MULTI-MODAL LEVEL OF SERVICE FRAMEWORK

HALIFAX

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1 Introduction

Purpose

This guide establishes a framework for conducting Multi-modal Level of Service (MMLOS) analysis for transportation projects within the Halifax Regional Municipality (HRM). The guide describes the preferred planning and design process for street corridors, segments, and intersections and HRM's methodology for calculating MMLOS for segments and intersections.

Background

HRM Regional Council unanimously approved the municipality's Integrated Mobility Plan (IMP) in December of 2017. The IMP will create a regional vision for mobility and help to direct future investment in transportation demand management, transit, active transportation, and the roadway network.

The plan strives to *identify the two-way relationship between land development patterns and investment in mobility and personal access*, with the objective of better linking people and their communities.

The Integrated Mobility Plan stems from municipal policy direction on public transit and transportation, land use, and growth centres, contained within the Regional Plan, including the following:

- Implement a sustainable transportation strategy by providing a choice of integrated and connected travel options emphasizing public and community-based transit, active transportation, carpooling, and other viable alternatives to the single occupant vehicle;
- Promote land settlement patterns and urban design approaches that support fiscally and environmentally sustainable transportation modes;
- Forecast the municipality's needs and provide service and infrastructure to meet this demand while influencing choice towards transportation sustainability; and,
- Design complete streets for all ages, abilities and travel options.

The IMP contains a total of 137 actions for HRM to undertake across nine policy areas to attain this vision for mobility in the region. Each action has been assigned an approximate time frame, level of effort, and level of resources required to accomplish the action. Action number 115 directs the municipality to:

> *"Develop Multi-Modal Level of Service guidelines for the municipality that can be used to assess road projects and be incorporated into the municipality's Guidelines for the Preparation of Transportation Impact Studies."*

The guide presents Multi-Modal Level of Service guidelines as developed by HRM and provides guidance on their proper application on transportation projects in the municipality.

2 What is an MMLOS Framework?

An MMLOS framework is an evaluation tool that determines the degree of service provided by a street for *all modes of transportation*. It is an instrument that allows a municipality to make planning, design, and operations decisions for streets that consider the needs and objectives for all users.

Historically, street network planning and design was focused on maximizing auto capacity and minimizing auto travel time in the name of "optimizing" roads. Levels of service (LOS) of streets have traditionally been calculated based on measures such as vehicular delay and volume-to-capacity ratio. Recently, transportation studies have acknowledged the need to serve non-auto modes, but there has been no instrument to assess levels of service of all travel modes on an even plane to determine the impact of trade-offs between modes.

An MMLOS framework is a valuable tool for promoting multi-modalism. A complete MMLOS framework considers:

- The five *modes* of travel found on a street – walking, cycling, transit, trucks, and autos
- The three most common *scales* for transportation studies – networks, corridors, intersections
- The three most common *purposes* for transportation studies – planning, design, operations

The analyst identifies the scale and purpose for the study being undertaken, identifying the MMLOS measures that are appropriate for the study.

3 Planning and Design Process for Streets

Role of the Planning and Design Process

Defining a process for the application of MMLOS is essential in making it a part of how HRM operates and ensuring that it is properly applied in a variety of contexts. As *MMLOS is a tool that is intended move HRM towards achieving its transportation policy goals* through the allocation and quality of space along transportation corridors and at specific locations, the processes involved in its application should be sensitive to the scale and context of the project to be analysed.

The processes laid out for application of MMLOS serve as the guideposts for moving a project or analysis from conception to completion. The processes should be clear and concise enough that two people should be able to walk through the process for the same project and come to the same conclusion. The process should be transparent and simple enough that it does not become a black box or an overly complex exercise. This keeps the analysis open and more accessible for non-technical stakeholders so that the project and findings are easily understood and open for discussion.

Corridor Planning

The examination of corridors from a planning perspective allows HRM to examine the overall role and function of the corridor, establishing new modal priorities or making a significant transformation over a larger area.

Greenfield Projects

For corridor planning and design in new areas, the process will be fairly straightforward and will generally follow the following steps:

1. Create proposed corridor alignment
2. Examine role and function of the new facility and required connections and capacity
3. Develop cross-section based on ideal widths for elements serving each mode according to current design standards
4. Apply minimum width to elements serving modes in a 'basic' capacity
5. Apply desired widths for elements serving modes in priority corridors
6. Review final cross-section and intersection treatments and adjust to suit the character of the facility and the area

Transformation Projects

This process should be applied to corridor planning and design projects where the available Right-of-Way (ROW) is less than ideal. The process should generally follow the steps below.

1. Identify project objective

Establish a clear objective for the project to ensure that the end point is clear from the beginning and can be kept in mind when discussing tradeoffs and alternatives.

2. Identify stakeholders and assemble team

Assemble a team consisting of internal stakeholders, external stakeholders, and consultant(s) appropriate for the project, given the project type, scale, and objective.

3. Identify mobility and land use context and priorities

Establish the mobility and land use context by answering these questions using the IMP, Centre Plan, and other relevant documents:

- Does the project land on any priority corridors?
- Is the available right-of-way limited? Is there opportunity to widen?
- Can on-street parking be added or removed?

4. Define project purpose, vision, and priorities

Collectively define the project purpose and vision, as well as the project timeline, level of engagement, expectations, and priorities.

5. Identify constraints and opportunities

Identify constraints within which the project must develop using technical input (e.g. road right-of-way, constraints based on roadway geometrics, short-term redevelopment opportunities, new technologies, etc.). Use these constraints to generate potential opportunities.

6. Identify alternatives

Generate logical alternatives to be evaluated, given the context from Step 4 and the constraints/opportunities from Step 5.

7. Evaluate alternatives and define tradeoffs

As a team, evaluate the alternatives according to the project evaluation methodology laid out in the IMP, then prioritize and eliminate less practical alternatives. In a retrofit situation, tradeoffs are inevitable. Apply MMLOS at a segment level if necessary to differentiate further between alternatives.

The evaluation phase may generate new alternatives, which must go through Step 6, to ensure appropriateness with established context. Steps 6 and 7 are iterative until a single preferred alternative is chosen.

8. Proceed with preferred alternative

Proceed with detailed design, cost estimation, etc. depending on the type of project, once a preferred alternative has been chosen.

Intersection / Segment Operations and Design

This approach should be applied when considering operational or design changes to existing intersections or corridors. It serves as the general approach to the mechanical application of the MMLOS, which follows these general steps.

1. Define project extents
2. Delineate roadway segments and intersections to be analysed. Segments should be broken at significant intersections or changes in infrastructure / roadway cross-section.
3. Perform any field observation, measurements, or technical analysis to collect required data or produce required measures for the defined segments and intersections
4. Determine target LOS values for each mode as defined by the project location (Regional Centre, Inner Suburb, Outer Suburb, and Rural). If the segment or intersection is located on a priority corridor for a specific mode, augment the LOS for that mode according to the target table.
5. Determine Level of Service for each mode and each time/space/environment measure according to the criteria grading tables
6. Determine overall modal level of service by combining the individual measures for each mode
7. Compare actual (or proposed) LOS for each mode to the target LOS
8. Consider operational or design changes where a mode's LOS falls below the target LOS

4 MMLOS Performance Measures

Traditionally, the measures used in assessing LOS in transportation planning have been limited to either average vehicle delay or volume-to-capacity ratio (V/C ratio), considering only the experience of automobile drivers in the equation. MMLOS tips this on its head and forces us to consider what is important to measuring the experience for all users of a street. Properly selected performance measures should help to inform planning, design, and operating decisions for HRM by examining the specific elements and indicators that determine the LOS for all modes of travel.

There are a large number of factors for each mode that can affect that user's experience as they move through the city. Everything from signal timing to sidewalk width to the presence of a curb to the number of trees and the warm summer breeze can affect our experience, depending on how we are moving about. Though, not all of these are necessarily important, measurable, or controllable within the context of a typical transportation analysis.

Factors Considered in Establishing Performance Measures

Measures for MMLOS can be broken into three major categories:

- **Space** – The *amount of physical space* dedicated to the mode, which is an indication of the safety provided for each mode
- **Environment** – The *quality of the space* provided for the mode, which measures how the design treatments prioritize and encourage the mode
- **Time** – The *amount of delay* or hindrance the mode experiences

Taken together, these three elements describe the essence of mobility related to the user experience: How much space do I have? How nice is it? And, how much waiting do I have to do?

HRM's Performance Measures

HRM's approach to MMLOS analysis is to examine the LOS for each mode at an intersection level and a road segment level (i.e., the space between intersections or significant infrastructure changes) and look at *the single most important element* for each category governing the LOS: Space, Environment, and Time.

Table 1 presents the performance measures to be applied:

Table 1: MMLOS Performance Measures

Area	Realm	Pedestrian	Bicycle	Transit	Goods Movement	Automobile
INTERSECTIONS	Space	# of Uncontrolled Conflicts	# of Uncontrolled Conflicts	% Transit Priority Measures (of Ideal)	Average Curb Lane Width	% Movements with Exclusive Turning Lanes
	Environment	Average Crossing Width	Priority Treatments	Transit Movement V/C Ratio	Average Curb Radius	Turn Prohibitions
	Time	Cycle Length	Cycle Length	Transit Movement Delay	Truck Intersection Delay	Car Intersection Delay
SEGMENTS	Space	Pedestrian Facility Width	Driveway Density	Transit Facility Type	Width Of Curb Lane	Midblock V/C Ratio
	Environment	Pedestrian Zone Width	Speed x Volume	% of Stops with Bus Lay-bys	% No Stopping/ No Loading	On-Street Parking Availability
	Time	Distance Between Marked Crossings	Block Length	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed

The final LOS for each mode is calculated by taking the weighted average LOS of each of the measures, with each providing a prescribed influence on the final value, as shown in Section 5. **Appendix A** provides descriptions of the individual measures to explain their intent and application in the process.

5 Grade Tables

Grade tables break the full range of potential performance into regular intervals and assign an appropriate grade; grade tables provide clear and meaningful differentiation between the LOS values for the purpose of comparison and analysis. A familiar example is the traditional scale of automobile level of service based on average vehicle delay (as established by the American Highway Capacity Manual). Using this grade table, an intersection measuring average vehicle delay between 21 and 35 seconds is assigned a grade of C, whereas an intersection measuring average vehicle delay between 36 and 55 seconds is assigned a grade of D.

Tables 2 and 3 present the Grade Tables for the Performance Measures shown in **Table 1**. The overall LOS for each mode will be calculated by taking the weighted average LOS of the three measures, with each providing a prescribed influence on the final value (e.g., 50% Space, 20% Environment, and 30% Delay).

