FEBRUARY 16, 2024

PROJECT NO: 1846-6748

SENT BY: EMAIL

Ambria (First Welland) Limited
400 Creditstone Road, Suite 9
Vaughan, ON L4K 3Z3

Attention: Benjamin Nicolucci

RE: TRANSPORTATION IMPACT BRIEF
744 FIRST AVENUE
CITY OF WELLAND, REGION OF NIAGARA

Dear Benjamin,

In support of the Zoning By-Law Amendment and Draft Plan of Subdivision, related to the proposed residential development at 744 First Avenue in the City of Welland (City), Niagara Region (Region), C.F. Crozier & Associates Inc. (Crozier) has prepared the following Transportation Impact Brief (TIB).

The purpose of this letter is to analyze the following aspects of the proposed development from a transportation operations perspective:

- The existing road network and record information relating to road jurisdiction, road classification, posted speed limit, lane configuration, cross-section elements.
- Forecast the trip generation characteristics of the proposed development using the Institute of Transportation Engineers Manual (11th edition).
- Analyze the full build-out traffic operations using Synchro modelling software during the critical peak hours.
- Evaluate the proposed site access from a sight distance perspective.

1.0 Introduction

C.F. Crozier & Associates Inc. (Crozier) was retained by Ambria (First Welland) Limited to complete a TIB for a proposed residential townhouse development situated at 744 First Avenue in the City of Welland.

The purpose of this letter is to analyze the impact of the proposed development on the surrounding road network and recommend transportation mitigation measures, if warranted.

A Terms of Reference (ToR) encompassing the scope of the TIB was circulated to the City of Welland on December 5, 2023, and comments were received from the City on December 5, 2023. The ToR was also circulated to the City of Thorold staff, and comments were received on December 6, 2023. Correspondence from the City of Welland and City of Thorold is included in Appendix A.

1.1 Development Lands

The subject lands cover an area of approximately 3.87 ha and currently consists of an existing residential building and agricultural lands. The site, located in a rural neighborhood zoned Agricultural (A1) and Environmental Conservation (EC), is bounded by First Avenue/Cataract Road to the west and agricultural zoned lands to the north, east, and south.

The location of the proposed development is attached in Appendix B as per the proposed development's concept plan prepared by the 4 Architecture Inc., dated April 5, 2023.

1.2 Development Proposal

Per the most recent concept plan prepared by 4 Architecture Inc. dated April 5, 2023, elements envisioned for the full buildout of this development include approximately:

- 22 stacked townhouse blocks with a total of 357 units.
- Proposed entrance road off First Avenue and a second access to a future roadway to the south.
- Two east-west internal roadways and three north-south internal roadways.
- A total of 661 parking spaces including 4 accessible parking spaces.
- A total of 60 bicycle parking spaces.

The most recent concept plan is attached in Appendix B.

1.3 Scope of Study

In accordance with the City of Welland and Niagara Region Guidelines, the following periods were analyzed:

- Analysis of the roadway network during the weekday a.m. and p.m. peak hours.
- Analysis of the roadway network at the full-buildout year (2025), and 10-years from the build out year (2035). The horizon years will be analyzed for future total traffic conditions.

As part of the study, the following intersection was reviewed:

- Site Access and First Avenue

2.0 Existing Conditions

The intersection of the development's Site Access and First Avenue was reviewed as the study intersection (per confirmation with City staff).

The following section provides a description of the study area from a transportation context under 2023 existing conditions.

2.1 Study Road

First Avenue is classified as an Arterial Road under the jurisdiction of the City of Welland and runs north-south with a posted speed of 50 km/h. There is a community safety zone south of Quaker Road, with a posted speed limit of 40 km/h. There are bike lanes along the roadway extending south of Quaker Road.

The City of Welland Official Plan is included in Appendix C.

2.2 Study Intersection

The study intersection of Site Access and First Avenue was analyzed as stop-controlled on the minor road. The characteristics of the intersection are summarized in Table 1. Additionally, each approach has a single shared lane for all the movements.

Table 1: Intersection Characteristics

Intersection	Control Method	Number of Approaches
Site Access and First Avenue	Stop-Controlled on Minor	3

2.3 Traffic Data

Turning movement counts at the intersection of Quaker Road and First Avenue and Merritt Road and Cataract Road were provided by Spectrum Traffic. The counts were undertaken on December 12, 2023, between the hours of 6:00 a.m. – 10:00 a.m. and 3:00 p.m. – 7:00 p.m. for the a.m. and p.m. peak periods, respectively. It is important to note that traffic data at these intersections was collected for the purposes of determining the through traffic volumes at the intersection of Site Access at First Avenue.

The existing traffic data is found in Appendix D.

2.4 Analysis Methodology

The evaluation of intersections within this report is conducted based on the methodology outlined in the Highway Capacity Manual, using Synchro 11 modelling software. Intersections are assessed using a Level of Service (LOS) metric, with ranges of intersection delays assigned a letter from "A" to "F".

Generally, a LOS "A" or "B" would typically be measured hours when lesser traffic volumes are on the roadways and delays are minimal. LOS "C" through "F" would typically be observed during commuter peak hours when significant vehicle volumes would cause lengthy travel times. The LOS definitions for stop-controlled intersections are included in Appendix E.

3.0 Future Background Conditions

Future background conditions refer to traffic conditions incorporating expected growth, development and improvements within the surrounding intersections occurring within the study horizons, outside of the development proposal.

Future background traffic volumes for horizon years consist of the following components:

- Background traffic growth from outside the study area.
- Traffic generated within the study area from other proposed developments.

It is important to note that the analysis was not performed under future background conditions as the purpose of this study was to examine the site access operations. The existing and future background traffic volumes were obtained for the purposes of analyzing the network under future total conditions.

3.1 Background Developments

Although the City has not received any formal Planning Act applications, there is currently one (1) active development application in the vicinity of the proposed site that were considered as part of this report.

For the Northwest Welland Secondary Plan, the application is for proposed mixed-use residential development. The development plan is a sustainable community that will incorporate several active transportation elements, including sidewalks, cycling facilities, multi-use pathways and other infrastructure. There are approximately 190 hectares of primarily rural/agricultural designated lands, with an estimated 55 hectares of land presently developed and municipally serviced. The development will include a mix of townhouses/condominium complexes, single-family dwellings and other mixed-use developments.

Per the findings in the Transportation Assessment Preferred Plan (TAPP) report, it is estimated the development will generate 744 two-way (185 inbound and 559 outbound) trips during the weekday a.m. peak hour. The Tapp Report does not provide p.m. peak hour trip generation due to a lack of directional flow information (Associated Engineering, 2020). For the purposes of this analysis, the site-generated trips were calculated using ITE Trip Generation Manual, 11th Edition and were confirmed by the City on January 18, 2024.

3.2 Future Roadway Improvement

There are currently no roadway or intersection improvements known at this time.

3.3 Traffic Growth Rates

Per discussion with the City of Welland, a growth rate of 2% was applied to all traffic, as confirmed in the Terms of Reference established with City staff.

4.0 Site Generated Traffic

The proposed development will result in additional vehicles on the boundary road network that would otherwise not exist. The development will also result in additional turning movements at the intersections.

4.1 ITE Trip Generation

The ITE Trip Generation Manual, 11th Edition, was used to forecast the site-generated traffic for the proposed development. The concept plan is presented in Appendix B.

The analysis was conducted with a previous version of the concept plan (dated July 8, 2022), which was analyzed with 22 stacked townhouse blocks, with a total of 360 units. As the updated concept plan (dated April 5, 2023) provided a lower unit count of 357, the trip generation used in this analysis was based on the concept plan dated July 8, 2022.

Table 2: Site Generated Trips (July 8, 2022 Concept Plan)

Land Use (ITE LUC)	Units	Equation or Average Used	Trip Generation			
			Weekday A.M.		Weekday P.M.	
			Inbound	Outbound	Inbound	Outbound
LUC 220: Multifamily Housing (Low-Rise)	360 Units	Equation A.M. T = 0.31 X + 22.85 P.M. T = 0.43 X + 20.55	32	102	110	65
Total			32	102	110	65

As shown in Table 2, the proposed development is expected to generate 134 two-way (32 inbound and 102 outbound) trips during the weekday a.m. peak hour, and 175 two-way (110 inbound and 65 outbound) trips during the weekday p.m. peak hour. Appendix G provides excerpts from the ITE Trip Generation Manual, 11th Edition.

4.2 Trip Distribution and Assignment

The site generated trips were distributed to the boundary roadways based on the Transportation Tomorrow Survey (TTS) data.

TTS is a comprehensive survey of transportation characteristics of households in the Golden Horseshoe and surrounding areas. 2016 Transportation Tomorrow Survey (TTS) data, provided in Appendix H, was used to determine the trip distribution for the proposed residential development.

The subject property is situated in 2016 TTS Zone 6259. TTS results were filtered from this zone to reflect trip distribution patterns during the weekday peak periods. To model the worst-case scenario, all site-generated traffic volumes were assigned to the intersection of Site Access and First Avenue.

As per section 3.1, the site-generated trips for the Northwest Welland Secondary Plan background development were calculated by determining the difference between 2031 future total volumes (Figure 5-2) and 2018 future background volumes (Figure 2-6) from the Northwest Welland Secondary Plan report.

Table *3* outlines the trip distribution for the proposed development divided into time and direction of travel.

Table 3: Trip Distribution

Direction	A.M. Inbound	A.M. Outbound	P.M. Inbound	P.M. Outbound
Northwest	0%	8%	3%	11%
North	0%	24%	26%	0%
Northeast	0%	6%	2%	0%
East	100%	9%	10%	0%
Southeast	0%	8%	17%	49%
South	0%	33%	22%	4%
Southwest	0%	4%	5%	16%
West	0%	7%	15%	19%
Total	100%	100%	100%	100%

5.0 Future Total Traffic Operations

Future Total traffic volumes for horizon years consist of the following components:

- Background traffic growth from outside the study area.
- Traffic generated within the study area from other proposed developments.
- Traffic expected to be generated by the development.

The resulting total volumes in the 2025 and 2035 horizon years are presented in Appendix I.

5.1 Study Horizon

As confirmed with the City of Welland, the horizon years selected to assess the impacts of the proposed development include:

- Full build-out year: 2025
- Ten years from full build-out year (2025): 2035

5.2 Intersection Operations

This section summarizes the results of the intersection operations during the Future Total scenario. Table 4 and Table 5 summarize the results from the Future Total scenario for each horizon year.

Detailed capacity analyses are provided in Appendix I.

Table 4: 2025 Future Total Traffic Operations

Intersection	Control	Peak Hour	Level of Service [1]	Control Delay (s)	Critical V/C Ratio[2]	95th Percentile Queue Length
Site Access and First Avenue	Minor Stop-Controlled	A.M.	C	19.8	0.32 (WBLR)	None
		P.M.	E	40.0	0.41 (WBLR)	None

Note 1: The Level of Service of a Stop-Controlled intersection is based on the delay associated with the critical approach. At unsignalized intersections, a Level of Service of "D" or worse is deemed critical.
Note 2: The critical v/c ratio is the maximum v/c ratio for movements at the intersection. In addition, all v/c ratios greater than 0.85 for through and shared through/turning movements are highlighted.

Table 5: 2035 Future Total Traffic Operations

Intersection	Control	Peak Hour	Level of Service [1]	Control Delay (s)	Critical V/C Ratio (Approach) [2]	95th Percentile Queue Length
Site Access and First Avenue	Minor Stop-Controlled	A.M.	C	22.0	0.35 (WBLR)	None
		P.M.	E	48.8	0.47 (WBLR)	None

Note 1: The Level of Service of a Stop-Controlled intersection is based on the delay associated with the critical approach. At unsignalized intersections, a Level of Service of "D" or worse is deemed critical.
Note 2: The critical v/c ratio is the maximum v/c ratio for movements at the intersection. In addition, all v/c ratios greater than 0.85 for through and shared through/turning movements are highlighted.

Under the 2037 Future Total Conditions, the study intersection of Site Access and First Avenue operates with Level of Service (LOS) "C" in the a.m. peak period, with minor delays and well under capacity. The intersection operates at a LOS "E" in the p.m. peak period. However, the maximum volume-to-capacity is below the critical threshold of 0.85. No other operational concerns are observed.

The LOS is acceptable as the delay is only seen on the site access approach and not on First Avenue. This scenario represents the worst-case scenario, and more vehicles are expected to utilize the other site access once the future road is constructed.

6.0 Left-Turn Lane Warrants

Based on the City's comments, a left-turn lane warrant was conducted at the southbound approach at the intersection of Site Access and First Avenue. According to Exhibit 9A-7 from section 9.17 Left-Turn Lanes in the MTO Design Supplement for TAC Geometric Design Guide for Canadian Roads – June 2017, a left-turn lane is warranted for the southbound approach at the intersection of Site Access and First Avenue. A storage of 15 m is recommended based on the warrants. It is important to note that although a left-turn warrant was conducted as requested by the City and that a left-turn is warranted, the intersection operations do not change with the addition of a southbound left-turn lane at the intersection of Site Access and First Avenue. All left-turn lane warrants are included in Appendix J.

7.0 Site Access Review

The site was reviewed including to check the sightlines, and there were no operational or safety issues from the transportation aspect.

7.1 Sightline Review

The available sightlines for the future site access at First Avenue was measured and compared to the standards set out in the Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads (GDGCR), June 2017. Appendix K contains excerpts from the TAC GDGCR Manual.

Sight distance was measured from the proposed site access using the following assumptions:

- A standard driver eye height of 1.08 meters for a passenger car.
- A 5.4-metre setback from the approximate extension of the outer curb to represent a vehicle waiting to exit the site.
- A passenger car was used as the design vehicle.
- The time gap was assumed for the design vehicle as per table 9.93 of the GDGCR.

Intersection sight distance is calculated using equation 9.9.1 from the GDGCR as outlined below:

$$ISD = 0.278 * V\ major * tg$$

Where;
ISD = Intersection Sight Distance
V major = design speed of roadway (km/h)
tg = assumed time gap for vehicles to turn from stop onto roadway (s)

A design speed 10 km/h higher than the posted or assumed speeds of each road of study was assumed for the sight distance analysis. Table 6 summarizes the sight distance analysis.

Table 6: Site Access Sight Distance Calculations

Feature	Site Access and First Avenue
Access Type	Full-Movement
Posted Speed Limit of Roadway	50 km/h
Assumed Design Speed	60 km/h
Base Time Gap	6.5 s (right) 7.5 s (left)
Grade of Roadway	Less than 3%
Horizontal Alignment of Roadway	Straight
Required Sight Distance (right turn)	110 m
Available Sight Distance (right turn)	>200 m
Required Sight Distance (left turn)	130 m
Available Sight Distance (left turn)	>200 m
Minimum Sight Distances Satisfied?	Yes

Utilizing equation 9.9.1 as well as tables 9.9.6 and 9.9.4 provided by the TAC guideline, the required sight distance of a passenger vehicle making a right-turn and a left-turn from stop are approximately 110 metres and 130 metres, respectively, for the design speed of 60 km/h. The proposed site access along First Avenue meets all relevant TAC GDGCR requirements of the sight distance analysis.

8.0 Conclusion

This study has analyzed potential traffic impact on the boundary road network in relation to the proposed residential development at 744 First Avenue in the City of Welland. The detailed capacity analyses contained within this report may be summarized with the following key findings:

- Turning movement counts at the intersection of Quaker Road and First Avenue and Merritt Road and Cataract Road were provided by Spectrum Traffic. It is important to note that traffic data at these intersections was collected for the purposes of interpolating traffic volumes at the intersection of Site Access at First Avenue.

- A growth rate of 2% was provided by the City of Welland and applied as directed.

- The proposed development was analyzed under future total conditions only. The existing and future background traffic volumes were obtained for the purposes of analyzing the study intersection under future total conditions.

- The proposed development is expected to generate 134 two-way (32 inbound and 102 outbound) trips during the weekday a.m. peak hour, and 175 two-way (110 inbound and 65 outbound) trips during the weekday p.m. peak hour.

- Under the 2037 Future Total Conditions, the study intersection of Site Access and First Avenue operates with Level of Service (LOS) "C" in the a.m. peak period, with= minor delays and no capacity concerns. The intersection operates at a LOS "E" in the p.m. peak period. However, the maximum volume-to-capacity is below the critical threshold of 0.85. No other operational concerns are observed.

- The delay is concentrated on the site access approach which occurs in the worst-case scenario in which the second access off the future road is not built.

- According to Exhibit 9A-7 from section 9.17 Left-Turn Lanes in the MTO Design Supplement for TAC Geometric Design Guide for Canadian Roads – June 2017, a left-turn lane is warranted in the southbound approach at the intersection of Site Access and First Avenue. A storage of 15 m is recommended by the warrants.

- The proposed site access along First Avenue meets all relevant TAC GDGCR requirements of the sight distance analysis.

Based on the information presented in this report, the proposed development can be supported from a transportation operations perspective.

Respectfully submitted,

C.F. CROZIER & ASSOCIATES INC.

Ian Lindley, M.A.Sc, P. Eng
Project Engineer, Transportation

C.F. CROZIER & ASSOCIATES INC.

R. Aaron Wignall, Associate
Senior Project Manager, Transportation

J:\1800\1846 - Ambria (First Welland) Limited\6748 - 744 First Avenue\Reports\Traffic\2024.02.16_744 First Avenue_TIB Final.docx

APPENDIX A

Correspondence

Aiman Khan

From: Shaira Ahmed
Sent: January 5, 2024 10:10 AM
To: Aiman Khan
Subject: FW: 744 First Avenue Terms of Reference (CFCA#1846-6748)

Shaira Ahmed
Engineering Intern, Transportation
DID: 905.693.4706

From: Haesun Jung <Haesun.Jung@thorold.ca>
Sent: Wednesday, December 6, 2023 10:04 AM
To: Shaira Ahmed <sahmed@cfcrozier.ca>
Cc: Ian Lindley <ilindley@cfcrozier.ca>; Aaron Wignall <awignall@cfcrozier.ca>; Sean Dunsmore <Sean.Dunsmore@thorold.ca>
Subject: RE: 744 First Avenue Terms of Reference (CFCA#1846-6748)

Good morning,

City of Thorold has no comment for townhouse development.

Thank you!

Haesun Jung
Engineering Technician I
Public Works and Community Services
City of Thorold
905-227-6613 x291
P.O. Box 1044, 3540 Schmon Parkway, Thorold, ON., L2V 4A7
www.thorold.ca

From: Shaira Ahmed <sahmed@cfcrozier.ca>
Sent: December 5, 2023 5:03 PM
To: Haesun Jung <Haesun.Jung@thorold.ca>; Sean Dunsmore <Sean.Dunsmore@thorold.ca>
Cc: Ian Lindley <ilindley@cfcrozier.ca>; Aaron Wignall <awignall@cfcrozier.ca>
Subject: FW: 744 First Avenue Terms of Reference (CFCA#1846-6748)

Hello,

We have received comments on our Terms of Reference (ToR) for a townhouse development from the City of Welland staff and have been advised to reach out to the City of Thorld staff for comments. Please see below for the ToR and Ali's comments.

Please let me know if there are any questions or concerns.

Regards,

Shaira Ahmed
Engineering Intern, Transportation
Office: 905.875.0026
Collingwood | Milton | Toronto | Bradford | Guelph

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From: Ali Khan <ali.khan@welland.ca>
Sent: Tuesday, December 5, 2023 2:46 PM
To: Shaira Ahmed <sahmed@cfcrozier.ca>
Cc: Ian Lindley <ilindley@cfcrozier.ca>; Aaron Wignall <awignall@cfcrozier.ca>
Subject: RE: 744 First Avenue Terms of Reference (CFCA#1846-6748)

Shaira,

My comments are highlighted below.

Regards,

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

CITY OF

From: Shaira Ahmed <sahmed@cfcrozier.ca>
Sent: Tuesday, December 5, 2023 1:21 PM
To: Ali Khan <ali.khan@welland.ca>
Cc: Ian Lindley <ilindley@cfcrozier.ca>; Aaron Wignall <awignall@cfcrozier.ca>
Subject: 744 First Avenue Terms of Reference (CFCA#1846-6748)

Hello,

C.F. Crozier and Associates (Crozier) has been retained to prepare a Transportation Impact Brief (TIB) for a residential townhouse development located at 744 First Avenue in the City of Welland in support of the Zoning By-Law Amendment (ZBA) and Draft Plan of Subdivision (DPS). These terms of reference are based upon the Pre-consultation meeting form dated January 20, 2022.

According to the Concept Plan, the elements envisioned for this development include:

- A total of 22 stacked townhouse blocks, with a total of 360 units.
- Proposed entrance road off First Avenue and a future roadway to the south.
- Two east-west internal roadways and three north-south internal roadways.
- A total of 657 parking spaces with an addition of 4 barrier free parking spaces.
- A total of 60 bicycle parking spaces.

Please see the attached concept plan for more details.

This letter and its attachment are intended to serve as the Terms of Reference (ToR) for the TIB to support the development application.

We are kindly requesting that you review the ToR and provide feedback regarding our scope of work and request for data. Should you not be the appropriate person for correspondence, it would be appreciated to be directed to the appropriate contact.

Study Methodology for the Transportation Impact Brief
The following intersection is proposed to be analyzed as part of the scope of the study:

- Site Access and First Avenue

In order to get the traffic counts expected to be seen at the site access, we will get traffic data from:

- Quaker Road and First Avenue --- 2022 TMC attached.
- Merritt Road and Cataract Road-----Please contact City of Thorold

We will consult specialty traffic counting firms we typically work with to obtain traffic data for the intersections listed above unless the City of Welland (City) has data for these intersections. If the City's data is available and preferred, please let us know. **Please confirm the above noted intersections are sufficient for the study.**

Analysis Periods and Scenarios
The above intersections will be analyzed in the weekday a.m. and p.m. peak hours of the full build-out year (2025), and 10-years from the build out year (2035). The horizon years will be analyzed for future total traffic conditions.
Please confirm if the peak hour periods and the horizon year is sufficient for the analysis.

Background Developments

Please confirm if any background development should be included in the analysis. If there are developments that need to be considered, please provide the associated transportation impact studies that should be included in our analysis.

Roadway and Transit Improvements

Please provide us with the details on any roadway improvements planned within the study area network.

Traffic Growth

We kindly request a recommended growth rate applicable to traffic volumes in the study area, to sufficiently reflect future conditions in the horizon years. If a growth rate is not available, an industry standard of 2% is suggested to forecast future traffic growth at the intersections of the study. **Please confirm if this is acceptable.**

Trip Generation and Distribution

Trip generation for the proposed development will be forecasted using the Trip Generation Manual, 11th Edition, prepared by the Institute of Transportation Engineers (ITE). Multifamily Housing (Low-Rise) (LUC 220) will be used to calculate the trips. **Please confirm if this is acceptable.**

Existing traffic and data from the 2016 Transportation Tomorrow Survey (TTS) will be used to determine the trip distribution for the a.m. and p.m. periods to the proposed development. **Please confirm if this is acceptable.**

Analysis Procedures

Weekday a.m. and p.m. peak hours will be analyzed using Synchro 11.0 analysis software based on Highway Capacity Manual (HCM) procedures. **Please confirm if this acceptable.**

Summary

We request the following information for inclusion in the study, along with any comments that arise with regards to the above Terms of Reference.
Please provide:

- Confirmation that the study intersection is sufficient. --- Include all access points from development onto First Ave.
- Relevant growth rate(s) applicable to the roadways of study. 2%
- Confirm the study horizon years are acceptable. Confirmed
- Any relevant background developments and the associated traffic impact studies that are to be included in our analysis. Forwarding your email to planning staff for their input.
- Details of any planned roadway or transit improvements in the surrounding study area within the horizon years, if there are any. Forwarding your email to Engineering staff for their input. For Transit input please contact the Region.

- Confirmation of analysis methodology. Please include warrant analysis for turning lane requirements on First Ave. Also, did you reach out to Thorold staff on this TIS?

I hope the contents outlined in this email are acceptable.

Should you have any questions or require any further information, please feel free to contact Ian Lindley or myself.

Regards,

Shaira Ahmed
Engineering Intern, Transportation
Office: 905.875.0026
Collingwood | Milton | Toronto | Bradford | Guelph

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Ian Lindley

From: Ali Khan <ali.khan@welland.ca>
Sent: January 18, 2024 3:35 PM
To: Ian Lindley; Taylor Meadows
Cc: Shaira Ahmed; Aaron Wignall; Aiman Khan
Subject: RE: 744 First Avenue Terms of Reference (CFCA#1846-6748)

Confirmed.

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: Ian Lindley <ilindley@cfcrozier.ca>
Sent: Thursday, January 18, 2024 3:23 PM
To: Taylor Meadows <taylor.meadows@welland.ca>; Ali Khan <ali.khan@welland.ca>
Cc: Shaira Ahmed <sahmed@cfcrozier.ca>; Aaron Wignall <awignall@cfcrozier.ca>; Aiman Khan <aiman.khan@cfcrozier.ca>
Subject: RE: 744 First Avenue Terms of Reference (CFCA#1846-6748)

Good Morning,

Upon reviewing the information provided from the NWSP TIS' at the links below we are unable to determine specific generated volumes at our study intersection from the Secondary Plan area.

We did however use the unit counts provided and the ITE trip generation manual, as well as our distribution as outlined below, to determine an estimate and apply it to our study.

Attached is the results of this estimate. Please confirm if this is acceptable for use or if a specific amount of trips along First Avenue that is generated by the secondary plan area is known.

Regards,
Ian

Ian Lindley, M.A.Sc., P.Eng.
Project Engineer, Transportation
Office: 905.876.7119
Collingwood | Milton | Toronto | Bradford | Guelph

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From: Taylor Meadows <taylor.meadows@welland.ca>
Sent: Tuesday, December 5, 2023 4:40 PM
To: Ali Khan <ali.khan@welland.ca>
Cc: Shaira Ahmed <sahmed@cfcrozier.ca>; Aaron Wignall <awignall@cfcrozier.ca>; Ian Lindley <ilindley@cfcrozier.ca>
Subject: RE: 744 First Avenue Terms of Reference (CFCA#1846-6748)

Afternoon,

The City has not received any formal Planning Act applications; however, the property is located within the City's Northwest Welland Secondary Plan area. It would be advisable to consult the information related to the NWSP via the following link: https://www.welland.ca/ReportsStudies.asp – under 'Planning Division'. Included in the information is a 'NWSP Transportation Assessment Preferred Plan' (https://www.welland.ca/planning/NorthWestStudy/RptSglNWSPTransportationAssessment20200513Rev1.pdf), which includes some pertinent information. I should also note that since the aforementioned studies were completed, the City has received commentary from land owners that the units could increase (potentially double) from what was considered at the time.

