane						
Headway Factor	1.23	1.23	1.33	1.33	1.21	1.33
Turning Speed (k/h)	25	15		15	25	
Sign Control	Stop		Free			Free

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 45.0% ICU Level of Service A

Analysis Period (min) 15

4: First Avenue & Street D

	↙	↖	↑	↗	↘	↓
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	Y		↱		↰	↑
Traffic Volume (veh/h)	129	80	126	72	115	76
Future Volume (Veh/h)	129	80	126	72	115	76
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	143	89	140	80	128	84
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	520	180			220	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	520	180			220	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	69	90			91	
cM capacity (veh/h)	467	863			1349	

Direction, Lane #	WB 1	NB 1	SB 1	SB 2
Volume Total	232	220	128	84
Volume Left	143	0	128	0
Volume Right	89	80	0	0
cSH	567	1700	1349	1700
Volume to Capacity	0.41	0.13	0.09	0.05
Queue Length 95th (m)	15.1	0.0	2.4	0.0
Control Delay (s)	15.7	0.0	7.9	0.0
Lane LOS	C		A	
Approach Delay (s)	15.7	0.0	4.8	
Approach LOS	C			

Intersection Summary			
Average Delay	7.0		
Intersection Capacity Utilization	45.0%	ICU Level of Service	A
Analysis Period (min)	15		

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↱		↰	↑	Y	
Traffic Volume (vph)	529	233	84	389	34	152
Future Volume (vph)	529	233	84	389	34	152
Ideal Flow (vphpl)	1535	1535	1651	1776	1630	1630
Storage Length (m)		0.0	30.0		0.0	0.0
Storage Lanes		0	1		1	0
Taper Length (m)			15.0		15.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	0.959				0.890	
Flt Protected			0.950		0.991	
Satd. Flow (prot)	1427	0	1521	1722	1394	0
Flt Permitted			0.950		0.991	
Satd. Flow (perm)	1427	0	1521	1722	1394	0
Link Speed (k/h)	50			50	50	
Link Distance (m)	281.2			541.7	109.5	
Travel Time (s)	20.2			39.0	7.9	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	575	253	91	423	37	165
Shared Lane Traffic (%)						
Lane Group Flow (vph)	828	0	91	423	202	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	3.5			3.5	3.5	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	3.0			3.0	3.0	
Two way Left Turn Lane						
Headway Factor	1.33	1.33	1.21	1.11	1.23	1.23
Turning Speed (k/h)		15	25		25	15
Sign Control	Free			Free	Stop	

Intersection Summary		
Area Type:	Other	
Control Type: Unsignalized		
Intersection Capacity Utilization 80.5%		ICU Level of Service D
Analysis Period (min) 15		

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↱		↰	↑	Y	
Traffic Volume (veh/h)	529	233	84	389	34	152
Future Volume (Veh/h)	529	233	84	389	34	152
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	575	253	91	423	37	165
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)	281					
pX, platoon unblocked			0.70		0.70	0.70
vC, conflicting volume			828		1306	702
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			534		1222	352
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			87		69	66
cM capacity (veh/h)			719		121	481

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	828	91	423	202
Volume Left	0	91	0	37
Volume Right	253	0	0	165
cSH	1700	719	1700	311
Volume to Capacity	0.49	0.13	0.25	0.65
Queue Length 95th (m)	0.0	3.3	0.0	32.3
Control Delay (s)	0.0	10.7	0.0	35.8
Lane LOS		B		E
Approach Delay (s)	0.0	1.9		35.8
Approach LOS				E

Intersection Summary			
Average Delay	5.3		
Intersection Capacity Utilization	80.5%	ICU Level of Service	D
Analysis Period (min)	15		

	↙	↖	↑	↗	↘	↓
Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	Y		↱		↰	↑
Traffic Volume (vph)	91	56	98	260	418	135
Future Volume (vph)	91	56	98	260	418	135
Ideal Flow (vphpl)	1630	1630	1535	1535	1651	1776
Storage Length (m)	0.0	0.0		0.0	30.0	
Storage Lanes	1	0		0	1	
Taper Length (m)	15.0				15.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	0.949		0.902			
Flt Protected	0.970				0.950	
Satd. Flow (prot)	1455	0	1342	0	1521	1722
Flt Permitted	0.970				0.950	
Satd. Flow (perm)	1455	0	1342	0	1521	1722
Link Speed (k/h)	50		50			50
Link Distance (m)	141.2		476.7			399.8
Travel Time (s)	10.2		34.3			28.8
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	99	61	107	283	454	147
Shared Lane Traffic (%)						
Lane Group Flow (vph)	160	0	390	0	454	147
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Right	Left	Left
Median Width(m)	3.5		3.5			3.5
Link Offset(m)	0.0		0.0			0.0
Crosswalk Width(m)	3.0		3.0			3.0
Two way Left Turn Lane						
Headway Factor	1.23	1.23	1.33	1.33	1.21	1.11
Turning Speed (k/h)	25	15		15	25	
Sign Control	Stop		Free			Free

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 72.7% ICU Level of Service C

Analysis Period (min) 15

HCM Unsignalized Intersection Capacity Analysis
4: First Avenue & Street D

2026 Future Background PM
Primont Welland

	↙	↖	↑	↗	↘	↓
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	Y		↱		↰	↑
Traffic Volume (veh/h)	91	56	98	260	418	135
Future Volume (Veh/h)	91	56	98	260	418	135
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)	99	61	107	283	454	147
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	1304	248			390	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1304	248			390	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	9	92			61	
cM capacity (veh/h)	108	790			1169	

Direction, Lane #	WB 1	NB 1	SB 1	SB 2
Volume Total	160	390	454	147
Volume Left	99	0	454	0
Volume Right	61	283	0	0
cSH	161	1700	1169	1700
Volume to Capacity	0.99	0.23	0.39	0.09
Queue Length 95th (m)	58.2	0.0	14.2	0.0
Control Delay (s)	125.2	0.0	10.0	0.0
Lane LOS	F		B	
Approach Delay (s)	125.2	0.0	7.6	
Approach LOS	F			

Intersection Summary			
Average Delay	21.4		
Intersection Capacity Utilization	72.7%	ICU Level of Service	C
Analysis Period (min)	15		

Appendix F

Traffic Signal and All-Way Stop Warrants

Intersection: Quaker and Street A

1 1

Major Street: East-West Lanes: 1
Minor Street: North-South Lanes: 1
Urban/Rural: Urban
Legs: 4

New/Existing Intersection: New

Quaker and Street A
2026 FT

Scenario: 2026 FT

	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
AHV	21	0	92	102	0	24	64	243	74	27	176	15
AM	48	0	215	245	0	57	60	428	64	23	304	14
PM	34	0	152	164	0	38	195	543	233	84	398	45

Justification #7

Justification	Description	Minimum Requirement		Minimum Requirement		Compliance			Signal
		1 Lane Highway		2 or More Lanes		Sectional		Entire %	
		Free Flow	Restr. Flow	Free Flow	Restr. Flow	Numerical	%		
1. Minimum Vehicular Volume	A. Vehicle volume, all approaches (average hour)	480	720	600	900	836	116%	116%	No
	B. Vehicle volume, along minor streets (average hour)	120	170	120	170	238	140%		
2. Delay to Cross Traffic	A. Vehicle volumes, major street (average hour)	480	720	600	900	598	83%	83%	No
	B. Combined vehicle and pedestrian volume crossing artery from minor streets (average hour)	50	75	50	75	123	164%		

Notes
1. Refer to OTM Book 12, pg 92, Mar 2012
2. Lowest section percentage governs justification
3. Average hourly volumes estimated from peak hour volumes, AHV = PM/2 or (AM + PM) / 4, including amplifcation factors
4. T-intersection factor corrected, applies only to 1B
5. Correction to 2B, as per MTO and City of Ottawa, for '2 or More Lanes' has been applied

Intersection: First Avenue and Street D

1 1

Major Street: North-South Lanes: 1
Minor Street: East-West Lanes: 1
Urban/Rural: Urban
Legs: 4

New/Existing Intersection: New

Scenario: 2026 FT

	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
AHV	12	75	83	133	56	18	86	0	62	55	0	34
AM	11	155	72	115	81	16	201	0	144	129	0	80
PM	36	144	260	418	144	56	144	0	102	91	0	56

First Avenue and Street D
2026 FT

Justification #7

Justification	Description	Minimum Requirement		Minimum Requirement		Compliance			Signal
		1 Lane Highway		2 or More Lanes		Sectional		Entire %	
		Free Flow	Restr. Flow	Free Flow	Restr. Flow	Numerical	%		
1. Minimum Vehicular Volume	A. Vehicle volume, all approaches (average hour)	480	720	600	900	614	85%	85%	No
	B. Vehicle volume, along minor streets (average hour)	120	170	120	170	237	139%		
2. Delay to Cross Traffic	A. Vehicle volumes, major street (average hour)	480	720	600	900	377	52%	52%	No
	B. Combined vehicle and pedestrian volume crossing artery from minor streets (average hour)	50	75	50	75	208	277%		

Notes
1. Refer to OTM Book 12, pg 92, Mar 2012
2. Lowest section percentage governs justification
3. Average hourly volumes estimated from peak hour volumes, AHV = PM/2 or (AM + PM) / 4, including amplifcation factors
4. T-intersection factor corrected, applies only to 1B
5. Correction to 2B, as per MTO and City of Ottawa, for '2 or More Lanes' has been applied

Warrants for AWSC on Urban Local and/or Collector Streets

Quaker Street at Street A

Volume Criteria		
Major Street 2-Way Hourly Volume (per 8-hr period)	Minor Street 2-Way Hourly Volume (per 8-hr period)	Minor Street Pedestrian 2-Way Hourly Volume (per 8-hr period)
1304	427	0
Control Required		
Total Vehicle Volume	YES	
Minor Street Volume & Pedestrian Volume	NO	
	3-Way Stop	4-Way Stop
Vehicle Split	YES	YES

OR

Collision Criteria		
Total Collisions (3-yr period)	Total Collisions Preventable by Stop	Control Required
		NO

Warrants for AWSC on Urban Local and/or Collector Streets

First Avenue at Street D

Volume Criteria		
Major Street 2-Way Hourly Volume (per 8-hr period)	Minor Street 2-Way Hourly Volume (per 8-hr period)	Minor Street Pedestrian 2-Way Hourly Volume (per 8-hr period)
789	611	0
Control Required		
Total Vehicle Volume	NO	
Minor Street Volume & Pedestrian Volume	NO	
	3-Way Stop	4-Way Stop
Vehicle Split	YES	YES

OR

Collision Criteria		
Total Collisions (3-yr period)	Total Collisions Preventable by Stop	Control Required
		NO

Appendix G

Left Turn Warrants

Scenario:

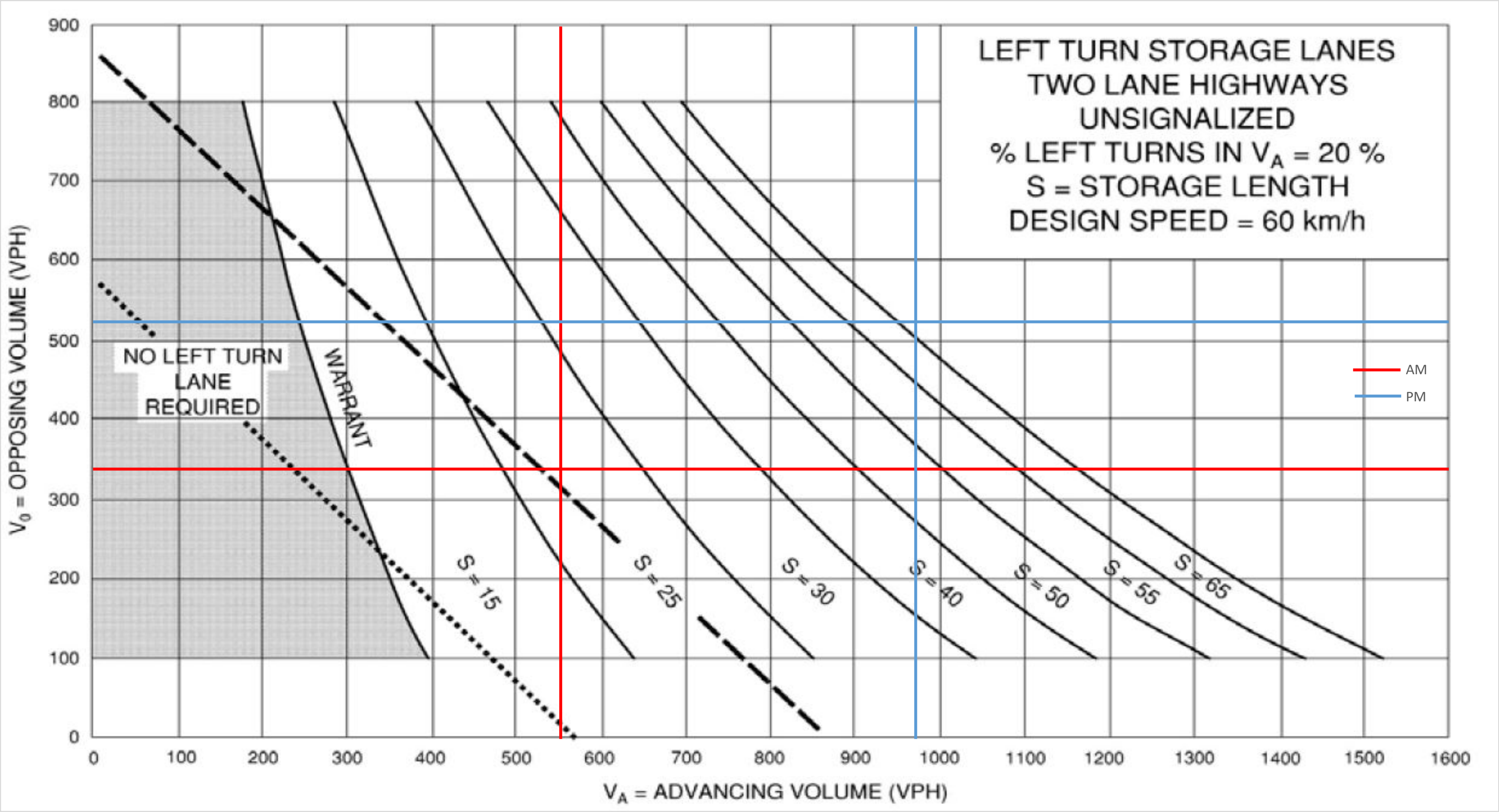
Future Total 2026

Eastbound Left

Design Speed

60 km/h

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	%Left Turn	Volume Advancing	Volume Opposing
AM	60	428	64	23	304	14	48	0	215	245	0	57	10.9%	552	341
PM	195	543	233	84	398	45	34	0	152	164	0	38	20.1%	971	527