Table 2: *Grade Tables – Intersections*

	Mode	Realm	Weight	Measure	A	B	C	D	E	F
INTERSECTIONS	Pedestrians	Space	33.4%	Number of Uncontrolled Conflicts	< 6	6-7	8-10	11-13		> 13
		Environment	33.3%	Avg. Crossing Width (m)	< 7	7 - 10.5	10.5 - 14	14 - 17.5	17.5 - 21	> 21
		Time	33.3%	Cycle Length (sec)	< 60	61 - 75	76 - 90	91 - 105	106 - 120	> 120
	Cyclists	Space	25.0%	Number of Uncontrolled Conflicts	< 6	6-7	8-10	11-13		> 13
		Environment	50.0%	Priority Treatments	90 - 100%	80 - 89%	70 - 79%	50 - 69%	30 - 49%	< 30%
		Time	25.0%	Cycle Length (sec)	< 60	61 - 75	76 - 90	91 - 105	106 - 120	> 120
	Transit	Space	50.0%	% of Transit Priority Measures (of Ideal)	90 - 100%	80 - 89%	70 - 79%	50 - 69%	30 - 49%	< 30%
		Environment	25.0%	Transit Movement V/C Ratio	< 0.60	0.60 - 0.69	0.70 - 0.79	0.80 - 0.89	0.90 - 0.99	> 1.0
		Time	25.0%	Transit Movement Delay (sec)	0 - 10	11 - 20	21 - 35	36 - 55	56 - 80	> 80
	Goods Movement	Space	40.0%	Avg. Curb Lane Width (m)	>= 4.00	3.80 - 3.99	3.60 - 3.79	3.40 - 3.59		< 3.40
		Environment	20.0%	Avg. Effective Curb Radius (m)	> 18	16 - 18	15 - 16	13 - 14	11 - 12	< 11
		Time	40.0%	Truck Intersection Delay (sec)	0 - 10	11 - 20	21 - 35	36 - 55	56 - 80	> 80
	Automobiles	Space	33.4%	% of movements with turn lanes	85 - 100%	60 - 85%	35 - 60%	10 - 35%		< 10%
		Environment	33.3%	Turn prohibitions	0	1	2	3	4	>= 5
		Time	33.3%	Car Intersection Delay (sec)	0 - 10	11 - 20	21 - 35	36 - 55	56 - 80	> 80

Table 3: *Grade Tables – Segments*

	Mode	Realm	Weight	Measure	A	B	C	D	E	F
SEGMENTS	Pedestrians	Space	33.4%	Pedestrian Facility Width (m)	>=2.00	1.80 - 1.99	1.64 - 1.79	1.50 - 1.64	1.25 - 1.49	<1.25
		Environment	33.3%	Pedestrian Zone Width (m)	>= 3.50	3.00 - 3.49	2.74 - 2.99	2.50 - 2.75	2.00 - 2.49	<2.00
		Time	33.3%	Distance Between Marked Crossings (m)	< 100	100-149	150-199	200-249	249-300	> 300
	Cyclists	Space	20.0%	Driveway Density	0 - 8	>8 - 16	>16 - 24	>24 - 32	>32 - 40	> 40
		Environment	60.0%	Speed x Volume	A	B	C	D	E	F
		Time	20.0%	Block Length	< 100	100 - 149	150 - 199	200 - 249	249 - 300	> 300
	Transit	Space	50.0%	Transit Facility Type	24 Hour Lanes / Dedicated Facility	Daytime Transit Lanes	Peak Period Transit Lanes	Mixed Traffic with >1 lane	Mixed traffic with 1 lane	Mixed Traffic + Parking
		Environment	25.0%	% of Stops with Bus Lay-bys	0%	1% - 20%	21% - 40%	41% - 60%	61% - 80%	> 80%
		Time	25.0%	Travel Speed / Ideal Speed	0.91 - 1.00	0.81 - 0.90	0.71 - 0.80	0.61 - 0.70	0.60 - 0.50	<0.50
	Goods Movement	Space	33.4%	Width of Curb Lane (m)	>= 4.00	3.80 - 3.99	3.60 - 3.79	3.40 - 3.59		<3.40
		Environment	33.3%	% No Stopping / No Loading	< 10%	11% - 19%	20% - 39%	40% - 49%	50% - 59%	> 60%
		Time	33.3%	Travel Speed / Ideal Speed	0.91 - 1.00	0.81 - 0.90	0.71 - 0.80	0.61 - 0.70	0.60 - 0.50	<0.50
	Automobiles	Space	33.4%	Midblock V/C Ratio	< 0.60	0.60 - 0.69	0.70 - 0.79	0.80 - 0.89	0.90 - 0.99	>= 1.00
		Environment	33.3%	On-street Parking Availablity (%)	100%	80% - 99%	60% - 79%	40% - 59%	20% - 39%	0% - 19%
		Time	33.3%	Travel Speed / Ideal Speed	0.91 - 1.00	0.81 - 0.90	0.71 - 0.80	0.61 - 0.70	0.60 - 0.50	< 0.50

6 MMLOS Performance Targets

Role of Performance Targets

The final key aspect of an MMLOS framework is the definition of target LOS values for each mode that direct solutions towards desired policy goals. These *targets help to define the priority for each mode in a variety of contexts*, which will drive changes in the allocation of space and time in the transportation network. These targets will, in effect, act as an important element in shaping the space and character of the city.

It is important to recognise that the goal is not to achieve LOS A for all modes, as this is not a feasible or desirable condition. In fact, improving the experience for some modes will be directly detrimental to others. It is important, then, to recognise this relationship and select target LOS values that prioritise the space while not setting expectations too high or that work at cross-purposes.

Factors in Setting Targets

There are many factors to consider when creating performance targets in general and specific to HRM.

Overall Policy Objectives for Shifting Mode Shares

HRM has stated clear goals in the IMP for shifting travel away from autos towards more sustainable modes, especially in the Regional Centre where at least 60% of trips should be by non-auto modes by 2031. The performance targets were therefore set to move the needle decisively in this direction.

Role of Different Modes in Different Locations

While there is clear direction to move away from auto trips, it is important to recognise that each of the travel modes (walk, bike, transit, truck, and car) will be more or less important in different geographies. The likelihood of travel by non-auto modes will naturally change in relation to the length and purpose of the trip, the established infrastructure network, and the land use mix and density in various parts of the municipality. HRM has also set an objective to maintain efficient travel for all modes, as and where appropriate, so it was important to recognise this when setting the targets.

Priority Networks

HRM has established clear priority networks via the IMP and related plans that seek to emphasize the performance of certain modes along a network of specific corridors. It was important that the targets be able to provide this emphasis and direct the infrastructure towards providing the necessary priority.

HRM's Performance Targets

As a general concept, it can be expected that as users of different modes move between different areas of HRM, their expectations for LOS will differ, as shown in the figure to the right. In general, as a resident moves closer to the Regional Centre (Halifax Peninsula, Downtown Dartmouth) their expectations of LOS for walking, biking, and transit service will generally increase. Similarly, the expectations of motorised modes (cars and trucks) for LOS will generally increase as they head away from the Regional Centre.

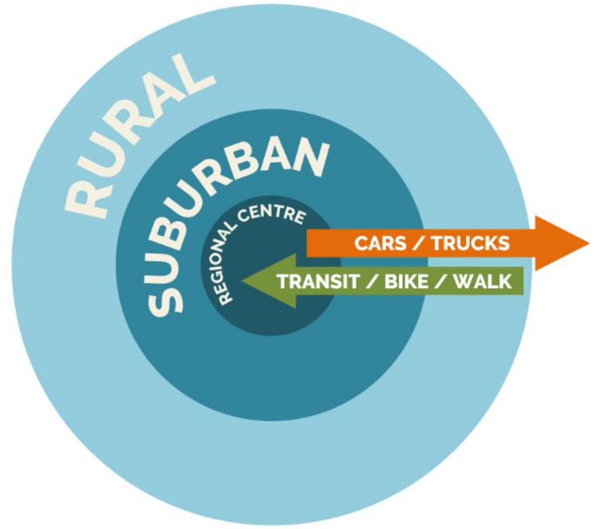


Figure 1 below illustrates the breakpoints between the area types for HRM. For projects near the borders of an area, consult with HRM staff to confirm the appropriate area for use on a project.

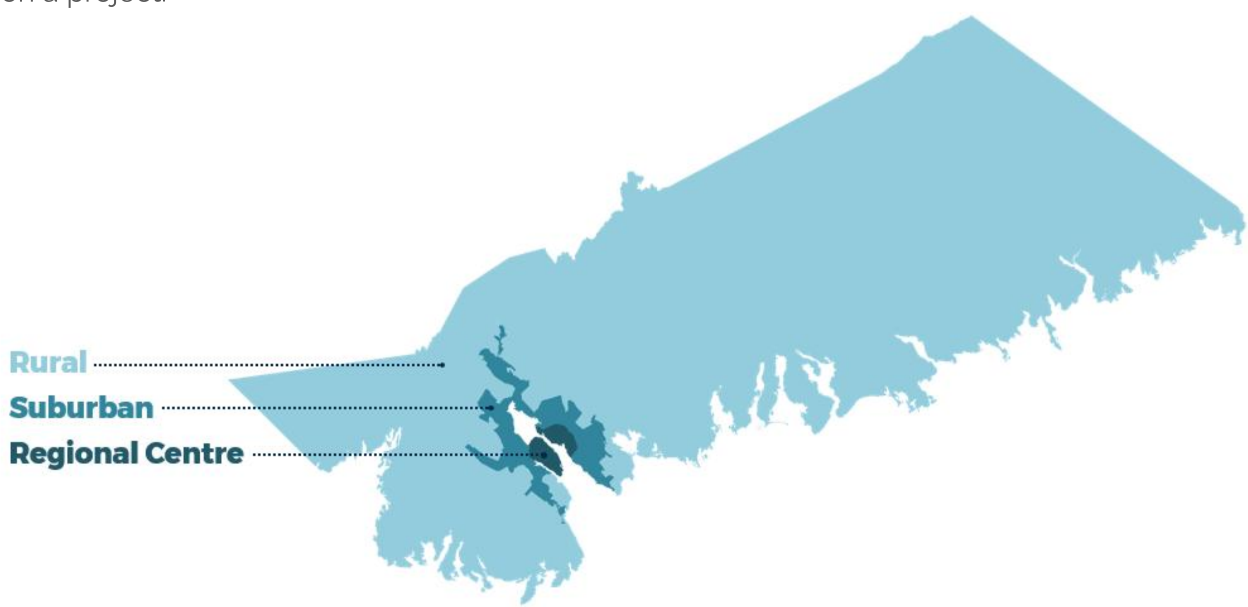


Figure 1: *Area Type Breakdown*

As shown **Table 4** below, the base LOS value for each mode is set to a reasonable maximum where the inner and outer extents of the region are defined. As you move between the concentric rings, the level of service generally changes by one value in the appropriate direction (with some exceptions). This provides a simple and logical progression for LOS targets across HRM.

This is augmented to provide consideration for priority corridors in the region based on those defined in the IMP and associated plans (e.g., Moving Forward Together, Making Connections). Where a corridor is defined as a priority for a specific mode, it also moves up one grade of LOS.

__Table 4:__ MMLOS Performance Targets

Mode	Corridor Type	Regional Centre	Suburban	Rural
Pedestrian	Basic	B	C	D
	Priority	A	B	C
Bicycle	Basic	B	C	D
	Priority	A	B	C
Transit	Basic	B	C	D
	Priority	A	B	C
Goods Movement	Basic	E	E	D
	Priority	D	D	C
Auto	Basic	E	E	D
	Priority	D	D	C

In absence of a redefined street hierarchy (to be produced by HRM in the medium term) and definition of priority area types that would define requirements by mode more precisely, this provides HRM with a flexible and logical table of LOS targets for each mode that is sensitive to the facility's location within the municipality and its priority for various modes.

7 Spreadsheet Analysis Tool

Throughout the development of the MMLOS framework for HRM, significant emphasis was placed on creating a process that was *simple to apply, understand, and present*, while still ensuring that the considerations for each mode were valid and useful to a range of project types. This emphasis was also extended to the creation of a standardised reporting tool for MMLOS. The ideal tool would have the following characteristics:

- Simple and intuitive to use
- Focused on graphic presentation of results
- Useful for data entry, analysis, and presentation to a range of stakeholders
- Able to be easily expanded or reduced to match differing project scales
- Easy to maintain and update

With these characteristics in mind, a Microsoft Excel spreadsheet tool has been created to simplify the overall process, and provide a standardised method for clear and simple communication of MMLOS results with technical and non-technical stakeholders. This section provides an overview of the elements contained in the spreadsheet and how to apply it.

Overview

The Microsoft Excel tool is broken into the following seven tabs:

- **Intersections** – This tab presents the interface for analysing intersections along the subject corridor
- **Segments** – This tab presents the interface for analysing segments along the subject corridor
- **Grades** – This tab presents the grade tables for intersections and segments as shown in *Section 5*. The Intersections and Segments tabs refer to these tables when values are selected from the drop-down lists.
- **Targets** – This tab presents the target LOS values for each mode as shown in *Section 6*. The Intersections and Segments tabs refer to these tables when the area type and corridor priority are selected.
- **Cyclist Intersection Environment** – This tab allows the analyst to quickly calculate the score for the Cyclist Intersection Environment measure, as described in *Appendix A*. Instructions for its application are contained within the spreadsheet.
- **Cyclist Segment Space** – This tab allows the analyst to quickly calculate the score for the Cyclist Segment Space measure, as described in *Appendix A*. Instructions for its application are contained within the spreadsheet.
- **Cyclist Segment Environment** – This tab allows the analyst to quickly calculate the score for the Cyclist Segment Environment measure, as described in *Appendix A*. Instructions for its application are contained within the spreadsheet.

Intersections

The basic layout of the interface on the Intersections tab is shown in **Figure 2**.