Regards,

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

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

Upcoming absence: December 21, 2023 – January 2, 2024.

From: Ali Khan <ali.khan@welland.ca>
Sent: Tuesday, December 5, 2023 2:50 PM
To: Taylor Meadows <taylor.meadows@welland.ca>
Cc: Shaira Ahmed <sahmed@cfcrozier.ca>; Aaron Wignall <awignall@cfcrozier.ca>; Ian Lindley <ilindley@cfcrozier.ca>
Subject: RE: 744 First Avenue Terms of Reference (CFCA#1846-6748)

Hi Taylor,

Do you have any comments related to section highlighted below. Thanks

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: Shaira Ahmed <sahmed@cfcrozier.ca>
Sent: Tuesday, December 5, 2023 1:21 PM
To: Ali Khan <ali.khan@welland.ca>
Cc: Ian Lindley <ilindley@cfcrozier.ca>; Aaron Wignall <awignall@cfcrozier.ca>
Subject: 744 First Avenue Terms of Reference (CFCA#1846-6748)

Hello,

C.F. Crozier and Associates (Crozier) has been retained to prepare a Transportation Impact Brief (TIB) for a residential townhouse development located at 744 First Avenue in the City of Welland in support of the Zoning By-Law Amendment (ZBA) and Draft Plan of Subdivision (DPS). These terms of reference are based upon the Pre-consultation meeting form dated January 20, 2022.

According to the Concept Plan, the elements envisioned for this development include:

- A total of 22 stacked townhouse blocks, with a total of 360 units.
- Proposed entrance road off First Avenue and a future roadway to the south.
- Two east-west internal roadways and three north-south internal roadways.
- A total of 657 parking spaces with an addition of 4 barrier free parking spaces.
- A total of 60 bicycle parking spaces.

Please see the attached concept plan for more details.

This letter and its attachment are intended to serve as the Terms of Reference (ToR) for the TIB to support the development application.

We are kindly requesting that you review the ToR and provide feedback regarding our scope of work and request for data. Should you not be the appropriate person for correspondence, it would be appreciated to be directed to the appropriate contact.

Study Methodology for the Transportation Impact Brief
The following intersection is proposed to be analyzed as part of the scope of the study:

- Site Access and First Avenue

In order to get the traffic counts expected to be seen at the site access, we will get traffic data from:

- Quaker Road and First Avenue

- Merritt Road and Cataract Road

We will consult specialty traffic counting firms we typically work with to obtain traffic data for the intersections listed above unless the City of Welland (City) has data for these intersections. If the City's data is available and preferred, please let us know.
Please confirm the above noted intersections are sufficient for the study.

Analysis Periods and Scenarios
The above intersections will be analyzed in the weekday a.m. and p.m. peak hours of the full build-out year (2025), and 10-years from the build out year (2035). The horizon years will be analyzed for future total traffic conditions.
Please confirm if the peak hour periods and the horizon year is sufficient for the analysis.

Background Developments
Please confirm if any background development should be included in the analysis. If there are developments that need to be considered, please provide the associated transportation impact studies that should be included in our analysis.

Roadway and Transit Improvements
Please provide us with the details on any roadway improvements planned within the study area network.

Traffic Growth
We kindly request a recommended growth rate applicable to traffic volumes in the study area, to sufficiently reflect future conditions in the horizon years. If a growth rate is not available, an industry standard of 2% is suggested to forecast future traffic growth at the intersections of the study. **Please confirm if this is acceptable.**

Trip Generation and Distribution
Trip generation for the proposed development will be forecasted using the Trip Generation Manual, 11th Edition, prepared by the Institute of Transportation Engineers (ITE). Multifamily Housing (Low-Rise) (LUC 220) will be used to calculate the trips. **Please confirm if this is acceptable.**

Existing traffic and data from the 2016 Transportation Tomorrow Survey (TTS) will be used to determine the trip distribution for the a.m. and p.m. periods to the proposed development.**Please confirm if this is acceptable.**

Analysis Procedures
Weekday a.m. and p.m. peak hours will be analyzed using Synchro 11.0 analysis software based on Highway Capacity Manual (HCM) procedures.**Please confirm if this acceptable.**

Summary
We request the following information for inclusion in the study, along with any comments that arise with regards to the above Terms of Reference.
Please provide:

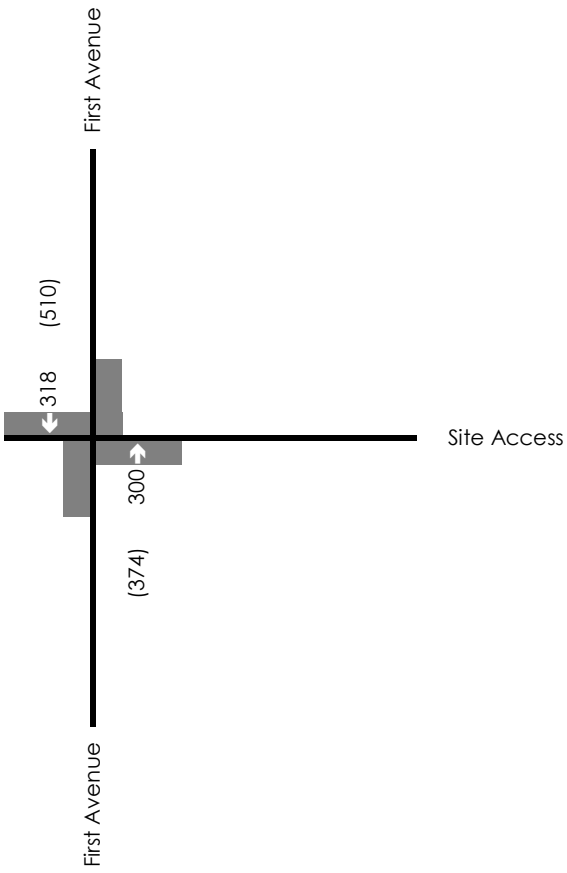
- Confirmation that the study intersection is sufficient.
- Relevant growth rate(s) applicable to the roadways of study.
- Confirm the study horizon years are acceptable.
- Any relevant background developments and the associated traffic impact studies that are to be included in our analysis.
- Details of any planned roadway or transit improvements in the surrounding study area within the horizon years, if there are any.
- Confirmation of analysis methodology.

I hope the contents outlined in this email are acceptable.

Should you have any questions or require any further information, please feel free to contact Ian Lindley or myself.

Regards,

Shaira Ahmed
Engineering Intern, Transportation
Office: 905.875.0026
Collingwood | Milton | Toronto | Bradford | Guelph



Legend	744 First Avenue	CROZIER CONSULTING ENGINEERS	Figure 4
xx A.M. Peak Hour Traffic Volumes (xx) P.M. Peak Hour Traffic Volumes	Background Development Trip Assignment		Project No. 1846-6748 Date. 2024-01-18 Analyst. Aiman Khan

APPENDIX B

Site Location and Concept Plan

Legend		744 First Avenue	CROZIER CONSULTING ENGINEERS	Figure 1
	Approximate Boundary	Site Location		Project No. 1846-6748 Date. 2024-01-17 Analyst. Aiman Khan

ISSUED FOR --

N 88°50'26" E 192.64m **BOUNDARY OF CITY OF THOROLD**

FIRST AVENUE

201.62m N 0°56'3" W

EX E/P

EX E/P

N 0°18'0" E 200.73m

FUTURE DEVELOPMENT

N 88°34'48" E 192.56m

FUTURE ROAD

FUTURE DEVELOPMENT

BLOCK 08 TYPE 'A' TOWNS (21 UNITS)
BLOCK 09 TYPE 'A' TOWNS (15 UNITS)
BLOCK 10 TYPE 'A' TOWNS (24 UNITS)
BLOCK 11 TYPE 'A' TOWNS (12 UNITS)
BLOCK 07 TYPE 'A' TOWNS (24 UNITS)
BLOCK 06 TYPE 'A' TOWNS (18 UNITS)
BLOCK 05 TYPE 'A' TOWNS (18 UNITS)
BLOCK 04 TYPE 'A' TOWNS (18 UNITS)
BLOCK 03 TYPE 'A' TOWNS (21 UNITS)
BLOCK 02 TYPE 'A' TOWNS (12 UNITS)
BLOCK 01 TYPE 'A' TOWNS (12 UNITS)
BLOCK 12 TYPE 'A' TOWNS (21 UNITS)
BLOCK 22 TYPE 'B' TOWNS (4 UNITS)
BLOCK 15 TYPE 'B' TOWNS (4 UNITS)
BLOCK 21 TYPE 'B' TOWNS (14 UNITS)
BLOCK 20 TYPE 'B' TOWNS (14 UNITS)
BLOCK 17 TYPE 'B' TOWNS (14 UNITS)
BLOCK 16 TYPE 'B' TOWNS (14 UNITS)
BLOCK 23 TYPE 'B' TOWNS (14 UNITS)
BLOCK 19 TYPE 'B' TOWNS (14 UNITS)
BLOCK 18 TYPE 'B' TOWNS (14 UNITS)
BLOCK 14 TYPE 'B' TOWNS (14 UNITS)

LANDSCAPE BUFFER
1.50M PEDESTRIAN SIDEWALK
MUNICIPAL SIDEWALK
FIRE ROUTE
CURB SIDE PICKUP MOLOK GARBAGE SYSTEM
SNOW STORAGE
9 BIKE PARKING
14 BIKE PARKING
LANDSCAPE AREA
AMENITY SPACE
1.50M PEDESTRIAN SW
BELL EASEMENT

SITE STATISTICS

ZONING BY-LAW	CITY OF WELLAND , BY-LAW 2017-117
ZONING	EXISTING: AGRICULTURAL; PROPOSED: RL2
SITE AREA	3.87 ha (9.25 ac)

UNIT COUNT - GROSS FLOOR AREA	NUMBER OF UNITS	GFA
TYPE 'A' - 3 1/2 STOREY, 6.30M STACKED TOWNHOUSE BLOCK 01-13 +/- 1200 SQ.FT. (EACH UNIT)	237 UNITS	(284,400 SQ. FT.)
TYPE 'B' - 3 STOREY, 6.48M STACKED TOWNHOUSE BLOCK 13-22 +/- 1400 SQ.FT. (EACH UNIT)	120 UNITS	(168,000 SQ. FT.)
TOTAL	357 UNITS	(452,400 SQ. FT.) (42,029 SQ. M.)

SITE STANDARD	REQUIRED	PROVIDED
DENSITY		357 units /3.87 ha = 92.25 units/ ha 357 units /9.25 ac = 38.59 units/ ac
FLOOR SPACE INDEX		1.08
LOT COVERAGE	MAX. 50%	APPROX. 13,800 (36%)
LANDSCAPE AREA	MIN. 20%	APPROX. 8290 SM (21%)

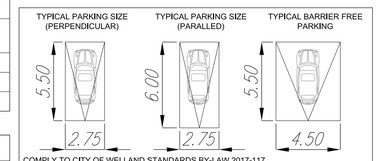
PARKING REQUIREMENTS	REQUIRED	PROVIDED	
TOWNHOUSES (TOTAL 360 UNITS	1 PS PER UNIT. MAY BE PROVIDED IN AN ATTACHED OR DETACHED GARAGE 357	357	158 PRIVATE GARAGE 79 SURFACE PARKING EXTRA 272 DRIVEWAY PARKING
VISITOR PARKING	N/A		27 SPACES PROVIDED (.07 SPACES PER UNIT)
BARRIER FREE PARKING	4		4
TOTAL PARKING			647 TOTAL
BICYCLE PARKING	(0.25 PER UNIT) 90		92

SETBACK (RL2)	REQUIRED	PROVIDED
FRONT YARD SETBACK	4.5 m	4.5 m
INT. /EXT. SIDE YARD SETBACK	2.0 m	4.36 m / 2.0 m
REAR YARD SETBACK	6.0 m	6.10 m

BUILDING HEIGHT	REQUIRED	PROVIDED
MAX. BUILDING HEIGHT	11.0 m	TBD
MAX. NUMBER OF STOREYS	3 STOREYS	3 STOREYS

KEY MAP

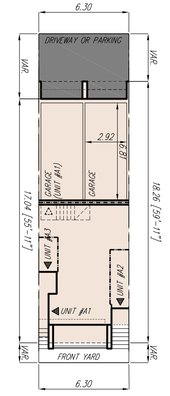
SCALE = N.T.S.



COMPLY TO CITY OF WELLAND STANDARDS BY-LAW 2017-117

LEGEND

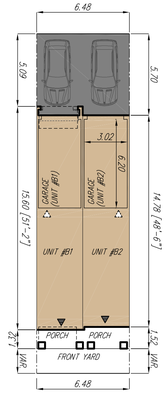
	PROPERTY BOUNDARY
	PROPERTY LINE
	FIRE ROUTE
	BUILDING SETBACK LINE
	GARAGE SETBACK LINE
	PORCH SETBACK LINE
	OUTLINE OF FLR/BOX-OUT ABOVE
	OUTLINE OF BALCONY ABOVE
	TRAVEL DISTANCE TO FIRE ROUTE
	EXTERIOR DOOR LOCATION
	EXTERIOR DOOR LOCATION IF GRADE PERMITS



TYPE 'A'

3 1/2 STOREY
STACKED TOWNHOUSE

6.30m x 18.26m
MAX. +/- 1200 SQ.FT.
(3 UNITS PER MODULE)



TYPE 'B'

3 STOREY
B2B - STACKED TOWNHOUSE

6.48m x 15.60m
MAX. +/- 1400 SQ.FT.
(2 UNITS PER MODULE)

CONCEPT PLAN

SCALE = 1:400

4 ARCHITECTURE INC
www.4architecture.ca

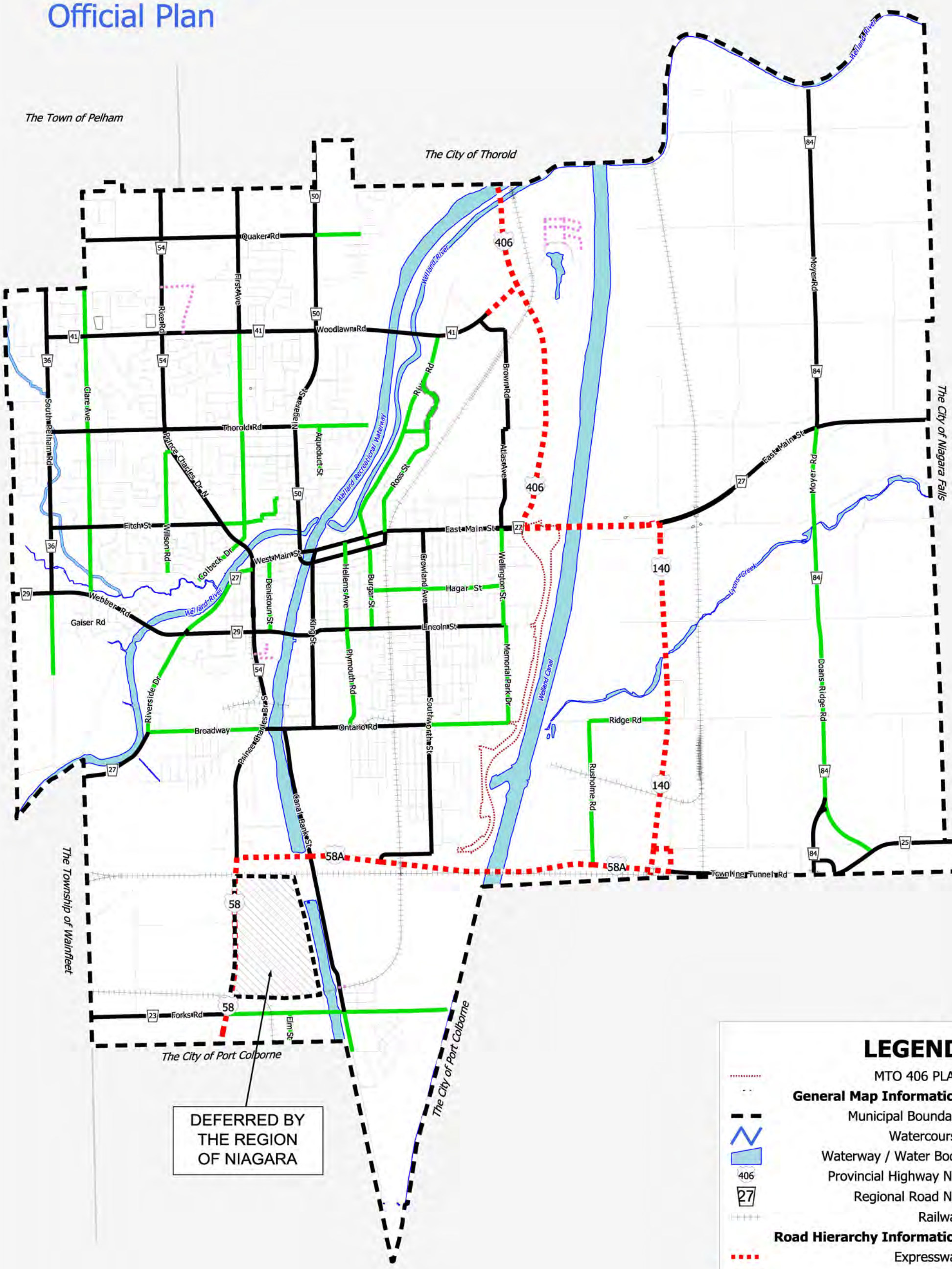
AMBRIA HOMES - 422016
WELLAND, ON.
8966 Woodbine Ave, Suite 300, Markham, ON L3R 0J7 ■ T 905.470.7212 ■ 2023.04.05 ■ SL ■

SITE PLAN
422016DSP01.dwg

APPENDIX C

City of Welland Official Plan Excerpts

City of Welland
Official Plan



DEFERRED BY THE REGION OF NIAGARA

LEGEND

- MTO 406 PLAN
- **General Map Information**
- Municipal Boundary
- Watercourse
- Waterway / Water Body
- Provincial Highway No.
- Regional Road No.
- Railway
- **Road Hierarchy Information**
- Expressway
- Arterial
- Collector
- Local
- Private

Welland
ONTARIO · CANADA

Schedule E

City of Welland Official Plan

Schedule E: Road Hierarchy

Infrastructure and Development Services
Planning Division

FILE: Z:\MAPPING\GIS\Official Plan\Final_OP.map
May 4, 2010
Revised: July 15, 2020

APPENDIX D

Traffic Data

Spectrum

Turning Movement Count
Location Name: QUAKER RD & FIRST AVE
Date: Tue, Dec 12, 2023 Deployment Lead: David Chu

Crozier & Associates
ACCOUNTS PAYABLE
TORONTO - SELECT PROVINCE -, M1W1Y6
- SELECT COUNTRY -

Turning Movement Count (1 . QUAKER RD & FIRST AVE)

Start Time	N Approach FIRST AVE						E Approach QUAKER RD						S Approach FIRST AVE						W Approach QUAKER RD						Int. Total (15 min)	Int. Total (1 hr)
	Right N:W	Thru N:S	Left N:E	UTurn N:N	Peds N:	Approach Total	Right E:N	Thru E:W	Left E:S	UTurn E:E	Peds E:	Approach Total	Right S:E	Thru S:N	Left S:W	UTurn S:S	Peds S:	Approach Total	Right W:S	Thru W:E	Left W:N	UTurn W:W	Peds W:	Approach Total		
06:00:00	0	0	1	0	0	1	1	5	4	0	0	10	13	14	1	0	0	28	1	6	1	0	0	8	47	
06:15:00	1	0	1	0	0	2	0	3	2	0	0	5	8	17	1	0	0	26	2	16	0	0	0	18	51	
06:30:00	1	2	0	0	0	3	0	12	5	0	0	17	14	15	4	0	0	33	0	18	1	0	0	19	72	
06:45:00	2	4	0	0	0	6	0	11	9	0	0	20	13	22	4	0	0	39	3	16	1	0	0	20	85	255
07:00:00	0	3	0	0	0	3	1	8	9	0	0	18	25	18	6	0	0	49	2	25	3	0	0	30	100	308
07:15:00	5	11	1	0	0	17	2	9	12	0	0	23	20	31	3	0	0	54	2	23	6	0	0	31	125	382
07:30:00	2	12	0	0	0	14	2	19	16	0	0	37	33	30	4	0	0	67	5	39	4	0	0	48	166	476
07:45:00	4	29	0	0	0	33	1	22	25	0	0	48	41	29	9	0	0	79	8	37	4	0	0	49	209	600
08:00:00	6	44	1	0	0	51	1	26	31	0	0	58	37	35	11	0	0	83	5	41	4	0	0	50	242	742
08:15:00	8	39	1	0	0	48	0	31	39	0	0	70	32	46	8	0	0	86	8	44	8	0	0	60	264	881
08:30:00	8	37	3	0	0	48	2	42	29	0	0	73	37	32	17	0	2	86	9	45	4	0	0	58	265	980
08:45:00	4	26	2	0	0	32	5	40	27	0	0	72	22	30	12	0	0	64	11	48	3	0	0	62	230	1001
09:00:00	8	51	0	0	0	59	0	46	35	0	0	81	23	33	12	0	11	68	24	62	6	0	0	92	300	1059
09:15:00	3	51	2	0	0	56	4	24	50	0	0	78	30	24	8	0	0	62	11	37	4	0	0	52	248	1043
09:30:00	5	34	3	0	0	42	0	22	24	0	0	46	20	22	6	0	0	48	9	43	5	0	0	57	193	971
09:45:00	3	24	4	0	0	31	1	22	22	0	0	45	25	20	4	0	0	49	2	47	5	0	0	54	179	920
BREAK																										
15:00:00	10	38	5	0	0	53	1	51	22	0	0	74	32	28	6	0	2	66	12	59	3	0	0	74	267	
15:15:00	15	36	2	0	0	53	1	50	28	0	0	79	28	29	16	0	2	73	15	43	2	0	0	60	265	
15:30:00	6	35	2	0	0	43	2	52	21	0	0	75	41	32	13	0	6	86	19	63	8	0	0	90	294	
15:45:00	6	49	2	0	0	57	6	42	31	0	0	79	30	35	8	0	1	73	7	59	6	0	0	72	281	1107
16:00:00	8	40	3	0	0	51	3	48	32	0	0	83	42	40	5	0	0	87	7	61	4	0	0	72	293	1133
16:15:00	15	47	4	0	0	66	3	60	26	0	0	89	48	29	5	0	0	82	11	61	3	0	0	75	312	1180
16:30:00	6	57	4	0	0	67	3	53	19	0	0	75	50	43	8	0	0	101	8	52	2	0	0	62	305	1191
16:45:00	9	55	2	0	0	66	3	50	20	0	0	73	31	34	5	0	2	70	10	51	4	0	2	65	274	1184
17:00:00	10	29	5	0	0	44	2	40	37	0	0	79	23	25	11	0	0	59	15	43	3	0	0	61	243	1134
17:15:00	6	51	3	0	0	60	3	51	36	0	0	90	16	16	7	0	0	39	11	50	2	0	0	63	252	1074
17:30:00	4	43	3	0	0	50	0	42	26	0	0	68	24	16	4	0	0	44	4	39	2	0	0	45	207	976
17:45:00	2	31	1	0	0	34	5	51	28	0	0	84	19	14	8	0	0	41	6	39	3	0	0	48	207	909
18:00:00	2	16	2	0	0	20	1	48	28	0	0	77	21	17	4	0	0	42	3	38	0	0	0	41	180	846
18:15:00	3	31	3	0	0	37	1	38	24	0	0	63	27	9	5	0	0	41	6	33	2	0	0	41	182	776
18:30:00	2	15	0	0	0	17	1	46	22	0	0	69	19	15	2	0	0	36	7	35	1	0	0	43	165	734
18:45:00	1	13	1	0	0	15	0	33	22	0	0	55	18	12	5	0	0	35	7	35	1	0	0	43	148	675
Grand Total	165	953	61	0	0	1179	55	1097	761	0	0	1913	862	812	222	0	26	1896	250	1308	105	0	2	1663	**6651**	-
Approach%	14%	80.8%	5.2%	0%		-	2.9%	57.3%	39.8%	0%		-	45.5%	42.8%	11.7%	0%		-	15%	78.7%	6.3%	0%		-	-	-
Totals %	2.5%	14.3%	0.9%	0%		17.7%	0.8%	16.5%	11.4%	0%		28.8%	13%	12.2%	3.3%	0%		28.5%	3.8%	19.7%	1.6%	0%		25%	-	-
Heavy	5	10	2	0		-	1	44	59	0		-	37	4	7	0		-	15	43	2	0		-	-	-
Heavy %	3%	1%	3.3%	0%		-	1.8%	4%	7.8%	0%		-	4.3%	0.5%	3.2%	0%		-	6%	3.3%	1.9%	0%		-	-	-
Bicycles	-	-	-	-		-	-	-	-	-		-	-	-	-	-		-	-	-	-	-		-	-	-
Bicycle %	-	-	-	-		-	-	-	-	-		-	-	-	-	-		-	-	-	-	-		-	-	-

Spectrum

Turning Movement Count
Location Name: QUAKER RD & FIRST AVE
Date: Tue, Dec 12, 2023 Deployment Lead: David Chu

Crozier & Associates
ACCOUNTS PAYABLE
TORONTO - SELECT PROVINCE -, M1W1Y6
- SELECT COUNTRY -