LEFT TURN STORAGE LANES
TWO LANE HIGHWAYS
UNSIGNALIZED
% LEFT TURNS IN V_A = 20 %
S = STORAGE LENGTH
DESIGN SPEED = 60 km/h
NO LEFT TURN LANE REQUIRED
WARRANT
S = 15
S = 25
S = 30
S = 40
S = 50
S = 55
S = 65
AM
PM
V_0 = OPPOSING VOLUME (VPH)
V_A = ADVANCING VOLUME (VPH)
900
800
700
600
500
400
300
200
100
0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600

Scenario:

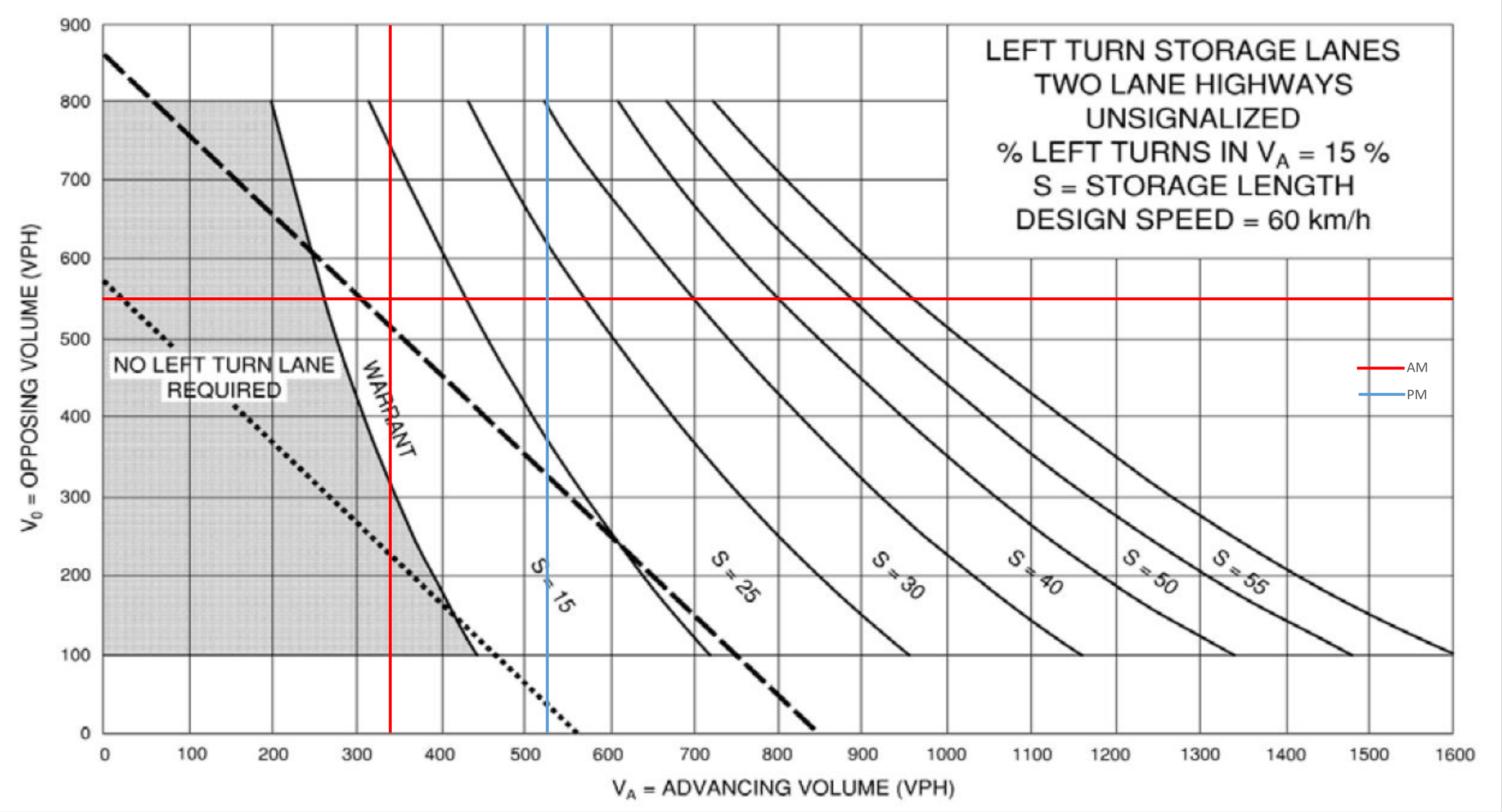
Future Total 2026

Westbound Left

Design Speed

60 km/h

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	%Left Turn	Volume Advancing	Volume Opposing
AM	60	428	64	23	304	14	48	0	215	245	0	57	6.7%	341	552
PM	195	543	233	84	398	45	34	0	152	164	0	38	15.9%	527	971


LEFT TURN STORAGE LANES
TWO LANE HIGHWAYS
UNSIGNALIZED
% LEFT TURNS IN V_A = 15 %
S = STORAGE LENGTH
DESIGN SPEED = 60 km/h
NO LEFT TURN LANE REQUIRED
WARRANT
S = 15
S = 25
S = 30
S = 40
S = 50
S = 55
AM
PM
V_0 = OPPOSING VOLUME (VPH)
V_A = ADVANCING VOLUME (VPH)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600

Scenario:

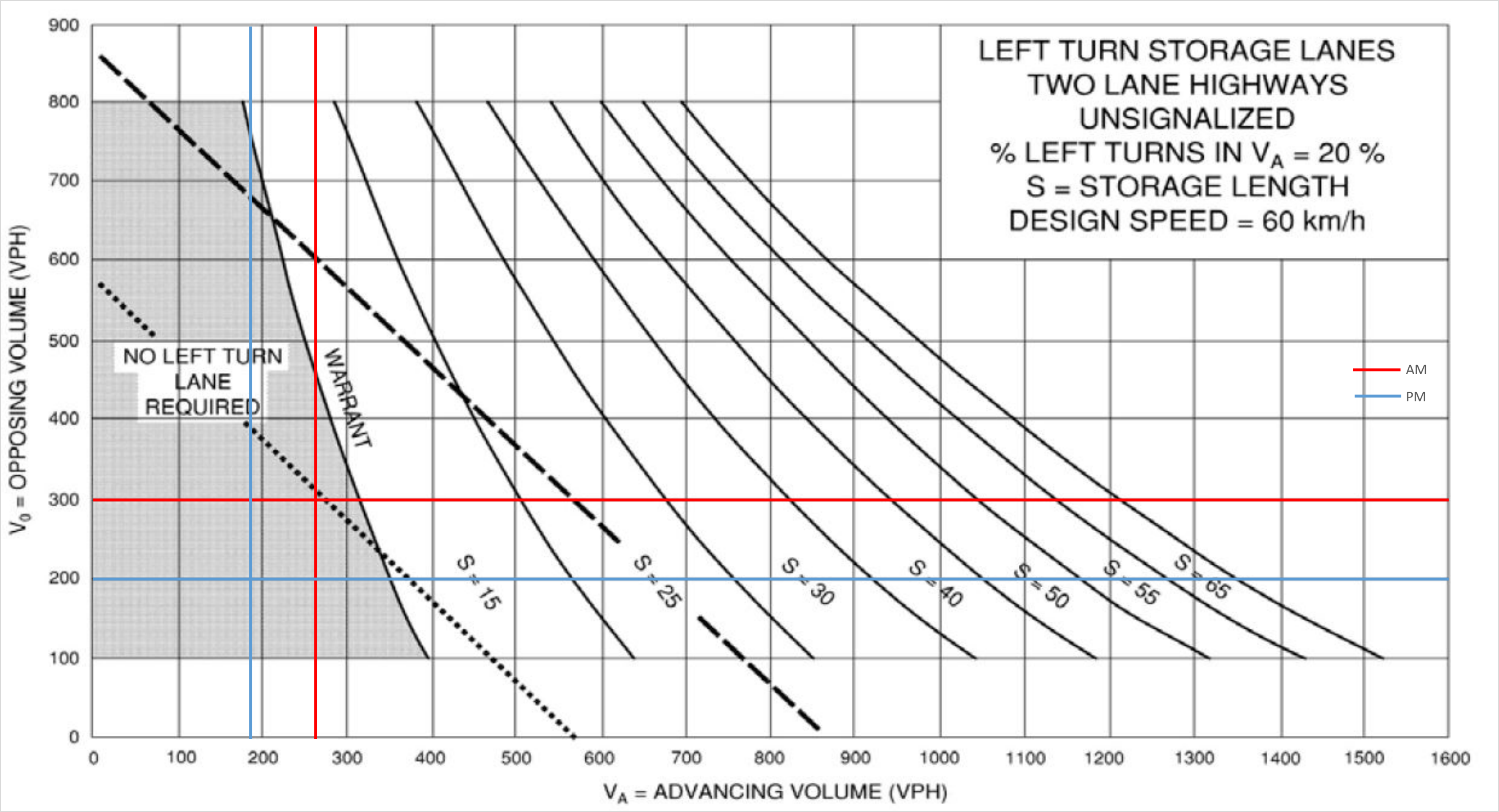
Future Total 2026

Northbound Left

Design Speed

60 km/h

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	%Left Turn	Volume Advancing	Volume Opposing
AM	**60**	**428**	**64**	**23**	**304**	**14**	**48**	**0**	**215**	**245**	**0**	**57**	**18.3%**	**263**	**302**
PM	**195**	**543**	**233**	**84**	**398**	**45**	**34**	**0**	**152**	**164**	**0**	**38**	**18.3%**	**186**	**202**


LEFT TURN STORAGE LANES
TWO LANE HIGHWAYS
UNSIGNALIZED
% LEFT TURNS IN V_A = 20 %
S = STORAGE LENGTH
DESIGN SPEED = 60 km/h
NO LEFT TURN LANE REQUIRED
WARRANT
S = 15
S = 25
S = 30
S = 40
S = 50
S = 55
S = 65
AM
PM
V_0 = OPPOSING VOLUME (VPH)
V_A = ADVANCING VOLUME (VPH)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600

Scenario:

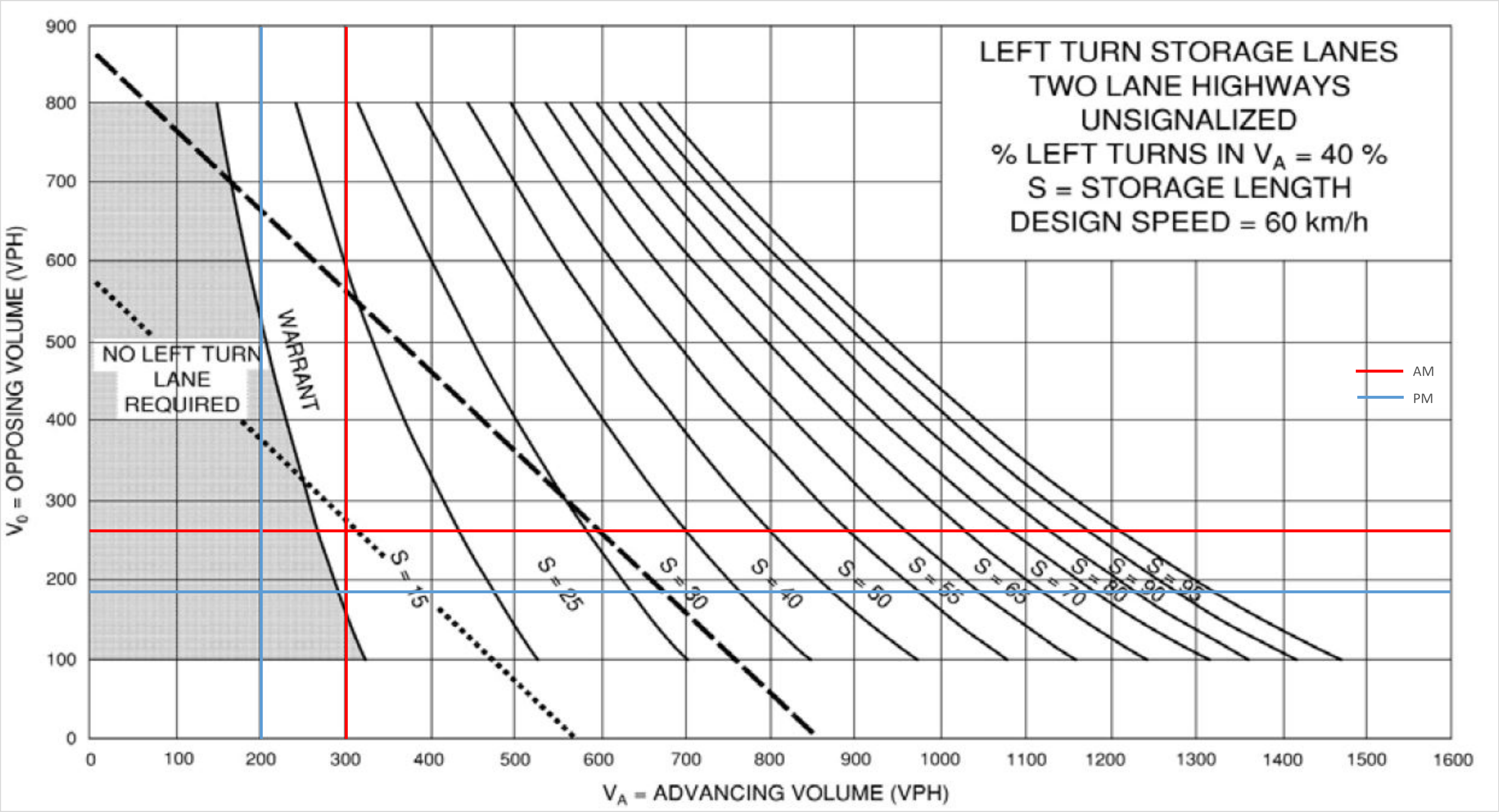
Future Total 2026

Southbound Left

Design Speed

60 km/h

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	%Left Turn	Volume Advancing	Volume Opposing
AM	60	428	64	23	304	14	48	0	215	245	0	57	81.1%	302	263
PM	195	543	233	84	398	45	34	0	152	164	0	38	81.2%	202	186