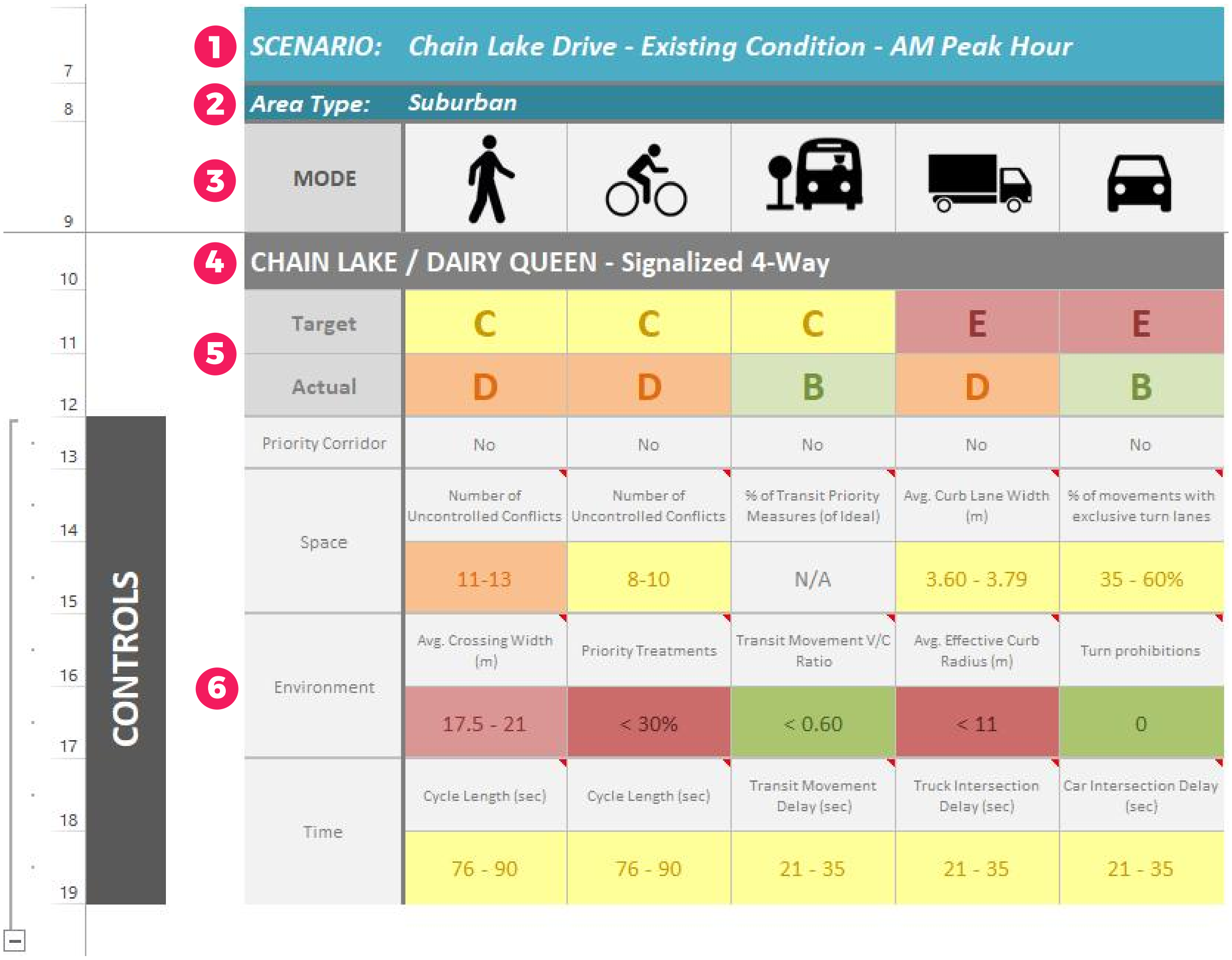


Figure 2: *Intersections Interface*

The interface is broken into the following basic sections:

1. Scenario Header – This area allows the analyst to enter identifying text for the project and scenario currently being tested.
2. Area Type Selection – This cell presents a drop-down list of area types that define where the project is located within HRM. This is used to lookup the appropriate target LOS values for each mode from the *Targets* tab.
3. Mode – The symbols here are used to associate the inputs in the column below with the specific modes pictured.
4. Intersection Information – This cell allows the analyst to input the name of the intersection and any other pertinent details (e.g., control type, alternative being considered).

5. LOS by Mode – These two rows present the target LOS for each mode (as defined by the Area Type Selection above and priority corridor selection below) and the actual LOS achieved, based on the inputs below.
6. Controls – This is the area where the analyst enters the data about the intersection based on their field observations, calculations, and any supporting analysis. All inputs are controlled by drop-down lists that reference the grade tables on the *Grades* tab.
    - Priority Corridor – Select 'yes' or 'no' for each mode if one of the intersecting corridors is part of a designated priority corridor. This affects the target LOS value.
    - The remainder of this section presents the three measures per mode that require input from the analyst regarding the Space, Environment, and Time criteria. Each has a header that describes the measure with a cell below that is controlled by a drop-down list that refers to the grade tables on the *Grades* tab. Additionally, there are comments in each header that present a more detailed description of the measure, as indicated by the red triangle in the upper-right corner of each cell. Placing the cursor over the header pops out the description, which matches the text presented in *Appendix A* of this document for easy reference. All of the cells will automatically colour themselves based on the LOS associated with the selected value according to the *Grades* tab.
    - Note that the Controls section of the spreadsheet can be quickly hidden for simplified presentation of results of single or multiple intersections by clicking the 'minus' button in the lower left of **Figure 2**. This can be returned just as easily by clicking the resulting 'plus' button when the rows are hidden.

Figure 2 presents the input for a single intersection. To enter data for multiple intersections, simply copy the *entire rows* in the Excel spreadsheet from the Intersection Information (Item 4 in the figure or Row 10) down to the bottom of Controls section (Item 6 or Row 19). This should then be pasted directly below the current table.

Note that there are four additional tables to the right of the interface shown in **Figure 2**. These are identical to the interface, but present the results of the input slightly differently. These tables are necessary to make the spreadsheet function, but also allow for slightly differing presentation of the LOS results:

- The first table to the right shows all inputs as LOS results (i.e., A to F). This table is useful when presenting the LOS for individual measures but without the specific values. This can be useful when discussing with non-technical stakeholders or to move the discussion away from detailed numbers and towards the experience for the various modes.
- The second table to the right shows all of the inputs as numerical representations of the resulting LOS (i.e., A = 6, B = 5, C = 4, etc.). This is necessary for calculating the average LOS for each mode. This can be useful to the analyst when determining how 'close' an LOS value is to the adjacent letter-grade, but is likely not useful for presentation purposes. Final LOS is

determined from the rounded value. *(Note that values that end in 0.5 will round up to the next whole number.)*

- The third and fourth tables are simply necessities to calculate the appropriate weighting of measures when one or more elements is missing. These can be ignored.

Segments

The basic layout of the interface on the Segments tab is shown in **Figure 3**. The interface is largely similar to the Intersections tab, but doubled to allow for input describing each direction on a roadway independently.

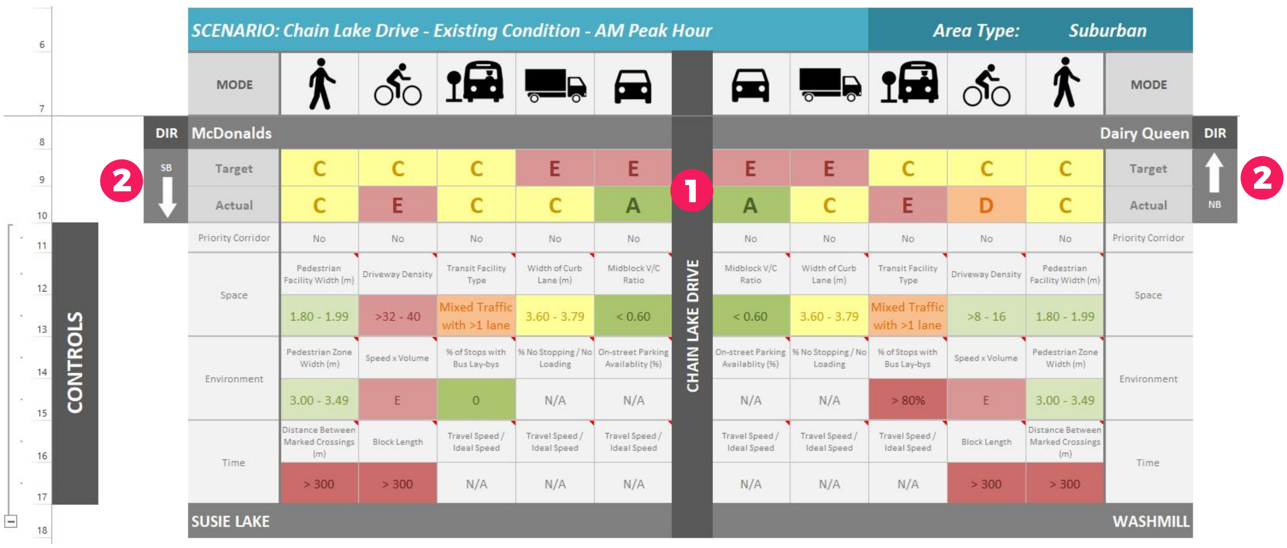


Figure 3: *Segments Interface*

The following differences should be noted between the Intersections and Segments interfaces, as indicated by the numbers in **Figure 3**. Refer to the Intersections section for description of the interface that is used in each direction on the segments.

1. The roadway is laid out schematically with the thick dark grey vertical line representing the corridor under investigation. The thick lighter grey horizontal lines represent the cross streets along the corridor and the characteristics for the segment between the two cross-streets are entered in between. The inputs for each direction of the roadway are mirrored on either side of the dark grey line.
2. The direction represented by the inputs should be selected from the drop-down list on either side of the interface to ensure clarity.

Figure 3 presents the input for a single segment. Similarly to the Intersections interface, to enter data for multiple segments, simply copy the *entire rows* in the Excel spreadsheet from the Target LOS (*Row 9*) down to and including the cross-street (*Row 18*). This should then be pasted directly below the current table.

APPENDIX A

MMLOS MEASURES

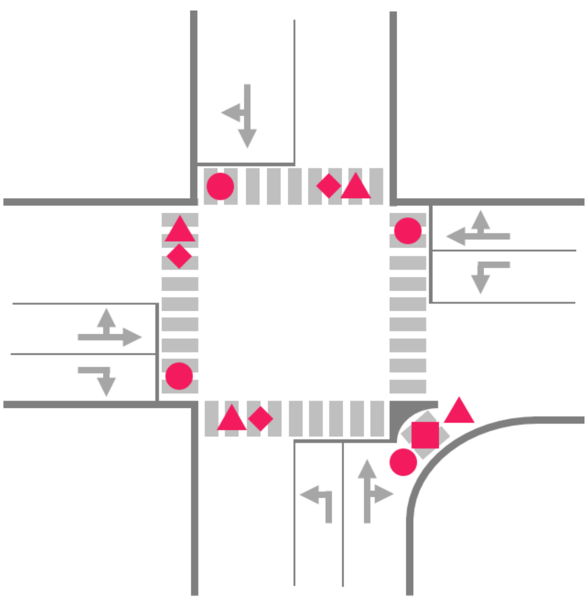
Space: Number of Uncontrolled Conflicts

An uncontrolled conflict occurs within an intersection where a pedestrian may be in conflict with another mode and there is no traffic control to direct their interaction. These are the areas within an intersection where pedestrians are vulnerable during normal operation. This measure is similar to the cyclist intersection measure for space.

For this measure, count the number of uncontrolled conflict points for the intersection. These consist of:

- Permitted left turns
- Right turn on red
- Right turn on green
- Right turn channels

The intent for this measure is to quantify ***the sources of risk to pedestrians as they cross the street***, primarily from turning cars, trucks, and buses. By examining the points where conflict can occur, we can quantify a simple examination of the safety of an intersection for pedestrians. Reducing the number of conflicts or giving the pedestrians priority in the intersection will serve to improve safety for pedestrians as they move through the intersection.