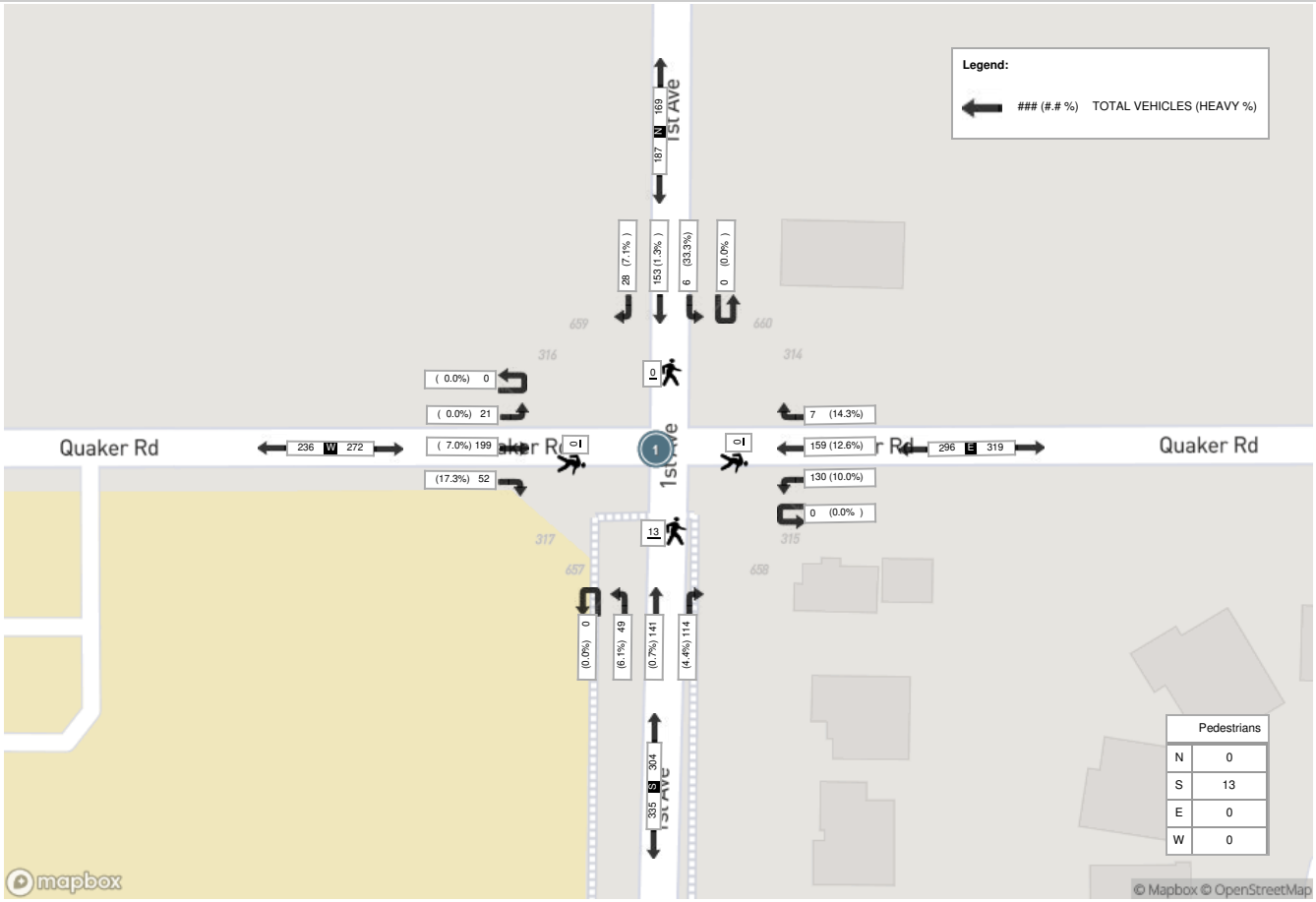
Peak Hour: 08:15 AM - 09:15 AM Weather: Broken Clouds (2.21 °C)

Start Time	N Approach FIRST AVE						E Approach QUAKER RD						S Approach FIRST AVE						W Approach QUAKER RD						Int. Total (15 min)
	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	
08:15:00	8	39	1	0	0	48	0	31	39	0	0	70	32	46	8	0	0	86	8	44	8	0	0	60	264
08:30:00	8	37	3	0	0	48	2	42	29	0	0	73	37	32	17	0	2	86	9	45	4	0	0	58	265
08:45:00	4	26	2	0	0	32	5	40	27	0	0	72	22	30	12	0	0	64	11	48	3	0	0	62	230
09:00:00	8	51	0	0	0	59	0	46	35	0	0	81	23	33	12	0	11	68	24	62	6	0	0	92	300
Grand Total	28	153	6	0	0	187	7	159	130	0	0	296	114	141	49	0	13	304	52	199	21	0	0	272	**1059**
Approach%	15%	81.8%	3.2%	0%		-	2.4%	53.7%	43.9%	0%		-	37.5%	46.4%	16.1%	0%		-	19.1%	73.2%	7.7%	0%		-	**-**
Totals %	2.6%	14.4%	0.6%	0%		17.7%	0.7%	15%	12.3%	0%		28%	10.8%	13.3%	4.6%	0%		28.7%	4.9%	18.8%	2%	0%		25.7%	**-**
PHF	0.88	0.75	0.5	0		0.79	0.35	0.86	0.83	0		0.91	0.77	0.77	0.72	0		0.88	0.54	0.8	0.66	0		0.74	**-**
Heavy	2	2	2	0		6	1	20	13	0		34	5	1	3	0		9	9	14	0	0		23	**-**
Heavy %	7.1%	1.3%	33.3%	0%		3.2%	14.3%	12.6%	10%	0%		11.5%	4.4%	0.7%	6.1%	0%		3%	17.3%	7%	0%	0%		8.5%	**-**
Lights	26	151	4	0		181	6	139	117	0		262	109	140	46	0		295	43	185	21	0		249	**-**
Lights %	92.9%	98.7%	66.7%	0%		96.8%	85.7%	87.4%	90%	0%		88.5%	95.6%	99.3%	93.9%	0%		97%	82.7%	93%	100%	0%		91.5%	**-**
Single-Unit Trucks	0	1	0	0		1	0	11	9	0		20	0	0	0	0		0	0	5	0	0		5	**-**
Single-Unit Trucks %	0%	0.7%	0%	0%		0.5%	0%	6.9%	6.9%	0%		6.8%	0%	0%	0%	0%		0%	0%	2.5%	0%	0%		1.8%	**-**
Buses	2	1	2	0		5	1	9	4	0		14	5	1	3	0		9	9	9	0	0		18	**-**
Buses %	7.1%	0.7%	33.3%	0%		2.7%	14.3%	5.7%	3.1%	0%		4.7%	4.4%	0.7%	6.1%	0%		3%	17.3%	4.5%	0%	0%		6.6%	**-**
Articulated Trucks	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	**-**
Articulated Trucks %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	**-**
Pedestrians	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	13	-	-	-	-	-	0	-	**-**
Pedestrians%	-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	100%		-	-	-	-	0%		**-**

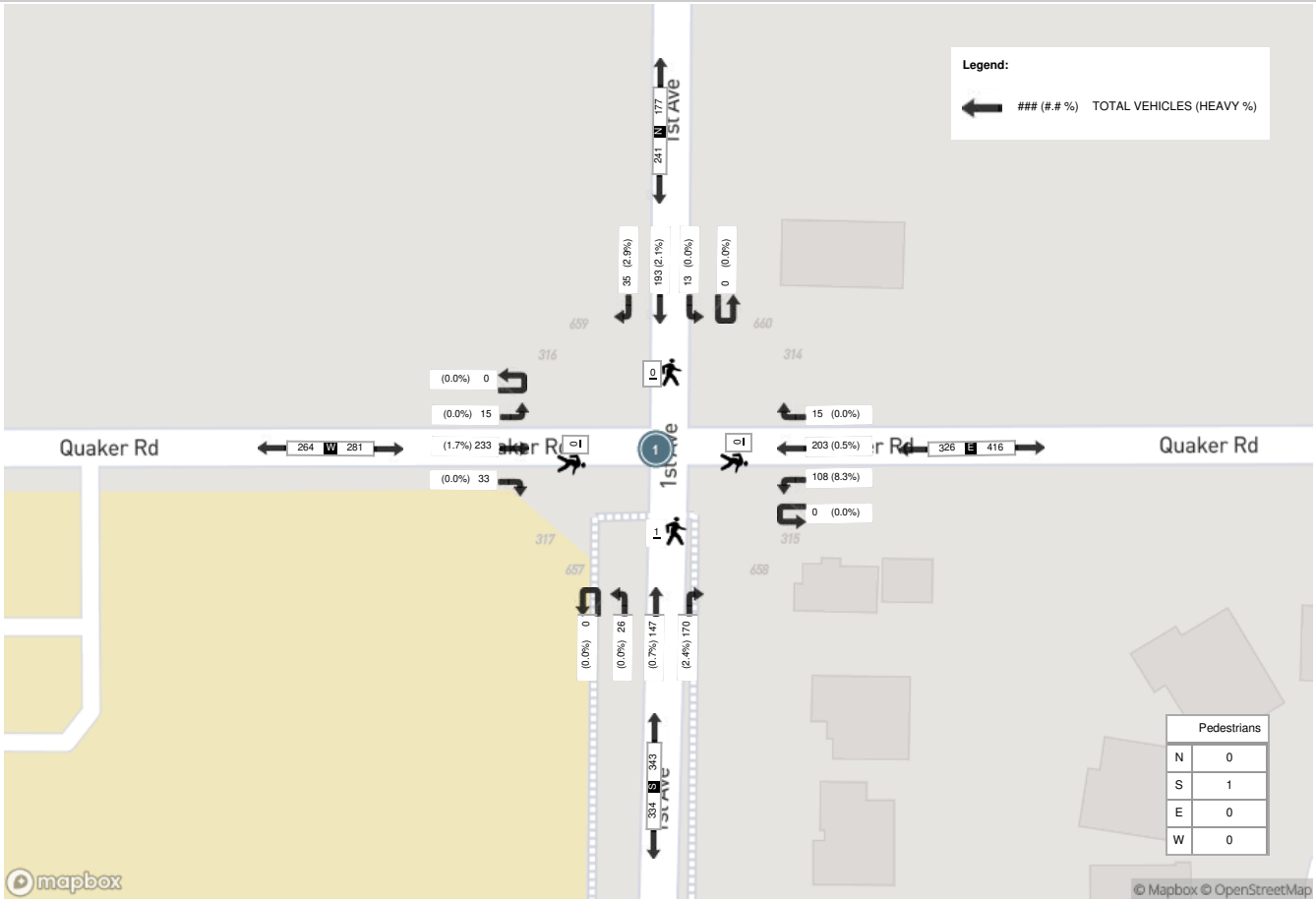
Peak Hour: 03:45 PM - 04:45 PM Weather: Overcast Clouds (5.29 °C)

Start Time	N Approach FIRST AVE						E Approach QUAKER RD						S Approach FIRST AVE						W Approach QUAKER RD						Int. Total (15 min)
	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	
15:45:00	6	49	2	0	0	57	6	42	31	0	0	79	30	35	8	0	1	73	7	59	6	0	0	72	281
16:00:00	8	40	3	0	0	51	3	48	32	0	0	83	42	40	5	0	0	87	7	61	4	0	0	72	293
16:15:00	15	47	4	0	0	66	3	60	26	0	0	89	48	29	5	0	0	82	11	61	3	0	0	75	312
16:30:00	6	57	4	0	0	67	3	53	19	0	0	75	50	43	8	0	0	101	8	52	2	0	0	62	305
Grand Total	35	193	13	0	0	241	15	203	108	0	0	326	170	147	26	0	1	343	33	233	15	0	0	281	**1191**
Approach%	14.5%	80.1%	5.4%	0%		-	4.6%	62.3%	33.1%	0%		-	49.6%	42.9%	7.6%	0%		-	11.7%	82.9%	5.3%	0%		-	**-**
Totals %	2.9%	16.2%	1.1%	0%		20.2%	1.3%	17%	9.1%	0%		27.4%	14.3%	12.3%	2.2%	0%		28.8%	2.8%	19.6%	1.3%	0%		23.6%	**-**
PHF	0.58	0.85	0.81	0		0.9	0.63	0.85	0.84	0		0.92	0.85	0.85	0.81	0		0.85	0.75	0.95	0.63	0		0.94	**-**
Heavy	1	4	0	0		5	0	1	9	0		10	4	1	0	0		5	0	4	0	0		4	**-**
Heavy %	2.9%	2.1%	0%	0%		2.1%	0%	0.5%	8.3%	0%		3.1%	2.4%	0.7%	0%	0%		1.5%	0%	1.7%	0%	0%		1.4%	**-**
Lights	34	189	13	0		236	15	202	99	0		316	166	146	26	0		338	33	229	15	0		277	**-**
Lights %	97.1%	97.9%	100%	0%		97.9%	100%	99.5%	91.7%	0%		96.9%	97.6%	99.3%	100%	0%		98.5%	100%	98.3%	100%	0%		98.6%	**-**
Single-Unit Trucks	0	1	0	0		1	0	1	0	0		1	0	0	0	0		0	0	2	0	0		2	**-**
Single-Unit Trucks %	0%	0.5%	0%	0%		0.4%	0%	0.5%	0%	0%		0.3%	0%	0%	0%	0%		0%	0%	0.9%	0%	0%		0.7%	**-**
Buses	1	3	0	0		4	0	0	9	0		9	4	1	0	0		5	0	2	0	0		2	**-**
Buses %	2.9%	1.6%	0%	0%		1.7%	0%	0%	8.3%	0%		2.8%	2.4%	0.7%	0%	0%		1.5%	0%	0.9%	0%	0%		0.7%	**-**
Articulated Trucks	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	**-**
Articulated Trucks %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	**-**
Pedestrians	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	1	-	-	-	-	-	0	-	**-**
Pedestrians%	-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	100%		-	-	-	-	0%		**-**

Peak Hour: 08:15 AM - 09:15 AM **Weather: Broken Clouds (2.21 °C)**



Peak Hour: 03:45 PM - 04:45 PM **Weather: Overcast Clouds (5.29 °C)**



Crozier & Associates
ACCOUNTS PAYABLE
TORONTO - SELECT PROVINCE -, M1W1Y6
- SELECT COUNTRY -

Turning Movement Count (2 . MERRITT RD & CATARACT RD)

Start Time	N Approach CATARACT RD						E Approach MERRITT RD						S Approach CATARACT RD						W Approach WEST SIDEWALK			Int. Total (15 min)	Int. Total (1 hr)
	Right N:W	Thru N:S	Left N:E	UTurn N:N	Peds N:	Approach Total	Right E:N	Thru E:W	Left E:S	UTurn E:E	Peds E:	Approach Total	Right S:E	Thru S:N	Left S:W	UTurn S:S	Peds S:	Approach Total	UTurn W:W	Peds W:	Approach Total		
06:00:00	0	1	0	0	0	1	0	0	0	0	0	0	1	14	0	0	0	15	0	0	0	16	
06:15:00	0	1	0	0	0	1	0	0	1	0	0	1	2	15	0	0	0	17	0	0	0	19	
06:30:00	0	5	0	0	0	5	0	0	0	0	0	0	5	12	0	0	0	17	0	0	0	22	
06:45:00	0	3	2	0	0	5	0	0	3	0	0	3	1	22	0	0	0	23	0	0	0	31	88
07:00:00	0	4	1	0	0	5	0	0	1	0	0	1	4	15	0	0	0	19	0	0	0	25	97
07:15:00	0	11	1	0	0	12	0	0	3	0	0	3	6	32	0	0	0	38	0	0	0	53	131
07:30:00	0	12	2	0	0	14	1	0	2	0	0	3	10	29	0	0	0	39	0	0	0	56	165
07:45:00	0	22	3	0	0	25	4	0	18	0	0	22	5	27	0	0	0	32	0	0	0	79	213
08:00:00	0	32	0	0	0	32	0	0	20	0	0	20	9	30	0	0	0	39	0	0	0	91	279
08:15:00	0	27	1	0	0	28	3	0	21	0	0	24	8	46	0	0	0	54	0	0	0	106	332
08:30:00	0	27	0	0	0	27	2	0	14	0	0	16	7	32	0	0	0	39	0	0	0	82	358
08:45:00	0	19	1	0	0	20	1	0	12	0	0	13	4	30	0	0	0	34	0	0	0	67	346
09:00:00	0	38	1	0	0	39	0	0	27	0	0	27	9	28	0	1	0	38	0	0	0	104	359
09:15:00	0	33	1	0	0	34	1	0	20	0	0	21	8	29	0	0	0	37	0	0	0	92	345
09:30:00	0	14	5	0	0	19	0	0	23	0	0	23	4	21	0	0	0	25	0	0	0	67	330
09:45:00	0	21	1	0	0	22	2	0	11	0	0	13	6	21	0	0	0	27	0	0	0	62	325
BREAK																							
15:00:00	0	33	0	0	0	33	3	0	21	0	0	24	11	20	0	0	0	31	0	0	0	88	
15:15:00	0	31	3	0	0	34	0	0	23	0	0	23	5	27	0	0	0	32	0	0	0	89	
15:30:00	0	36	4	0	0	40	5	0	8	0	0	13	10	27	0	0	0	37	0	0	0	90	
15:45:00	0	37	2	0	1	39	2	0	20	0	0	22	11	37	0	0	0	48	0	0	0	109	376
16:00:00	0	41	6	0	0	47	2	0	11	0	0	13	13	32	0	0	0	45	0	0	0	105	393
16:15:00	0	52	1	0	0	53	2	0	13	0	0	15	6	31	0	0	0	37	0	0	0	105	409
16:30:00	0	57	0	0	0	57	2	0	9	0	0	11	14	37	0	0	0	51	0	0	0	119	438
16:45:00	0	60	2	0	0	62	3	0	8	0	0	11	7	32	0	0	0	39	0	0	0	112	441
17:00:00	0	32	4	0	0	36	1	0	13	0	0	14	5	26	0	0	0	31	0	0	0	81	417
17:15:00	0	51	3	0	0	54	1	0	11	0	0	12	8	15	0	0	0	23	0	0	0	89	401
17:30:00	0	37	1	0	0	38	1	0	11	0	0	12	2	15	0	0	0	17	0	0	0	67	349
17:45:00	0	24	1	0	0	25	0	0	11	0	0	11	2	21	0	0	0	23	0	0	0	59	296
18:00:00	0	10	1	0	0	11	1	0	7	0	0	8	1	16	0	0	0	17	0	0	0	36	251
18:15:00	0	29	0	0	0	29	1	0	9	0	0	10	3	9	0	0	0	12	0	0	0	51	213
18:30:00	0	13	0	0	0	13	0	0	4	0	0	4	4	12	0	0	0	16	0	0	0	33	179
18:45:00	0	12	0	0	0	12	2	0	3	0	0	5	1	14	0	0	0	15	0	0	0	32	152
Grand Total	0	825	47	0	1	872	40	0	358	0	0	398	192	774	0	1	0	967	0	0	0	**2237**	-
Approach%	0%	94.6%	5.4%	0%		-	10.1%	0%	89.9%	0%		-	19.9%	80%	0%	0.1%		-	0%		-	**-**	-
Totals %	0%	36.9%	2.1%	0%		39%	1.8%	0%	16%	0%		17.8%	8.6%	34.6%	0%	0%		43.2%	0%		0%	**-**	-
Heavy	0	14	2	0		-	3	0	4	0		-	3	4	0	0		-	0		-	**-**	-
Heavy %	0%	1.7%	4.3%	0%		-	7.5%	0%	1.1%	0%		-	1.6%	0.5%	0%	0%		-	0%		-	**-**	-
Bicycles	-	-	-	-		-	-	-	-	-		-	-	-	-	-		-	-		-	**-**	-
Bicycle %	-	-	-	-		-	-	-	-	-		-	-	-	-	-		-	-		-	**-**	-

Peak Hour: 08:15 AM - 09:15 AM Weather: Broken Clouds (2.21 °C)

Start Time	N Approach CATARACT RD						E Approach MERRITT RD						S Approach CATARACT RD						W Approach WEST SIDEWALK			Int. Total (15 min)
	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	UTurn	Peds	Approach Total	
08:15:00	0	27	1	0	0	28	3	0	21	0	0	24	8	46	0	0	0	54	0	0	0	106
08:30:00	0	27	0	0	0	27	2	0	14	0	0	16	7	32	0	0	0	39	0	0	0	82
08:45:00	0	19	1	0	0	20	1	0	12	0	0	13	4	30	0	0	0	34	0	0	0	67
09:00:00	0	38	1	0	0	39	0	0	27	0	0	27	9	28	0	1	0	38	0	0	0	104
Grand Total	0	111	3	0	0	114	6	0	74	0	0	80	28	136	0	1	0	165	0	0	0	**359**
Approach%	0%	97.4%	2.6%	0%		-	7.5%	0%	92.5%	0%		-	17%	82.4%	0%	0.6%		-	0%		-	**-**
Totals %	0%	30.9%	0.8%	0%		31.8%	1.7%	0%	20.6%	0%		22.3%	7.8%	37.9%	0%	0.3%		46%	0%		0%	**-**
PHF	0	0.73	0.75	0		0.73	0.5	0	0.69	0		0.74	0.78	0.74	0	0.25		0.76	0		0	**-**
Heavy	0	3	0	0		3	0	0	2	0		2	1	1	0	0		2	0		0	**-**
Heavy %	0%	2.7%	0%	0%		2.6%	0%	0%	2.7%	0%		2.5%	3.6%	0.7%	0%	0%		1.2%	0%		0%	**-**
Lights	0	108	3	0		111	6	0	72	0		78	27	135	0	1		163	0		0	**-**
Lights %	0%	97.3%	100%	0%		97.4%	100%	0%	97.3%	0%		97.5%	96.4%	99.3%	0%	100%		98.8%	0%		0%	**-**
Single-Unit Trucks	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	0		0	**-**
Single-Unit Trucks %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%		0%	**-**
Buses	0	3	0	0		3	0	0	2	0		2	1	1	0	0		2	0		0	**-**
Buses %	0%	2.7%	0%	0%		2.6%	0%	0%	2.7%	0%		2.5%	3.6%	0.7%	0%	0%		1.2%	0%		0%	**-**
Pedestrians	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	0	-	**-**
Pedestrians%	-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	0%		-	0%		**-**

Spectrum

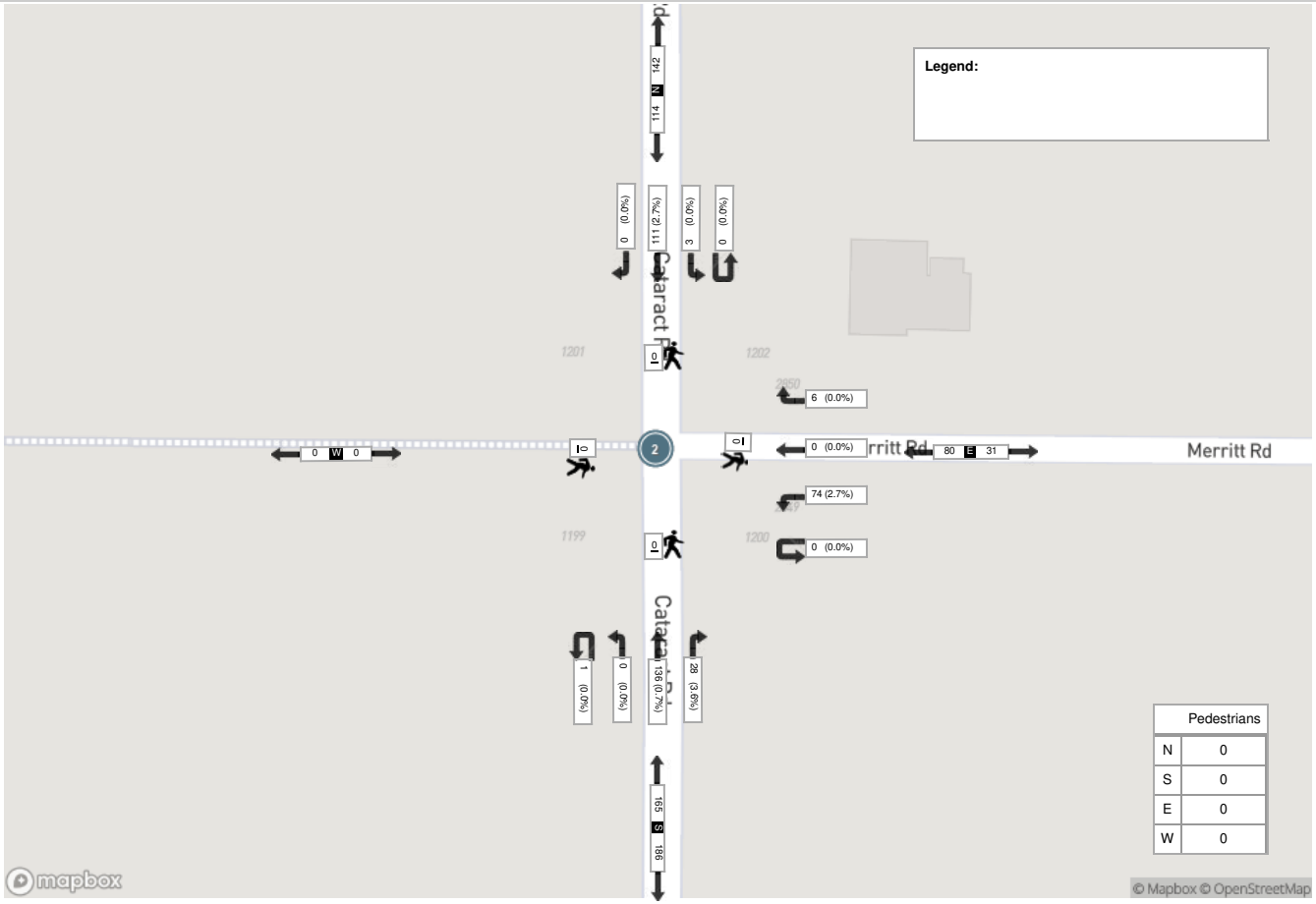
Turning Movement Count
Location Name: MERRITT RD & CATARACT RD
Date: Tue, Dec 12, 2023 Deployment Lead: David Chu

Crozier & Associates
ACCOUNTS PAYABLE
TORONTO - SELECT PROVINCE -, M1W1Y6
- SELECT COUNTRY -