LEFT TURN STORAGE LANES
TWO LANE HIGHWAYS
UNSIGNALIZED
% LEFT TURNS IN V_A = 40 %
S = STORAGE LENGTH
DESIGN SPEED = 60 km/h
NO LEFT TURN LANE REQUIRED
WARRANT
S = 15
S = 25
S = 30
S = 40
S = 50
S = 55
S = 65
S = 70
S = 80
S = 90
S = 95
AM
PM
V_0 = OPPOSING VOLUME (VPH)
0
100
200
300
400
500
600
700
800
900
V_A = ADVANCING VOLUME (VPH)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600

Scenario:

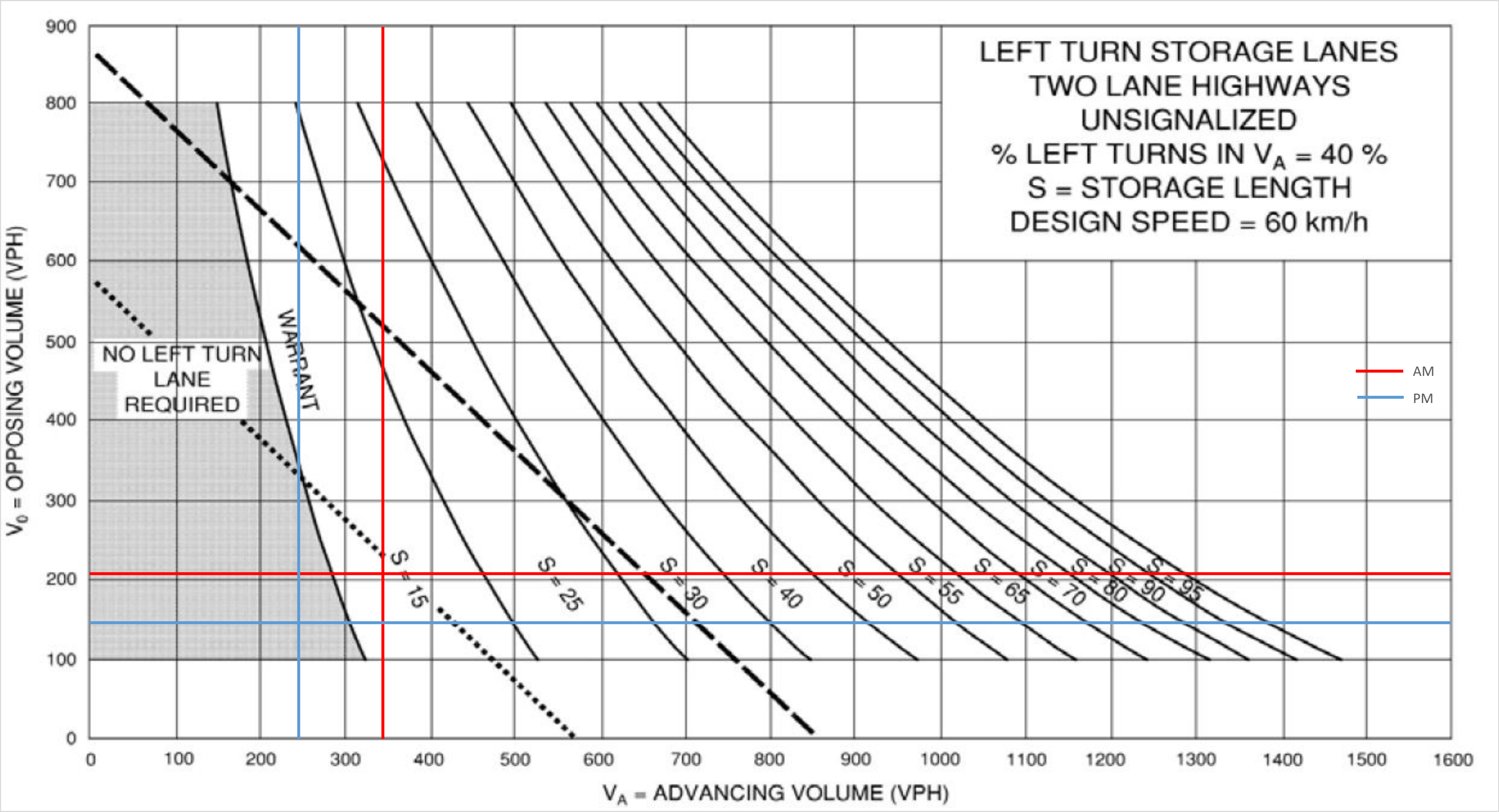
Future Total 2026

Eastbound Left

Design Speed

60 km/h

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	%Left Turn	Volume Advancing	Volume Opposing
AM	**201**	**0**	**144**	**129**	**0**	**80**	**11**	**155**	**72**	**115**	**81**	**16**	**58.3%**	**345**	**209**
PM	**144**	**0**	**102**	**91**	**0**	**56**	**36**	**144**	**260**	**418**	**144**	**56**	**58.5%**	**246**	**147**


LEFT TURN STORAGE LANES
TWO LANE HIGHWAYS
UNSIGNALIZED
% LEFT TURNS IN V_A = 40 %
S = STORAGE LENGTH
DESIGN SPEED = 60 km/h
NO LEFT TURN LANE REQUIRED
WARRANT
S = 15
S = 25
S = 30
S = 40
S = 50
S = 55
S = 65
S = 70
S = 80
S = 90
S = 95
AM
PM
V_0 = OPPOSING VOLUME (VPH)
V_A = ADVANCING VOLUME (VPH)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600

Scenario:

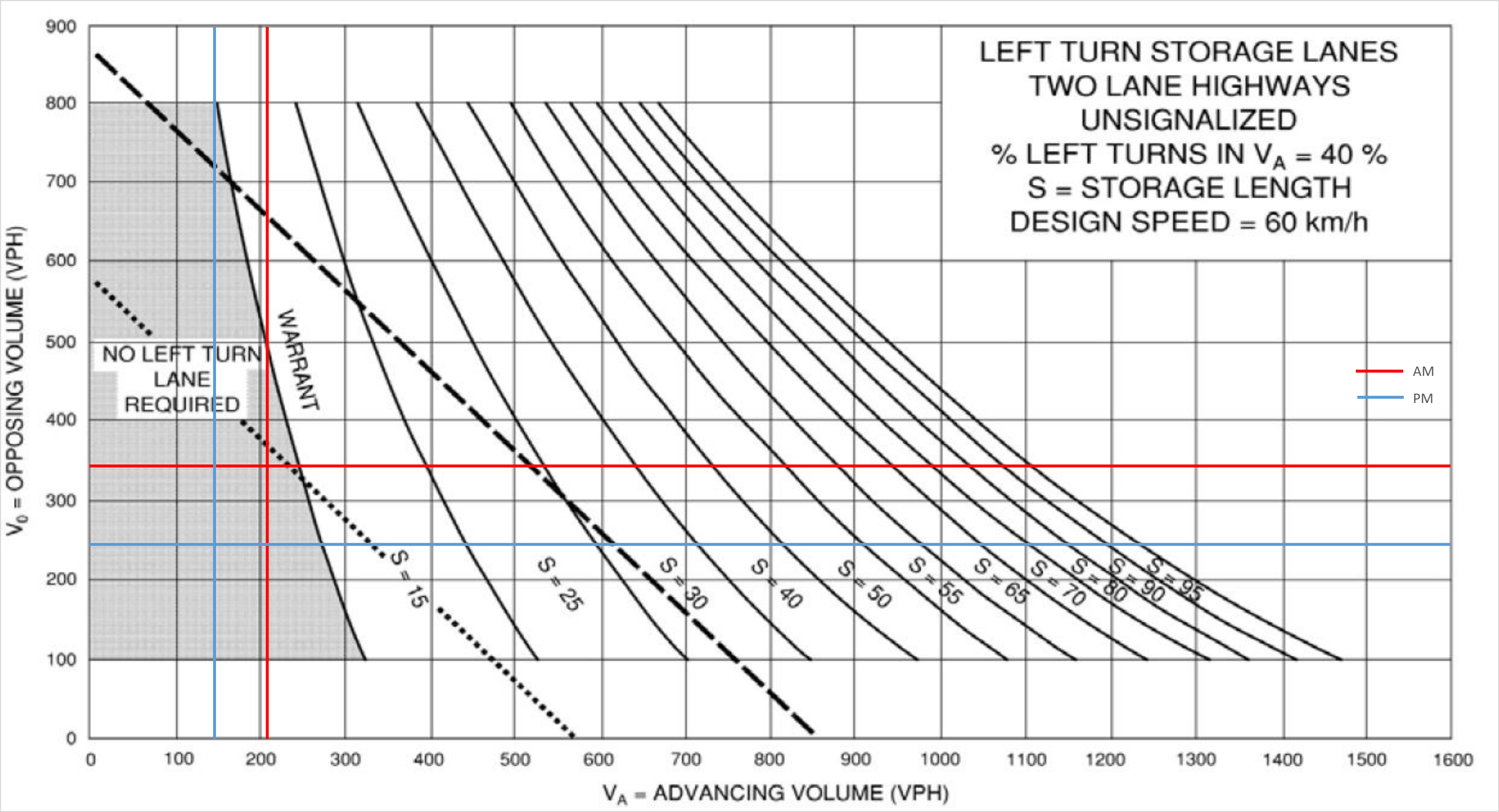
Future Total 2026

Westbound Left

Design Speed

60 km/h

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	%Left Turn	Volume Advancing	Volume Opposing
AM	201	0	144	129	0	80	11	155	72	115	81	16	61.7%	209	345
PM	144	0	102	91	0	56	36	144	260	418	144	56	61.9%	147	246


LEFT TURN STORAGE LANES
TWO LANE HIGHWAYS
UNSIGNALIZED
% LEFT TURNS IN V_A = 40 %
S = STORAGE LENGTH
DESIGN SPEED = 60 km/h
NO LEFT TURN LANE REQUIRED
WARRANT
S = 15
S = 25
S = 30
S = 40
S = 50
S = 55
S = 65
S = 70
S = 80
S = 90
S = 95
AM
PM
V_0 = OPPOSING VOLUME (VPH)
V_A = ADVANCING VOLUME (VPH)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600

Scenario:

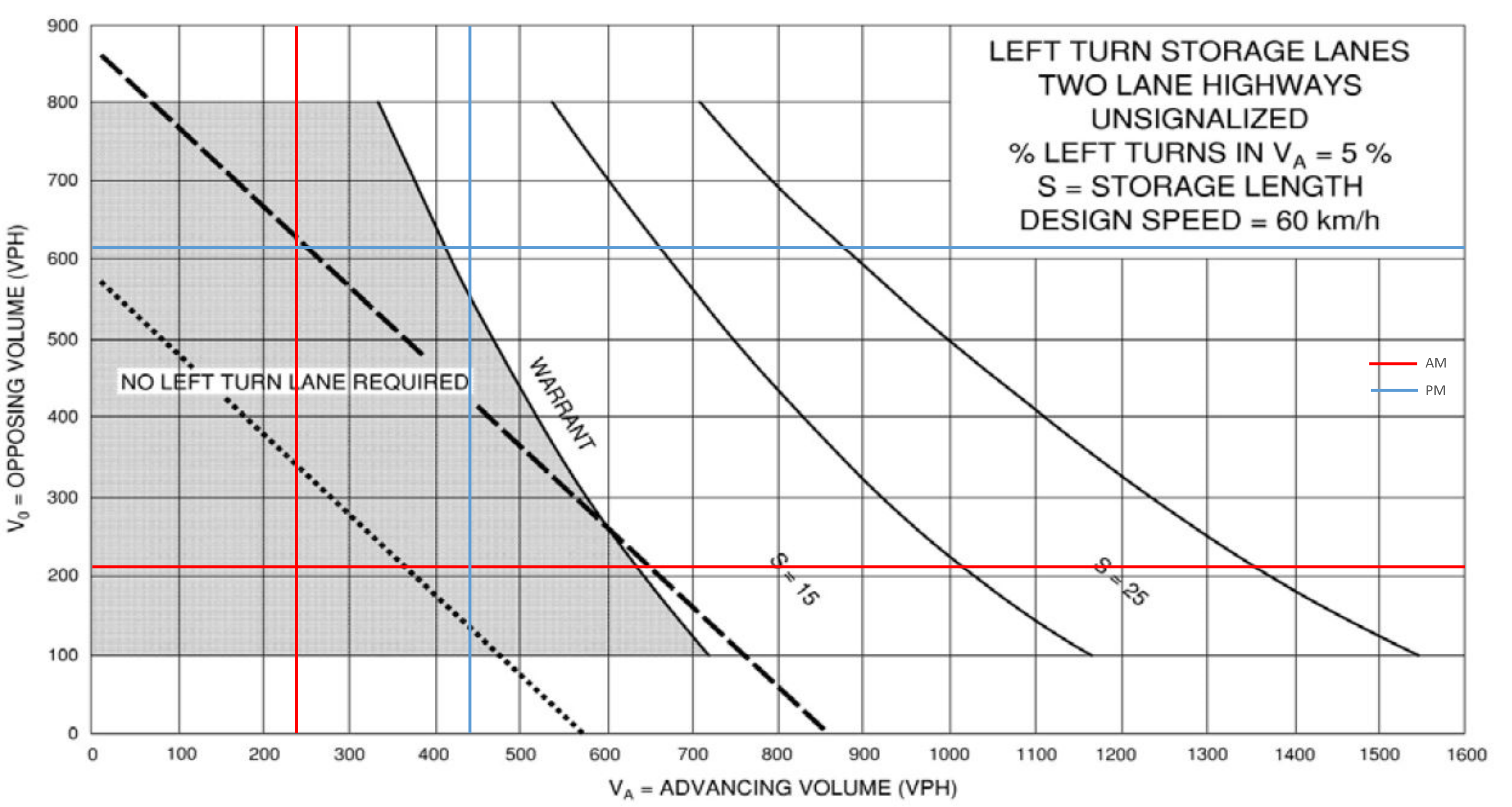
Future Total 2026

Northbound Left

Design Speed

60 km/h

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	%Left Turn	Volume Advancing	Volume Opposing
AM	201	0	144	129	0	80	11	155	72	115	81	16	4.6%	238	212
PM	144	0	102	91	0	56	36	144	260	418	144	56	8.2%	440	618


LEFT TURN STORAGE LANES
TWO LANE HIGHWAYS
UNSIGNALIZED
% LEFT TURNS IN V_A = 5 %
S = STORAGE LENGTH
DESIGN SPEED = 60 km/h
NO LEFT TURN LANE REQUIRED
WARRANT
S = 15
S = 25
AM
PM
V_0 = OPPOSING VOLUME (VPH)
V_A = ADVANCING VOLUME (VPH)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600

Scenario:

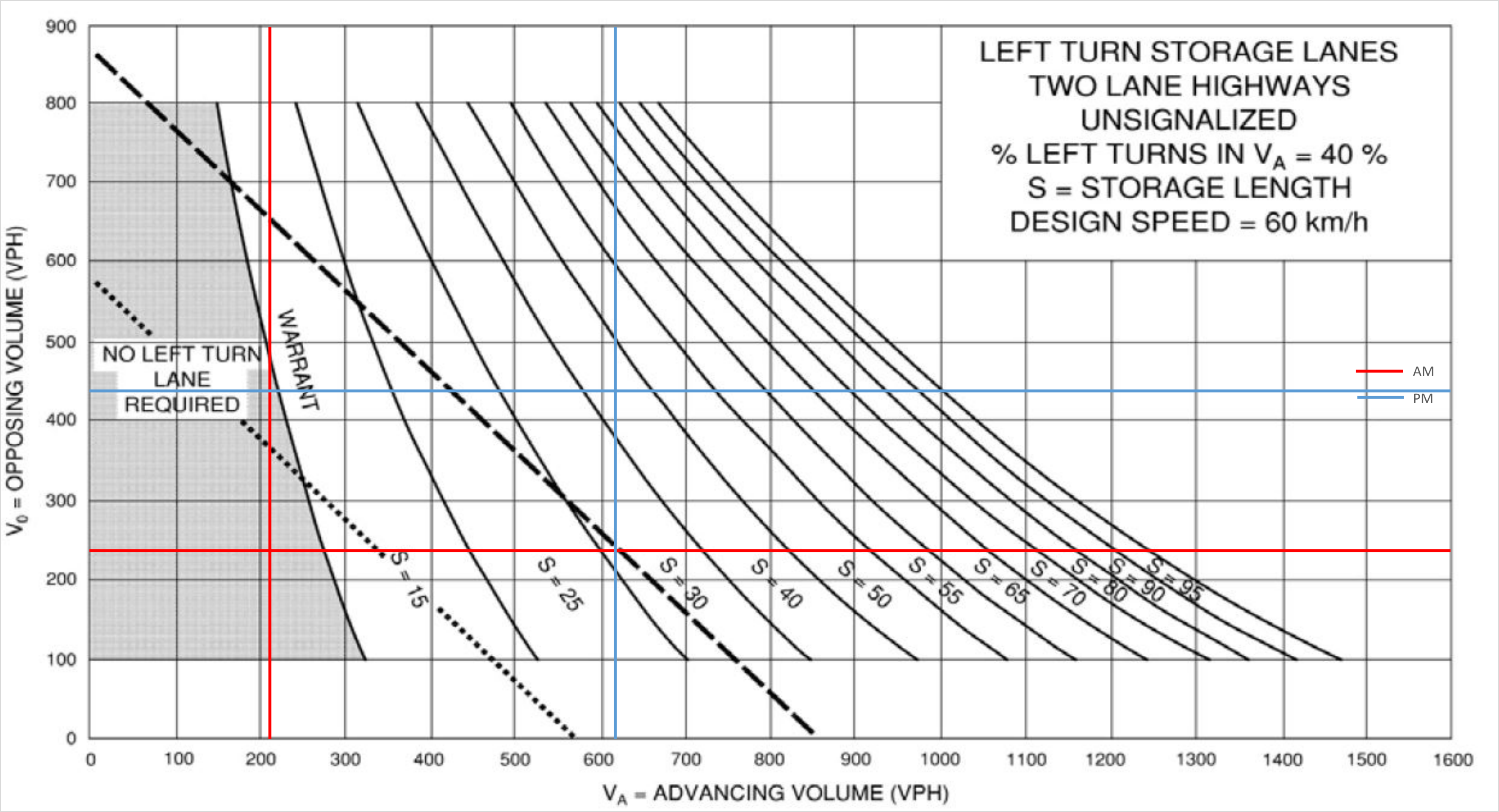
Future Total 2026

Southbound Left

Design Speed

60 km/h

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	%Left Turn	Volume Advancing	Volume Opposing
AM	201	0	144	129	0	80	11	155	72	115	81	16	54.2%	212	238
PM	144	0	102	91	0	56	36	144	260	418	144	56	67.6%	618	440


LEFT TURN STORAGE LANES
TWO LANE HIGHWAYS
UNSIGNALIZED
% LEFT TURNS IN V_A = 40 %
S = STORAGE LENGTH
DESIGN SPEED = 60 km/h
NO LEFT TURN LANE REQUIRED
WARRANT
S = 15
S = 25
S = 30
S = 40
S = 50
S = 55
S = 65
S = 70
S = 80
S = 90
S = 95
AM
PM
V_0 = OPPOSING VOLUME (VPH)
V_A = ADVANCING VOLUME (VPH)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600

Appendix H

2026 Future Total Conditions Synchro Worksheets

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱			✥		↰	↱	
Traffic Volume (vph)	60	428	64	23	302	14	48	0	215	245	0	57
Future Volume (vph)	60	428	64	23	302	14	48	0	215	245	0	57
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1630	1630	1630	1630	1630	1630
Storage Length (m)	30.0		0.0	30.0		0.0	0.0		0.0	40.0		0.0
Storage Lanes	1		0	1		0	0		0	1		0
Taper Length (m)	15.0			15.0			15.0			15.0		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.980			0.993			0.890			0.850	
Flt Protected	0.950			0.950				0.991		0.950		
Satd. Flow (prot)	1521	1458	0	1521	1478	0	0	1394	0	1501	1343	0
Flt Permitted	0.950			0.950				0.991		0.950		
Satd. Flow (perm)	1521	1458	0	1521	1478	0	0	1394	0	1501	1343	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		281.2			541.7			127.4			98.2	
Travel Time (s)		20.2			39.0			9.2			7.1	
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
Adj. Flow (vph)	65	465	70	25	328	15	52	0	234	266	0	62
Shared Lane Traffic (%)												
Lane Group Flow (vph)	65	535	0	25	343	0	0	286	0	266	62	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.5			3.5			3.5			3.5	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		3.0			3.0			3.0			3.0	
Two way Left Turn Lane												
Headway Factor	1.21	1.33	1.33	1.21	1.33	1.33	1.23	1.23	1.23	1.23	1.23	1.23
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Stop			Stop	

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 83.7% ICU Level of Service E

Analysis Period (min) 15

3: Street A & Quaker Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱			✥		↰	↱	
Sign Control		Stop			Stop			Stop			Stop	
Traffic Volume (vph)	60	428	64	23	302	14	48	0	215	245	0	57
Future Volume (vph)	60	428	64	23	302	14	48	0	215	245	0	57
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)	65	465	70	25	328	15	52	0	234	266	0	62

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total (vph)	65	535	25	343	286	266	62
Volume Left (vph)	65	0	25	0	52	266	0
Volume Right (vph)	0	70	0	15	234	0	62
Hadj (s)	0.53	-0.06	0.53	0.00	-0.42	0.53	-0.67
Departure Headway (s)	8.6	8.0	8.8	8.3	8.2	9.0	7.8
Degree Utilization, x	0.16	1.19	0.06	0.79	0.65	0.67	0.13
Capacity (veh/h)	407	453	396	423	422	380	441
Control Delay (s)	12.0	130.6	11.2	34.5	25.1	27.1	10.8
Approach Delay (s)	117.7		32.9		25.1	24.0	
Approach LOS	F		D		D	C	

Intersection Summary			
Delay	61.8		
Level of Service	F		
Intersection Capacity Utilization	83.7%	ICU Level of Service	E
Analysis Period (min)	15		

4: First Avenue & Street D

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱			✥		↰	↱		↰	↱	
Traffic Volume (vph)	201	0	144	129	0	80	11	145	72	115	79	16
Future Volume (vph)	201	0	144	129	0	80	11	145	72	115	79	16
Ideal Flow (vphpl)	1630	1630	1630	1630	1630	1630	1651	1535	1535	1651	1535	1535
Storage Length (m)	30.0		0.0	0.0		0.0	30.0		0.0	40.0		0.0
Storage Lanes	1		0	0		0	1		0	1		0
Taper Length (m)	15.0			15.0			15.0			15.0		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.850			0.948			0.950			0.975	
Flt Protected	0.950				0.970		0.950			0.950		
Satd. Flow (prot)	1501	1343	0	0	1453	0	1521	1414	0	1521	1451	0
Flt Permitted	0.950				0.970		0.950			0.950		
Satd. Flow (perm)	1501	1343	0	0	1453	0	1521	1414	0	1521	1451	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		574.4			127.1			476.7			399.8	
Travel Time (s)		41.4			9.2			34.3			28.8	
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
Adj. Flow (vph)	218	0	157	140	0	87	12	158	78	125	86	17
Shared Lane Traffic (%)												
Lane Group Flow (vph)	218	157	0	0	227	0	12	236	0	125	103	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.5			3.5			3.5			3.5	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		3.0			3.0			3.0			3.0	
Two way Left Turn Lane												
Headway Factor	1.23	1.23	1.23	1.23	1.23	1.23	1.21	1.33	1.33	1.21	1.33	1.33
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Stop			Stop	

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 62.6% ICU Level of Service B

Analysis Period (min) 15

4: First Avenue & Street D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱			✥		↰	↱		↰	↱	
Sign Control		Stop			Stop			Stop			Stop	
Traffic Volume (vph)	201	0	144	129	0	80	11	145	72	115	79	16
Future Volume (vph)	201	0	144	129	0	80	11	145	72	115	79	16
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)	218	0	157	140	0	87	12	158	78	125	86	17

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	218	157	227	12	236	125	103
Volume Left (vph)	218	0	140	12	0	125	0
Volume Right (vph)	0	157	87	0	78	0	17
Hadj (s)	0.53	-0.67	-0.07	0.53	-0.20	0.53	-0.08
Departure Headway (s)	6.9	5.7	6.5	7.3	6.5	7.3	6.7
Degree Utilization, x	0.42	0.25	0.41	0.02	0.43	0.25	0.19
Capacity (veh/h)	491	589	520	461	516	457	497
Control Delay (s)	13.7	9.4	14.0	9.3	13.2	11.6	10.1
Approach Delay (s)	11.9		14.0	13.0		10.9	
Approach LOS	B		B	B		B	

Intersection Summary			
Delay	12.4		
Level of Service	B		
Intersection Capacity Utilization	62.6%	ICU Level of Service	B
Analysis Period (min)	15		