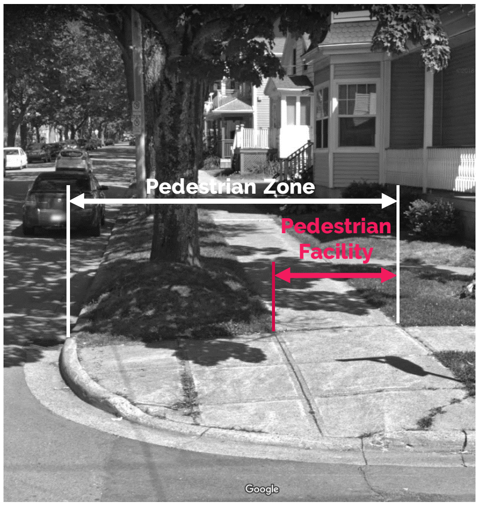
The example to the left shows the location and source of uncontrolled conflicts at a typical four-leg intersection. The signal operates with permitted left turns on all phases, which means left turning vehicles will cross the crosswalk while pedestrians move (◆). Right turns on red are allowed (●); vehicles turning right on green will cross the crosswalk (▲); and, there is a right turn channel (■). The right turn channel represents three conflicts, as this is a higher risk situation for pedestrians. Southbound left turns are prohibited, which removes a conflict on the east crosswalk. At a roundabout, count the number of approaching and departing lanes that intersect the crosswalks.

There are **12** uncontrolled conflicts for pedestrians at this intersection.

Approaches to reduce the number of uncontrolled conflicts at an intersection include: prohibition of turning movements; implementation of protected-only left turns; elimination of right turns on red; signalisation of right turn channels; removal of right turn channels; and, one-way street conversion.

In practice, the risk to pedestrians at the conflicts can be reduced through the implementation of Leading Pedestrian Intervals (LPI), though the conflicts would remain.

Space: Pedestrian Facility Width



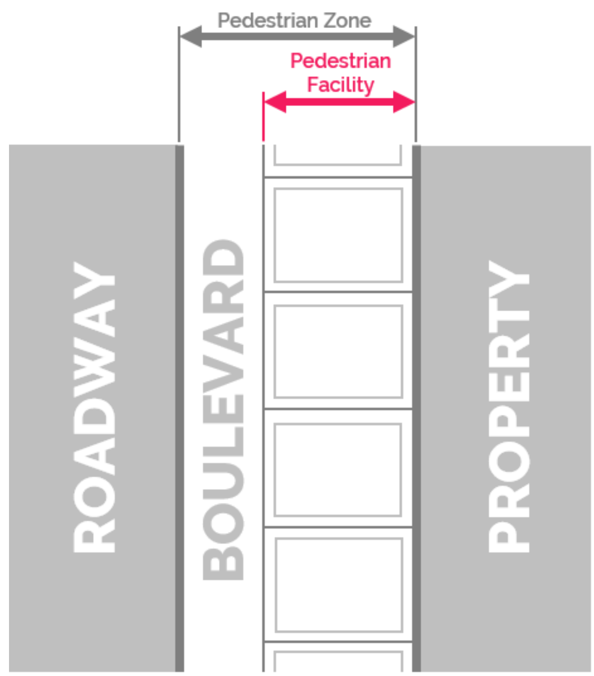
The width of pedestrian facilities (e.g., sidewalks, trails) is a basic measure of the amount of walking space that is given to pedestrians along a road segment. This width is the foundational element that ensures pedestrians can move safely along the roadway.

The pedestrian facility width can be considered the remaining space between the property line (or building face) and the edge of the roadway when the space for the boulevard where utilities, trees, parking meters, and other objects are removed.

The concept of pedestrian facility width is tied closely to that of pedestrian zone width (the Segment Environment measure), as shown in the figures.

The intent for this measure is to quantify ***the effective width available for walking and rolling*** along the side of the roadway segment to assess its sufficiency for providing a safe walking environment.

The example to the right demonstrates the basic measurement of pedestrian facility and zone width, where there is a strong demarcation between the facility and boulevard space.



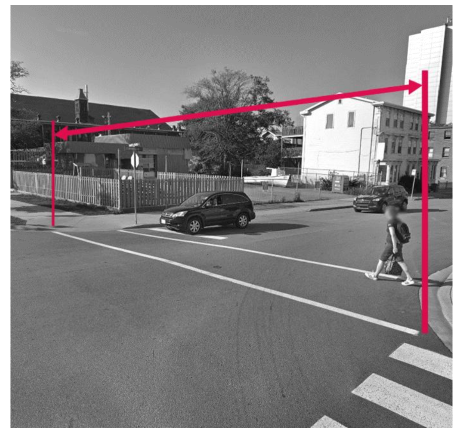
The separation between facility and boulevard may be indicated by differences in material (e.g., brick, grass, trees), but may not be obvious when the same material makes up both. To determine the pedestrian facility width, look for elements that reduce the effective width of the pedestrian facility for walking, such as parking meters, bike racks, and power poles. The facility width can be equivalent to zone width where there is no boulevard.

Where there is variation along a segment, take a minimum of three measurements of width and calculate the average to produce a representative pedestrian facility width.

Improvements to the pedestrian facility width can be implemented through approaches such as: expansion to right-of-way boundaries; property acquisition; reduction of boulevard width; reduction of vehicle lane width; removal of vehicle lanes; removal of on-street parking; or, removal of bus lay-bys.

Remain cognisant of required minimums for vehicle and pedestrian facility types, transit stops, accessibility legislation, and other considerations. Consult HRM design guidelines for details.

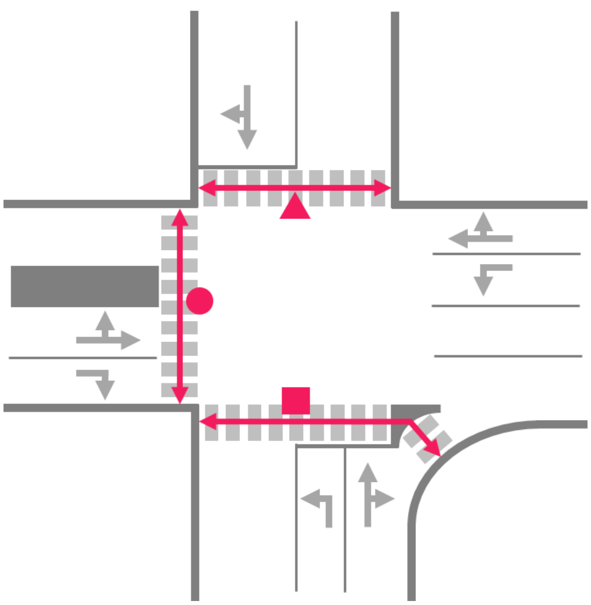
Environment: Average Crossing Width



This is a measure of the distance a pedestrian must walk to cross the intersection at marked crossings. It collects the crossing distance for all marked crossings to create a representative average for the intersection.

This provides a quantification of how well-sized the intersection is for crossing on foot. The longer the average crossing distance is for an intersection, the more daunting and risky the crossing will be for pedestrians, particularly those with mobility issues. Shortening the crossing distances creates a more comfortable and pedestrian-friendly environment.

The intent for this measure is to quantify ***the average crossing distance for all marked crosswalks at the intersection.*** This gives us a picture of how well the environment is sized for pedestrians. Reducing this distance will create a more comfortable and attractive environment for walking.



The example to the left shows the distances to be measured at a typical four-leg intersection. There are four possible desired crossings for pedestrians and only three crosswalks: Northern Crossing (▲); Western Crossing (●); Southern Crossing (■); and, Eastern Crossing (▲+●+■)

Calculate the average value for all four crossings.

Note two important illustrations here:

- Measure the distance from curb to curb where the pedestrian enters the intersection to where they leave. Do not discount for medians or breaks in the path.
- The intersection is penalised for forcing pedestrians to make three crossings to remain on the eastern side of the intersection.

Approaches to reduce the average crossing distance include: clear marking of all pedestrian crossings, removal of exclusive turning lanes, removal of general travel lanes, reduction of lane widths, removal of right turn channels, and closure of intersection legs or individual approaching / departing segments.

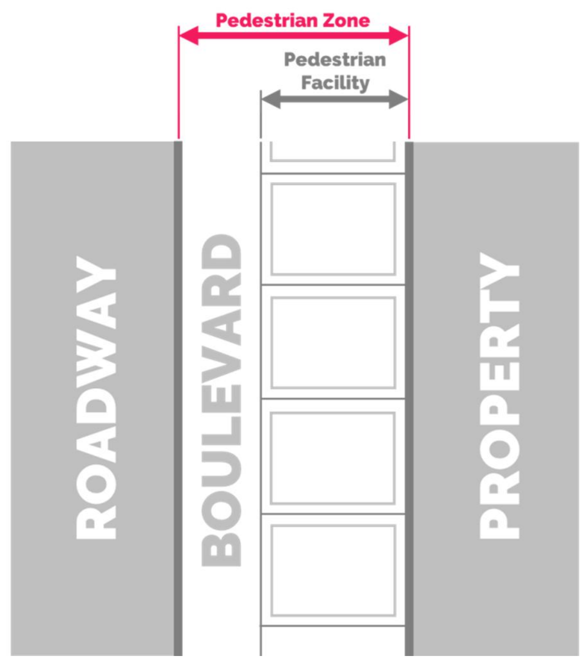
In reality, the eastern crossing at this location would be considered an 'unmarked crosswalk' under Provincial legislation, where drivers are required to yield to pedestrians and allow them to cross. In practice, however, drivers largely tend to ignore this crossing due to the designation on the western side. This, at best, creates inconvenience for pedestrians, and, at worst, creates a stressful and potentially dangerous situation. Neither of these situations are comfortable or attractive for walking.

Environment: Pedestrian Zone Width

The pedestrian zone width is a measure of the overall pedestrian environment. This zone includes both the sidewalk and boulevard space of a street.

The Segment Space measure "pedestrian facility width" is one component of the total pedestrian zone width, which is a more encompassing measure.

The intent of this measure is to quantify ***the width of space dedicated for pedestrians*** to measure the level of comfort for pedestrians on a given street. The wider the zone, the more comfortable it is for pedestrians to use the street.



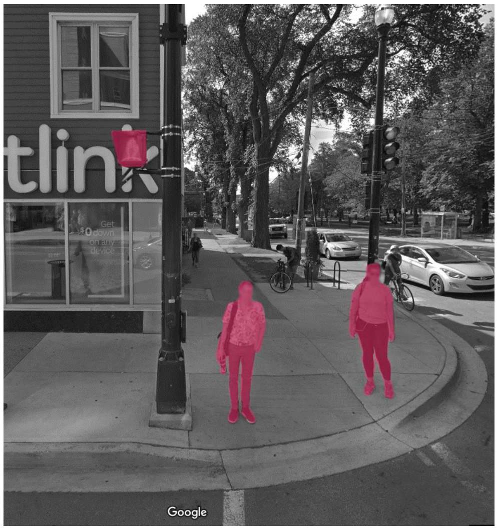
The example on the right, similar to the figure shown in the pedestrian facility width measure (see the Segment Space measure for pedestrians) shows the boundaries of the pedestrian zone width where there is a clear demarcation between the sidewalk facility and boulevard space. The boulevard space will include the buffer space, any street furniture, landscaping, and any other space given over to the pedestrian realm.

As a general rule, the pedestrian zone measurement should include the entire width of space where pedestrians can comfortably be found in a way that does not put them at conflict with another mode within another mode's dedicated area and which does not involve trespassing or loitering. Typically, this will be a measurement from the street-facing property line to the curb line, as shown in the example. However, some exceptions exist.

If a raised cycle track runs parallel to the sidewalk, its width should be excluded from the measurement as it is not useable pedestrian space. Additionally, in some locations, the "walkable area" of a street may extend into private property if a building setback is designed to act as part of the pedestrian realm (e.g., patios, promenades). In such cases, this zone should be measured from building face to the curb. Where there is variation in pedestrian zone width along a segment, take a minimum of three measurements of width and calculate the average to produce a representative pedestrian facility width.

Improvements for this measure can be implemented though: right-of-way boundary expansions, property acquisition; partnerships with private properties to transform their building frontage areas; reduction of vehicle lane width; removal of vehicle lanes; removal of on-street parking; or removal of bus lay-bys. The practical realities of this measure are largely the same as those for the "pedestrian facility width" measure.