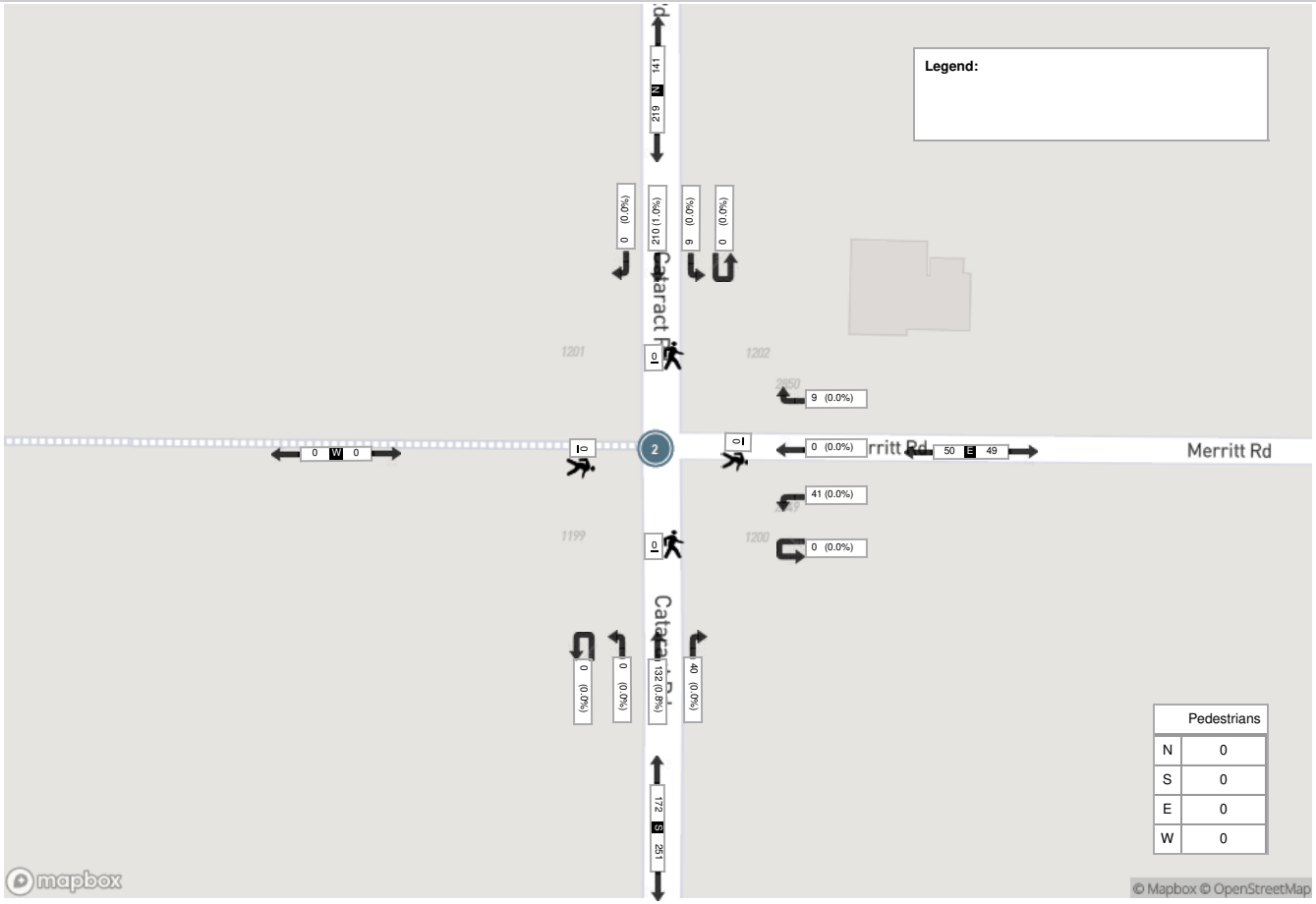
Peak Hour: 04:00 PM - 05:00 PM Weather: Overcast Clouds (5.29 °C)

Start Time	N Approach CATARACT RD						E Approach MERRITT RD						S Approach CATARACT RD						W Approach WEST SIDEWALK			Int. Total (15 min)
	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	UTurn	Peds	Approach Total	
16:00:00	0	41	6	0	0	47	2	0	11	0	0	13	13	32	0	0	0	45	0	0	0	105
16:15:00	0	52	1	0	0	53	2	0	13	0	0	15	6	31	0	0	0	37	0	0	0	105
16:30:00	0	57	0	0	0	57	2	0	9	0	0	11	14	37	0	0	0	51	0	0	0	119
16:45:00	0	60	2	0	0	62	3	0	8	0	0	11	7	32	0	0	0	39	0	0	0	112
Grand Total	0	210	9	0	0	219	9	0	41	0	0	50	40	132	0	0	0	172	0	0	0	**441**
Approach%	0%	95.9%	4.1%	0%		-	18%	0%	82%	0%		-	23.3%	76.7%	0%	0%		-	0%		-	**-**
Totals %	0%	47.6%	2%	0%		49.7%	2%	0%	9.3%	0%		11.3%	9.1%	29.9%	0%	0%		39%	0%		0%	**-**
PHF	0	0.88	0.38	0		0.88	0.75	0	0.79	0		0.83	0.71	0.89	0	0		0.84	0		0	**-**
Heavy	0	2	0	0		2	0	0	0	0		0	0	1	0	0		1	0		0	**-**
Heavy %	0%	1%	0%	0%		0.9%	0%	0%	0%	0%		0%	0%	0.8%	0%	0%		0.6%	0%		0%	**-**
Lights	0	208	9	0		217	9	0	41	0		50	40	131	0	0		171	0		0	**-**
Lights %	0%	99%	100%	0%		99.1%	100%	0%	100%	0%		100%	100%	99.2%	0%	0%		99.4%	0%		0%	**-**
Single-Unit Trucks	0	1	0	0		1	0	0	0	0		0	0	0	0	0		0	0		0	**-**
Single-Unit Trucks %	0%	0.5%	0%	0%		0.5%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%		0%	**-**
Buses	0	1	0	0		1	0	0	0	0		0	0	1	0	0		1	0		0	**-**
Buses %	0%	0.5%	0%	0%		0.5%	0%	0%	0%	0%		0%	0%	0.8%	0%	0%		0.6%	0%		0%	**-**
Pedestrians	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	0	-	**-**
Pedestrians%	-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	0%		-	0%		**-**

Peak Hour: 08:15 AM - 09:15 AM Weather: Broken Clouds (2.21 °C)



Peak Hour: 04:00 PM - 05:00 PM **Weather: Overcast Clouds (5.29 °C)**



APPENDIX E

Level of Service Definitions

Level of Service Definitions

Two-Way Stop Controlled Intersections

Level of Service	Control Delay per Vehicle (seconds)	Interpretation
A	≤ 10	EXCELLENT. Large and frequent gaps in traffic on the main roadway. Queuing on the minor street is rare.
B	> 10 and ≤ 15	VERY GOOD. Many gaps exist in traffic on the main roadway. Queuing on the minor street is minimal.
C	> 15 and ≤ 25	GOOD. Fewer gaps exist in traffic on the main roadway. Delay on minor approach becomes more noticeable.
D	> 25 and ≤ 35	FAIR. Infrequent and shorter gaps in traffic on the main roadway. Queue lengths develop on the minor street.
E	> 35 and ≤ 50	POOR. Very infrequent gaps in traffic on the main roadway. Queue lengths become noticeable.
F	> 50	UNSATISFACTORY. Very few gaps in traffic on the main roadway. Excessive delay with significant queue lengths on the minor street.

Adapted from Highway Capacity Manual 2000, Transportation Research Board

APPENDIX F

Northwest Welland Secondary Plan Transportation Assessment Preferred Plan Excerpts

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

REPORT

City of Welland

Northwest Welland Secondary Plan
Transportation Assessment
Preferred Plan

MAY 2020

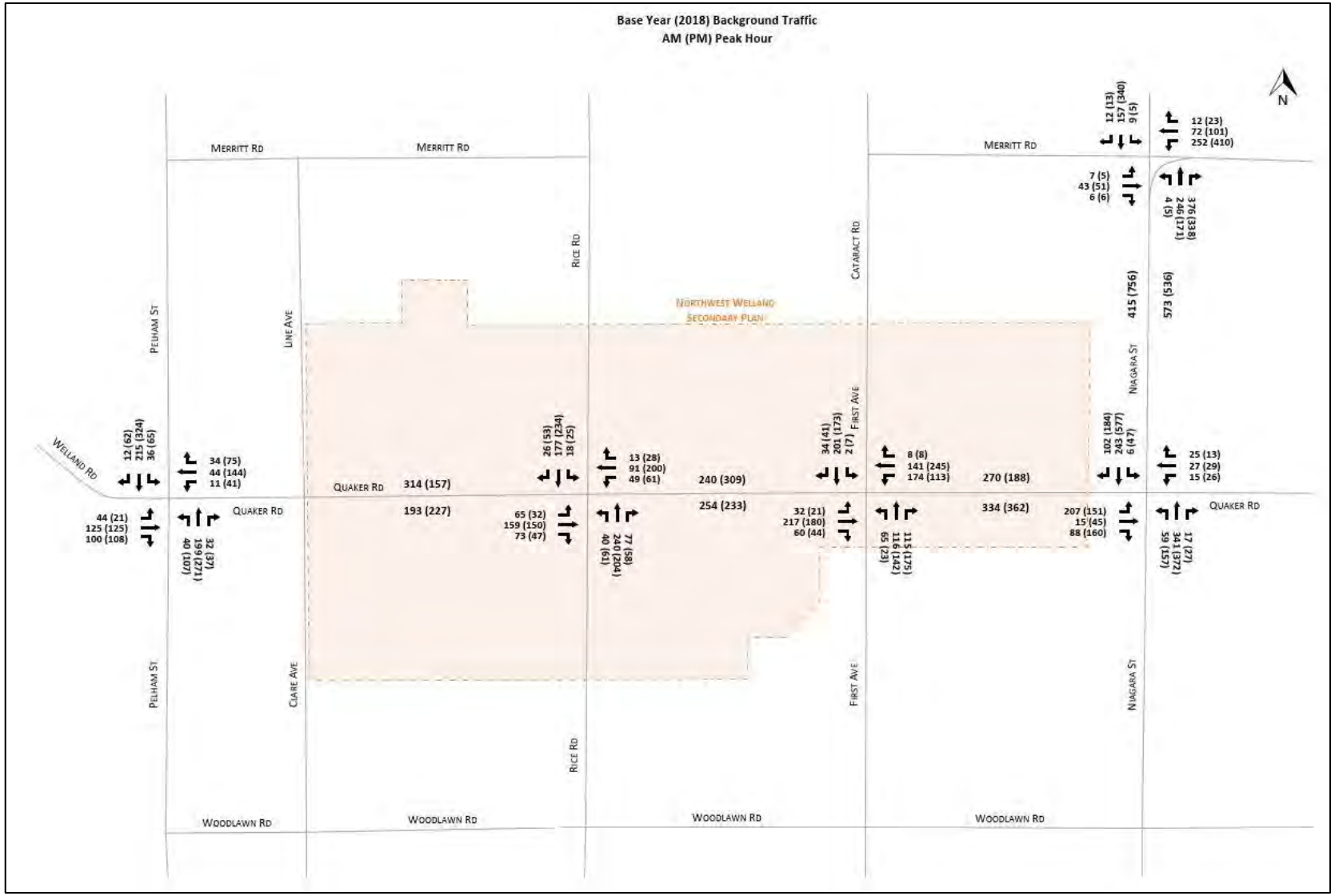


Figure 2-6: Base Year (2018) Background Traffic Peak Hour Turning Movement Volumes

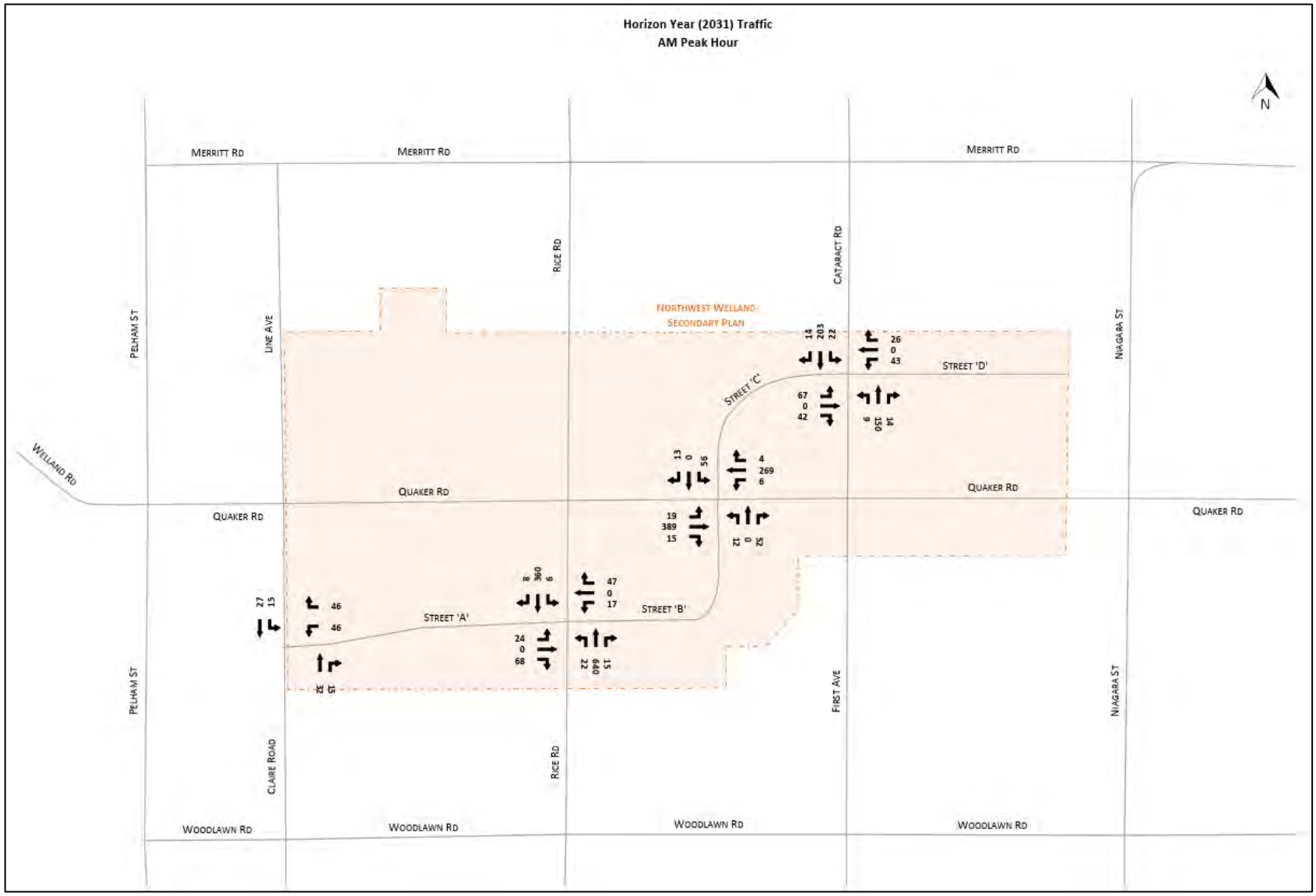


Figure 5-2: Future (2031) Peak Hour Turning Movement Volumes – Collector Roads

APPENDIX G

ITE Trip Generation 11th Edition

Land Use: 220
Multifamily Housing (Low-Rise)

Description

Low-rise multifamily housing includes apartments, townhouses, and condominiums located within the same building with at least three other dwelling units and that have two or three floors (levels). Various configurations fit this description, including walkup apartment, mansion apartment, and stacked townhouse.

- A walkup apartment typically is two or three floors in height with dwelling units that are accessed by a single or multiple entrances with stairways and hallways.
- A mansion apartment is a single structure that contains several apartments within what appears to be a single-family dwelling unit.
- A fourplex is a single two-story structure with two matching dwelling units on the ground and second floors. Access to the individual units is typically internal to the structure and provided through a central entry and stairway.
- A stacked townhouse is designed to match the external appearance of a townhouse. But, unlike a townhouse dwelling unit that only shares walls with an adjoining unit, the stacked townhouse units share both floors and walls. Access to the individual units is typically internal to the structure and provided through a central entry and stairway.

Multifamily housing (mid-rise) (Land Use 221), multifamily housing (high-rise) (Land Use 222), affordable housing (Land Use 223), and off-campus student apartment (low-rise) (Land Use 225) are related land uses.

Land Use Subcategory

Data are presented for two subcategories for this land use: (1) not close to rail transit and (2) close to rail transit. A site is considered close to rail transit if the walking distance between the residential site entrance and the closest rail transit station entrance is ½ mile or less.

Additional Data

For the three sites for which both the number of residents and the number of occupied dwelling units were available, there were an average of 2.72 residents per occupied dwelling unit.

For the two sites for which the numbers of both total dwelling units and occupied dwelling units were available, an average of 96.2 percent of the total dwelling units were occupied.

The technical appendices provide supporting information on time-of-day distributions for this land use. The appendices can be accessed through either the ITETripGen web app or the trip

generation resource page on the ITE website (https://www.ite.org/technical-resources/topics/trip-and-parking-generation/).

For the three sites for which data were provided for both occupied dwelling units and residents, there was an average of 2.72 residents per occupied dwelling unit.

It is expected that the number of bedrooms and number of residents are likely correlated to the trips generated by a residential site. To assist in future analysis, trip generation studies of all multifamily housing should attempt to obtain information on occupancy rate and on the mix of residential unit sizes (i.e., number of units by number of bedrooms at the site complex).

The sites were surveyed in the 1980s, the 1990s, the 2000s, the 2010s, and the 2020s in British Columbia (CAN), California, Delaware, Florida, Georgia, Illinois, Indiana, Maine, Maryland, Massachusetts, Minnesota, New Jersey, Ontario (CAN), Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, and Washington.

Source Numbers

188, 204, 237, 300, 305, 306, 320, 321, 357, 390, 412, 525, 530, 579, 583, 638, 864, 866, 896, 901, 903, 904, 936, 939, 944, 946, 947, 948, 963, 964, 966, 967, 1012, 1013, 1014, 1036, 1047, 1056, 1071, 1076

Multifamily Housing (Low-Rise)
Not Close to Rail Transit (220)

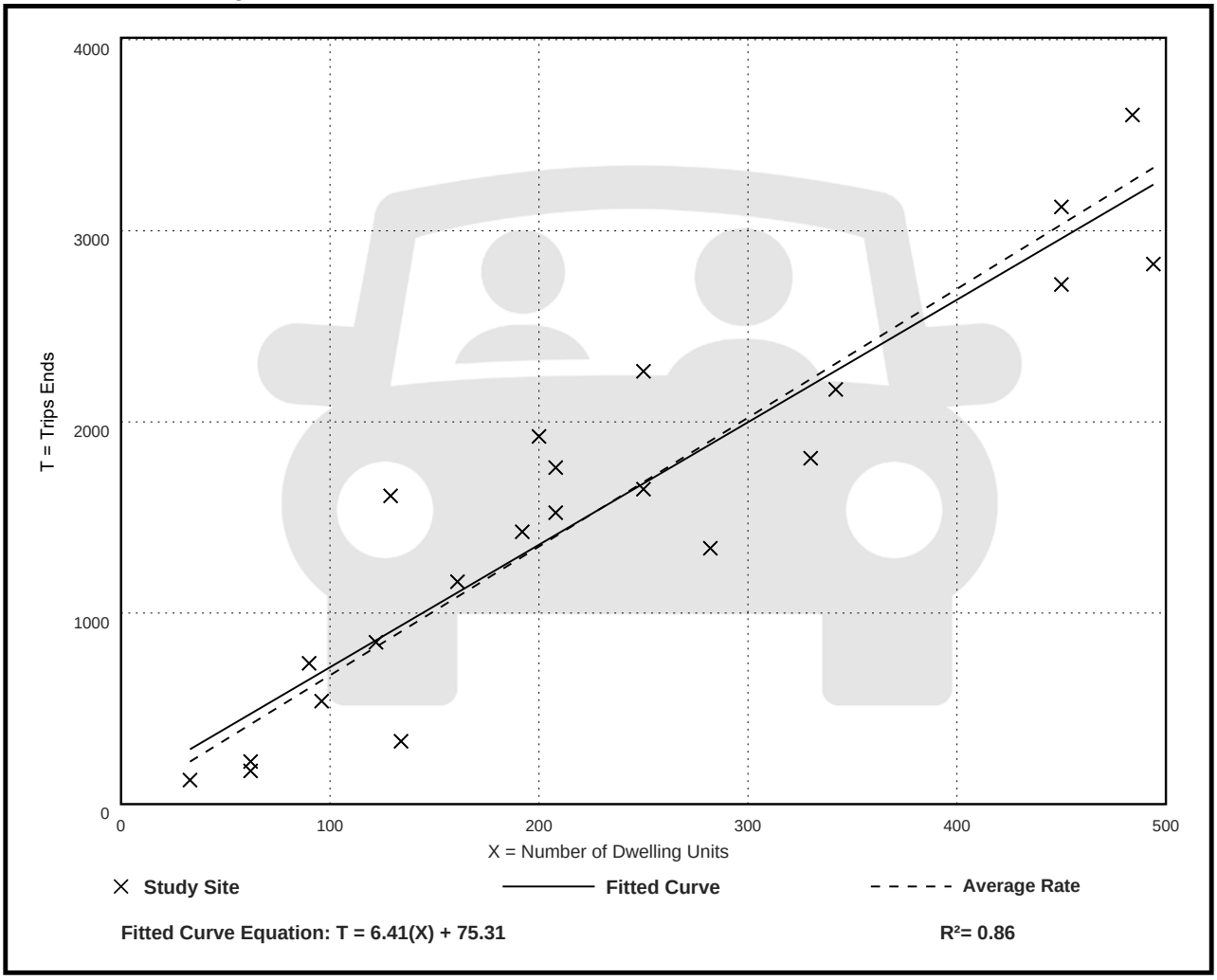
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Setting/Location: General Urban/Suburban
Number of Studies: 22
Avg. Num. of Dwelling Units: 229
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
6.74	2.46 - 12.50	1.79

Data Plot and Equation



Fitted Curve Equation: T = 6.41(X) + 75.31

R^2= 0.86

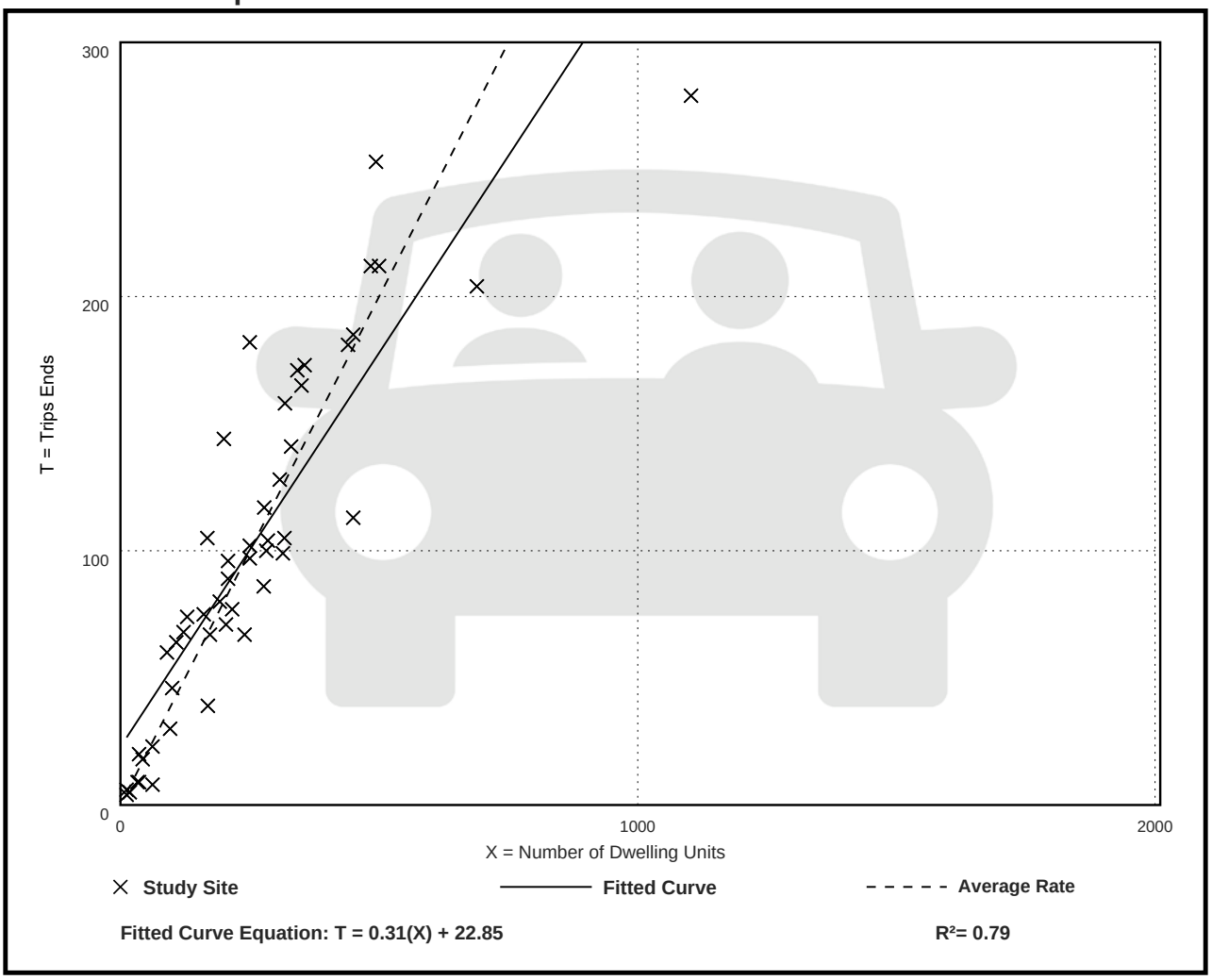
Multifamily Housing (Low-Rise)
Not Close to Rail Transit (220)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.
Setting/Location: General Urban/Suburban
Number of Studies: 49
Avg. Num. of Dwelling Units: 249
Directional Distribution: 24% entering, 76% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.40	0.13 - 0.73	0.12