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↱			↰	↰↱	
Traffic Volume (vph)	255	0	15	2	0	46
Future Volume (vph)	255	0	15	2	0	46
Ideal Flow (vphpl)	1535	1535	1375	1375	1630	1630
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt					0.865	
Flt Protected				0.957		
Satd. Flow (prot)	1488	0	0	1276	1367	0
Flt Permitted				0.957		
Satd. Flow (perm)	1488	0	0	1276	1367	0
Link Speed (k/h)	50			50	50	
Link Distance (m)	128.9			574.4	261.5	
Travel Time (s)	9.3			41.4	18.8	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	277	0	16	2	0	50
Shared Lane Traffic (%)						
Lane Group Flow (vph)	277	0	0	18	50	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	3.5			3.5	3.5	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	3.0			3.0	3.0	
Two way Left Turn Lane						
Headway Factor	1.33	1.33	1.52	1.52	1.23	1.23
Turning Speed (k/h)		15	25		25	15
Sign Control	Stop			Stop	Stop	

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 27.8% ICU Level of Service A

Analysis Period (min) 15

HCM Unsignalized Intersection Capacity Analysis
5: Street A & Street D

2026 Future Total AM
Primont Welland

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↱			↰	Y	
Sign Control	Stop			Stop	Stop	
Traffic Volume (vph)	255	0	15	2	0	46
Future Volume (vph)	255	0	15	2	0	46
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	277	0	16	2	0	50

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total (vph)	277	18	50
Volume Left (vph)	0	16	0
Volume Right (vph)	0	0	50
Hadj (s)	0.03	0.21	-0.57
Departure Headway (s)	4.1	4.5	4.0
Degree Utilization, x	0.31	0.02	0.06
Capacity (veh/h)	873	781	840
Control Delay (s)	8.9	7.6	7.2
Approach Delay (s)	8.9	7.6	7.2
Approach LOS	A	A	A

Intersection Summary			
Delay	8.6		
Level of Service	A		
Intersection Capacity Utilization	27.8%	ICU Level of Service	A
Analysis Period (min)	15		

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱			✣		↰	↱	
Traffic Volume (vph)	195	543	233	84	393	45	34	0	152	164	0	38
Future Volume (vph)	195	543	233	84	393	45	34	0	152	164	0	38
Ideal Flow (vphpl)	1630	1630	1630	1630	1630	1630	1651	1535	1535	1651	1535	1535
Storage Length (m)	30.0		0.0	30.0		0.0	0.0		0.0	40.0		0.0
Storage Lanes	1		0	1		0	0		0	1		0
Taper Length (m)	15.0			15.0			15.0			15.0		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.955			0.985			0.890			0.850	
Flt Protected	0.950			0.950				0.991		0.950		
Satd. Flow (prot)	1501	1509	0	1501	1557	0	0	1313	0	1521	1265	0
Flt Permitted	0.950			0.950				0.991		0.950		
Satd. Flow (perm)	1501	1509	0	1501	1557	0	0	1313	0	1521	1265	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		281.2			541.7			109.5			98.2	
Travel Time (s)		20.2			39.0			7.9			7.1	
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
Adj. Flow (vph)	212	590	253	91	427	49	37	0	165	178	0	41
Shared Lane Traffic (%)												
Lane Group Flow (vph)	212	843	0	91	476	0	0	202	0	178	41	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.5			3.5			3.5			3.5	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		3.0			3.0			3.0			3.0	
Two way Left Turn Lane												
Headway Factor	1.23	1.23	1.23	1.23	1.23	1.23	1.21	1.33	1.33	1.21	1.33	1.33
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Stop			Stop	

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 93.0% ICU Level of Service F

Analysis Period (min) 15

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱			✥		↰	↱	
Sign Control		Stop			Stop			Stop			Stop	
Traffic Volume (vph)	195	543	233	84	393	45	34	0	152	164	0	38
Future Volume (vph)	195	543	233	84	393	45	34	0	152	164	0	38
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)	212	590	253	91	427	49	37	0	165	178	0	41

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total (vph)	212	843	91	476	202	178	41
Volume Left (vph)	212	0	91	0	37	178	0
Volume Right (vph)	0	253	0	49	165	0	41
Hadj (s)	0.53	-0.18	0.53	-0.04	-0.42	0.53	-0.67
Departure Headway (s)	8.0	7.3	8.0	7.5	8.1	9.1	7.9
Degree Utilization, x	0.47	1.71	0.20	0.99	0.45	0.45	0.09
Capacity (veh/h)	445	499	440	476	420	384	439
Control Delay (s)	16.8	345.0	11.9	64.3	17.6	18.0	10.5
Approach Delay (s)	279.0		55.9		17.6	16.6	
Approach LOS	F		F		C	C	

Intersection Summary			
Delay	163.1		
Level of Service	F		
Intersection Capacity Utilization	93.0%	ICU Level of Service	F
Analysis Period (min)	15		

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱			✥		↰	↱		↰	↱	
Traffic Volume (vph)	144	0	102	91	0	56	36	128	260	418	139	56
Future Volume (vph)	144	0	102	91	0	56	36	128	260	418	139	56
Ideal Flow (vphpl)	1630	1630	1630	1630	1630	1630	1651	1535	1535	1651	1535	1535
Storage Length (m)	30.0		0.0	0.0		0.0	30.0		0.0	40.0		0.0
Storage Lanes	1		0	0		0	1		0	1		0
Taper Length (m)	15.0			15.0			15.0			15.0		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.850			0.949			0.899			0.957	
Flt Protected	0.950				0.970		0.950			0.950		
Satd. Flow (prot)	1501	1343	0	0	1455	0	1521	1338	0	1521	1424	0
Flt Permitted	0.950				0.970		0.950			0.950		
Satd. Flow (perm)	1501	1343	0	0	1455	0	1521	1338	0	1521	1424	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		574.4			141.2			476.7			399.8	
Travel Time (s)		41.4			10.2			34.3			28.8	
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
Adj. Flow (vph)	157	0	111	99	0	61	39	139	283	454	151	61
Shared Lane Traffic (%)												
Lane Group Flow (vph)	157	111	0	0	160	0	39	422	0	454	212	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.5			3.5			3.5			3.5	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		3.0			3.0			3.0			3.0	
Two way Left Turn Lane												
Headway Factor	1.23	1.23	1.23	1.23	1.23	1.23	1.21	1.33	1.33	1.21	1.33	1.33
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Stop			Stop	

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 81.3% ICU Level of Service D

Analysis Period (min) 15

4: First Avenue & Street D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱			✥		↰	↱		↰	↱	
Sign Control		Stop			Stop			Stop			Stop	
Traffic Volume (vph)	144	0	102	91	0	56	36	128	260	418	139	56
Future Volume (vph)	144	0	102	91	0	56	36	128	260	418	139	56
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)	157	0	111	99	0	61	39	139	283	454	151	61

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	157	111	160	39	422	454	212
Volume Left (vph)	157	0	99	39	0	454	0
Volume Right (vph)	0	111	61	0	283	0	61
Hadj (s)	0.53	-0.67	-0.07	0.53	-0.44	0.53	-0.17
Departure Headway (s)	8.7	7.5	8.2	8.0	7.0	7.6	6.9
Degree Utilization, x	0.38	0.23	0.37	0.09	0.82	0.96	0.41
Capacity (veh/h)	401	462	415	443	505	454	508
Control Delay (s)	15.7	11.5	15.9	10.5	32.9	59.0	13.4
Approach Delay (s)	14.0		15.9	31.0		44.5	
Approach LOS	B		C	D		E	

Intersection Summary			
Delay	32.3		
Level of Service	D		
Intersection Capacity Utilization	81.3%	ICU Level of Service	D
Analysis Period (min)	15		

5: Street A & Street D

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↱			↰	⑂	
Traffic Volume (vph)	182	0	42	0	0	37
Future Volume (vph)	182	0	42	0	0	37
Ideal Flow (vphpl)	1535	1535	1375	1375	1630	1630
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt					0.865	
Flt Protected				0.950		
Satd. Flow (prot)	1488	0	0	1266	1367	0
Flt Permitted				0.950		
Satd. Flow (perm)	1488	0	0	1266	1367	0
Link Speed (k/h)	50			50	50	
Link Distance (m)	128.9			574.4	261.5	
Travel Time (s)	9.3			41.4	18.8	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	198	0	46	0	0	40
Shared Lane Traffic (%)						
Lane Group Flow (vph)	198	0	0	46	40	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	3.5			3.5	3.5	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	3.0			3.0	3.0	
Two way Left Turn Lane						
Headway Factor	1.33	1.33	1.52	1.52	1.23	1.23
Turning Speed (k/h)		15	25		25	15
Sign Control	Stop			Stop	Stop	

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 28.5% ICU Level of Service A

Analysis Period (min) 15

5: Street A & Street D

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↱			↰	⋎	
Sign Control	Stop			Stop	Stop	
Traffic Volume (vph)	182	0	42	0	0	37
Future Volume (vph)	182	0	42	0	0	37
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	198	0	46	0	0	40

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total (vph)	198	46	40
Volume Left (vph)	0	46	0
Volume Right (vph)	0	0	40
Hadj (s)	0.03	0.23	-0.57
Departure Headway (s)	4.1	4.4	3.9
Degree Utilization, x	0.22	0.06	0.04
Capacity (veh/h)	872	800	870
Control Delay (s)	8.2	7.7	7.0
Approach Delay (s)	8.2	7.7	7.0
Approach LOS	A	A	A

Intersection Summary			
Delay	8.0		
Level of Service	A		
Intersection Capacity Utilization	28.5%	ICU Level of Service	A
Analysis Period (min)	15		

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↱		↰	↱	
Traffic Volume (vph)	60	428	64	23	302	14	48	0	215	245	0	57
Future Volume (vph)	60	428	64	23	302	14	48	0	215	245	0	57
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1535	1535	1651	1535	1535
Storage Length (m)	30.0		0.0	30.0		0.0	30.0		0.0	60.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Taper Length (m)	15.0			15.0			15.0			15.0		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.980			0.993			0.850			0.850	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1521	1458	0	1521	1478	0	1521	1265	0	1521	1265	0
Flt Permitted	0.469			0.269			0.717			0.600		
Satd. Flow (perm)	751	1458	0	431	1478	0	1148	1265	0	960	1265	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		16			5			285			426	
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		281.2			541.7			127.4			98.2	
Travel Time (s)		20.2			39.0			9.2			7.1	
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
Adj. Flow (vph)	65	465	70	25	328	15	52	0	234	266	0	62
Shared Lane Traffic (%)												
Lane Group Flow (vph)	65	535	0	25	343	0	52	234	0	266	62	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.5			3.5			3.5			3.5	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		3.0			3.0			3.0			3.0	
Two way Left Turn Lane												
Headway Factor	1.21	1.33	1.33	1.21	1.33	1.33	1.21	1.33	1.33	1.21	1.33	1.33
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Number of Detectors	1	2		1	2		1	2		1	2	
Detector Template	Left	Thru		Left	Thru		Left	Thru		Left	Thru	
Leading Detector (m)	2.0	10.0		2.0	10.0		2.0	10.0		2.0	10.0	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Position(m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Size(m)	2.0	0.6		2.0	0.6		2.0	0.6		2.0	0.6	
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 2 Position(m)		9.4			9.4			9.4			9.4	
Detector 2 Size(m)		0.6			0.6			0.6			0.6	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		

3: Street A & Quaker Road

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
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)	31.5	31.5		31.5	31.5		28.5	28.5		28.5	28.5	
Total Split (%)	52.5%	52.5%		52.5%	52.5%		47.5%	47.5%		47.5%	47.5%	
Maximum Green (s)	27.0	27.0		27.0	27.0		24.0	24.0		24.0	24.0	
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?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		C-Max	C-Max		C-Max	C-Max	
Walk Time (s)	7.0	7.0		7.0	7.0		7.0	7.0		7.0	7.0	
Flash Dont Walk (s)	11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	24.7	24.7		24.7	24.7		26.3	26.3		26.3	26.3	
Actuated g/C Ratio	0.41	0.41		0.41	0.41		0.44	0.44		0.44	0.44	
v/c Ratio	0.21	0.88		0.14	0.56		0.10	0.33		0.63	0.08	
Control Delay	15.4	33.0		12.2	16.8		12.0	2.4		23.6	0.2	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	15.4	33.0		12.2	16.8		12.0	2.4		23.6	0.2	
LOS	B	C		B	B		B	A		C	A	
Approach Delay		31.1			16.5			4.1			19.2	
Approach LOS		C			B			A			B	
Queue Length 50th (m)	4.7	43.1		1.5	25.0		3.5	0.0		23.3	0.0	
Queue Length 95th (m)	m7.6	m53.0		5.6	45.4		9.3	7.0		#55.6	0.0	
Internal Link Dist (m)		257.2			517.7			103.4			74.2	
Turn Bay Length (m)	30.0			30.0			30.0			60.0		
Base Capacity (vph)	337	664		193	667		503	715		421	793	
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	0.19	0.81		0.13	0.51		0.10	0.33		0.63	0.08	