Time: Cycle Length



For pedestrians, this is a relative measure of the delay they experience due to the length of the cycle at a signalised intersection.

The intent for this measure is to evaluate ***the delay experienced by pedestrians at intersections.*** The longer a cycle length is, the longer a pedestrian may have to wait to proceed at an intersection and the less convenient the pedestrian travelling experience is.

To calculate this measure, use applicable traffic-related software or other typical traffic analysis methods to determine the full cycle time length for the signal controlling pedestrian movements. If the same cycle length applies to both pedestrians and bicycles, the score for this measure will be the same as the score for the cyclist intersection time measure.

For unsignalised intersections and roundabouts, consideration should be given to level of control and the presence of marked crosswalks at the intersection. The more clearly that the crossing points are marked for pedestrians, the less delay they will experience when attempting to cross. The Level of Service can be assigned as follows:

- All-way Stop Control or Roundabout or All Legs with Marked Crosswalks – LOS A
- Two-way Stop Control with all major leg crosswalks marked – LOS B
- Two-way Stop Control with one major leg crosswalk marked – LOS C
- Two-way Stop Control with all minor leg crosswalks marked – LOS D
- Two-way Stop Control with one minor leg crosswalk marked – LOS E
- Two-way Stop Control with no crosswalks marked – LOS F

The approach to assigning LOS for unsignalised intersections represents the likely increase in delay for pedestrians as the intersection has fewer clearly marked crosswalks. Drivers are far less likely to yield to pedestrians where the crosswalk is not clearly indicated, despite provincial legislation to yield at all marked and unmarked crosswalks. This will lead to generally higher delays for pedestrians where they must wait for drivers to yield appropriately to allow them to cross.

Shortening the overall signal cycle length and designing smaller intersections with shorter crossing lengths (since the pedestrian phases, based on the time required to cross the pedestrian crossing at an average walking speed, often govern the signal length) are two possible solutions to improve the score for this measure.

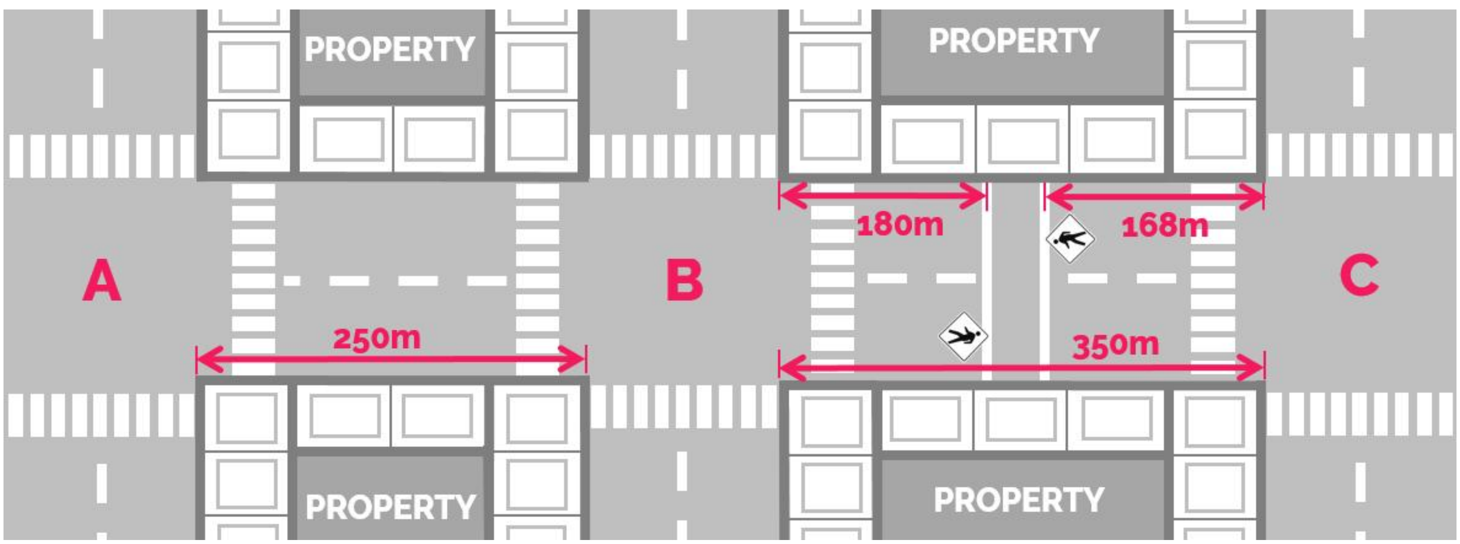
Attention should be paid to the fact that any modifications to the traffic signal timing will affect all modes. Additionally, modification of phase or interval lengths should never be done at the sake of compromising motorist, cyclist, or pedestrian safety.

Time: Distance Between Marked Crossings

This measure considers the average distance between marked pedestrian crossings along a given segment. Shorter distances between marked intersections along a corridor are a significant determinant to how attractive as an option is walking along the corridor.

The intent of this measure is to quantify ***the hindrance caused for pedestrians by added travel time to the marked crossing nearest to their desired location***. Shorter distances between marked crossings mean more convenience for pedestrians to cross the street at desired locations, connect to the surrounding street network, and ultimately make their way to their destination.

To calculate, measure the distance(s) between marked pedestrian crossings for the segment and average them out. Note that marked crossings can be located mid-block and not only at intersections.

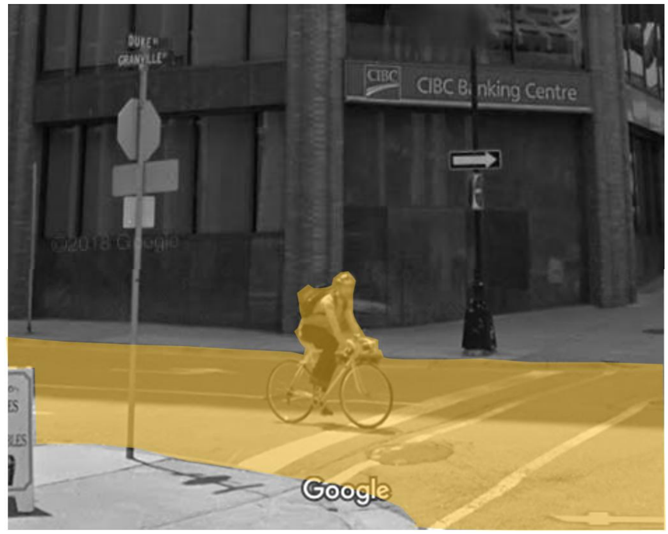


Measurements should be taken from curb to curb and should NOT include the crossing distances. It is possible that the length of the segment is equivalent to the average distance between intersections in cases where marked crossings exist only at the two ends of a segment. In the example shown above, if the study segment ran from A to B, the average distance between blocks would be ***250m***. However, if the segment measured from A to C, the average distance would be ***199m*** on both sides (calculated as the average of 250m, 180m, and 168m since block BC has a mid-block marked crossing)

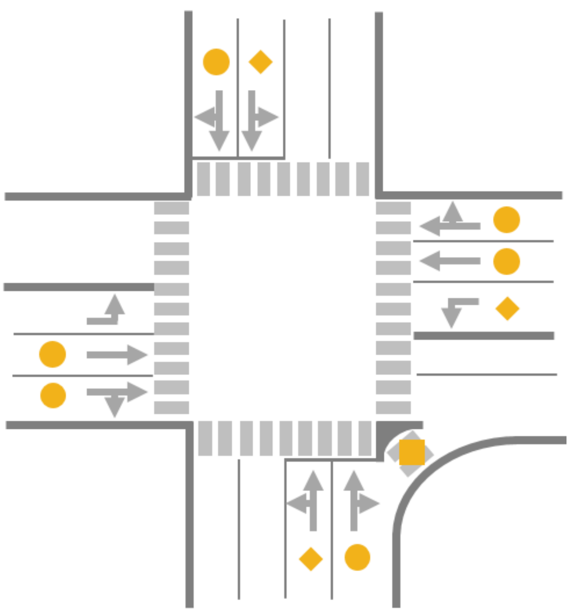
Two possible ways to improve the score for this measure include designing shorter street block lengths and introducing more marked crosswalks (whether at intersections or mid-block) along a corridor.

Space: Number of Uncontrolled Conflicts

An uncontrolled conflict occurs within an intersection where a cyclist may be in conflict with another mode and vulnerable. This measure considers the number of locations at an intersection where cyclists need to cross moving vehicle traffic streams to move through the intersection.



The intent of the measure is to ***quantify the sources of risk to cyclists as they cross an intersection***, primarily from turning cars, trucks, and buses. As with pedestrians (see the pedestrian intersection measure for space), by examining the points where conflict can occur, we can quantify a simple examination of the safety of an intersection for cyclists.



To calculate this, count the total number of the following conditions present at the intersection:

- Permitted left turns for vehicles
- Exclusive right turn lanes for vehicles
- Right turn channels for vehicles
- Number of lane changes required for a cyclist to make a left turn (through or through-right lanes)

In the example to the left (assumed to be a signalised intersection), the score for this measure is **10**: there are **3** permitted left turns (◆) assuming the EBL is protected, **1** right turn channel (■), and **6** possible lanes that a cyclist in the curb lane would have to change to turn left (●).

Note that this measure must be calculated for both signalised and unsignalised intersections.

Narrower roadways (due to a lesser overall number of lanes) are one way to improve the score on this measure. Other ways to improve the score include: minimizing the number of right turn channels; minimizing the number of exclusive right turn lanes; and protecting all left turns at an intersection.

In practice, all intersection designs will be subject to relevant HRM design guidelines and should be designed in accordance with the intent and requirements of these guidelines. Intersection designs should never compromise user safety for the sake of a higher score on this measure.

Space: Driveway Density

The driveway density measure considers the number and type of driveways along the segment that conflict with the direction of cyclist travel. The more conflicting driveways and the higher the volumes using those driveways, the less comfortable and less safe the cycling space is.

The intent of this measure is to ***determine the level of safety for cyclists in their dedicated space along a segment.***

To calculate this measure, count the number of driveways along the segment and sort them into the categories listed in the table below. The various driveway types receive factors based on their frequency of use to indicate the likelihood of vehicles conflicting with cyclists. Multiply the number of driveways of each type by the appropriate factor and sum up the individual scores to get the total score for the segment. Divide the score by the length of the segment (in kilometres) to obtain the driveway density. The HRM MMLOS spreadsheet includes the appropriate calculations on a separate tab.

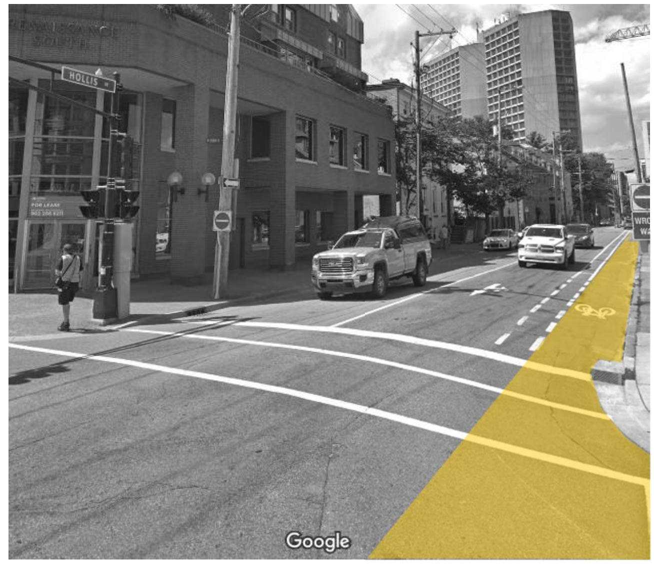
Possible strategies to improve this measure include: reducing the number of driveways on a segment; providing alternate driveway access on an adjacent corridor; reducing the number of units or parking spaces that are served by the driveway; and designing driveways and cyclist paths so as to minimize conflicts between the two elements. Particularly, minimize conflicts with commercial driveways where possible. The optimal combination for this measure is long blocks with minimal or no driveways.