Data Plot and Equation



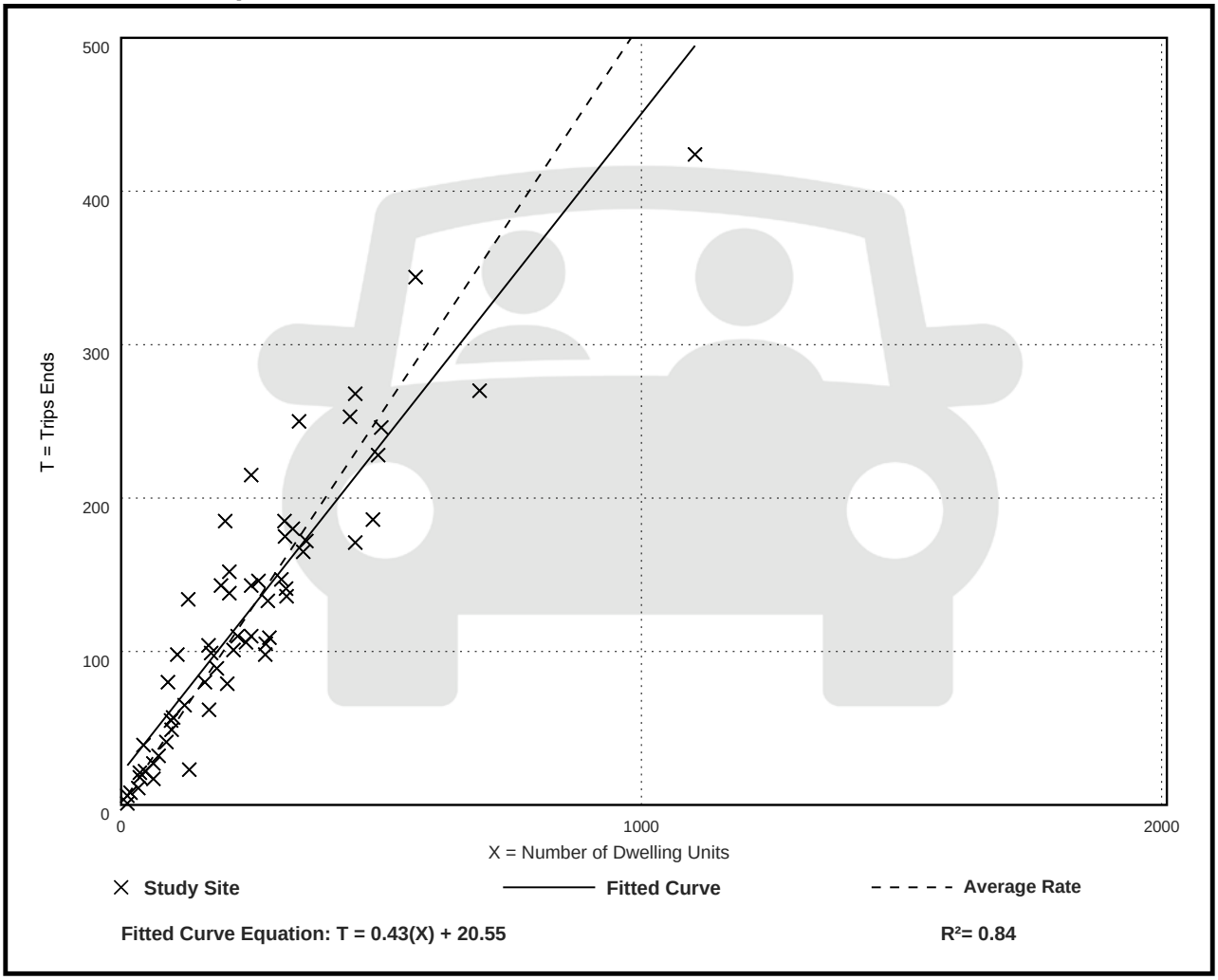
Multifamily Housing (Low-Rise)
Not Close to Rail Transit (220)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.
Setting/Location: General Urban/Suburban
Number of Studies: 59
Avg. Num. of Dwelling Units: 241
Directional Distribution: 63% entering, 37% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.51	0.08 - 1.04	0.15

Data Plot and Equation



Multifamily Housing (Low-Rise)
Not Close to Rail Transit (220)

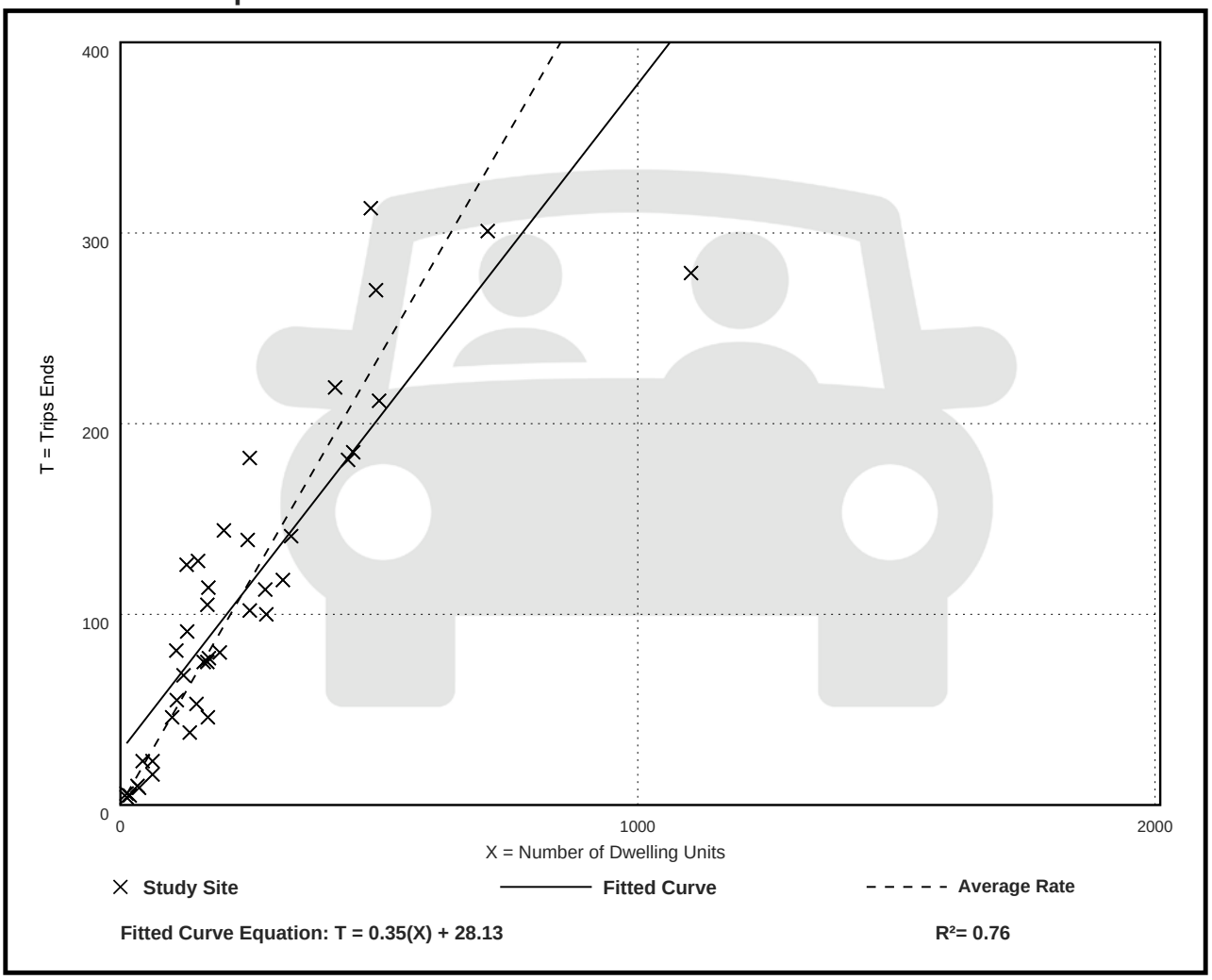
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
AM Peak Hour of Generator

Setting/Location: General Urban/Suburban
Number of Studies: 40
Avg. Num. of Dwelling Units: 234
Directional Distribution: 24% entering, 76% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.47	0.25 - 0.98	0.16

Data Plot and Equation



Fitted Curve Equation: T = 0.35(X) + 28.13

R^2= 0.76

Multifamily Housing (Low-Rise)
Not Close to Rail Transit (220)

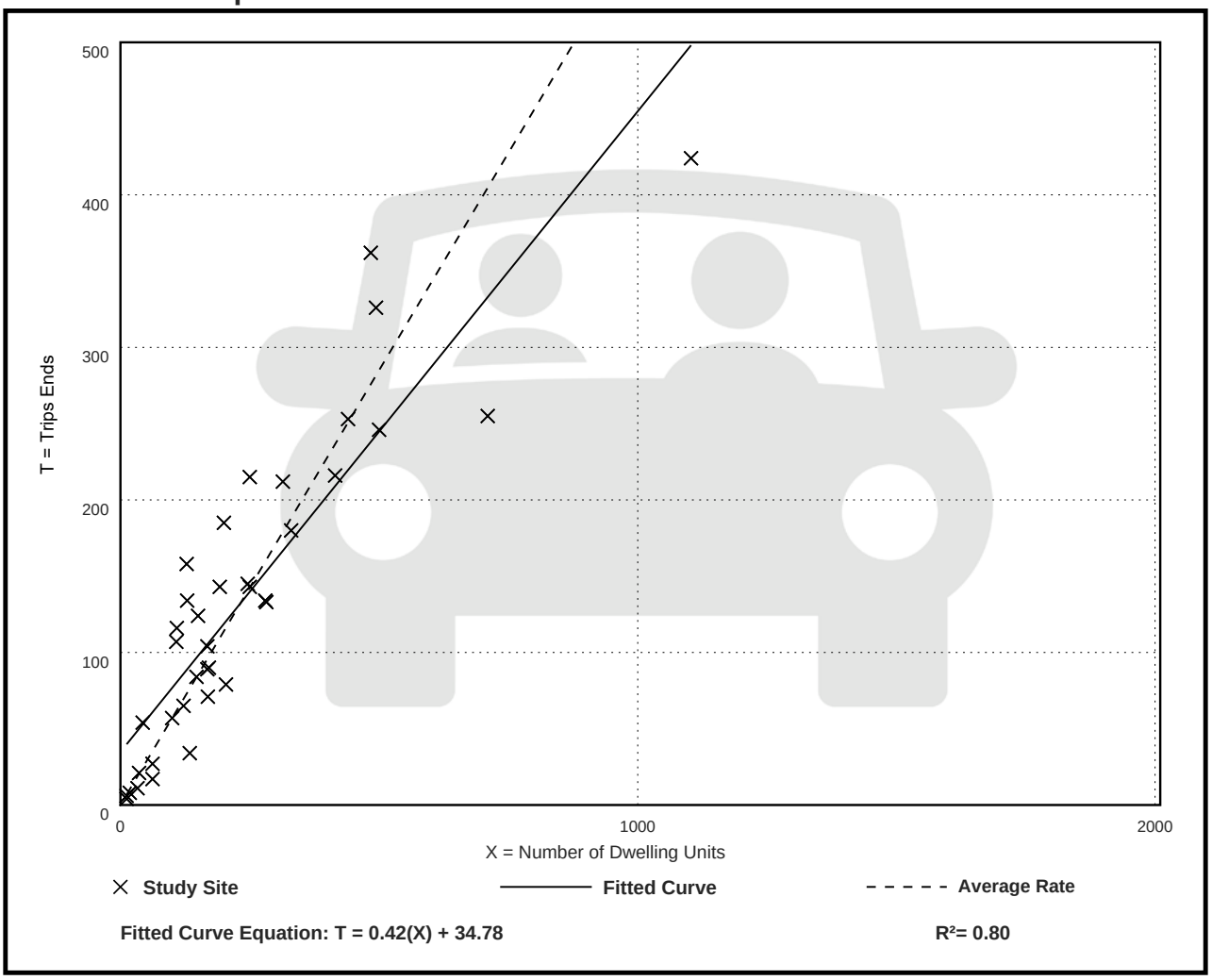
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
PM Peak Hour of Generator

Setting/Location: General Urban/Suburban
Number of Studies: 38
Avg. Num. of Dwelling Units: 231
Directional Distribution: 62% entering, 38% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.57	0.25 - 1.26	0.20

Data Plot and Equation



Fitted Curve Equation: T = 0.42(X) + 34.78

R^2= 0.80

Multifamily Housing (Low-Rise)
Not Close to Rail Transit (220)

Vehicle Trip Ends vs: Dwelling Units
On a: Saturday

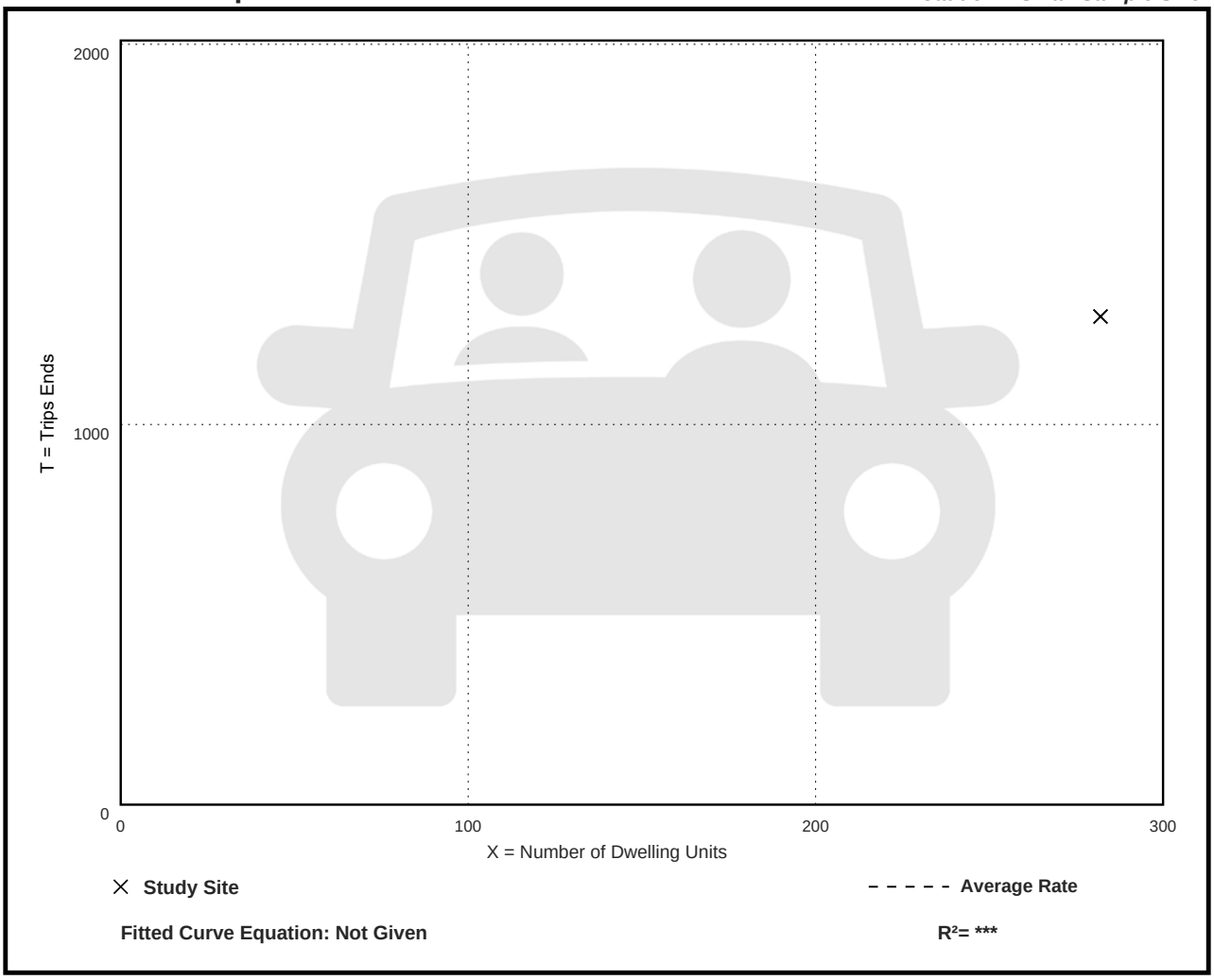
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Dwelling Units: 282
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
4.55	4.55 - 4.55	***

Data Plot and Equation

Caution – Small Sample Size



Multifamily Housing (Low-Rise)
Not Close to Rail Transit (220)

Vehicle Trip Ends vs: Dwelling Units
On a: Saturday, Peak Hour of Generator

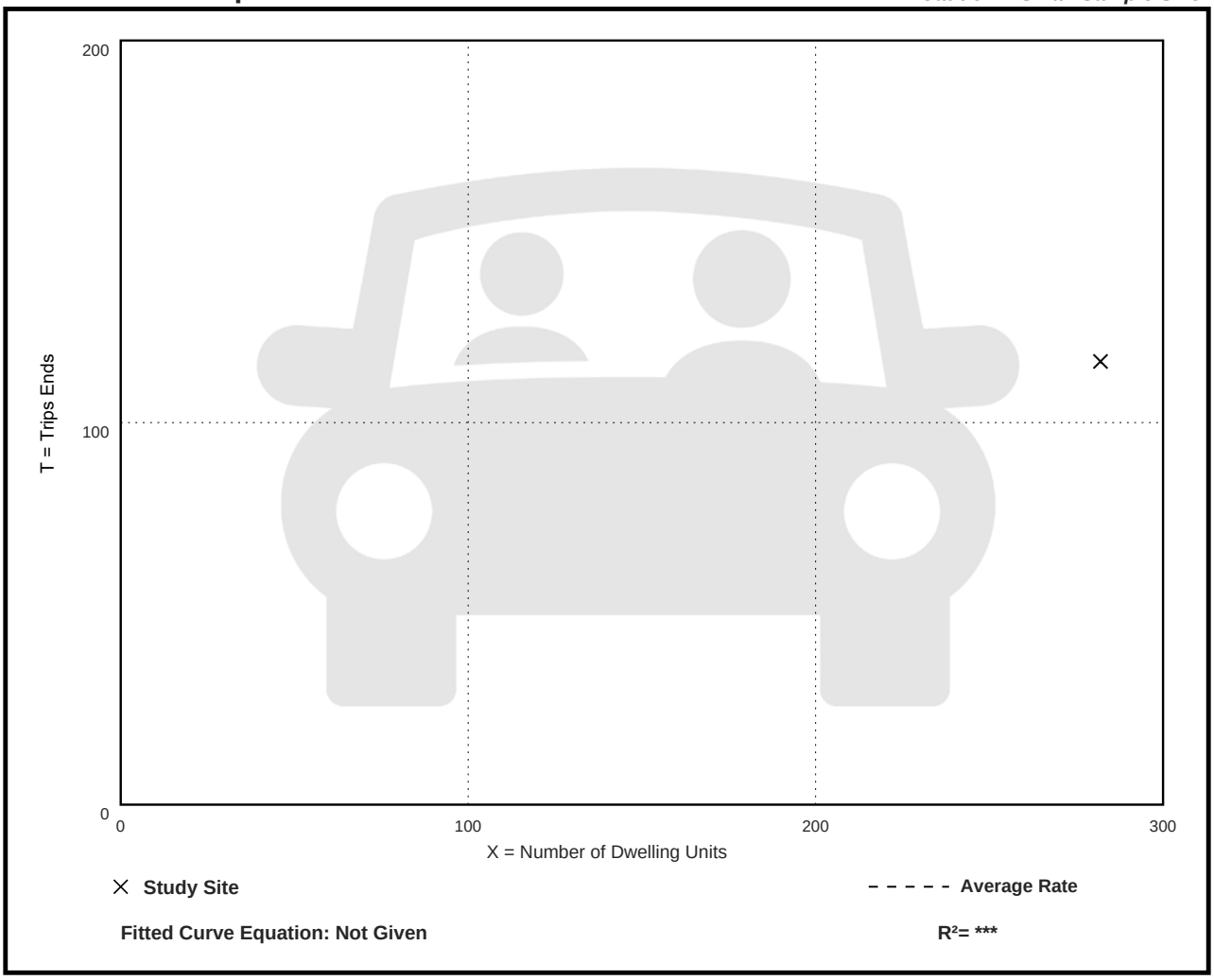
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Dwelling Units: 282
Directional Distribution: Not Available

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.41	0.41 - 0.41	***

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= *

Multifamily Housing (Low-Rise)
Not Close to Rail Transit (220)

Vehicle Trip Ends vs: Dwelling Units
On a: Sunday

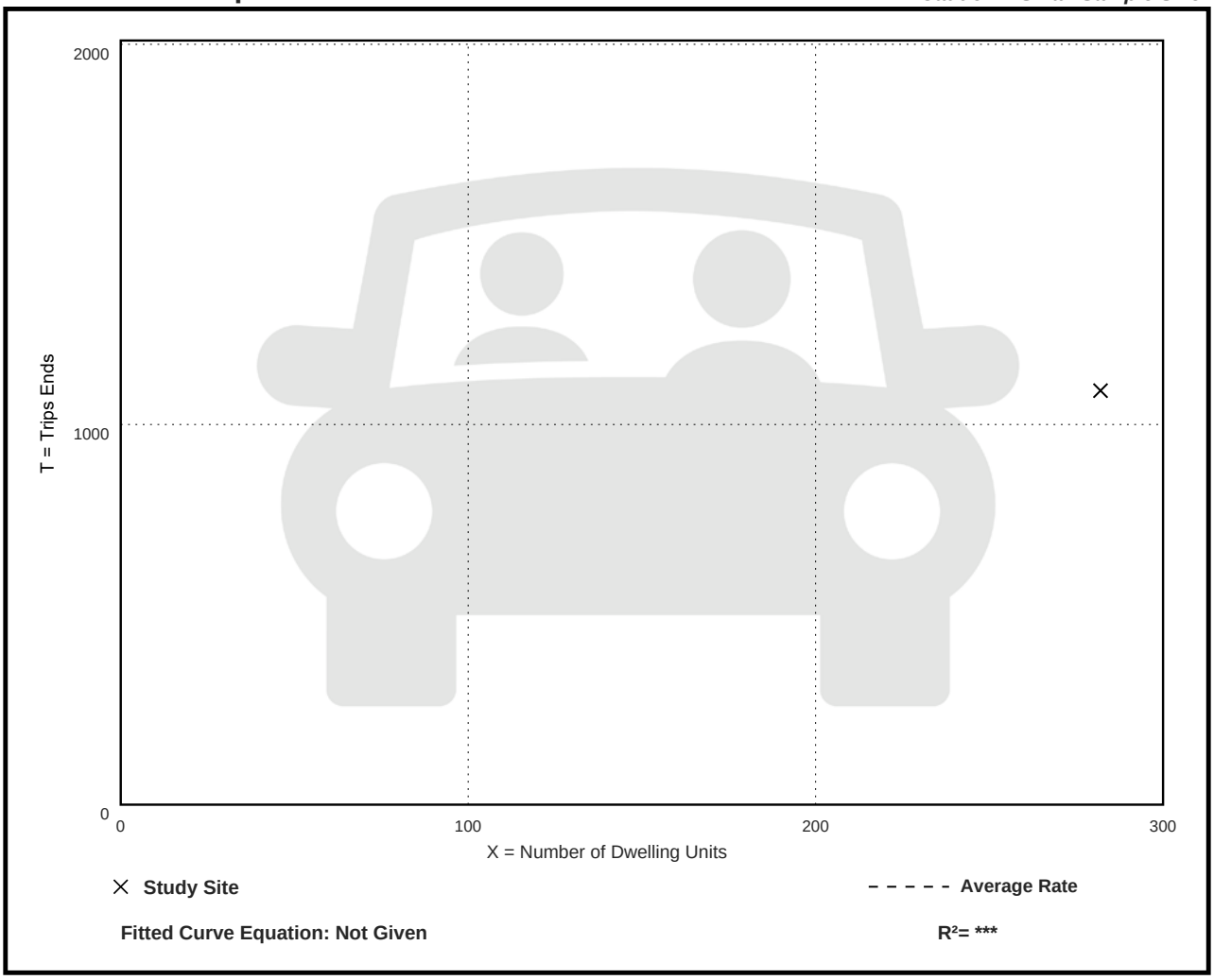
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Dwelling Units: 282
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
3.86	3.86 - 3.86	***

Data Plot and Equation

Caution – Small Sample Size



Multifamily Housing (Low-Rise)
Not Close to Rail Transit (220)

Vehicle Trip Ends vs: Dwelling Units
On a: Sunday, Peak Hour of Generator

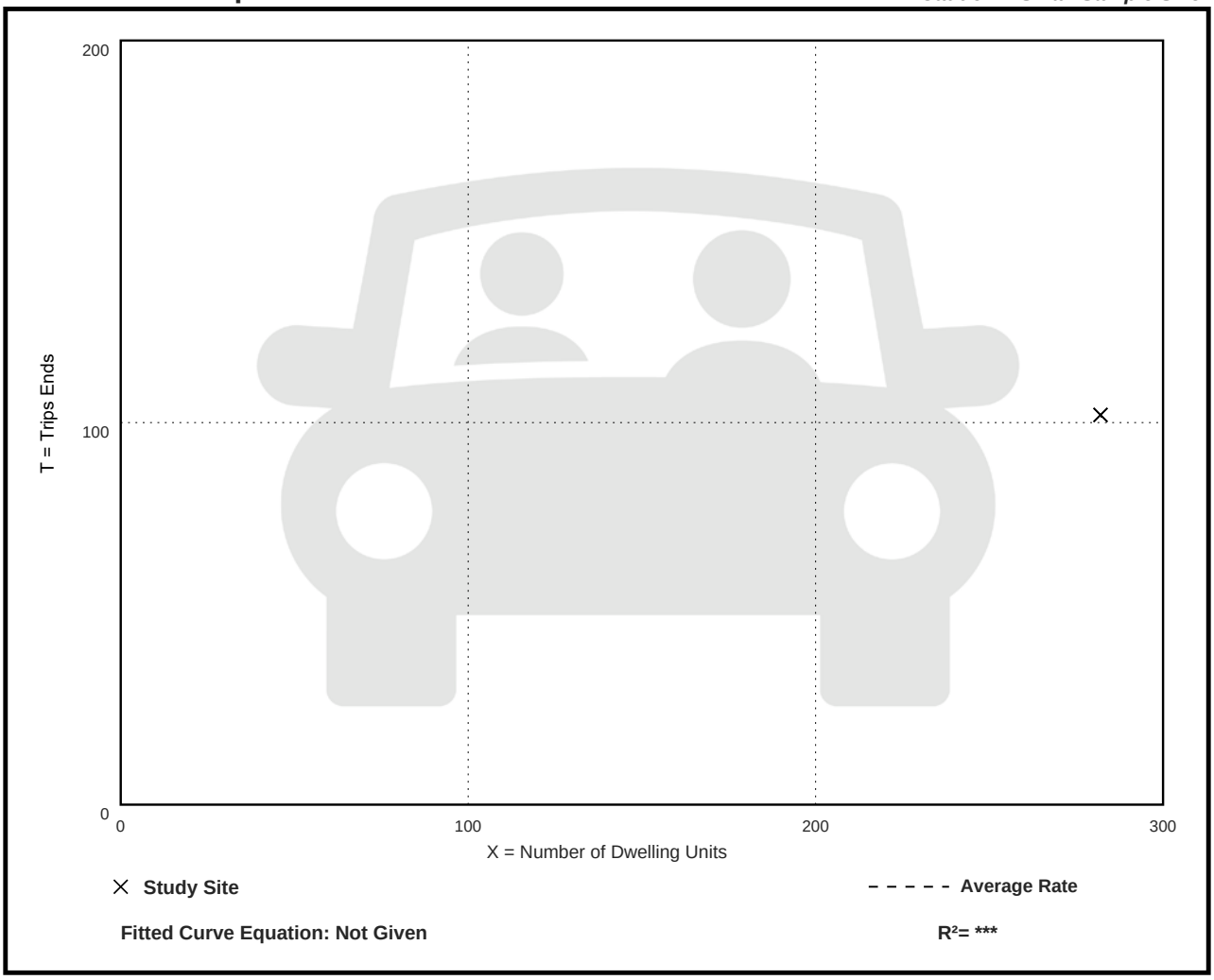
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Dwelling Units: 282
Directional Distribution: Not Available