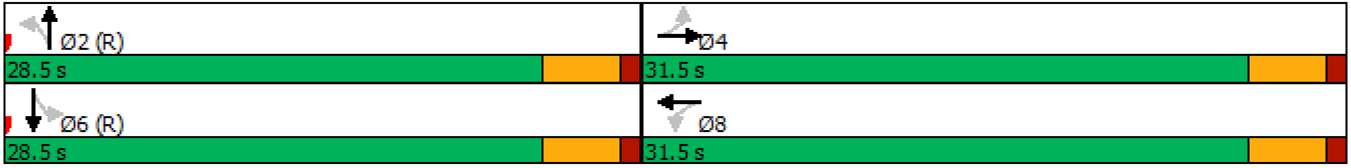
Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 60
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 55
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.88
Intersection Signal Delay: 20.3 Intersection LOS: C
Intersection Capacity Utilization 84.0% ICU Level of Service E
Analysis Period (min) 15
\# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 3: Street A & Quaker Road



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↱		↰	↱	
Traffic Volume (vph)	60	428	64	23	302	14	48	0	215	245	0	57
Future Volume (vph)	60	428	64	23	302	14	48	0	215	245	0	57
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1535	1535	1651	1535	1535
Total Lost time (s)	4.5	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		1.00	1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.99		1.00	0.85		1.00	0.85	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1521	1459		1521	1478		1521	1265		1521	1265	
Flt Permitted	0.47	1.00		0.27	1.00		0.72	1.00		0.60	1.00	
Satd. Flow (perm)	751	1459		430	1478		1147	1265		961	1265	
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)	65	465	70	25	328	15	52	0	234	266	0	62
RTOR Reduction (vph)	0	9	0	0	3	0	0	131	0	0	35	0
Lane Group Flow (vph)	65	526	0	25	340	0	52	103	0	266	27	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)	24.7	24.7		24.7	24.7		26.3	26.3		26.3	26.3	
Effective Green, g (s)	24.7	24.7		24.7	24.7		26.3	26.3		26.3	26.3	
Actuated g/C Ratio	0.41	0.41		0.41	0.41		0.44	0.44		0.44	0.44	
Clearance Time (s)	4.5	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	3.0	
Lane Grp Cap (vph)	309	600		177	608		502	554		421	554	
v/s Ratio Prot		c0.36			0.23			0.08			0.02	
v/s Ratio Perm	0.09			0.06			0.05			c0.28		
v/c Ratio	0.21	0.88		0.14	0.56		0.10	0.19		0.63	0.05	
Uniform Delay, d1	11.4	16.2		11.0	13.5		9.9	10.3		13.1	9.7	
Progression Factor	1.33	1.23		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.2	10.2		0.4	1.1		0.4	0.7		7.0	0.2	
Delay (s)	15.4	30.1		11.4	14.6		10.3	11.0		20.1	9.8	
Level of Service	B	C		B	B		B	B		C	A	
Approach Delay (s)		28.6			14.4			10.9			18.2	
Approach LOS		C			B			B			B	

Intersection Summary			
HCM 2000 Control Delay	19.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	84.0%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↱		↰	↱	
Traffic Volume (vph)	201	0	144	129	0	80	11	145	72	115	79	16
Future Volume (vph)	201	0	144	129	0	80	11	145	72	115	79	16
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1535	1535	1651	1535	1535
Storage Length (m)	60.0		0.0	30.0		0.0	30.0		0.0	30.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Taper Length (m)	15.0			15.0			15.0			15.0		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.850			0.850			0.950			0.975	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1521	1265	0	1521	1265	0	1521	1414	0	1521	1451	0
Flt Permitted	0.701			0.657			0.690			0.612		
Satd. Flow (perm)	1122	1265	0	1052	1265	0	1104	1414	0	980	1451	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		834			665			50			17	
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		574.4			127.1			476.7			399.8	
Travel Time (s)		41.4			9.2			34.3			28.8	
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
Adj. Flow (vph)	218	0	157	140	0	87	12	158	78	125	86	17
Shared Lane Traffic (%)												
Lane Group Flow (vph)	218	157	0	140	87	0	12	236	0	125	103	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.5			3.5			3.5			3.5	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		3.0			3.0			3.0			3.0	
Two way Left Turn Lane												
Headway Factor	1.21	1.33	1.33	1.21	1.33	1.33	1.21	1.33	1.33	1.21	1.33	1.33
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Number of Detectors	1	2		1	2		1	2		1	2	
Detector Template	Left	Thru		Left	Thru		Left	Thru		Left	Thru	
Leading Detector (m)	2.0	10.0		2.0	10.0		2.0	10.0		2.0	10.0	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Position(m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Size(m)	2.0	0.6		2.0	0.6		2.0	0.6		2.0	0.6	
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 2 Position(m)		9.4			9.4			9.4			9.4	
Detector 2 Size(m)		0.6			0.6			0.6			0.6	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
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)	31.0	31.0		31.0	31.0		29.0	29.0		29.0	29.0	
Total Split (%)	51.7%	51.7%		51.7%	51.7%		48.3%	48.3%		48.3%	48.3%	
Maximum Green (s)	26.5	26.5		26.5	26.5		24.5	24.5		24.5	24.5	
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?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		C-Max	C-Max		C-Max	C-Max	
Walk Time (s)	7.0	7.0		7.0	7.0		7.0	7.0		7.0	7.0	
Flash Dont Walk (s)	11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	17.0	17.0		17.0	17.0		34.0	34.0		34.0	34.0	
Actuated g/C Ratio	0.28	0.28		0.28	0.28		0.57	0.57		0.57	0.57	
v/c Ratio	0.69	0.16		0.47	0.10		0.02	0.29		0.23	0.12	
Control Delay	29.5	0.4		21.5	0.2		8.5	7.9		9.9	7.6	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	29.5	0.4		21.5	0.2		8.5	7.9		9.9	7.6	
LOS	C	A		C	A		A	A		A	A	
Approach Delay		17.3			13.3			8.0			8.9	
Approach LOS		B			B			A			A	
Queue Length 50th (m)	21.1	0.0		12.6	0.0		0.5	9.1		6.1	3.9	
Queue Length 95th (m)	33.6	0.0		21.7	0.0		3.1	26.4		18.5	12.9	
Internal Link Dist (m)		550.4			103.1			452.7			375.8	
Turn Bay Length (m)	60.0			30.0			30.0			30.0		
Base Capacity (vph)	495	1024		464	930		625	823		555	830	
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	0.44	0.15		0.30	0.09		0.02	0.29		0.23	0.12	

Intersection Summary

Area Type: Other

Cycle Length: 60

Actuated Cycle Length: 60

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

Natural Cycle: 45

Control Type: Actuated-Coordinated

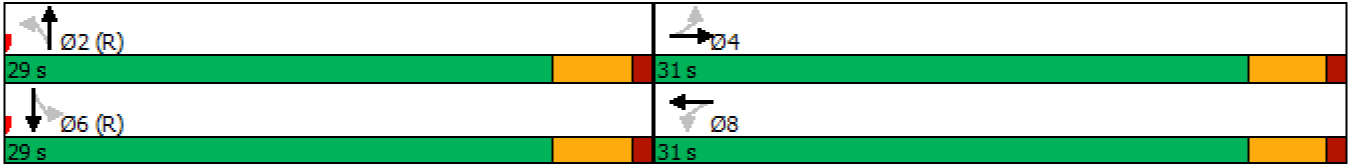
Maximum v/c Ratio: 0.69

Intersection Signal Delay: 12.5 Intersection LOS: B

Intersection Capacity Utilization 56.5% ICU Level of Service B

Analysis Period (min) 15

Splits and Phases: 4: First Avenue & Street D



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↱		↰	↱	
Traffic Volume (vph)	201	0	144	129	0	80	11	145	72	115	79	16
Future Volume (vph)	201	0	144	129	0	80	11	145	72	115	79	16
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1535	1535	1651	1535	1535
Total Lost time (s)	4.5	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		1.00	1.00		1.00	1.00	
Frt	1.00	0.85		1.00	0.85		1.00	0.95		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)	1521	1265		1521	1265		1521	1414		1521	1451	
Flt Permitted	0.70	1.00		0.66	1.00		0.69	1.00		0.61	1.00	
Satd. Flow (perm)	1121	1265		1052	1265		1105	1414		979	1451	
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)	218	0	157	140	0	87	12	158	78	125	86	17
RTOR Reduction (vph)	0	113	0	0	62	0	0	22	0	0	7	0
Lane Group Flow (vph)	218	44	0	140	25	0	12	214	0	125	96	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)	17.0	17.0		17.0	17.0		34.0	34.0		34.0	34.0	
Effective Green, g (s)	17.0	17.0		17.0	17.0		34.0	34.0		34.0	34.0	
Actuated g/C Ratio	0.28	0.28		0.28	0.28		0.57	0.57		0.57	0.57	
Clearance Time (s)	4.5	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	3.0	
Lane Grp Cap (vph)	317	358		298	358		626	801		554	822	
v/s Ratio Prot		0.04			0.02			c0.15			0.07	
v/s Ratio Perm	c0.19			0.13			0.01			0.13		
v/c Ratio	0.69	0.12		0.47	0.07		0.02	0.27		0.23	0.12	
Uniform Delay, d1	19.1	16.0		17.8	15.7		5.7	6.6		6.5	6.0	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	6.1	0.2		1.2	0.1		0.1	0.8		0.9	0.3	
Delay (s)	25.2	16.1		18.9	15.8		5.8	7.5		7.4	6.3	
Level of Service	C	B		B	B		A	A		A	A	
Approach Delay (s)		21.4			17.7			7.4			6.9	
Approach LOS		C			B			A			A	

Intersection Summary			
HCM 2000 Control Delay	14.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	56.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↱		↰	↱	
Traffic Volume (vph)	195	543	233	84	393	45	34	0	152	164	0	38
Future Volume (vph)	195	543	233	84	393	45	34	0	152	164	0	38
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1535	1535	1651	1535	1535
Storage Length (m)	30.0		0.0	30.0		0.0	30.0		0.0	60.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Taper Length (m)	15.0			15.0			15.0			15.0		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.955			0.985			0.850			0.850	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1521	1421	0	1521	1466	0	1521	1265	0	1521	1265	0
Flt Permitted	0.426			0.190			0.730			0.611		
Satd. Flow (perm)	682	1421	0	304	1466	0	1168	1265	0	978	1265	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		52			14			325			456	
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		281.2			541.7			109.5			98.2	
Travel Time (s)		20.2			39.0			7.9			7.1	
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
Adj. Flow (vph)	212	590	253	91	427	49	37	0	165	178	0	41
Shared Lane Traffic (%)												
Lane Group Flow (vph)	212	843	0	91	476	0	37	165	0	178	41	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.5			3.5			3.5			3.5	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		3.0			3.0			3.0			3.0	
Two way Left Turn Lane												
Headway Factor	1.21	1.33	1.33	1.21	1.33	1.33	1.21	1.33	1.33	1.21	1.33	1.33
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Number of Detectors	1	2		1	2		1	2		1	2	
Detector Template	Left	Thru		Left	Thru		Left	Thru		Left	Thru	
Leading Detector (m)	2.0	10.0		2.0	10.0		2.0	10.0		2.0	10.0	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Position(m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Size(m)	2.0	0.6		2.0	0.6		2.0	0.6		2.0	0.6	
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 2 Position(m)		9.4			9.4			9.4			9.4	
Detector 2 Size(m)		0.6			0.6			0.6			0.6	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
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)	55.0	55.0		55.0	55.0		25.0	25.0		25.0	25.0	
Total Split (%)	68.8%	68.8%		68.8%	68.8%		31.3%	31.3%		31.3%	31.3%	
Maximum Green (s)	50.5	50.5		50.5	50.5		20.5	20.5		20.5	20.5	
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?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		C-Max	C-Max		C-Max	C-Max	
Walk Time (s)	7.0	7.0		7.0	7.0		7.0	7.0		7.0	7.0	
Flash Dont Walk (s)	11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	49.4	49.4		49.4	49.4		21.6	21.6		21.6	21.6	
Actuated g/C Ratio	0.62	0.62		0.62	0.62		0.27	0.27		0.27	0.27	
v/c Ratio	0.50	0.94		0.49	0.52		0.12	0.29		0.67	0.06	
Control Delay	13.3	33.5		18.7	10.6		24.2	1.2		42.0	0.2	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	13.3	33.5		18.7	10.6		24.2	1.2		42.0	0.2	
LOS	B	C		B	B		C	A		D	A	
Approach Delay		29.4			11.9			5.4			34.2	
Approach LOS		C			B			A			C	
Queue Length 50th (m)	15.3	95.1		6.5	33.7		4.3	0.0		24.6	0.0	
Queue Length 95th (m)	33.0	#187.0		20.8	55.6		11.6	0.0		#53.9	0.0	
Internal Link Dist (m)		257.2			517.7			85.5			74.2	
Turn Bay Length (m)	30.0			30.0			30.0			60.0		
Base Capacity (vph)	430	916		191	930		316	578		264	674	
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	0.49	0.92		0.48	0.51		0.12	0.29		0.67	0.06	

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 80
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 80
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.94
Intersection Signal Delay: 22.7 Intersection LOS: C
Intersection Capacity Utilization 95.4% ICU Level of Service F
Analysis Period (min) 15
\# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 3: Street A & Quaker Road