Driveway Type		Factor
Residential	Low Density (1-4 units)	0.5
	Medium Density (5-13)	1
	High Density (13+)	1.5
Commercial, Industrial, Institutional	Low (0-10 parking spaces, includes loading zones)	1.5
	Medium (10-50 parking spaces)	2
	Sites with open access	2
	High (>50 parking spaces)	3
	Drive-Thrus (high turnover)	4

However, in reality, always segregating cyclists from driveways and other modes is not realistic or practical. For most properties, driveways are the main point of access and cannot be avoided or already exist with no other options for access. And finally, moving driveways from one corridor to another may simply be displacing the issue to another corridor. There may be advantages in this context, however, related to the number of cyclists using (or forecasted to use) the corridors in question based on existing or planned infrastructure. In this case it may be useful to place driveway access so that it doesn't not interfere with a priority cycling route.

Consult relevant HRM design guidelines/policy documents and design segments to meet their intent and requirements.

Environment: Priority Treatments



This measure presents a simple calculation that examines the type of cycling infrastructure present at an intersection.

The intent of the measure is ***to push the analysis towards the need to provide quality cycling infrastructure along priority routes***. The intent is also to ***recognize that implementation of improved cycling infrastructure on non-priority routes is also beneficial to the cycling experience***.

Each approach to the intersection is given a maximum possible score of 10 points if it is located along a priority cycling route or 5 points if not. To calculate, assign a score to each approach based on the available infrastructure, according the table below. Then, sum the points for each approach for a total score for the overall intersection and calculate the percentage of the possible points achieved. The maximum points for each approach (depending on if it's a cycling priority or a regular corridor) are also shown in the table below. The HRM MMLOS spreadsheet includes the appropriate calculations on a separate tab.

Treatment	Cycling Priority Corridor	Basic Corridor
Maximum Score	**10**	**5**
Physically Separated	10	5
Horizontally Separated	6	5
Curb Lane >4m	2	2
Curb Lane <4m	0	0
Right Turn Lane	-2	-1

Introducing dedicated cycling infrastructure at intersections (especially in cycling priority corridors but also on non-priority routes), eliminating exclusive right turn lanes, and widening curb lanes are all ways to improve the score for this measure.

In practice, all intersection designs will be subject to relevant HRM design guidelines and should be designed in accordance with the intent and requirements of these guidelines. Intersection designs should never compromise user safety for the sake of a higher score on this measure.

Environment: Speed x Volume

This measure considers a combination of the cycling facility type, speed of adjacent vehicular traffic, and the volume of adjacent vehicular traffic to assess the comfort of cycling.

Though the cycling facility type is a major component of the attractiveness of cycling along a corridor, it alone doesn't tell the whole story of the cycling environment. Cyclist comfort is also dependent on the traffic movement alongside the cyclist. Even cyclists on separated cycling facilities will still feel uncomfortable or unsafe near a roadway with high car volumes traveling at great speeds. Therefore, the intent of this measure is to ***quantify the attractiveness of cycling along a segment as a function of cyclist comfort***.

To calculate, first determine the type of cycling facility along the segment. Note that the All Ages and Abilities (AAA) facility refers to a fully separated cycle track (curb, bollards, parking, planters), multi-use pathway, or local street bikeway. By virtue of their characteristics, only AAA facilities can get an LOS A; all other facilities have subsequently lower maximum possible scores. Next, multiply the Average Annual Daily Traffic (AADT) for the segment by the ***operating speed*** (<u>not</u> posted or design speed) and divide by 1000. Look up the corresponding LOS in the table below based on the facility type and score. The HRM MMLOS spreadsheet includes the appropriate calculations on a separate tab.

If AADT for the segment is not readily available, use the AM or PM peak hour auto volume (whichever is higher) and multiply by a factor of 10 to approximate the AADT.

	AADT (x1000) x Operating Speed			
Facility Type	**<120**	**300**	**450**	**600+**
AAA Facility	LOS A		LOS B	
Buffered Bike Lane OR Painted Bike Lane ≥ 1.8m	LOS B	LOS C		LOS D
Painted Bike Lane (No Buffer) <1.8m	LOS C	LOS D		LOS E
Mixed Traffic	LOS D	LOS E		LOS F
Mixed Traffic + Parking	LOS E		LOS F	

For instance, a 1.5m painted bike lane (3rd row of facility types) on a roadway with an operating speed of 50km/hr and an AADT of 6,500 vehicles would get an LOS D (50 x 6,500 / 1,000 = 325). Meanwhile, a multi-use pathway (1st row of facility types) with an adjacent roadway with operating speeds of 70km/hr and an AADT of 10,000 vehicles would get an LOS B (70 x 10,000 / 1,000 = 700).

To improve the score for this measure, build the highest quality cycling infrastructure possible, reduce the speed of cars on the segment, or reduce the volume of cars on the segment.

Time: Cycle Length

This is a proxy for the relative delay that cyclists experience due to the length of the cycle at a signalised intersection.

The intent for this measure is to evaluate ***the delay experienced by cyclists at intersections.*** The longer the cycle length is, the longer a cyclist may have to wait to proceed at an intersection and the less convenient the cycling experience is.

To calculate this measure, use applicable traffic-related software or other typical traffic analysis methods to determine the full cycle time length for the signal controlling cyclist movements. If the same cycle length applies for both pedestrians and bicycles, the score for this measure will be the same as the score for the pedestrian intersection time measure.

For unsignalised intersections and roundabouts, consideration should be given to the level of control and size of the intersecting facilities. The increased vulnerability and reduced acceleration of cyclists compared to cars means that the delays they experience when making through or turning movements from stop-controlled approaches will be significant, as they must wait for larger gaps in traffic to proceed safely (or dismount and cross as a pedestrian). The Level of Service for unsignalised intersections can be assigned as follows:

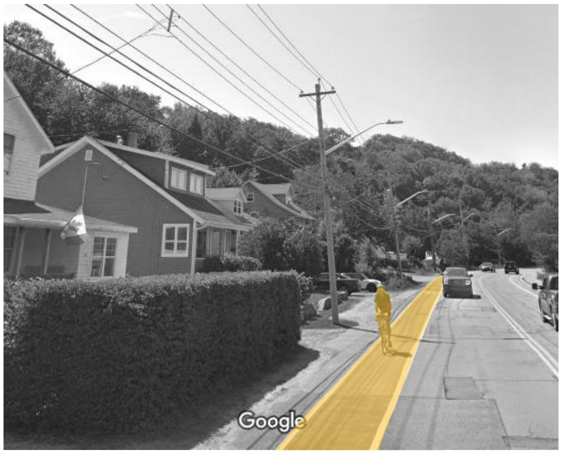
- All-way Stop Control or Roundabout – Identical to auto intersection LOS from traffic analysis
- Two-way Stop Control with one lane per direction on major street – LOS C
- Two-way Stop Control with two lanes per direction on major street – LOS E
- Two-way Stop Control with more than two lanes per direction on major street – LOS F

The approach to assigning LOS for unsignalised intersections represents the likely increase in ***delay*** for cyclists arriving at the intersection on the stop-controlled approaches. It also gives consideration for cyclists turning left from the major facility, as they would necessarily need to cross the opposing lanes of traffic. For All-Way Stop Control intersections and roundabouts, the approach here assumes that the cyclist would take the lane and assume the same level of delay experienced by motorists.

Shortening the overall signal cycle length and designing smaller intersections with shorter crossing distances (as pedestrian crossing time often dictates cycle length), and intersections with fewer lanes are some possible solutions to improve the score for this measure.

Attention should be paid to the fact that any modifications to the traffic signal timing will affect all modes. Additionally, modification of phase or interval lengths should never be done at the sake of compromising motorist, cyclist, or pedestrian safety.

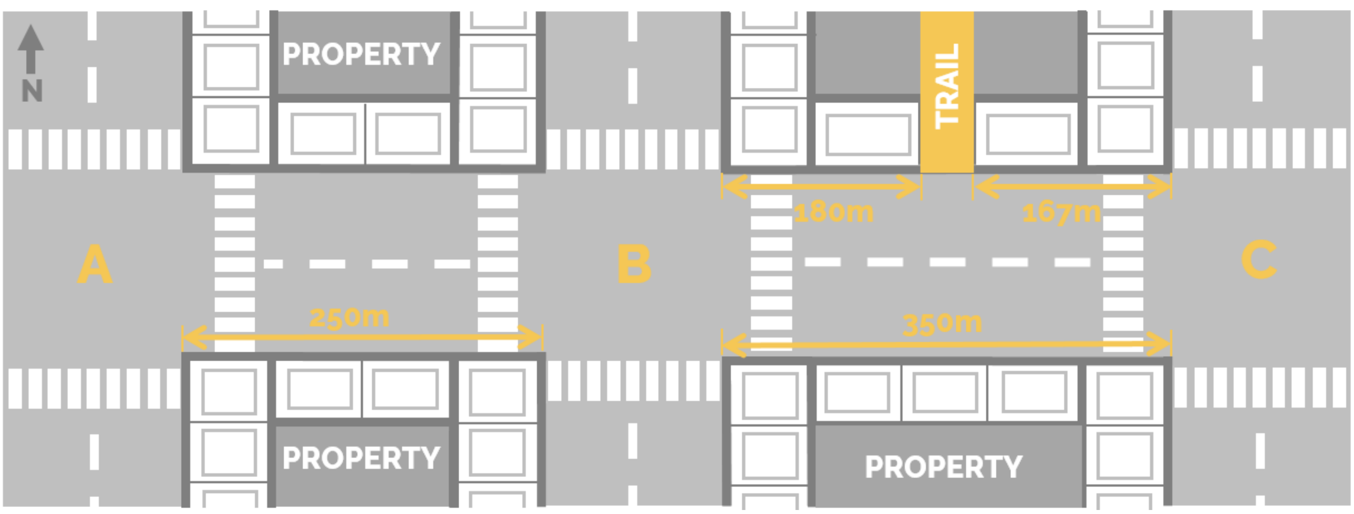
Time: Block Length



This measure considers the average length of blocks along a segment. The shorter the block length, the more bikeable the segment is, as shorter blocks provide flexibility for cyclists attempting to wiggle through the network on facilities where they feel comfortable (relative to grade, facility type, traffic, speed, etc.) while minimising their travel distance.

Therefore, the intent of the measure is to ***quantify the level of mobility and convenience offered for cycling trips along the segment***. The fundamental concepts behind this measure for cyclists are similar to the pedestrian segment measure for time.

To calculate this, measure the distance(s) between adjacent cycling pathways that intersect a given segment and average them out. Measurements should be taken from curb to curb and should NOT include the widths of any intersections in the segment.



It is possible for the length of the segment to be equivalent to the average distance between intersections in cases where cycling intersections exist only at the two ends of a segment. In the example shown above, if the study segment ran from A to B, the average block length would be **250m**. However, if the segment measured from A to C, the average block length would be **199m** on the ***north side*** (calculated as the average of 250m, 180m, and 167m, since a multi-use trail that cyclists can use is present mid-block) and **300m** on the ***south side*** (average of 250m and 350m).

Possible ways to improving the score for this measure include encouraging porosity in greenfield developments (by planning shorter block lengths), and introducing mid-block paths or trails on existing networks to give cyclists access to adjacent roads. In practice, block length will be naturally longer in suburbs and rural areas. This is due to the typical curvilinear street network and limited access of a traditional suburb as well as the sheer amount of distance between destinations and roads in rural areas.

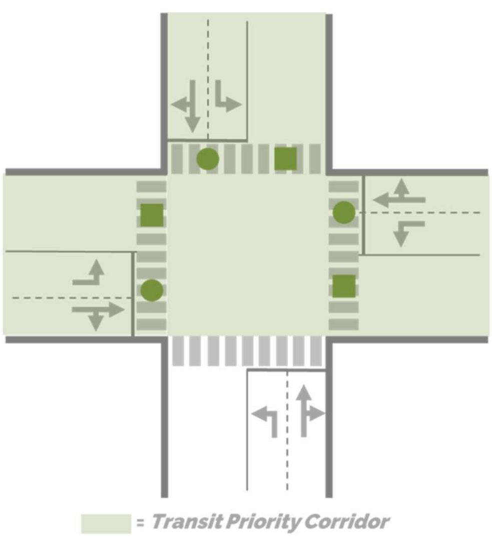
Space: % of Transit Priority Measures (of Ideal)

Although the presence of transit priority measures at the intersection prioritises the transit mode, it would be unfair to penalise intersections for not providing these on all approaches if that is not the intent, due to the nature of transit planning and routing. Therefore, this measure compares the level of compliance of transit facilities to the intention of the planned transit network at the intersection.