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.36	0.36 - 0.36	***

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= *

Multifamily Housing (Low-Rise)
Not Close to Rail Transit (220)

Vehicle Trip Ends vs: Residents
On a: Weekday

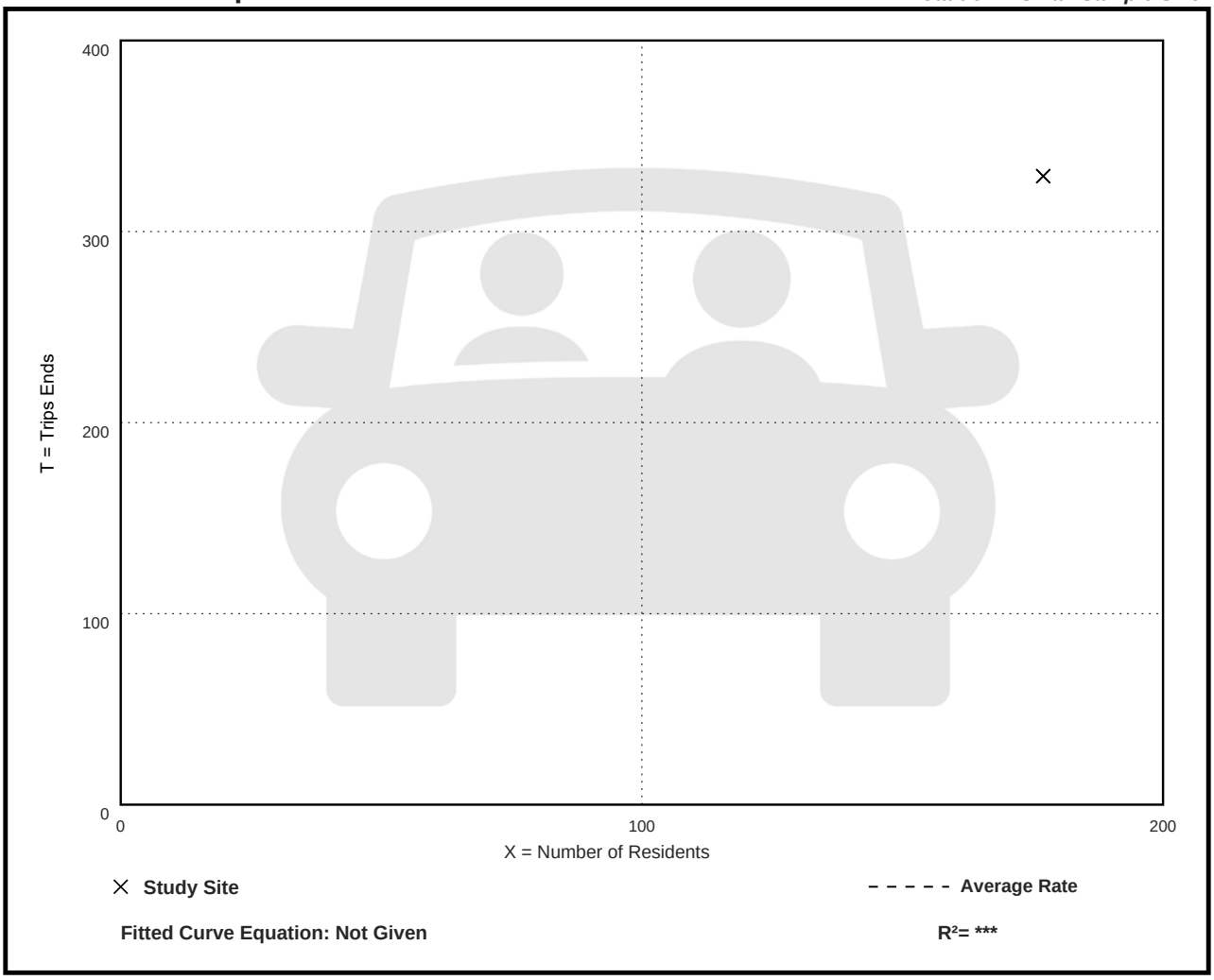
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Residents: 177
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Resident

Average Rate	Range of Rates	Standard Deviation
1.86	1.86 - 1.86	***

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= ***

Multifamily Housing (Low-Rise)
Not Close to Rail Transit (220)

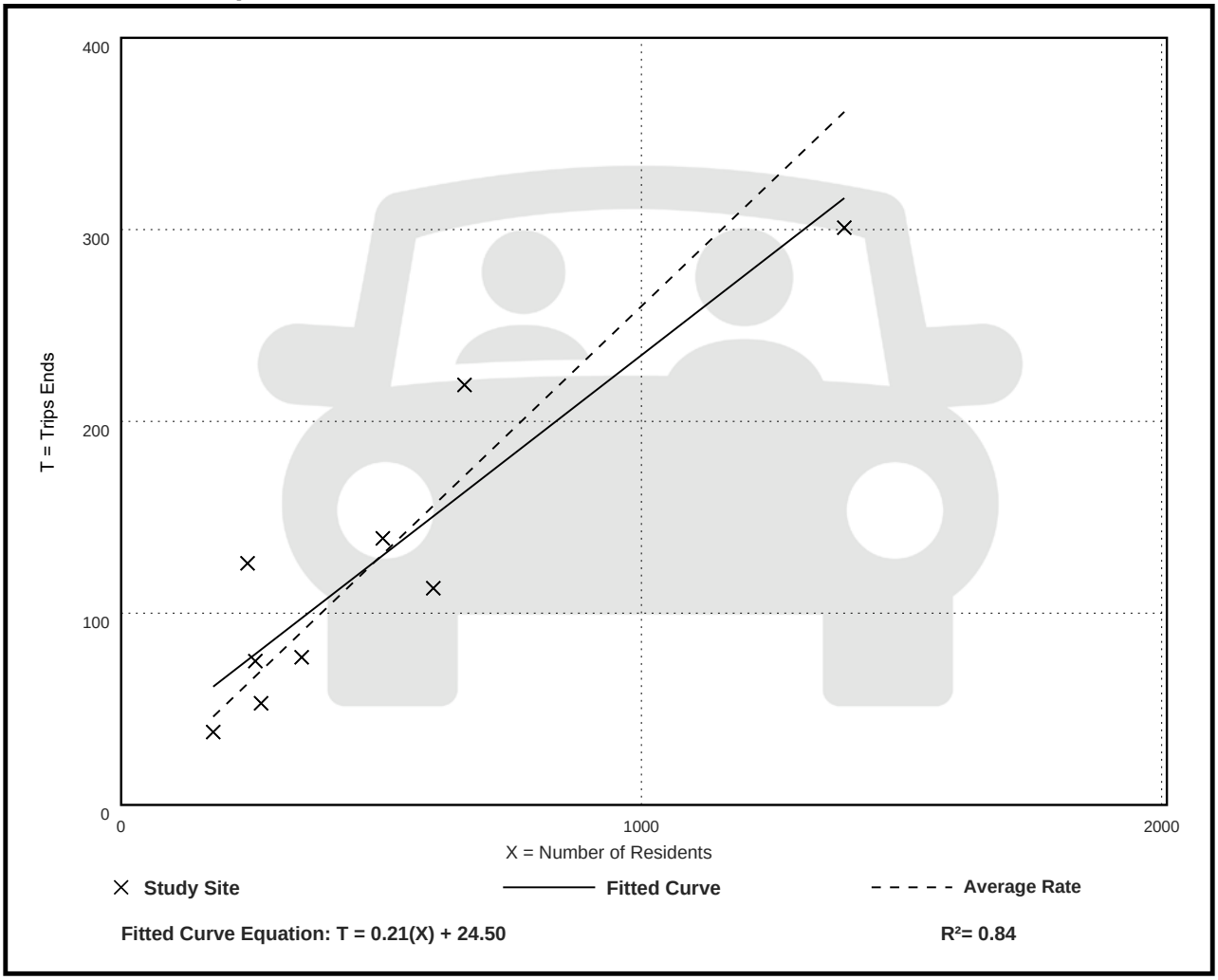
Vehicle Trip Ends vs: Residents
On a: Weekday,
AM Peak Hour of Generator

Setting/Location: General Urban/Suburban
Number of Studies: 9
Avg. Num. of Residents: 494
Directional Distribution: 17% entering, 83% exiting

Vehicle Trip Generation per Resident

Average Rate	Range of Rates	Standard Deviation
0.26	0.19 - 0.52	0.08

Data Plot and Equation



Fitted Curve Equation: T = 0.21(X) + 24.50

R^2= 0.84

Multifamily Housing (Low-Rise)
Not Close to Rail Transit (220)

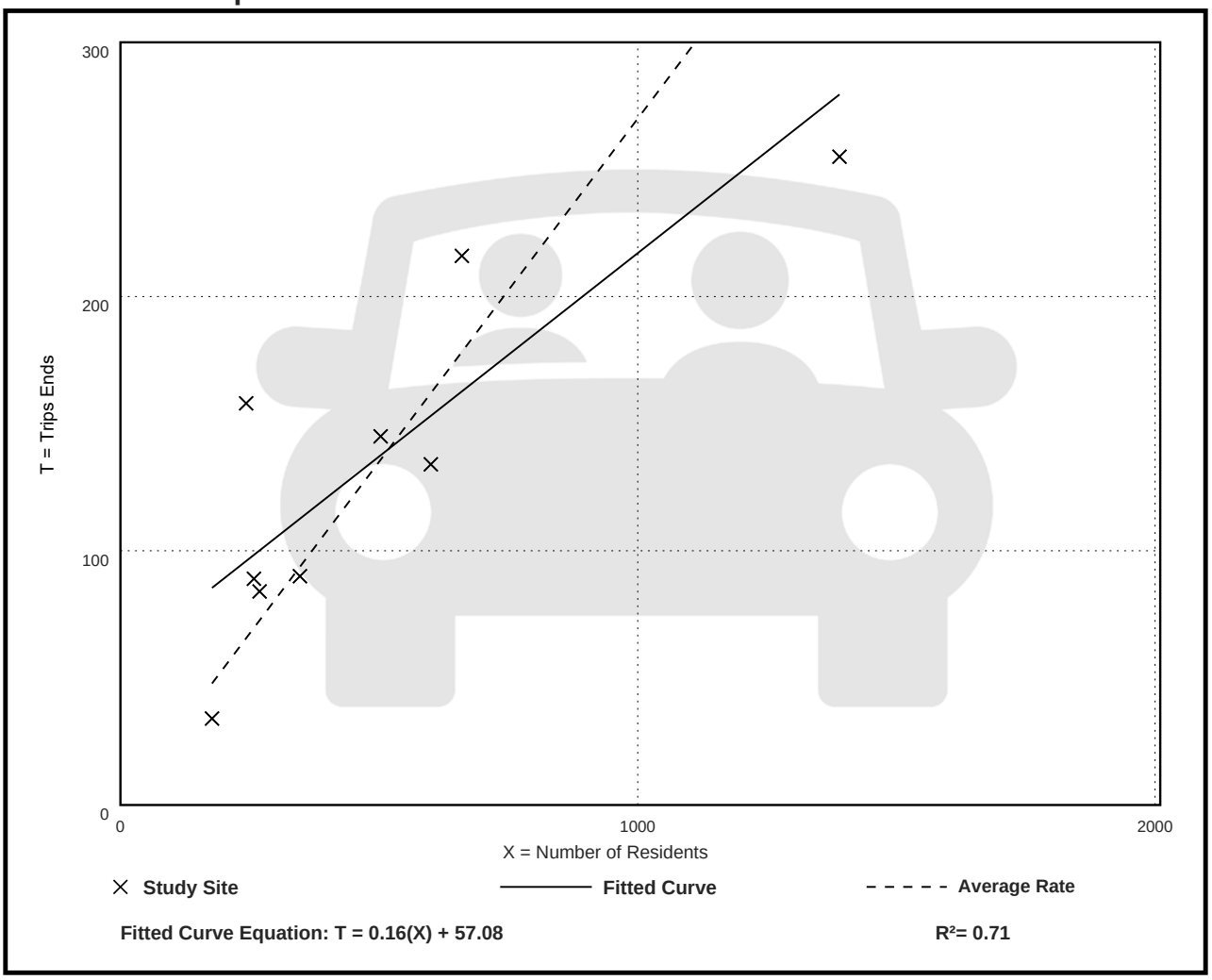
Vehicle Trip Ends vs: Residents
On a: Weekday,
PM Peak Hour of Generator

Setting/Location: General Urban/Suburban
Number of Studies: 9
Avg. Num. of Residents: 494
Directional Distribution: 66% entering, 34% exiting

Vehicle Trip Generation per Resident

Average Rate	Range of Rates	Standard Deviation
0.27	0.18 - 0.65	0.11

Data Plot and Equation



Fitted Curve Equation: T = 0.16(X) + 57.08

R^2= 0.71

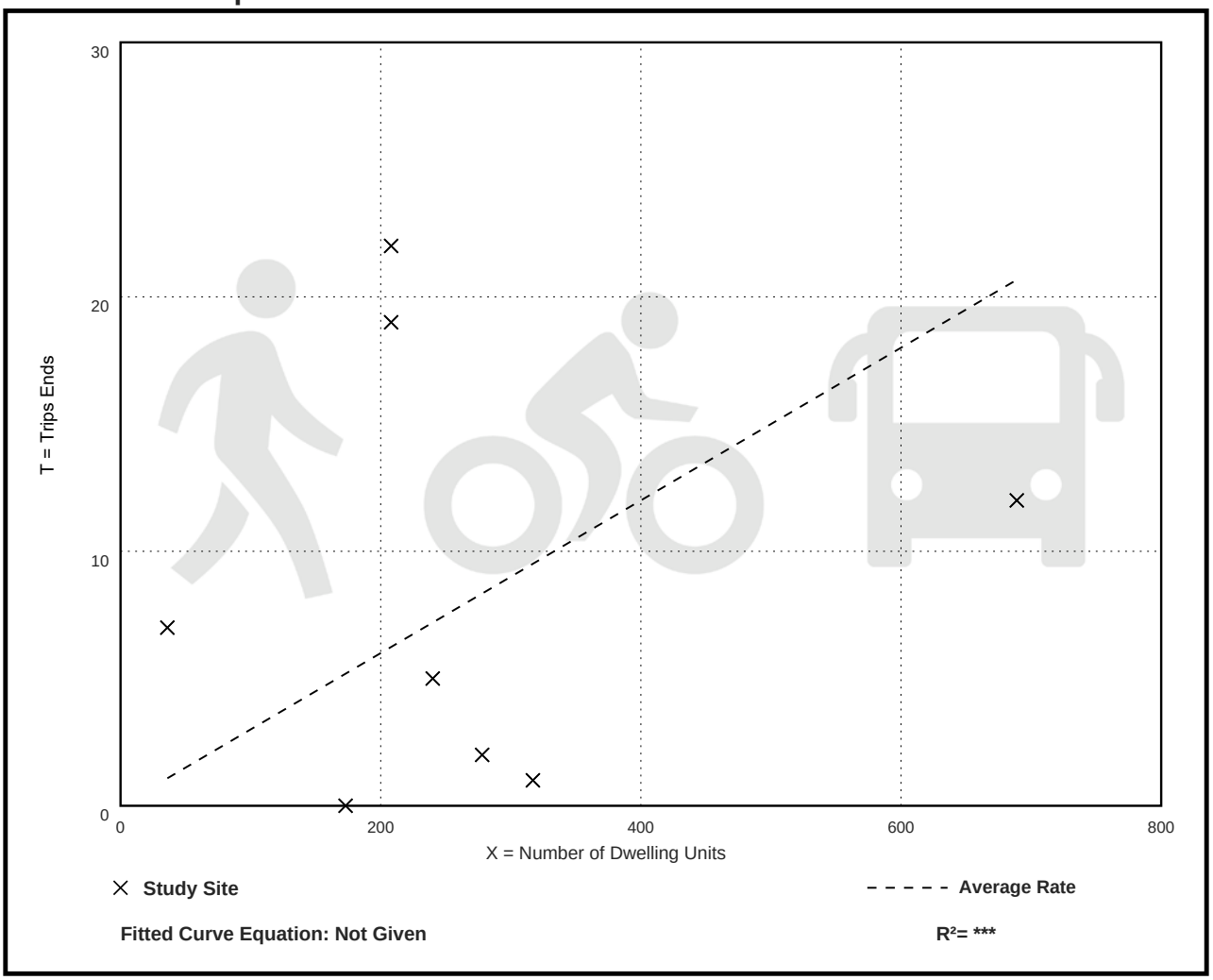
Multifamily Housing (Low-Rise)
Not Close to Rail Transit (220)

Walk+Bike+Transit Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.
Setting/Location: General Urban/Suburban
Number of Studies: 8
Avg. Num. of Dwelling Units: 269
Directional Distribution: 43% entering, 57% exiting

Walk+Bike+Transit Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.03	0.00 - 0.19	0.04

Data Plot and Equation



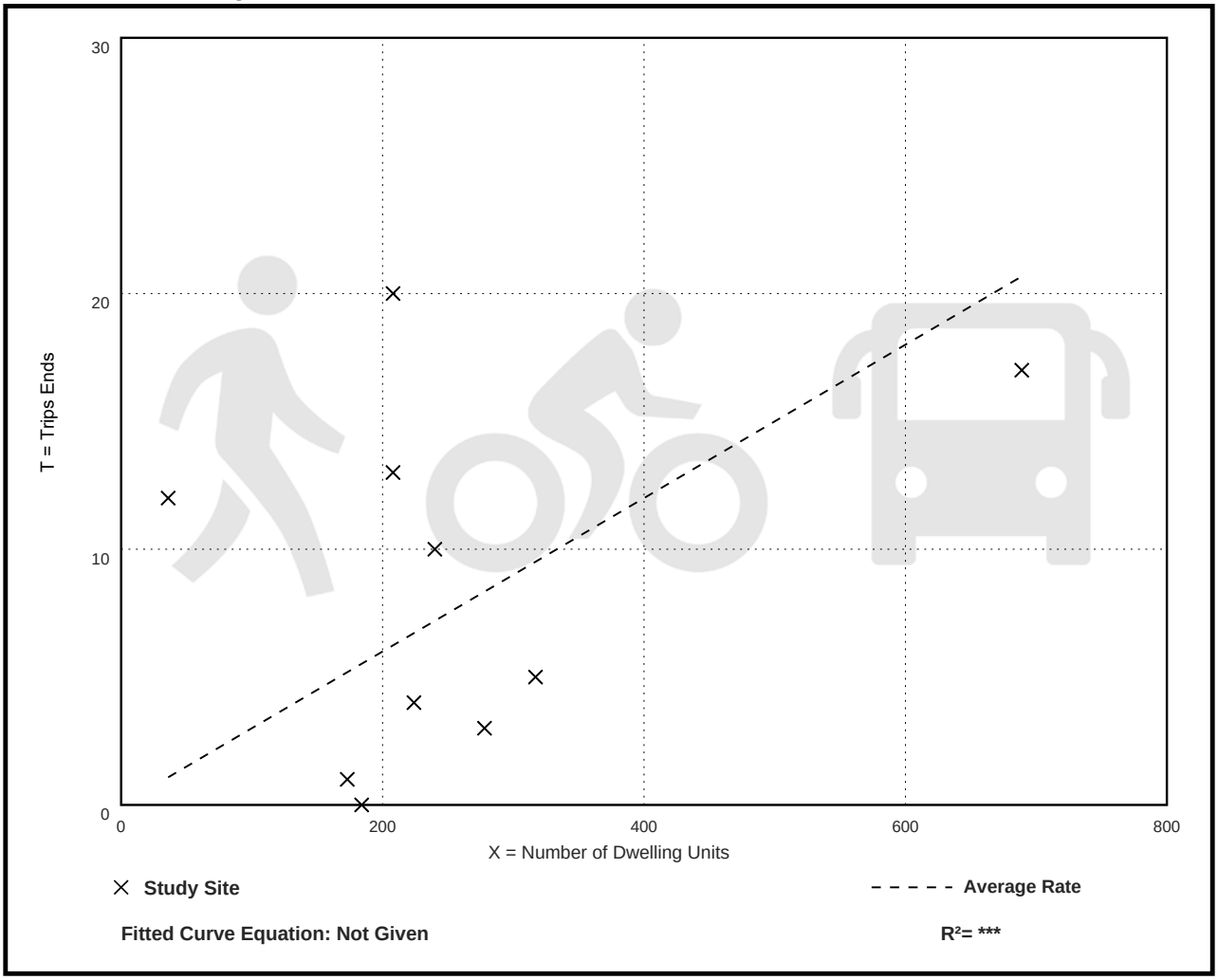
Multifamily Housing (Low-Rise)
Not Close to Rail Transit (220)

Walk+Bike+Transit Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.
Setting/Location: General Urban/Suburban
Number of Studies: 10
Avg. Num. of Dwelling Units: 256
Directional Distribution: 50% entering, 50% exiting

Walk+Bike+Transit Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.03	0.00 - 0.33	0.05

Data Plot and Equation



Multifamily Housing (Low-Rise)
Close to Rail Transit (220)

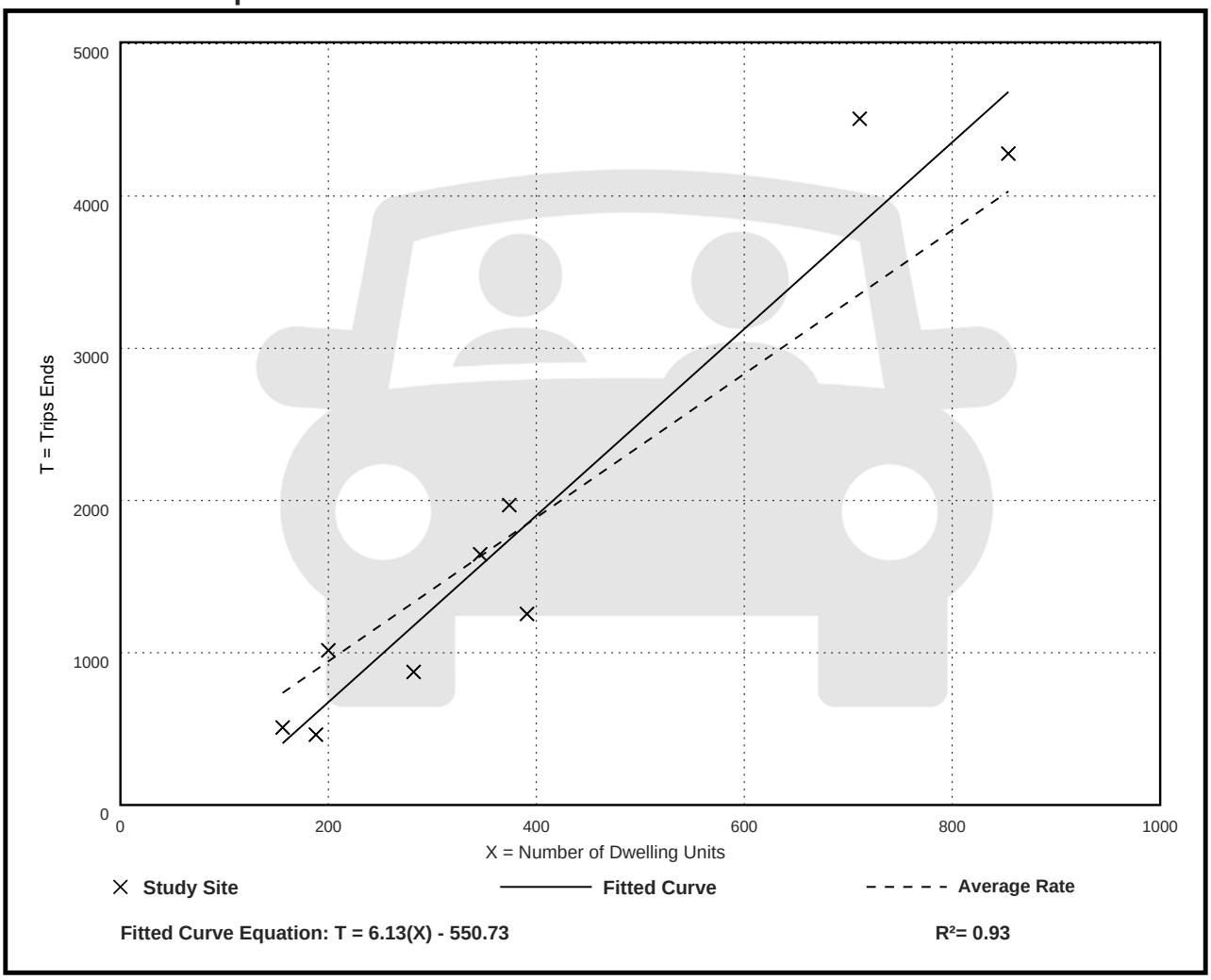
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Setting/Location: General Urban/Suburban
Number of Studies: 9
Avg. Num. of Dwelling Units: 389
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
4.72	2.46 - 6.34	1.27

Data Plot and Equation



Fitted Curve Equation: T = 6.13(X) - 550.73

R^2= 0.93

Multifamily Housing (Low-Rise)
Close to Rail Transit (220)