3: Street A & Quaker Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↱		↰	↱	
Traffic Volume (vph)	195	543	233	84	393	45	34	0	152	164	0	38
Future Volume (vph)	195	543	233	84	393	45	34	0	152	164	0	38
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1535	1535	1651	1535	1535
Total Lost time (s)	4.5	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		1.00	1.00		1.00	1.00	
Frt	1.00	0.95		1.00	0.98		1.00	0.85		1.00	0.85	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1521	1421		1521	1465		1521	1265		1521	1265	
Flt Permitted	0.43	1.00		0.19	1.00		0.73	1.00		0.61	1.00	
Satd. Flow (perm)	682	1421		305	1465		1169	1265		977	1265	
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)	212	590	253	91	427	49	37	0	165	178	0	41
RTOR Reduction (vph)	0	20	0	0	5	0	0	120	0	0	30	0
Lane Group Flow (vph)	212	823	0	91	471	0	37	45	0	178	11	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)	49.4	49.4		49.4	49.4		21.6	21.6		21.6	21.6	
Effective Green, g (s)	49.4	49.4		49.4	49.4		21.6	21.6		21.6	21.6	
Actuated g/C Ratio	0.62	0.62		0.62	0.62		0.27	0.27		0.27	0.27	
Clearance Time (s)	4.5	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	3.0	
Lane Grp Cap (vph)	421	877		188	904		315	341		263	341	
v/s Ratio Prot		c0.58			0.32			0.04			0.01	
v/s Ratio Perm	0.31			0.30			0.03			c0.18		
v/c Ratio	0.50	0.94		0.48	0.52		0.12	0.13		0.68	0.03	
Uniform Delay, d1	8.5	13.9		8.3	8.6		22.0	22.1		26.1	21.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.0	17.2		2.0	0.5		0.8	0.8		13.1	0.2	
Delay (s)	9.4	31.1		10.3	9.2		22.8	22.9		39.2	21.7	
Level of Service	A	C		B	A		C	C		D	C	
Approach Delay (s)		26.7			9.4			22.9			35.9	
Approach LOS		C			A			C			D	

Intersection Summary			
HCM 2000 Control Delay	22.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	95.4%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↱		↰	↱	
Traffic Volume (vph)	144	0	102	91	0	56	36	128	260	418	139	56
Future Volume (vph)	144	0	102	91	0	56	36	128	260	418	139	56
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1535	1535	1651	1535	1535
Storage Length (m)	40.0		0.0	30.0		0.0	30.0		0.0	30.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Taper Length (m)	15.0			15.0			15.0			15.0		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.850			0.850			0.899			0.957	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1521	1265	0	1521	1265	0	1521	1338	0	1521	1424	0
Flt Permitted	0.717			0.685			0.625			0.490		
Satd. Flow (perm)	1148	1265	0	1096	1265	0	1000	1338	0	784	1424	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		815			835			270			54	
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		574.4			141.2			476.7			399.8	
Travel Time (s)		41.4			10.2			34.3			28.8	
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
Adj. Flow (vph)	157	0	111	99	0	61	39	139	283	454	151	61
Shared Lane Traffic (%)												
Lane Group Flow (vph)	157	111	0	99	61	0	39	422	0	454	212	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.5			3.5			3.5			3.5	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		3.0			3.0			3.0			3.0	
Two way Left Turn Lane		Yes			Yes							
Headway Factor	1.21	1.33	1.33	1.21	1.33	1.33	1.21	1.33	1.33	1.21	1.33	1.33
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Number of Detectors	1	2		1	2		1	2		1	2	
Detector Template	Left	Thru		Left	Thru		Left	Thru		Left	Thru	
Leading Detector (m)	2.0	10.0		2.0	10.0		2.0	10.0		2.0	10.0	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Position(m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Size(m)	2.0	0.6		2.0	0.6		2.0	0.6		2.0	0.6	
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 2 Position(m)		9.4			9.4			9.4			9.4	
Detector 2 Size(m)		0.6			0.6			0.6			0.6	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		

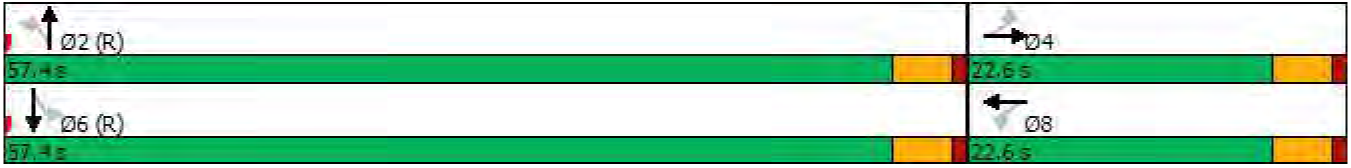
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	4	4		8	8		2	2		6	6	
Switch Phase												
Minimum Initial (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Minimum Split (s)	22.5	22.5		22.5	22.5		22.5	22.5		22.5	22.5	
Total Split (s)	22.6	22.6		22.6	22.6		57.4	57.4		57.4	57.4	
Total Split (%)	28.3%	28.3%		28.3%	28.3%		71.8%	71.8%		71.8%	71.8%	
Maximum Green (s)	18.1	18.1		18.1	18.1		52.9	52.9		52.9	52.9	
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	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?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		C-Max	C-Max		C-Max	C-Max	
Walk Time (s)	7.0	7.0		7.0	7.0		7.0	7.0		7.0	7.0	
Flash Dont Walk (s)	11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	14.9	14.9		14.9	14.9		56.1	56.1		56.1	56.1	
Actuated g/C Ratio	0.19	0.19		0.19	0.19		0.70	0.70		0.70	0.70	
v/c Ratio	0.74	0.12		0.49	0.07		0.06	0.41		0.83	0.21	
Control Delay	50.7	0.3		36.6	0.1		4.8	3.3		26.1	4.1	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	50.7	0.3		36.6	0.1		4.8	3.3		26.1	4.1	
LOS	D	A		D	A		A	A		C	A	
Approach Delay		29.8			22.7			3.5			19.1	
Approach LOS		C			C			A			B	
Queue Length 50th (m)	22.3	0.0		13.3	0.0		1.7	6.9		43.6	7.2	
Queue Length 95th (m)	#42.2	0.0		26.8	0.0		4.8	18.8		#115.8	15.7	
Internal Link Dist (m)		550.4			117.2			452.7			375.8	
Turn Bay Length (m)	40.0			30.0			30.0			30.0		
Base Capacity (vph)	259	916		247	932		701	1019		550	1014	
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	0.61	0.12		0.40	0.07		0.06	0.41		0.83	0.21	

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 80
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 80
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.83
Intersection Signal Delay: 16.7 Intersection LOS: B
Intersection Capacity Utilization 81.8% ICU Level of Service D
Analysis Period (min) 15
\# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 4: First Avenue & Street D



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↱		↰	↱	
Traffic Volume (vph)	144	0	102	91	0	56	36	128	260	418	139	56
Future Volume (vph)	144	0	102	91	0	56	36	128	260	418	139	56
Ideal Flow (vphpl)	1651	1535	1535	1651	1535	1535	1651	1535	1535	1651	1535	1535
Total Lost time (s)	4.5	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		1.00	1.00		1.00	1.00	
Frt	1.00	0.85		1.00	0.85		1.00	0.90		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1521	1265		1521	1265		1521	1338		1521	1424	
Flt Permitted	0.72	1.00		0.69	1.00		0.63	1.00		0.49	1.00	
Satd. Flow (perm)	1148	1265		1097	1265		1001	1338		784	1424	
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)	157	0	111	99	0	61	39	139	283	454	151	61
RTOR Reduction (vph)	0	90	0	0	50	0	0	81	0	0	16	0
Lane Group Flow (vph)	157	21	0	99	11	0	39	341	0	454	196	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)	14.9	14.9		14.9	14.9		56.1	56.1		56.1	56.1	
Effective Green, g (s)	14.9	14.9		14.9	14.9		56.1	56.1		56.1	56.1	
Actuated g/C Ratio	0.19	0.19		0.19	0.19		0.70	0.70		0.70	0.70	
Clearance Time (s)	4.5	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	3.0	
Lane Grp Cap (vph)	213	235		204	235		701	938		549	998	
v/s Ratio Prot		0.02			0.01			0.26			0.14	
v/s Ratio Perm	c0.14			0.09			0.04			c0.58		
v/c Ratio	0.74	0.09		0.49	0.05		0.06	0.36		0.83	0.20	
Uniform Delay, d1	30.7	26.9		29.1	26.7		3.7	4.8		8.5	4.1	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	12.5	0.2		1.8	0.1		0.2	1.1		13.4	0.4	
Delay (s)	43.2	27.1		30.9	26.8		3.9	5.9		21.9	4.6	
Level of Service	D	C		C	C		A	A		C	A	
Approach Delay (s)		36.5			29.4			5.7			16.4	
Approach LOS		D			C			A			B	

Intersection Summary			
HCM 2000 Control Delay	18.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	81.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Appendix I

City of Welland Official Plan Section 6.4

6.4 TRANSPORTATION

6.4.1 Planning Objectives

6.4.1.1 To Provide a Transportation System which Supports a Variety of Modes

The City aims to reduce dependence on the automobile and develop a diverse transportation system which supports a variety of transportation modes, including road, rail, transit, cycling, pedestrian modes and transportation demand management modes.

6.4.1.2 To Provide an Integrated Transportation System

The City will encourage and plan for an integrated transportation system which allows for cost-effective and efficient movement of people and goods in a manner compatible with existing and future land uses.

6.4.1.3 To Create a Responsible Transportation System

The City will encourage a transportation system in Welland which supports economic development and social inclusion, with minimum social and environmental disruption.

6.4.1.4 To Ensure a Coordinated Transportation System

The City will encourage other municipalities, agencies, and stakeholders in the transportation system to coordinate and cooperate towards optimizing the transportation system.

6.4.1.5 To Protect Future System Needs

The City will anticipate, designate and protect transportation rights-of-way and areas required for future transportation facilities in cooperation with the Province, Region and neighbouring municipalities.

6.4.1.6 To Plan for a Safe Transportation Network

The City will plan its transportation network as a safe and accessible system. Additionally, the City will ensure that its transportation network also provides fast and efficient routes for emergency response purposes.

6.4.2 Policies

6.4.2.1 Roads

6.4.2.1.A Road Classification

All roads within the municipality are classified according to their function as expressways, arterials, collectors and local roads as shown on Schedule "E". This hierarchy of roads is intended to optimize the roadway network and provides the following:

i. Accommodation of intra-city, regional and inter-city traffic with minimal disruption to the quality of life of local residents;
ii. Direct large volumes of commercial and truck traffic around residential areas;
iii. Allow for logical vehicular movement throughout the City; and,
iv. Facilitate the establishment of public transit and on-street cycling routes.

6.4.2.1.B Definitions for Roadway Classifications

The following definitions shall serve as guidelines for roadway classifications within the City:

i. Expressway: a median or fully divided provincial highway or undivided provincial highway with full access control serving large volumes of inter-city traffic at high speeds.
ii. Arterial Road: a divided or undivided road primarily used for traffic movement and servicing moderate to large volumes of inter-City and/or through traffic at moderate speeds.
iii. Collector Road: an undivided road where traffic movements and land access are of equal importance and serving moderate volumes of traffic at moderate speeds.
iv. Local Road: an undivided road primarily used for land access and serving low volumes of traffic.

6.4.2.1.C Right-of-way Widths

Generally, the planned minimum right-of-way widths for roads should be:

30.0 metres for arterial roads;
24.5 metres for collector roads; and,
20.0 metres for local roads.

6.4.2.1.D Alternative Designs

In circumstances where a road is proposed to be less than these minimum standards, the City will ensure that:

i. The planned function of the road is capable of accommodating anticipated travel demand;

ii. Municipal services, including maintenance and emergency services can be delivered in a safe and efficient manner;

iii. The proposed right of way is consistent with planned adjacent land uses; and,

iv. The road design is consistent with the Objectives and Policies of Section 6.4 of this Plan.

6.4.2.1.E Planned Widenings

The right-of-way widths in Policy 6.4.2.1.C indicate the amount of land which may be required as part of the development approval process. **Schedule F** shows the location of the planned road widenings. **Table 6.3** lists roads which may require widenings to achieve their right-of-way widths. Also refer to the Regional Policy Plan for additional information on Regional Road widenings.

Table 6-3: Planned Road Widenings, City of Welland
Atlas Avenue
Biggar Road – East of Moyer Road
Broadway
Brown Road
Burgar Street
Canal Bank Street – Ontario Road to Forks Road
Clare Avenue – Gaiser Road to North City Limit
Colbeck Drive
Crowland Avenue
Division Street
Doans Ridge Road
East Main Street
Elm Street
First Avenue
Fitch Street – West of First Avenue
Forks Road – Kingsway to west limits of the City of Welland
Gaiser Road – South Pelham Road to Colbeck Drive

Table 6-3: Planned Road Widenings, City of Welland
Hagar Street – Burgar Street to Wellington Street
Hellems Avenue
Humberstone Road – West of Prince Charles Drive South
Humberstone Road – Townline Tunnel Road east to Southworth Street
Keefer Road
King Street
Lincoln Street
Memorial Park Drive
Miller Road
Moyer Road
Netherby Road – East to Townline Tunnel Road
Netherby Road – Reaker Road to Rusholme Road
Niagara Street
Ontario Road
Plymouth Road
Prince Charles Drive North and South
Quaker Road – South Pelham Road to St. Lawrence Drive
Reaker Road – South of Netherby Road
Rice Road
Ridge Road – Rusholme Road to Highway No. 140
River Road
Riverside Drive
Ross Street
Schisler Road
South Pelham Road
Southworth Street
Thorold Road
Townline Tunnel Road
Webber Road
Wellington Street
West Main Street
Willson Road – North of Endicott Terrance to Willsonway
Willsonway
Woodlawn Road

6.4.2.1.F Development Subject to Widening

No new development or redevelopment will be permitted which does not front on a public road of an acceptable standard of construction. As a condition of development approval, the City will require that sufficient lands be conveyed to provide for a road right-of-way in accordance with the classification set out above.