The intent of this measure is to ***determine whether dedicated transit lanes exist at locations that have been prioritised as transit priority corridors in overarching planning documents***.

To calculate this, consult the transit priority corridor map in HRM's Integrated Mobility Plan (and Halifax Transit staff, as necessary) to determine if any approaches of the intersection fall within a transit priority corridor and their proposed treatment. If any priority corridors affect the intersection, the following value must be calculated:

$$\text{\% Transit Priority Measures} = \frac{\text{\# of approaches with transit priority measures}}{\text{\# of approaches with planned transit priority measures}}$$



If no approaches appear on the transit priority corridor map, omit calculation of this measure.

Note that both approaching and departing lanes are considered for this calculation. Therefore, in the example on the right, the denominator of the equation would be **6**. This is because ideally, there would be three approaching (●) and three departing (■) transit priority measures. The south leg of the intersection is not part of a transit priority corridor.

To improve this measure, a new development/re-development could act as an opportunity to construct transit lanes, queue jumps, or other treatments on streets planned to have these transit priority measures.

However, in reality, the timeline of a development may not line up with the implementation plan of the IMP and a corridor may not be ready for transit lanes at the same time as a development comes online. Discuss with HRM staff if the conditions and timing are right for the implementation of transit lanes in the study area.

Space: Transit Facility Type

This measure evaluates the transit facility present along a segment. In general, the more permanent and separated dedicated transit facilities score higher, while conditions that place public transit vehicles in mixed-traffic conditions with no dedicated transit facilities score lower.

The intent of the measure is to ***evaluate the space dedicated to transit vehicles along a segment*** through a simple observation of the type of facility present for transit vehicles.

To evaluate, choose the transit treatment used from the following discrete list of possibilities:

- 24-hour transit lanes / Dedicated infrastructure (e.g., transitway);
- Day time transit lanes;
- Peak period dedicated transit lanes;
- Mixed traffic with more than one lane;
- Mixed traffic with one lane; and,
- Mixed traffic and on-street parking.

Improving the transit treatments to any of the treatments higher on the list above will result in a higher score on this measure.

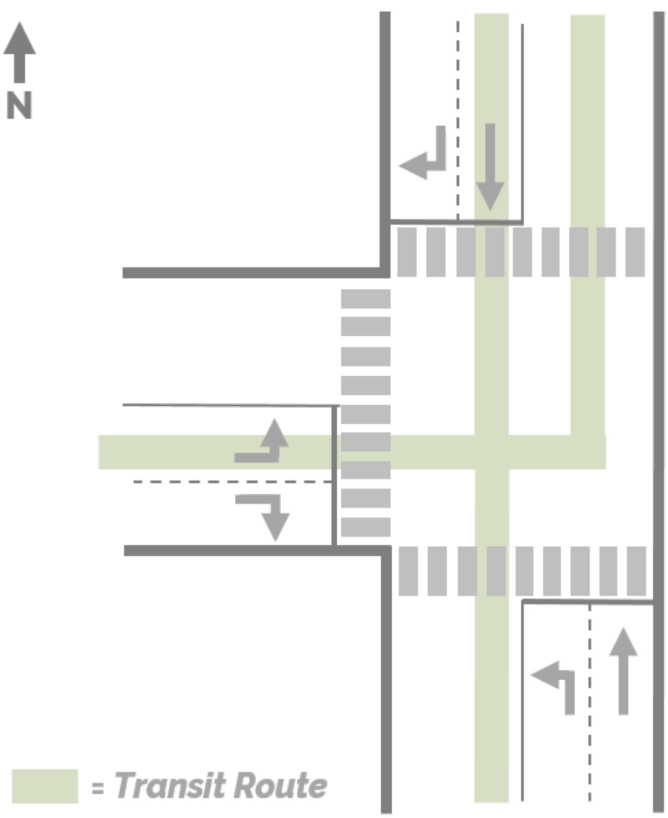
However, sometimes the timeline of a development may not line up with preferred construction of new transit facilities or a project may have unique constraints that do not allow for the construction of certain transit treatments. Additionally, if the corridor is not planned as a transit priority corridor but is designated as priority for another mode, it may make more sense to use right-of-way to construct treatments for the priority mode(s) rather than transit. Discuss with HRM staff if upgrading of transit facilities makes sense in the study area.

Environment: Transit Movement V/C Ratio

This measure calculates the average volume to capacity ratio (v/c ratio) for movements at the intersection that concern transit vehicles, based on their routing.

The intent of this measure is to ***determine the available roadway capacity for transit and the level of congestion affecting transit***. Where transit vehicles are in mixed traffic, this is a measure of their freedom of movement through the intersection.

Use applicable traffic-related software or other intersection analysis methods to calculate the v/c ratios for each movement. The v/c ratios should be measured regardless of whether transit operates in mixed traffic conditions or on dedicated facilities but only for movements that are used by transit routes. Then, determine which movements at the intersection are used by transit vehicles and average the v/c ratios for those movements ONLY to obtain the final value for this measure.



In the example to the left, assuming mixed traffic conditions, only the v/c ratios for the southbound through and eastbound left movements would be averaged to find the transit movement v/c ratio.

Traffic signal optimization to prioritize transit movements, increasing general roadway capacity (though studies show that this is generally a very-short term solution), exclusive transit lanes, and effective transportation demand management (TDM) programs could all help to improve the score for this measure.

However, note that optimizing the signal timing for a single movement will affect all movements. Additionally, endless widening of roadways to increase general capacity is not in line with the long term goals and direction of the IMP. Depending on the unique intersection context, motorized vehicles may be required to operate near or at capacity to reach the desired planning future for the area.

Environment: % of Stops with Bus Lay-bys

This is a measure of how many stops along the segment are completed via a bus lay-by, which forces the bus to pull off to the side of the right lane to board and alight passengers before merging back into traffic.

While the bus lay-by setup is advantageous to automobiles, it presents delay and difficulty for the transit vehicle in re-entering the traffic stream and increases the time required to enter and exit stops. Bus lay-bys are representative of an environment designed for cars and not transit. Therefore, the intent of the measure is to ***evaluate the extent that the transit environment causes additional inconvenience experienced by a bus along a segment*** due to having pull off to the side and later re-join the traffic.

To calculate this measure, divide the number of bus stops along the segment that use bus lay-bys by the total number of bus stops. A bus lay-by can be considered as any condition where the bus must leave the primary travel lane to board/alight passengers, such as a bus bay, a designated bus stop adjacent to on-street parking, or other such condition. If the segment does not have any bus stops, this measure does not apply and should not be calculated.

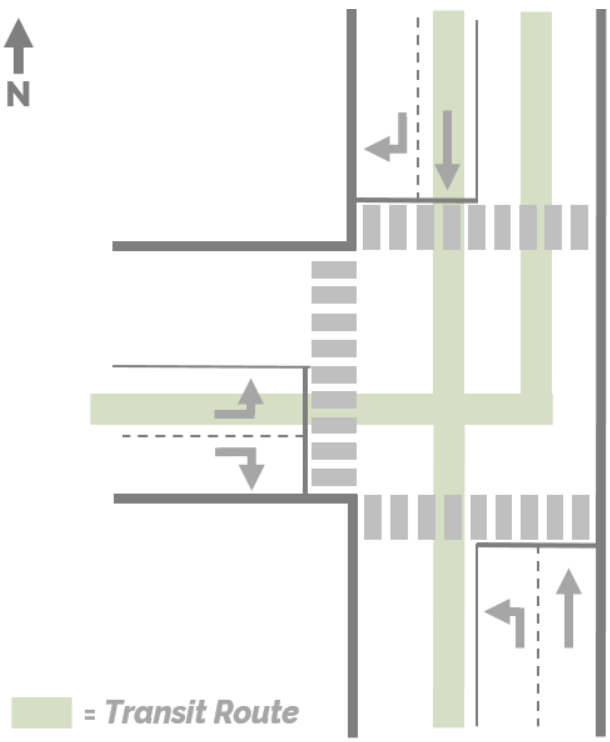
Designing bus stops without a lay-by area along a corridor will improve the scores for this measure. However, bus stop designs are also subject to any applicable HRM and Halifax Transit design guidelines.

Time: Transit Movement Delay

This measure for transit refers to the delay experienced specifically by transit vehicles at an intersection.

The intent for this measure is to ***quantify the average delay experienced by transit*** in order to determine the level of convenience for transit. The shorter the delay felt by transit, the more convenient and less broken up a transit trip is.

To calculate this, use applicable traffic-related software or other typical intersection analysis methods to determine the delay for each movement. The delay should be measured regardless of whether transit operates in mixed traffic conditions or on dedicated facilities. Then, determine which movements at the intersection are used by transit vehicles and calculate the average delay for those movements ONLY to obtain the final value for this measure.



In the example to the left, transit experiences delay on the southbound through and eastbound left movements. Therefore, the calculated delay for transit should be the average of the delay for those two movements only.

Since delay for vehicular traffic can be calculated for unsignalised intersections as well as signalised, this calculation should be performed even at unsignalised intersections with transit movements. If an intersection has no movements along which transit moves, this measure does not require calculation.

Possible ways to improve this measure include: implementing transit signal priority at signalised intersections; optimizing the signal timing to provide more time for movements with transit routes; exclusive transit lanes or queue jumps; and, shortening the overall cycle length.

In reality, any modification of the traffic signal will likely affect all movements and modes. Keep this in mind when dealing with this measure. Additionally, modification of phasing or splits should not be modified in a way that would compromise the safety of users of any mode (e.g., minimum pedestrian crossing times).

Time: Travel Speed/Ideal Speed

This measure compares the actual travel speed for a vehicle travelling on a corridor to the ideal speed (i.e., posted speed limit) for the corridor.

As the speed along the corridor degrades, the LOS for a travelling vehicle also degrades. The intent of the measure is to ***quantify the extent to which vehicular travel along a corridor is smooth and unhindered***.

Note that this calculation ***should be applied at a corridor level only*** *for sections that are at least 700m in length, dependent on logical breakpoints. The calculation should be calculated for the overall corridor or section and applied identically to all segments within that section / corridor. Consideration of travel speed along short segments is not informative or representative of movement for motorised modes, as delay generally occurs at the intersections at the end of individual segments.*

To calculate this ratio, do the following:

1. Note the posted speed limit for the corridor.
2. Measure the overall corridor distance taken between the inner intersection curbs.
3. Calculate ***freeflow time (s)*** = $\frac{\textbf{segment length (m)}}{\textbf{posted speed }\left(\frac{km}{hr}\right)} \times 3.6$
4. Obtain the approach delay for the segment using conventional traffic analysis methodology and any applicable traffic analysis software
5. Calculate ***congested time (s)*** = $\textbf{approach delay (s)} + \textbf{freeflow time (s)}$
6. Calculate ***congested speed (km/hr)*** = $\frac{\textbf{segment length (m)}}{\textbf{congested time (s)}} \times 3.6$
7. Calculate ***ratio*** = $\frac{\textbf{congested speed (km/hr)}}{\textbf{posted speed }\left(\frac{km}{hr}\right)}$

The final ratio is the required result for this measure. The closer the value is to 1, the more efficient the travel experience for a vehicle. Note that in mixed traffic conditions (i.e. in cases with no specific dedicated infrastructure for any of the following modes), this ratio will be the same for transit, trucks, and automobiles. Omit this calculation if transit does not travel on the corridor. Apply the same result to all segments within the corridor or section.