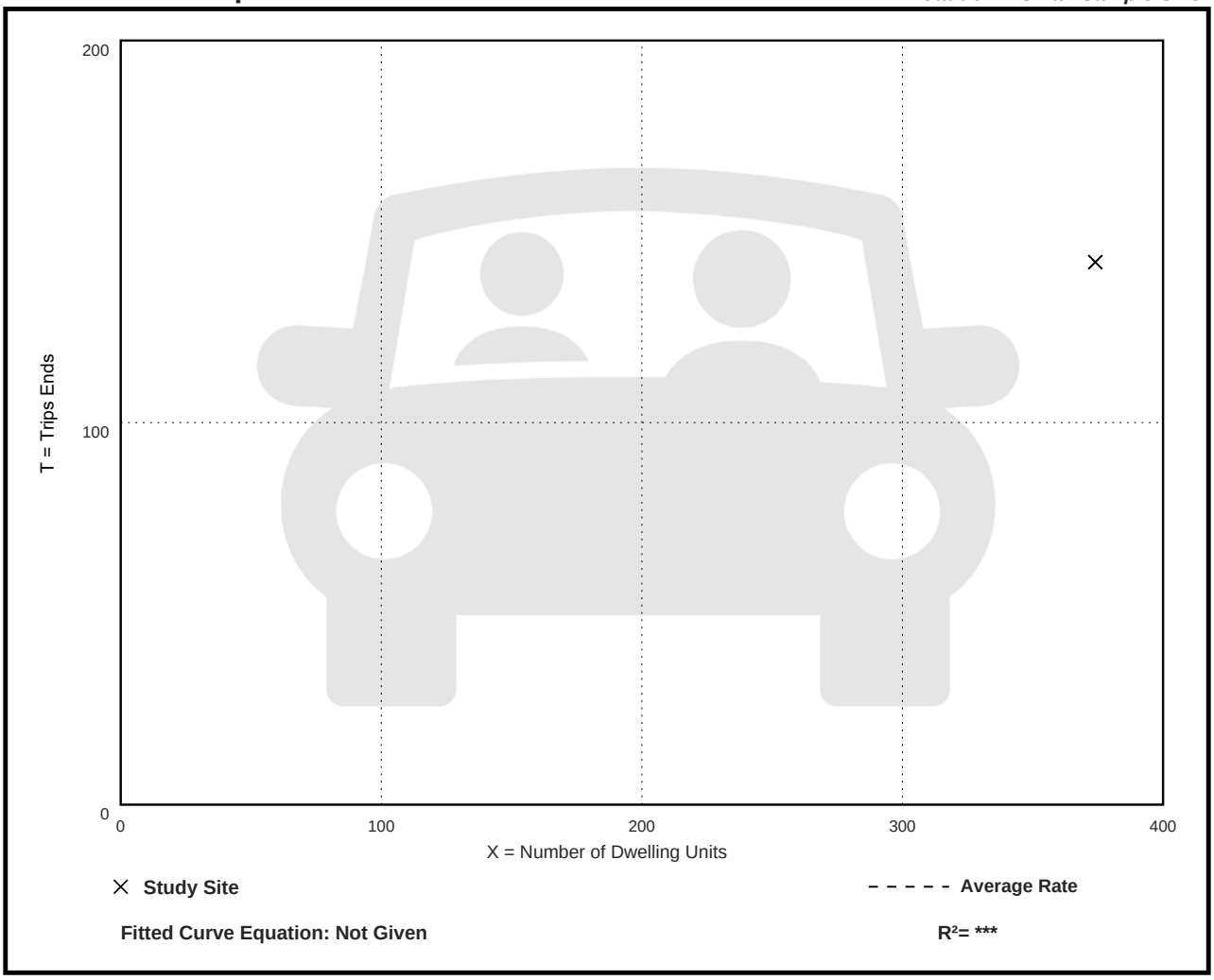
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Dwelling Units: 374
Directional Distribution: 29% entering, 71% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.38	0.38 - 0.38	***

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= *

Multifamily Housing (Low-Rise)
Close to Rail Transit (220)

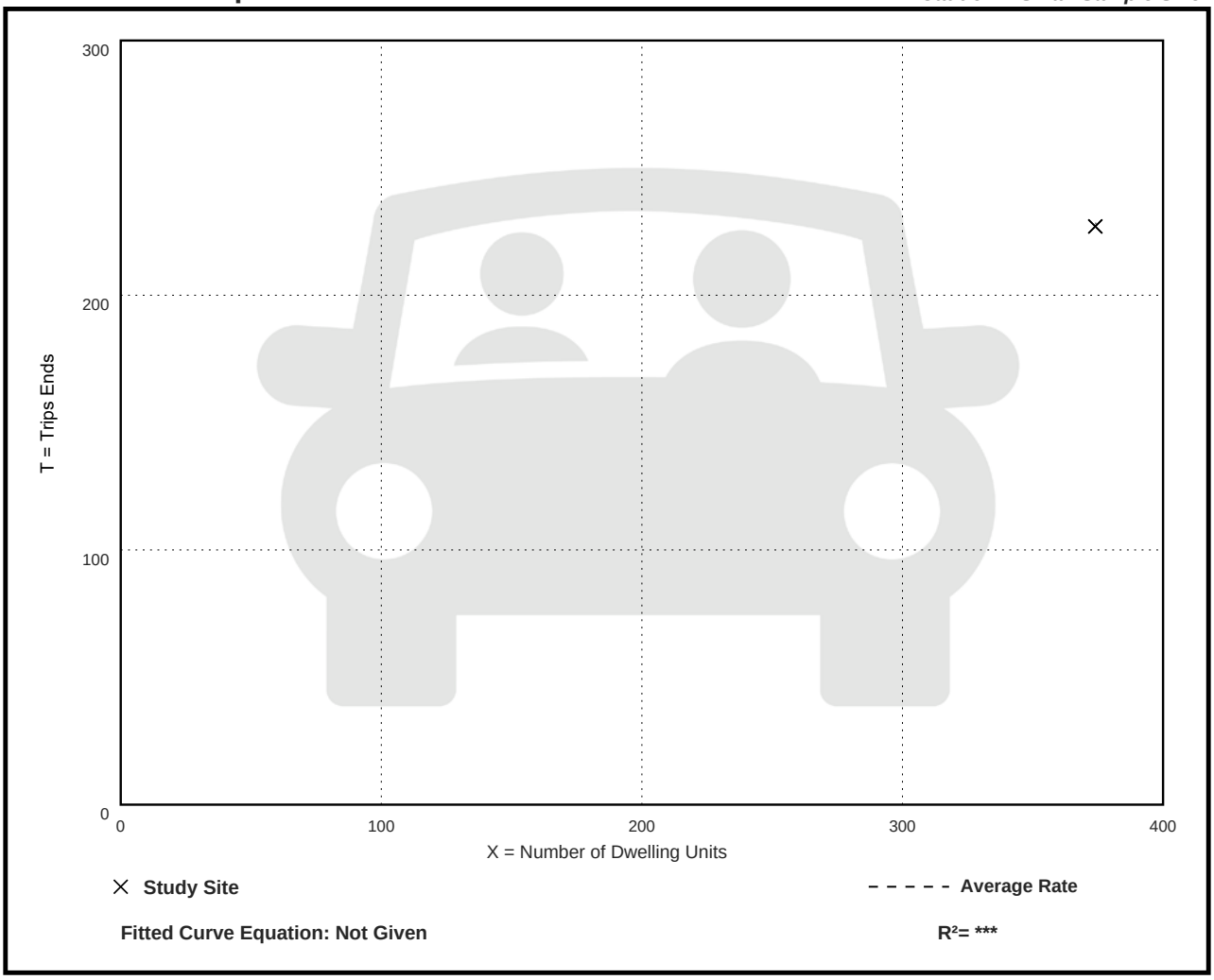
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Dwelling Units: 374
Directional Distribution: 60% entering, 40% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.61	0.61 - 0.61	***

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= *

Multifamily Housing (Low-Rise)
Close to Rail Transit (220)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
AM Peak Hour of Generator

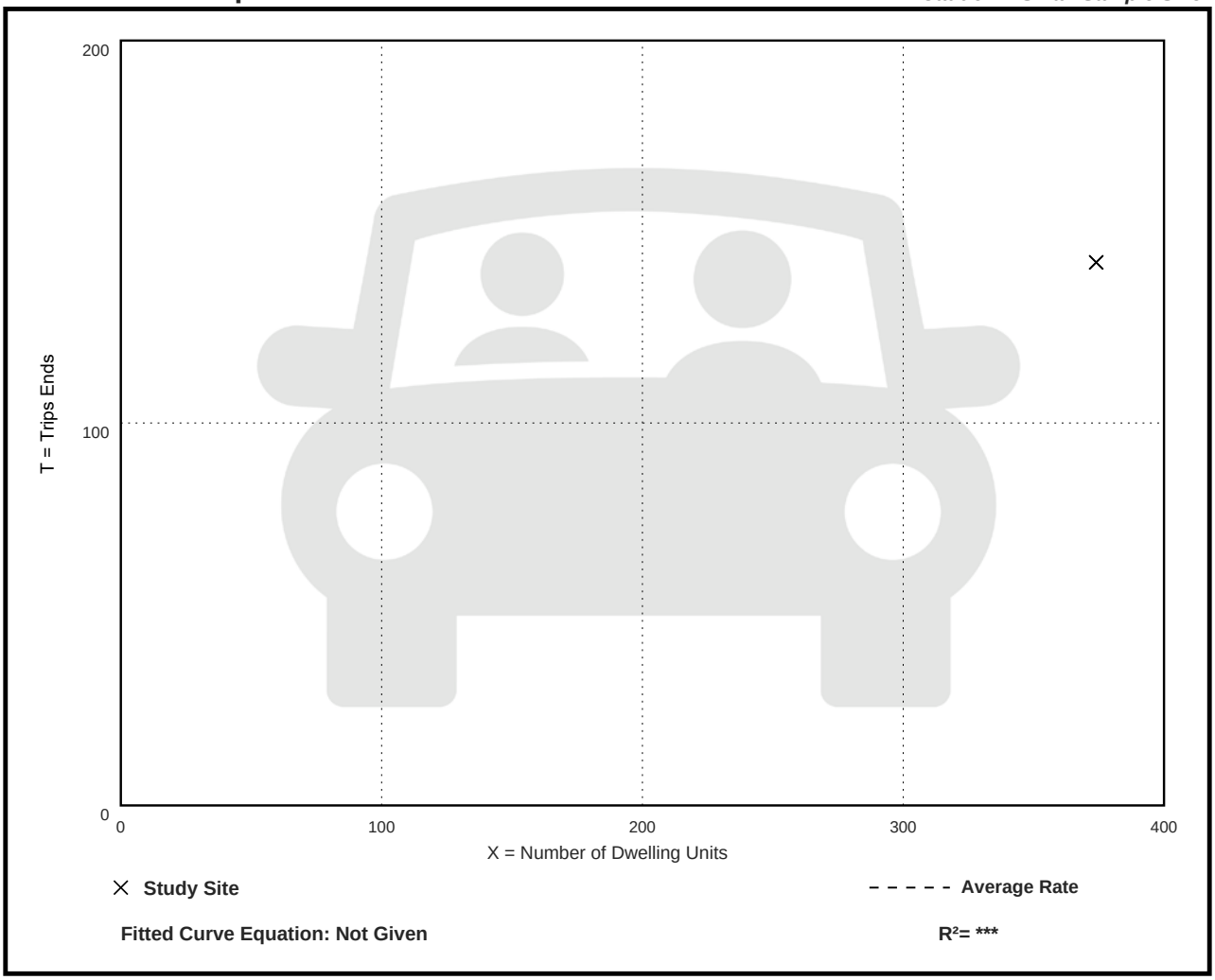
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Dwelling Units: 374
Directional Distribution: 29% entering, 71% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.38	0.38 - 0.38	***

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= *

Multifamily Housing (Low-Rise)
Close to Rail Transit (220)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
PM Peak Hour of Generator

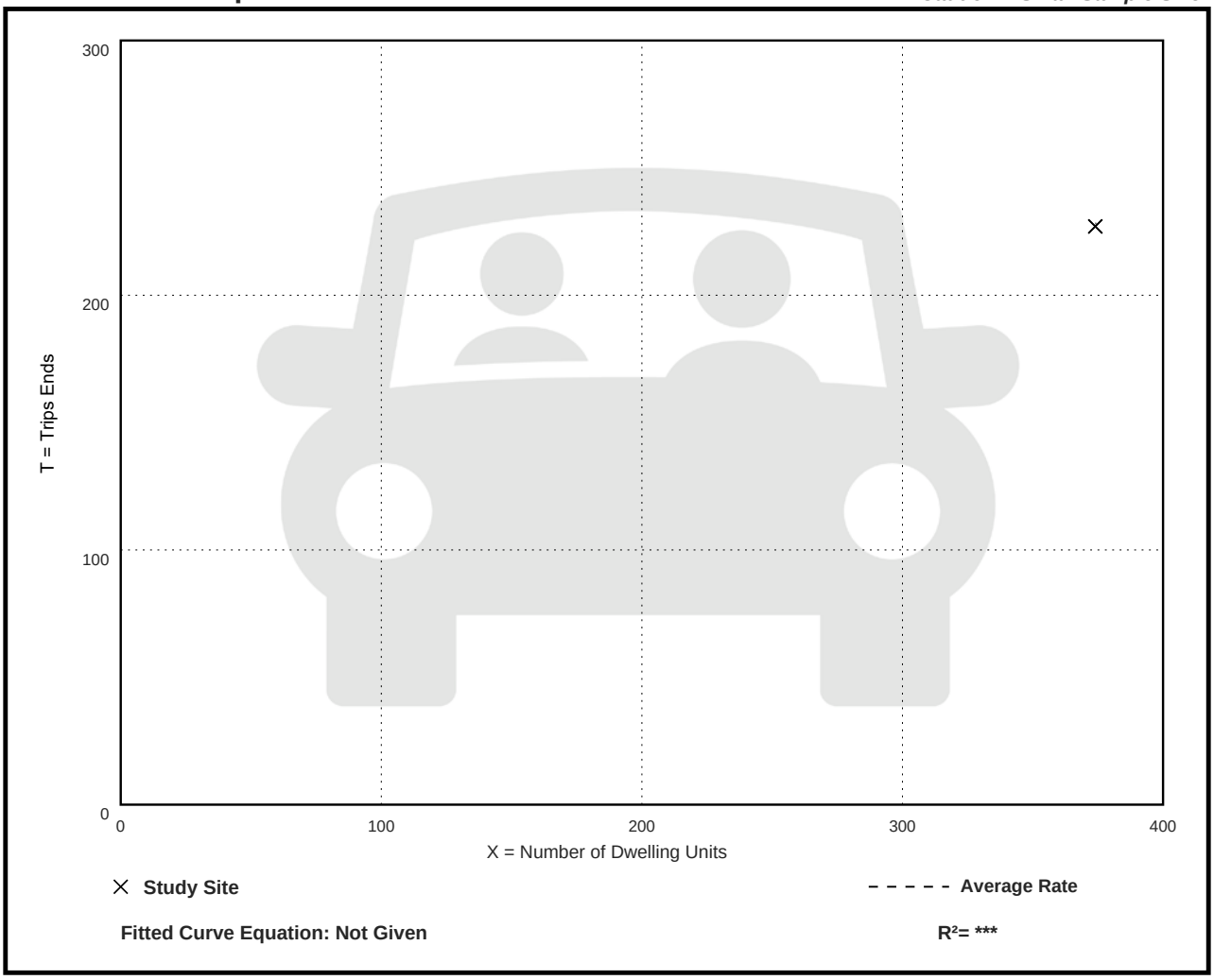
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Dwelling Units: 374
Directional Distribution: 60% entering, 40% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.61	0.61 - 0.61	***

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= *

APPENDIX H

Transportation Tomorrow Survey Results

Mon Jan 15 2024 10:54:27 GMT-0500 (Eastern Standard Time) - Run Time: 2683ms

Cross Tabulation Query Form - Trip - 2016 v1.1

Row: 2006 GTA zone of origin - gta06_orig

Column: 2006 GTA zone of destination - gta06_dest

Filters:

(2006 GTA zone of destination - gta06_dest In 6259

and

Start time of trip - start_time In 0630-0930

and

Trip purpose of destination - purp_dest In H,)

Trip 2016

Table:

,6259

6262,9

Mon Jan 15 2024 10:57:12 GMT-0500 (Eastern Standard Time) - Run Time: 2474ms

Cross Tabulation Query Form - Trip - 2016 v1.1

Row: 2006 GTA zone of destination - gta06_dest

Column: 2006 GTA zone of origin - gta06_orig

Filters:

(2006 GTA zone of origin - gta06_orig In 6259

and

Start time of trip - start_time In 0630-0930

and

Trip purpose of origin - purp_orig In H,)

Trip 2016

Table:

,6259

4002,18

5028,10

6026,38

6039,10

6069,11

6094,7

6096,18

6126,18

6127,23

6136,10

6146,18

6157,37

6169,10

6182,10

6188,9

6199,28

6257,28

6258,29

6259,41

6260,18

6262,33

6263,10

6271,80

6274,28

6275,10

6278,19

6282,39

6296,58

6331,19

6342,14

9998,10

Mon Jan 15 2024 11:02:01 GMT-0500 (Eastern Standard Time) - Run Time: 3185ms

Cross Tabulation Query Form - Trip - 2016 v1.1

Row: 2006 GTA zone of origin - gta06_orig

Column: 2006 GTA zone of destination - gta06_dest

Filters:

(2006 GTA zone of destination - gta06_dest In 6259

and

Start time of trip - start_time In 1530-1830

and

Trip purpose of destination - purp_dest In H,)

Trip 2016

Table:

,6259

4002,18

5028,10

6039,40

6069,11

6094,7

6096,18

6126,18

6136,10

6146,18

6157,38

6169,10

6182,10

6186,10

6257,28

6258,20

6260,18

6261,38

6262,34

6269,7

6271,40

6274,28

6275,10

6277,24

6278,19

6289,15

6296,18

6342,14

Mon Jan 15 2024 11:40:59 GMT-0500 (Eastern Standard Time) - Run Time: 2465ms

Cross Tabulation Query Form - Trip - 2016 v1.1

Row: 2006 GTA zone of destination - gta06_dest

Column: 2006 GTA zone of origin - gta06_orig

Filters:

(2006 GTA zone of origin - gta06_orig In 6259

and

Start time of trip - start_time In 1530-1830

and

Trip purpose of origin - purp_orig In H,)

Trip 2016

Table:

,6259

26,10

6039,40

6259,19

6,261,103

6266,9

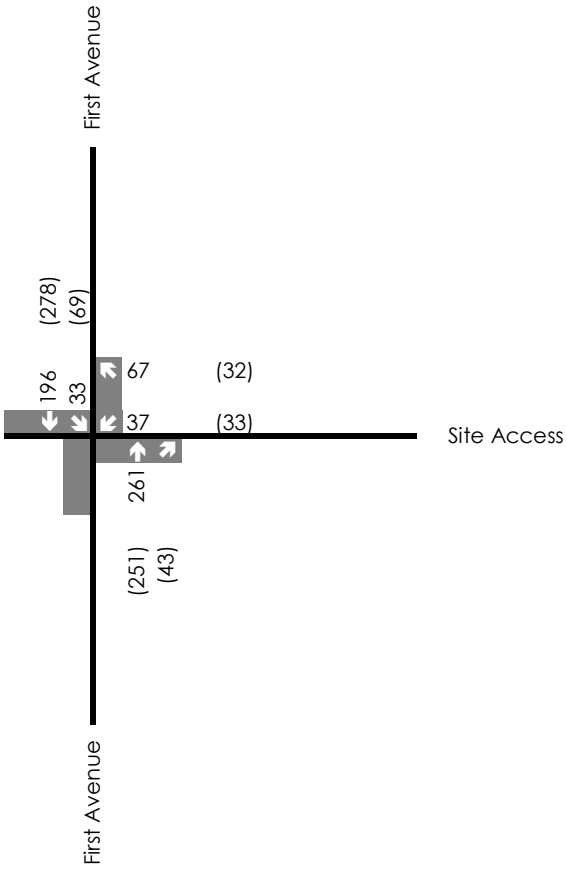
6268,34

7336,14

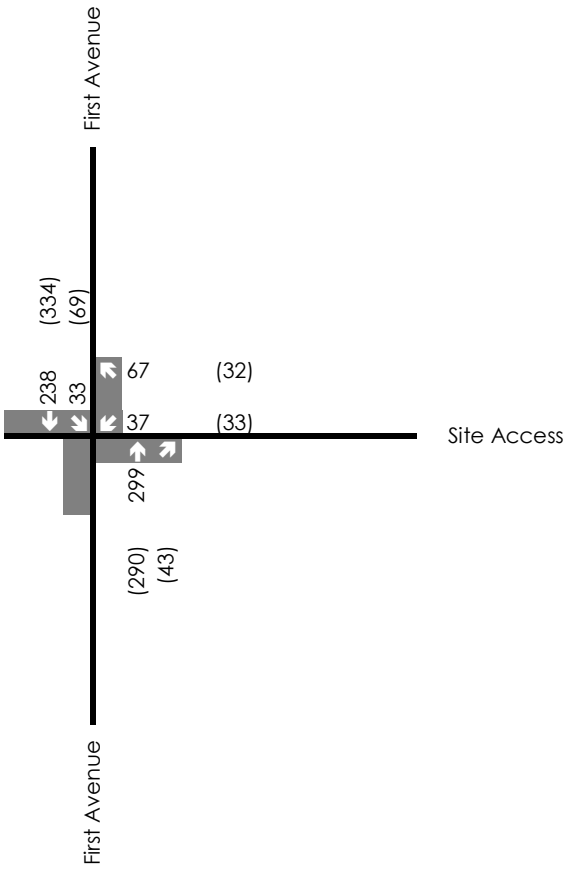
9054,10

APPENDIX I

Future Total Traffic Volumes and Detailed Capacity Analysis



Legend	744 First Avenue	CROZIER CONSULTING ENGINEERS	Figure 2
xx A.M. Peak Hour Traffic Volumes (xx) P.M. Peak Hour Traffic Volumes	2025 Future Total Traffic Volumes		Project No. 1846-6748 Date. 2024-01-17 Analyst. Aiman Khan



Legend	744 First Avenue	CROZIER CONSULTING ENGINEERS	Figure 3
xx A.M. Peak Hour Traffic Volumes (xx) P.M. Peak Hour Traffic Volumes	2035 Future Total Traffic Volumes		Project No. 1846-6748 Date. 2024-01-17 Analyst. Aiman Khan

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	37	67	474	0	33	512
Future Volume (vph)	37	67	474	0	33	512
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	0.913					
Flt Protected	0.983					0.997
Satd. Flow (prot)	1672	0	1863	0	0	1857
Flt Permitted	0.983					0.997
Satd. Flow (perm)	1672	0	1863	0	0	1857
Link Speed (k/h)	50		50			50
Link Distance (m)	314.0		318.6			251.1
Travel Time (s)	22.6		22.9			18.1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	40	73	515	0	36	557
Shared Lane Traffic (%)						
Lane Group Flow (vph)	113	0	515	0	0	593
Sign Control	Stop		Free			Free

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 66.8%		ICU Level of Service C	
Analysis Period (min) 15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	37	67	474	0	33	512
Future Volume (Veh/h)	37	67	474	0	33	512
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)	40	73	515	0	36	557
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	1144	515			515	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1144	515			515	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	81	87			97	
cM capacity (veh/h)	213	560			1051	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	113	515	593
Volume Left	40	0	36
Volume Right	73	0	0
cSH	356	1700	1051
Volume to Capacity	0.32	0.30	0.03
Queue Length 95th (m)	10.7	0.0	0.9
Control Delay (s)	19.8	0.0	0.9
Lane LOS	C		A
Approach Delay (s)	19.8	0.0	0.9
Approach LOS	C		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	66.8%	ICU Level of Service	C
Analysis Period (min)	15		

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	33	32	557	43	69	766
Future Volume (vph)	33	32	557	43	69	766
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	0.933		0.990			
Flt Protected	0.975					0.996
Satd. Flow (prot)	1694	0	1844	0	0	1855
Flt Permitted	0.975					0.996
Satd. Flow (perm)	1694	0	1844	0	0	1855
Link Speed (k/h)	50		50			50
Link Distance (m)	314.0		318.6			251.1
Travel Time (s)	22.6		22.9			18.1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	36	35	605	47	75	833
Shared Lane Traffic (%)						
Lane Group Flow (vph)	71	0	652	0	0	908
Sign Control	Stop		Free			Free

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 89.8%		ICU Level of Service E	
Analysis Period (min) 15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	33	32	557	43	69	766
Future Volume (Veh/h)	33	32	557	43	69	766
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)	36	35	605	47	75	833
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	1612	628			652	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1612	628			652	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	66	93			92	
cM capacity (veh/h)	106	483			935	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	71	652	908
Volume Left	36	0	75
Volume Right	35	47	0
cSH	172	1700	935
Volume to Capacity	0.41	0.38	0.08
Queue Length 95th (m)	14.8	0.0	2.1
Control Delay (s)	40.0	0.0	2.1
Lane LOS	E		A
Approach Delay (s)	40.0	0.0	2.1
Approach LOS	E		

Intersection Summary			
Average Delay	2.9		
Intersection Capacity Utilization	89.8%	ICU Level of Service	E
Analysis Period (min)	15		

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	37	67	512	0	33	554
Future Volume (vph)	37	67	512	0	33	554
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	0.913					
Flt Protected	0.983					0.997
Satd. Flow (prot)	1672	0	1863	0	0	1857
Flt Permitted	0.983					0.997
Satd. Flow (perm)	1672	0	1863	0	0	1857
Link Speed (k/h)	50		50			50
Link Distance (m)	314.0		318.6			251.1
Travel Time (s)	22.6		22.9			18.1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	40	73	557	0	36	602
Shared Lane Traffic (%)						
Lane Group Flow (vph)	113	0	557	0	0	638
Sign Control	Stop		Free			Free

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 69.0%		ICU Level of Service C	
Analysis Period (min) 15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	37	67	512	0	33	554
Future Volume (Veh/h)	37	67	512	0	33	554
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)	40	73	557	0	36	602
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	1231	557			557	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1231	557			557	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	79	86			96	
cM capacity (veh/h)	189	530			1014	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	113	557	638
Volume Left	40	0	36
Volume Right	73	0	0
cSH	323	1700	1014
Volume to Capacity	0.35	0.33	0.04
Queue Length 95th (m)	12.2	0.0	0.9
Control Delay (s)	22.0	0.0	0.9
Lane LOS	C		A
Approach Delay (s)	22.0	0.0	0.9
Approach LOS	C		

Intersection Summary			
Average Delay		2.4	
Intersection Capacity Utilization		69.0%	ICU Level of Service C
Analysis Period (min)		15	

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	33	32	596	43	69	822
Future Volume (vph)	33	32	596	43	69	822
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	0.933		0.991			
Flt Protected	0.975					0.996
Satd. Flow (prot)	1694	0	1846	0	0	1855
Flt Permitted	0.975					0.996
Satd. Flow (perm)	1694	0	1846	0	0	1855
Link Speed (k/h)	50		50			50
Link Distance (m)	314.0		318.6			251.1
Travel Time (s)	22.6		22.9			18.1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	36	35	648	47	75	893
Shared Lane Traffic (%)						
Lane Group Flow (vph)	71	0	695	0	0	968
Sign Control	Stop		Free			Free

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 94.8%		ICU Level of Service F	
Analysis Period (min) 15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	33	32	596	43	69	822
Future Volume (Veh/h)	33	32	596	43	69	822
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)	36	35	648	47	75	893
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	1714	672			695	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1714	672			695	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	60	92			92	
cM capacity (veh/h)	91	456			901	