6.4.2.1.G Lands to be Dedicated

Unless otherwise specified in this Plan, a dedication of land to widen a roadway will be taken equally from both sides of the road allowance measured from the centreline of the roadway. In certain circumstances, where factors such as topography and existing development dictate, it may be necessary to require more than half of the widening on one side of the road allowance.

6.4.2.1.H Prioritizing Road Improvements

All existing roads shall be brought up to the approved municipal standards for roadways. However, it is recognized that, due to the expense of undertaking such works, this may not be achieved for many years. Priority will be given to those areas where the residents or businesses indicate that they are prepared to assist the City through the application of the *Local Improvement Act*, or where it is desirable to carry out the improvements in conjunction with other public works in the vicinity.

6.4.2.1.I Road Improvement Criteria

Notwithstanding the above, road improvements can have a significant impact on the character of the neighbourhood. Therefore, the City shall undertake road improvements when:

i. The need is demonstrated through an analysis and public consultation regarding the safety, efficiency, affordability, diversity, land use impact, and integration of the transportation system;

ii. The resulting road improvements through the design process shall improve the liveability of affected residential areas by:
    a. Reducing the use of local streets in residential areas by cut-through traffic;
    b. Minimizing conflicts between local and through traffic; and,
    c. Minimizing any adverse impacts on the social and natural environment of adjacent lands.

6.4.2.1.J Roadway Functional Principles

To improve the designated functions of the roadway system, the following general principles shall be used:

i. Where feasible, direct access from individual properties on arterial roads will be restricted to enhance the flow of traffic and minimize the negative impacts on abutting properties and pedestrian movement;

ii. The spacing of intersections between arterial and collector roads will be appropriate to accommodate traffic control devices;

iii. The spacing and possible reduction of driveways on arterial roads through the use of controlled joint access and common off-street parking facilities;

iv. Discouraging the intersection of local roads with arterial roads;

v. Controlling the number and design of driveways for multi-residential and commercial uses on collector and arterial roads;

vi. Encouraging service roads for low density residential uses abutting arterial roads, and, where appropriate, collector roads; and,

vii. Consideration of various traffic calming and management measures to reduce through-traffic on local streets and to promote safer streets.

6.4.2.1.K Provisions for Road Design

Where appropriate, the design of roads shall include provisions for:

i. Pedestrians, by way of sidewalks to promote safety and reduce pedestrian-vehicle conflicts;

ii. Bicycles and other non-motorized vehicle traffic, by way of bicycle lanes, pre-paved boulevards, etc.

iii. Aesthetic and noise reducing applications, by way of tree planting, landscaping, street furniture, berms, etc., where necessary;

iv. Universal access and ease of movement with minimal physical and psychological obstacles, by way of sloped curbs, level entranceways, minimal grade changes, etc.

6.4.2.1.L Truck Traffic Management

Truck traffic shall be managed by:

i. Directing it away from, or around, residential or sensitive areas where the road capacities are inadequate or where there is a potential for noise and/or safety hazards, and, in particular, designate, establish and monitor truck routes in coordination with the Region;

ii. Encouraging the relocation of existing land uses (which generate volumes of truck traffic which contribute to current noise and safety hazards) to more suitable locations in the City;

iii. Discouraging the movement of heavy truck traffic on all collector and local streets in residential areas.

6.4.2.2 Transit

6.4.2.2.A Promote Transit Usage

In the interests of overall energy conservation, environmental protection, and public mobility, the City shall promote the use of public transit, wherever possible.

6.4.2.2.B Transit within Walking Distance

The City shall facilitate the provision of local transit services within a reasonable walking distance of all urban land uses. The City may require that 90% of the new residential and non-residential units in a proposed subdivision are within 400 metres of a transit stop.

6.4.2.2.C Linking Land Uses with Transit

In the planning of transit service, the City shall consider the location of the following types of uses and the appropriateness of transit linkages between these uses:

i. Concentrations of housing, employment and retail;

ii. Concentrations of schools and other developments which may generate high volumes of transit users;

iii. Terminals for inter-city transportation systems;

iv. Major medical, social service, or community service facilities;

v. Parks, multi-use trails, theatres, museums, and other arts, culture, and recreation facilities.

6.4.2.2.D Tools to Encourage Transit Use

The City shall encourage the use of public transit by:

i. Encouraging intensification in the vicinity of established transit routes, as well as in, and around, the Welland Transit Terminal;

ii. Requiring that new development provide convenient and direct access to public transportation facilities;

iii. Integrating pedestrian linkages, trails, and intersections of major roadways with transit stops;
iv. Providing for universal access so that users with varying needs have the fullest access possible to the transit system; and,
v. Supporting an on-going investment in transit vehicles which provide transit user safety and comfort, and takes advantage of new technology.

6.4.2.2.E Design of Stops and Transfer Locations

New transit stops and transfer locations will be designed to offer comfort, amenities and safety considerations (including, but not limited to, seating areas, weather protection, and lighting). A program of upgrading existing transit stops and transfer locations to standards, as applicable, is encouraged.

6.4.2.2.F Reducing Automobile Reliance

New major development or redevelopment will incorporate transit and pedestrian systems aimed at reducing the reliance on the automobile.

6.4.2.2.G Parking Reductions to Support Ridership

Reduced parking requirements may be supported for development fronting corridors which have major transit service, as a means to encourage transit ridership and transit cost-effectiveness.

6.4.2.2.H Considering Transit in Road Design

Roadway design proposals shall consider and incorporate transit service needs and requirements.

6.4.2.3 Cycling

6.4.2.3.A Cycling System for Welland

The City shall implement, in a staged program, the development of a continuous and safe system of on-street and off-street cycling trails.

6.4.2.3.B Cycling Considerations during Road Projects

The design of new, and reconstruction of existing, arterial and collector roads shall consider bicycle movements by ensuring that such projects incorporate cycling facilities. New on-street cycling routes on arterial or collector roads will be designed to buffer the effect of high traffic volumes through wide cycling lane widths, paving materials, special demarcation, etc.

6.4.2.3.C Cycling Considerations at Bridge Crossings

The City will consider and accommodate, as much as possible, the needs of cyclists on bridge crossings.

6.4.2.3.D Cycling Considered during Development

Development applications shall be reviewed to ensure that cycling linkages are incorporated into the design of the development in a safe and efficient manner, wherever warranted. In all new development and redevelopment, consideration shall be given to safe and secure bicycle movements and bicycle parking facilities.

6.4.2.3.E Zoning Requirements for Cycling

The Zoning By-law may require development in certain Zones to provide a minimum number of bicycle parking facilities and may specify whether these facilities are required to be weather-protected.

6.4.2.3.F Cycling Advisory Committee

The City may establish an Advisory Committee to seek advice and input on issues related to cycling, from time-to-time.

6.4.2.3.G Funding Support for Cycling Trails

The City may provide funding for implementing a cycling trails system by allocating a portion of the City's budget on an annual basis for this purpose.

6.4.2.4 Pedestrians

6.4.2.4.A A Safe, Convenient and Attractive System

Transportation facilities, including the construction of new roads and reconstruction of roads, shall include safe, convenient and attractive pedestrian systems such as sidewalks, corner ramps, pedestrian signals and appropriate lighting. A continuous sidewalk/walkway system providing accessible, safe, convenient and enjoyable walking for all users shall be developed and maintained.

6.4.2.4.B Pedestrian-Friendly Streets

The development of pedestrian-scale streets and streetscapes which are safe, convenient and attractive will be supported through measures such as providing wide sidewalks, sheltered transit stops, street furniture, canopies on buildings, landscaping, locating retail and personal service uses at street level, and supporting building design which provides shelter and other amenities.

6.4.2.4.C Required New Sidewalks and Walkways

The City will require that new subdivisions provide sidewalks and walkways, as per the City's municipal standards manual, as deemed appropriate. Pedestrian crossing signals will be required at all signalized intersections.

6.4.2.4.D Transition between Sidewalks and Walkways

There should be a smooth transition between sidewalks and pedestrians walkways, with appropriate signage provided for pedestrian walkways.

6.4.2.4.E Connection to Transit Stops

Sidewalks will be required to link directly to new transit stops.

6.4.2.4.F Reducing Walking Distances

Sidewalks, walkways, and trails shall be designed in a manner to reduce the walking distances between residential development and transit, recreational/community facilities, schools and commercial facilities. This requirement shall be evaluated at a variety of scales.

6.4.2.4.G Sidewalk Requirements within the Right of Way

For new or reconstruction, sidewalks shall be provided as follows:

i. On both sides of arterial roads;
ii. On both sides of collector roads; and,
iii. On at least one side of all local roads, (except cul-de-sacs, unless the cul-de-sac can connect to a destination such as a school, park, etc., in which case the sidewalk will be required on the side of the street which provides the most direct pedestrian route to the destination).

6.4.2.4.H Sidewalks Serving Certain Land Uses

Sidewalks are considered essential near bus stops, schools, community facilities, and institutions, and should be provided on both sides of the streets.

6.4.2.4.I Extension of Sidewalks

As a condition of approval, a sidewalk shall be required beyond the limits of a proposed subdivision to complete connection to the following:

i. An existing sidewalk;

ii. Isolated sections of sidewalk created by development; and,

iii. An intersection, walkway or logical ending point where the length of the sidewalk is reasonable.

6.4.2.4.J Upgrading Pedestrian Facilities

The City will undertake a program of sidewalk reconstruction to upgrade existing walkways and to provide new walkways in established areas. Upgrades to existing walkways and the construction of new walkways shall be safe, accessible, well-lighted and have a relative degree of visibility. Priority will be given to those areas adjacent to schools, community centres, neighbourhood commercial areas, and public transit stops.

6.4.2.5 Railways

6.4.2.5.A Rail to Support Industry

The City shall support the location of rail service to meet the needs of industrial uses within the City. It will further encourage multi-modal connections to rail as a means of supporting economic development .

6.4.2.5.B Surplus Railway Lands

The City, together with the railway authority, will identify potential reuse of railway lands which becomes surplus to the railway's needs. Where appropriate, the City will consider the use of surplus railway lands for new trails and open space uses.

6.4.2.5.C Mitigating Conflicts with Rail

The City, together with the railway authority, the Region, and other agencies, will identify where conflicts exist between rail, vehicles, cyclists, pedestrians, and adjacent land uses and will implement appropriate measures to mitigate the conflict, wherever possible.

6.4.2.5.D Level Crossings

The City will identify those level crossings requiring grade separations and seek appropriate government assistance for such construction. At the same time, the City will identify those level crossings which are hazardous to public safety and will seek appropriate measures to improve and/or close such crossings.

6.4.2.5.E Required Studies

Where development is proposed adjacent to a rail corridor, the City together with the railway authority, will consider the impact of the development on the rail corridor and may require studies (including, but not limited to, snow, noise, vibration, air quality studies) to demonstrate that the rail corridor's function is not negatively impacted and that potential negative impacts of the rail corridor on the proposed land use can be mitigated.

6.4.2.6 The Welland Canal

6.4.2.6.A Authority

The St. Lawrence Seaway has jurisdiction for the area within the Welland Canal. The City will work with Transport Canada and the St. Lawrence Seaway Authority on matters related to the Welland Canal which affects the City and its citizens.

6.4.2.6.B Importance of the Welland Canal

The City recognizes the significance of the Welland Canal as an important goods movement corridor and the environmental benefits of shipping as a mode of goods movement.

6.4.2.6.C Canal-Side Development

The City, where possible, will encourage and support the St. Lawrence Seaway Authority in its on-going efforts to improve the economic and environmental impacts of the Welland Canal. In particular, the City will encourage development adjacent to the canal which supports this Plan's strategic goals and objectives related to establishing a multi-modal economic driver in Welland.

6.4.2.6.D Mitigation of Impacts

The City will require that new development, which may be considered a sensitive land use and is located adjacent to the canal, shall be subject to appropriate technical studies and that appropriate mitigation measures are provided as a condition of development approval.

6.4.2.6.E Heritage Value

The Welland Canal is recognized as having a built and cultural heritage value to the City and opportunities will be sought to promote and celebrate this heritage.

6.4.2.6.F Partnership

Dialogue between the City of Welland, Regional Municipality of Niagara, and the St. Lawrence Seaway authority is encouraged on matters of mutual interest where the potential solutions will benefit from partnership and cooperation.

6.4.2.7 Accessibility

6.4.2.7.A Mobility for All Persons

The City shall strive to improve the mobility of all persons to make conditions safe for walking, persons using mobility devices, including wheel chairs and scooters, and people utilizing accessible conventional transit, specialized transit and accessible taxis.

6.4.2.7.B Accessible Design for New Buildings

All new public, commercial, residential, recreational, and institutional buildings and facilities will incorporate accessible design, including, but not limited to, escalators/elevators where appropriate, automatic door openers, and ramps at building entrances.

6.4.2.7.C Development Review Considerations

In the review of development Applications, the City will address accessibility needs by:

i. Requiring driveway and sidewalk slopes at a ratio of 1:12, height to length;
ii. Requiring sidewalk curb cuts at all intersections;
iii. Requiring that paving changes (e.g. interlocking brick, tactile strips, etc.) be incorporated at grade changes and intersections;
iv. Requiring designated parking spaces for persons with disabilities, as specified in the Zoning By-law;
v. Encouraging any other features appropriate to ensure that barrier-free design is provided and,

vi. Where appropriate, circulating the Application to an Accessibility Advisory Committee for comment.

6.4.2.7.D Preparation of Guidelines

The City may prepare specific design guidelines for accessibility and/or ensure that accessible design is addressed when preparing design guidelines for neighbourhoods.