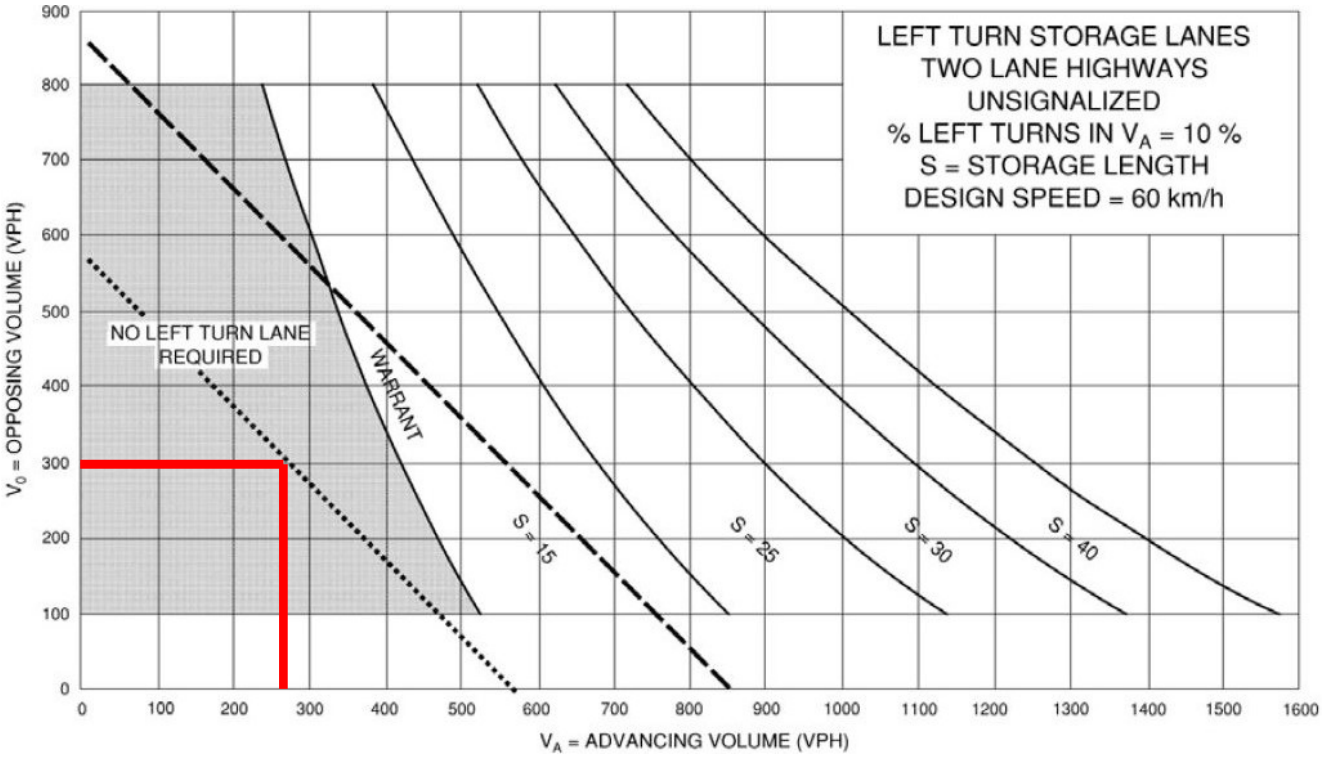
Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	71	695	968
Volume Left	36	0	75
Volume Right	35	47	0
cSH	150	1700	901
Volume to Capacity	0.47	0.41	0.08
Queue Length 95th (m)	17.6	0.0	2.2
Control Delay (s)	48.8	0.0	2.2
Lane LOS	E		A
Approach Delay (s)	48.8	0.0	2.2
Approach LOS	E		

Intersection Summary			
Average Delay		3.2	
Intersection Capacity Utilization		94.8%	ICU Level of Service F
Analysis Period (min)		15	

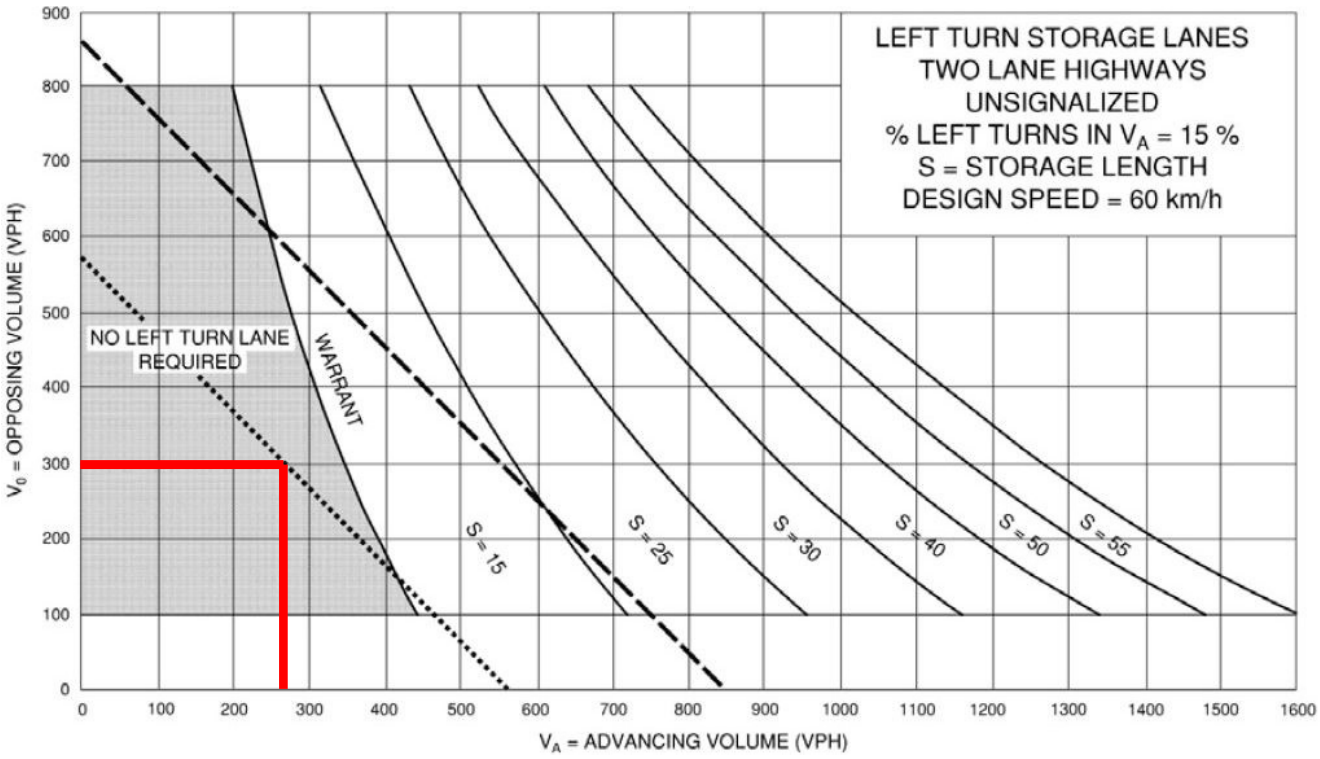
APPENDIX J

Left-Turn Lane Warrants

AM Peak Hour

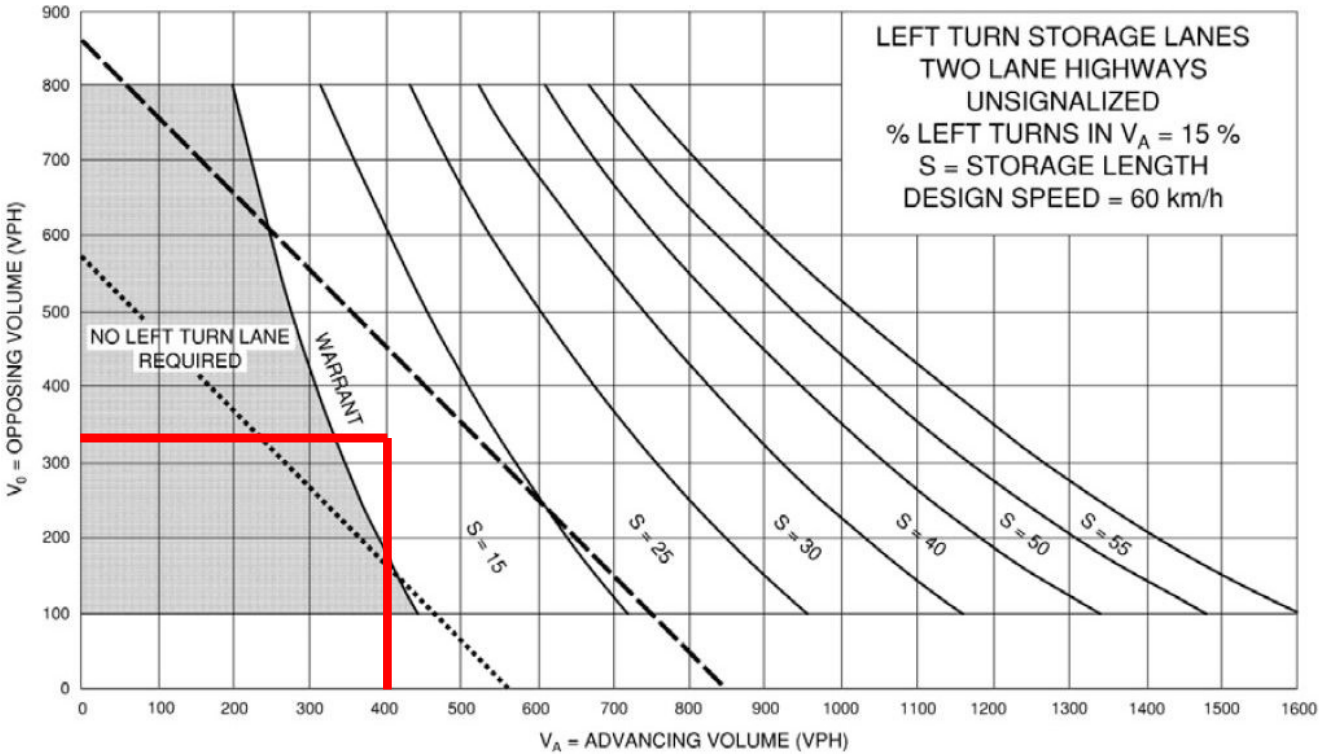


AM Peak Hour

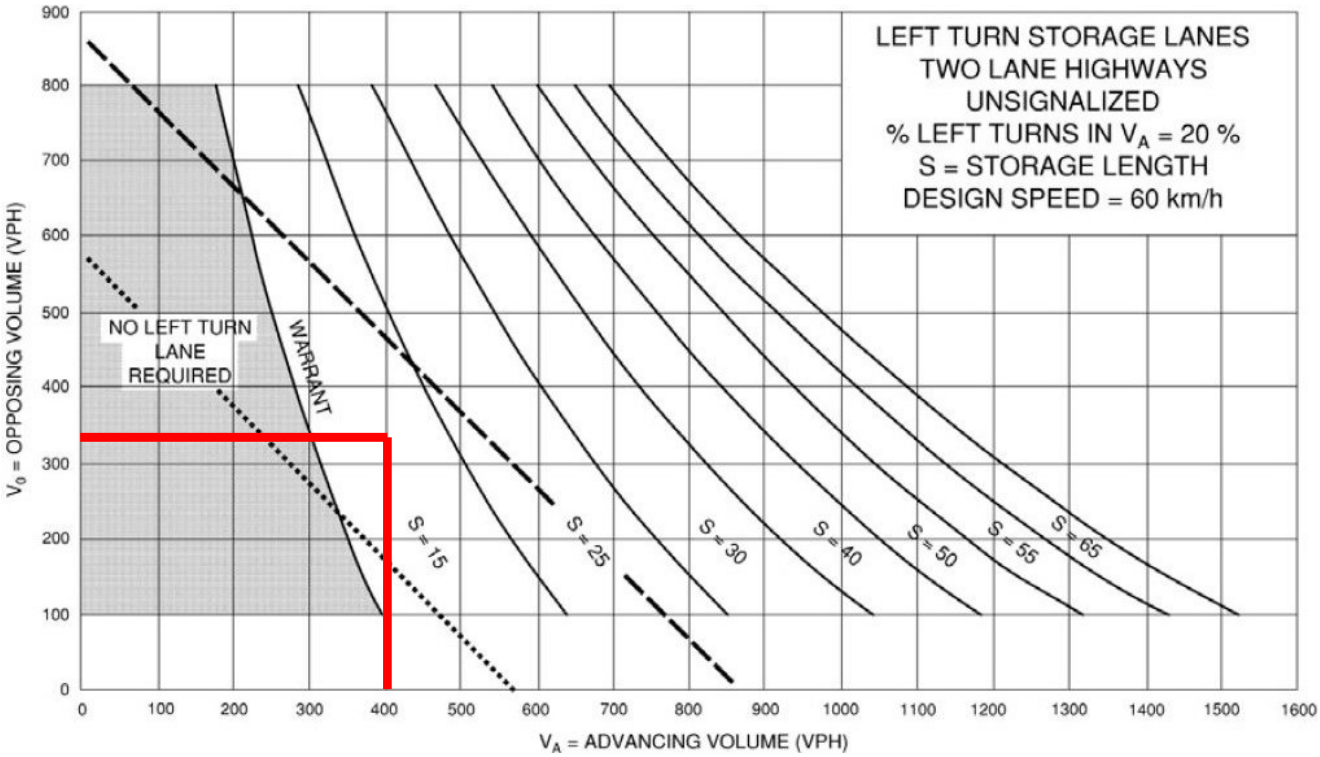


Soutbou

PM Peak Hour



PM Peak Hour



APPENDIX K

TAC Excerpts

Stopping sight distance is the sum of the distance travelled during the perception and reaction time and the braking distance.

$$SSD = 0.278Vt + 0.039 \frac{V^2}{a} \quad (2.5.2)$$

Where:

SSD = Stopping sight distance (m)
t = Brake reaction time, 2.5 s
V = Design speed (km/h)
a = Deceleration rate (m/s^2)

Table 2.5.2 gives the minimum stopping sight distances on level grade, on wet pavement, for a range of design speeds. These values are used for vertical curve design, intersection geometry and the placement of traffic control devices. The stopping sight distances quoted in **Table 2.5.2** may need to be increased for a variety of reasons related to grade and vehicle type as noted below.

Table 2.5.2: Stopping Sight Distance on level roadways for Automobiles[54]

Design speed (km/h)	Brake reaction distance (m)	Braking distance on level (m)	Stopping sight distance	
			Calculated (m)	Design (m)
20	13.9	4.6	18.5	20
30	20.9	10.3	31.2	35
40	27.8	18.4	46.2	50
50	34.8	28.7	63.5	65
60	41.7	41.3	83.0	85
70	48.7	56.2	104.9	105
80	55.6	73.4	129.0	130
90	62.6	92.9	155.5	160
100	69.5	114.7	184.2	185
110	76.5	138.8	215.3	220
120	83.4	165.2	248.6	250
130	90.4	193.8	284.2	285

Note: Brake reaction distance predicated on a time of 2.5 s; deceleration rate of 3.4 m/s^2 used to determine calculated sight distance.

Table 9.9.3: Time Gap for Case B1, Left Turn from Stop

Design Vehicle	Time Gap (t_g)(s) at Design Speed of Major Road
Passenger car	7.5
Single-unit truck	9.5
Combination truck (WB 19 and WB 20)	11.5
Longer truck	To be established by road authority

Notes: Time gaps are for a stopped vehicle to turn left onto a two-lane highway with no median and with grades of 3% or less. The table values should be adjusted as follows:

- For multi-lane highways: For left turns onto two-lane highways with more than two lanes, add 0.5 s for passenger cars and 0.7 s for trucks for each additional lane, from the left, in excess of one, to be crossed by the turning vehicle.
- For minor approach grades: If the approach grade is an upgrade that exceeds 3%, add 0.2 s for each percent grade for left turns.
- Some road authorities use higher values for certain specialized vehicles (e.g., Alberta uses 22 s for very long log trucks).

The intersection sight distance along the major road (distance b in **Figure 9.9.2**) is determined by:

$$ISD = 0.278\ V_{major}\ t_g \qquad (9.9.1)$$

Where:

ISD = intersection sight distance (length of the leg of sight triangle along the major road) (m)
V_{major} = design speed of the major road (km/h)
t_g = time gap for minor road vehicle to enter the major road (s)

For example, a passenger car turning left onto a two-lane major road should be provided sight distance equivalent to a time gap of 7.5 s in major-road traffic. If the design speed of the major road is 100 km/h, this corresponds to a sight distance of 0.278(100)(7.5) = 208.5 or 210 m, rounded for design.

A passenger car turning left onto a four-lane undivided roadway will need to cross two near lanes, rather than one. This increases the recommended gap in major-road traffic from 7.5 to 8.0 s. The corresponding value of sight distance for this example would be 223 m. If the minor-road approach to such an intersection is located on a 4% upgrade, then the time gap selected for intersection sight distance design for left turns should be increased from 8.0 to 8.8 s, equivalent to an increase of 0.2 s for each percent grade.

The design values for intersection sight distance for passenger cars are shown in **Table 9.9.4**. **Figure 9.9.4** includes design values, based on the time gaps for the design vehicles included in **Table 9.9.3**.

No adjustment of the recommended sight distance values for the major-road grade is generally needed because both the major- and minor-road vehicle will be on the same grade when departing from the intersection. However, if the minor-road design vehicle is a heavy truck and the intersection is located near a sag vertical curve with grades over 3%, then an adjustment to extend the recommended sight distance based on the major-road grade should be considered.

Table 9.9.4: Design Intersection Sight Distance – Case B1, Left Turn From Stop

Design Speed (km/h)	Stopping Sight Distance (m)	Intersection Sight Distance for Passenger Cars	
		Calculated (m)	Design (m)
20	20	41.7	45
30	35	62.6	65
40	50	83.4	85
50	65	104.3	105
60	85	125.1	130
70	105	146.0	150
80	130	166.8	170
90	160	187.7	190
100	185	208.5	210
110	220	229.4	230
120	250	250.2	255
130	285	271.1	275

Note: Intersection sight distance shown is for a stopped passenger car to turn left onto a two-lane highway with no median and grades 3% or less. For other conditions, the time gap should be adjusted and the sight distance recalculated.

Sight distance design for left turns at divided-highway intersections should consider multiple design vehicles and median width. If the design vehicle used to determine sight distance for a divided-highway intersection is larger than a passenger car, then sight distance for left turns will need to be checked for that selected design vehicle and for smaller design vehicles as well. If the divided-highway median is wide enough to store the design vehicle with a clearance to the through lanes of approximately 1 m at both ends of the vehicle, no separate analysis for the departure sight triangle for left turns is needed on the minor-road approach for the near roadway to the left. In most cases, the departure sight triangle for right turns (case B2) will provide sufficient sight distance for a passenger car to cross the near roadway to reach the median. Possible exceptions are addressed in the discussion of case B3.

The time gaps in **Table 9.9.3** can be decreased by 1.0 s for right-turn maneuvers without undue interference with major-road traffic. These adjusted time gaps for the right turn from the minor road are shown in **Table 9.9.5**. Design values based on these adjusted time gaps are shown in **Table 9.9.6** for passenger cars. **Figure 9.9.5** includes the design values for the design vehicles for each of the time gaps in **Table 9.9.5.**

Table 9.9.5: Time Gap for Case B2—Right Turn from Stop and Case B3—Crossing Maneuver

Design Vehicle	Time Gap (t_g)(s) at Design Speed of Major Road
Passenger car	6.5
Single-unit truck	8.5
Combination truck (WB 19 and WB 20)	10.5

Note: Time gaps are for a stopped vehicle to turn left onto a two-lane highway with no median and with grades of 3% or less. The table values should be adjusted as follows:

- For multi-lane highways: For left turns onto two-lane highways with more than two lanes, add 0.5 s for passenger cars and 0.7 s for trucks for each additional lane, from the left, in excess of one, to be crossed by the turning vehicle.
- For minor approach grades: If the approach grade is an upgrade that exceeds 3%, add 0.1 s for each percent grade for left turns.

Table 9.9.6: Design Intersection Sight Distance – Case B2, Right Turn from Stop, and Case B3, Crossing Maneuver

Design Speed (km/h)	Stopping Sight Distance (m)	Intersection Sight Distance for Passenger Cars	
		Calculated (m)	Design (m)
20	20	36.1	40
30	35	54.2	55
40	50	72.3	75
50	65	90.4	95
60	85	108.4	110
70	105	126.5	130
80	130	144.6	145
90	160	162.6	165
100	185	180.7	185
110	220	198.8	200
120	250	216.8	220
130	285	234.9	235

Note: Intersection sight distance shown is for a stopped passenger car to turn right onto or to cross a two-lane highway with no median and with grades of 3% or less. For other conditions, the time gap should be adjusted and the sight distance recalculated.

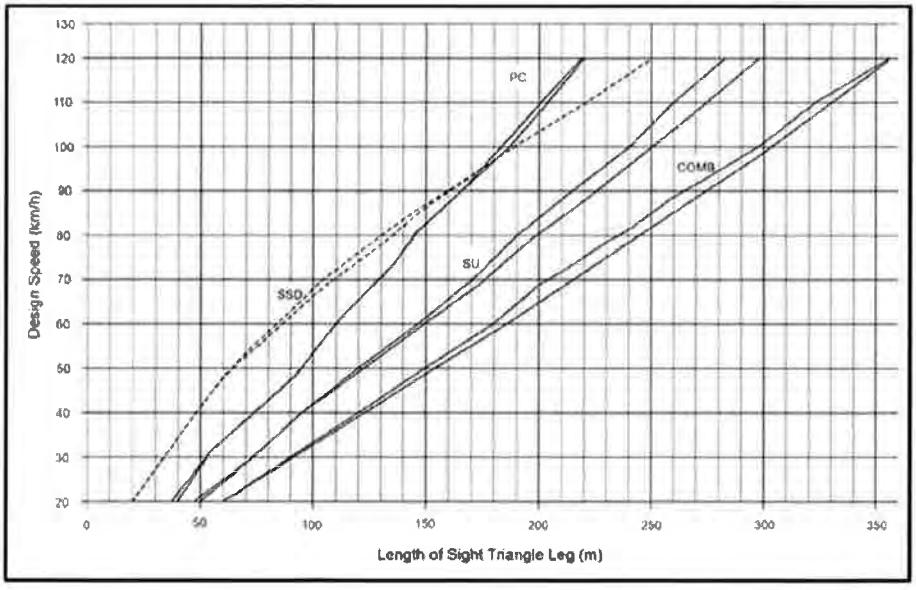


Figure 9.9.5: Intersection Sight Distance – Case B2, Right Turn from Stop, and Case B3, Crossing Maneuver (Calculated and Design Values Plotted)

Case F – Left Turns from the Major Road

All locations along a major highway from which vehicles are permitted to turn left across opposing traffic, including intersections and driveways, should have sufficient sight distance to accommodate the left-turn maneuver. Left-turning drivers need sufficient sight distance to decide when to turn left across the lane(s) used by opposing traffic. Sight distance design should be based on a left turn by a stopped vehicle, since a vehicle that turns left without stopping would need less sight distance. The sight distance along the major road to accommodate left turns is the distance traversed at the design speed of the major road in the travel time for the design vehicle given in **Table 9.9.11**.

Table 9.9.11: Time Gap for Case F, Left Turns from the Major Road

Design Vehicle	Time Gap (t_g)(s) at Design Speed of Major Road
Passenger car	5.5
Single-unit truck	6.5
Combination truck (WB 19 and WB 20)	7.5

Note: Adjustment for multi-lane highways: For turning vehicles that cross more than one opposing lane, add 0.5 s for passenger cars and 0.7 s for trucks for each additional lane to be crossed.

The table also contains appropriate adjustment factors for the number of major-road lanes to be crossed by the turning vehicle. The unadjusted time gap in **Table 9.9.11** for passenger cars was used to develop the sight distances in **Table 9.9.12** and is illustrated in **Figure 9.9.8.**

Table 9.9.12: Intersection Sight Distance – Case F, Left Turn from the Major Road

Design Speed (km/h)	Stopping Sight Distance (m)	Intersection Sight Distance	
		Passenger Cars	
		Calculated (m)	Design (m)
20	20	30.6	35
30	35	45.9	50
40	50	61.2	65
50	65	76.5	80
60	85	91.7	95
70	105	107.0	110
80	130	122.3	125
90	160	137.6	140
100	185	152.9	155
110	220	168.2	170
120	250	183.5	185
130	285	198.8	200

Note: Intersection sight distance shown is for a passenger car making a left turn from an undivided highway. For other conditions and design vehicles, the time gap should be adjusted and the sight distance recalculated.

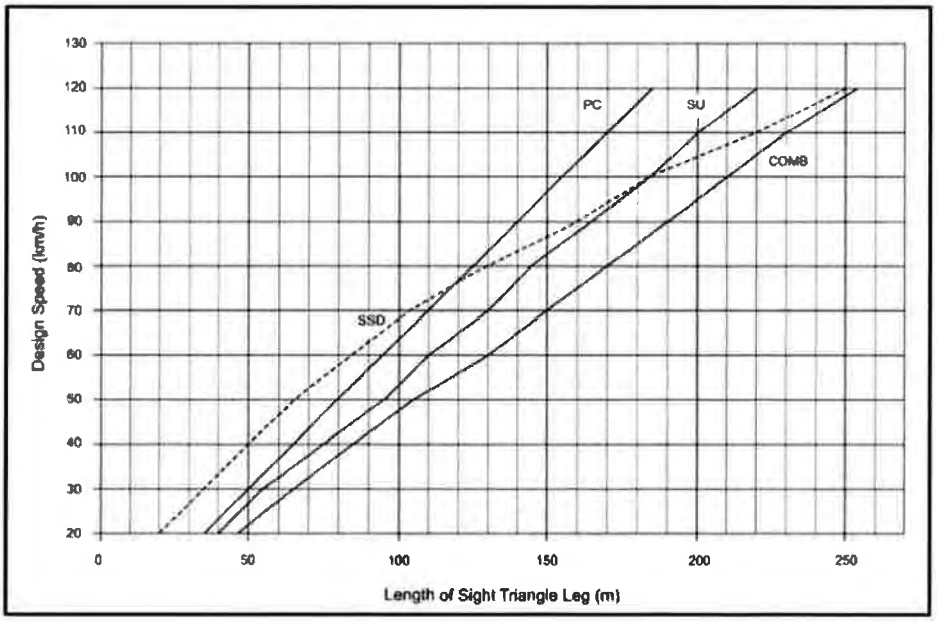


Figure 9.9.8: Intersection Sight Distance – Case F, Left Turn from the Major Road