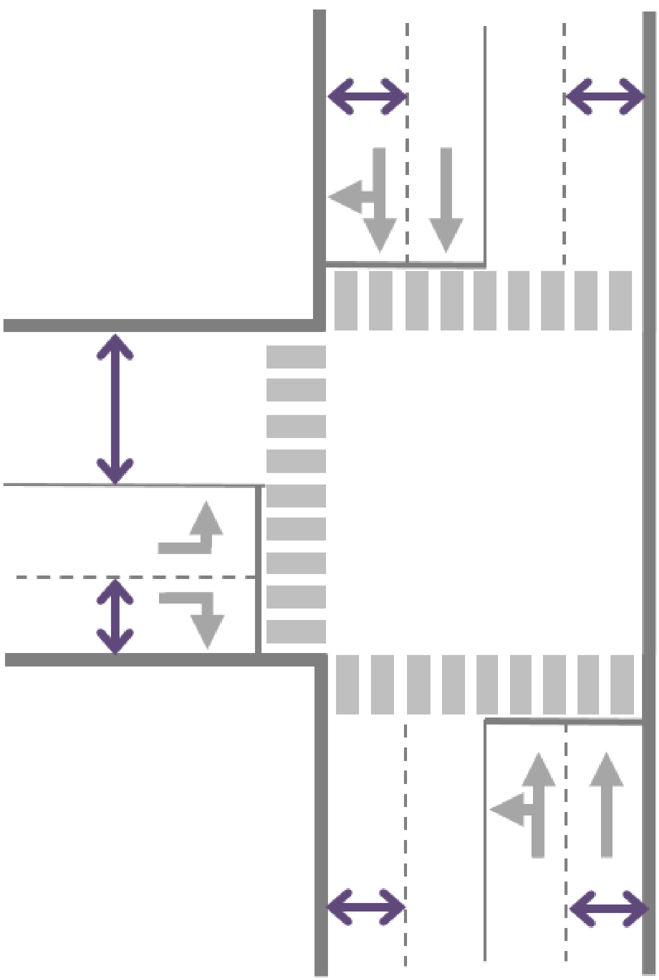
This measure can be improved by lengthening block lengths to minimize the number of intersections in a segment, minimizing the number of uncontrolled active transportation crossings in a segment, and lowering the posted speed limit to match the travel speed.

Goods Movement

Space: Average Curb Lane Width

The average curb lane width measure averages the curb lane widths at an intersection. This is because trucks will typically travel in the right-hand lane in an urban environment where there are multiple lanes available, as these lanes are typically wider and allow more agile vehicles to pass the truck on the left-hand side. The wider the curb lane is, the easier it will be for the larger vehicle to complete a turning movement.

The intent of this measure is to ***determine how safely trucks can navigate through the intersection***. This measure also provides consideration of the suitability of the environment for trucks relative to completing turning movements safely.



To calculate the measure, average the width of all approaching AND departing curb lanes at an intersection width for each approach that permits truck movement along it. Consider only the traveled width of the lane, discounting for any on-street parking, painted bike lanes, or other considerations that narrow the traveled width. In the example on the left, **six** different widths would be averaged.

To improve this measure, widen curb lanes for any intersection legs that permit truck movements.

In reality, all intersection and lane designs are subject to relevant HRM design guidelines and should be designed in accordance with the intent and requirements of these guidelines. Lane widths may also be limited by existing policies that determine the modal priority of a given corridor. Road designs should never compromise user safety for the sake of a higher score on this measure.

Space: Width of Curb Lane

While similar to the intersection space measure for trucks, this measure looks at the average mid-block curb lane width along a segment. As trucks tend to be larger than the majority of other vehicles on the road, they generally require larger lane widths to safely accommodate the vehicle. Trucks also generally travel in the right-hand lane of a roadway.

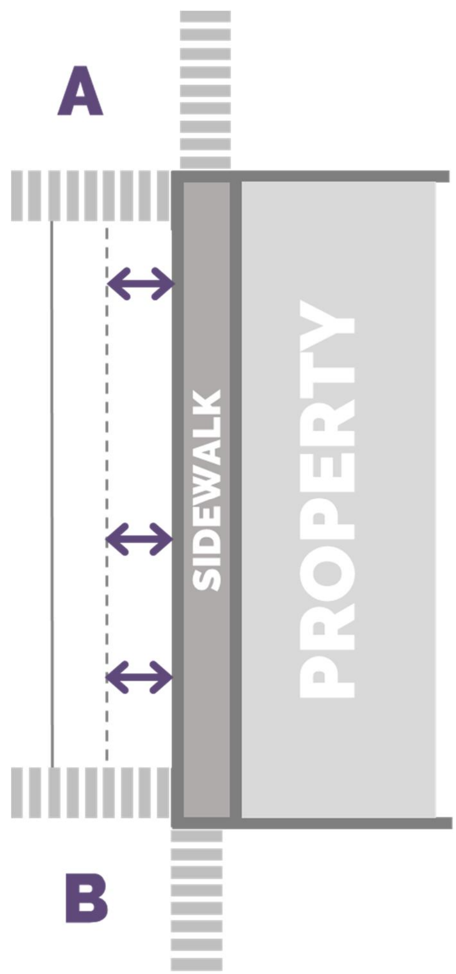
Therefore, the intent of this measure is to ***determine the extent of safety and comfort experienced by trucks along the segment***.

To calculate, measure the width of the right-hand lane along the segment. It is recommended that the width of at least three locations along the segment are averaged to determine the final value. This can be accomplished via field measurement, or through application of CAD, GIS, or online mapping tools.

The example on the left shows three measurement locations along Segment AB that would be averaged to determine the final value for this measure.

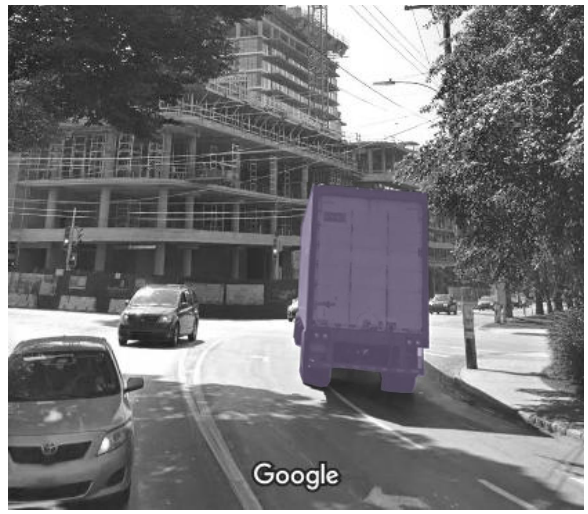
To improve this measure, widen curb lanes along any corridors that permit truck movement.

In reality, available right-of-way may limit the possibility of widening lanes along a corridor. Additionally, all roadway designs and lane widths are subject to relevant HRM design guidelines and existing policies that determine the modal priority of a given corridor. Roads should thus be planned and designed in accordance with the intent and requirements of these guidelines. Road designs should also never compromise user safety for the sake of a higher score on this measure.



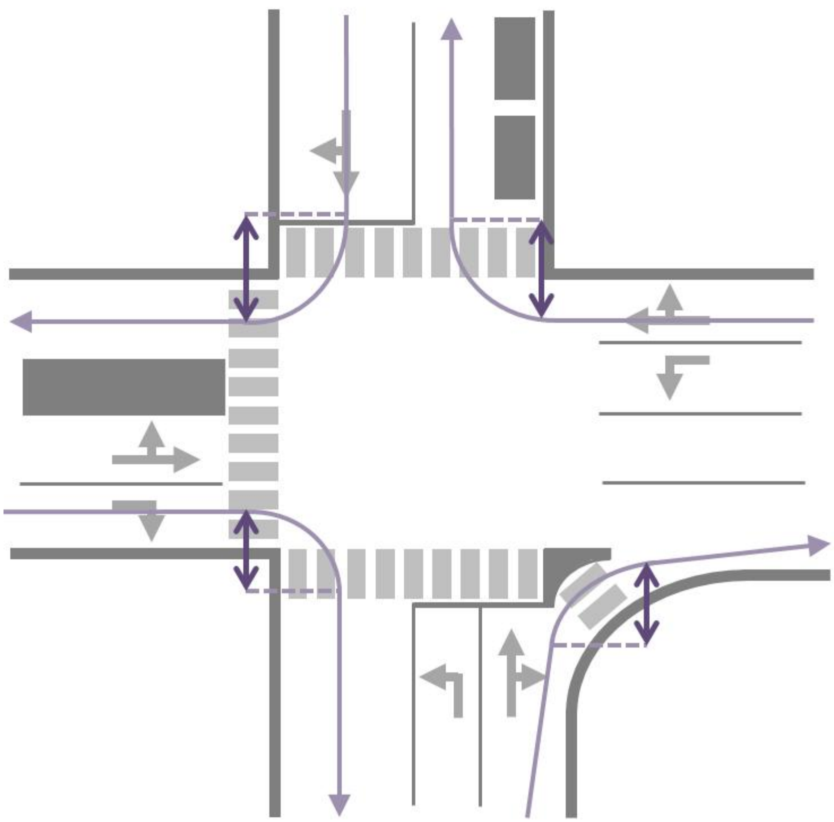
Environment: Average Effective Curb Radius

This measure evaluates the average effective curb radius at an intersection. The larger this radius is, the easier it is for the truck to navigate turns.



The intent of the measure is to ***evaluate how easily trucks can navigate in the road environment***.

The effective curb radius refers to the actual path to be traced by the truck when turning right. It is NOT the radius of the pavement curb. The example below shows the path of travel for right turning vehicles. The purple arrows represent the effective curb radius.



To calculate this measure, take the average of the curb radii at the intersection for right-turns at all approaches where truck movement is permitted. Curb radii must be measured from the furthest practical point where the truck could begin and complete the turn (i.e. mid-lane, not at the pavement curb). This can be accomplished via field measurement, or through application of CAD, GIS, or online mapping tools.

When determining the path that would be travelled, also keep in mind the effects of any curbside parking lanes or other features that would shrink or increase the effective curb radius.

To improve this measure, design curbs with larger radii at any right-turn movements that permit trucks.

In reality, all intersection designs are subject to relevant HRM design guidelines and should be designed in accordance with the intent and requirements of these guidelines. A redesign of an entire intersection to accommodate larger radii will also affect other intersection users and may not be the most efficient solution to improving a goods movement LOS. Intersection designs should never compromise user safety for the sake of a higher score on this measure.

Environment: % No Stopping/No Loading

This measure examines how restrictive a space is to loading/unloading of trucks. It is essentially a measure of "no stopping," "no parking," and "no loading" restrictions along a segment compared to the total segment length.

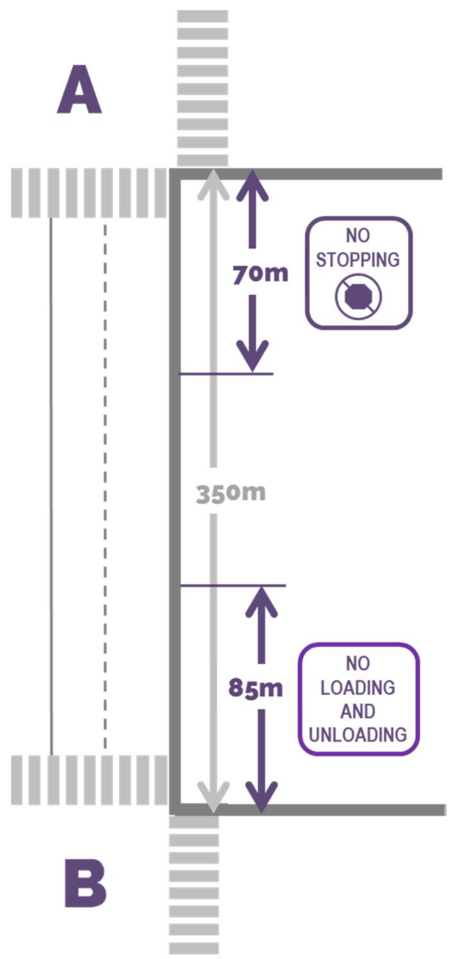
The intent of the measure is to ***quantify the convenience for commercial deliveries along a segment***, which is the primary purpose of a goods movement trip.

To calculate the measure, measure the total length where truck loading is not permitted (e.g. "No Stopping", "No Loading," etc.) along the segment and divide it by the total segment length (measured between inner curbs). In the example below, for the Segment AB the ratio would be equivalent to **44%** (there is 155m of truck-restricted length in a 350m long segment).

In environments where curbside loading is generally not possible (e.g. major arterials) or unnecessary (e.g., suburban business park with loading bays and/or large parking lots) this measure can be omitted.

This measure can be improved by minimizing truck loading restrictions along segments. Adding on-street parking can also help indirectly as trucks can use parking spaces for short periods of time while loading or unloading.

However, in reality, some segments may not have any land uses along them that require loading zones even if the street type allows for curbside loading in theory and there is no additional loading space nearby. Therefore, if trying to improve the goods movement score for the segment, focusing on the time or space segment measures may be more appropriate.

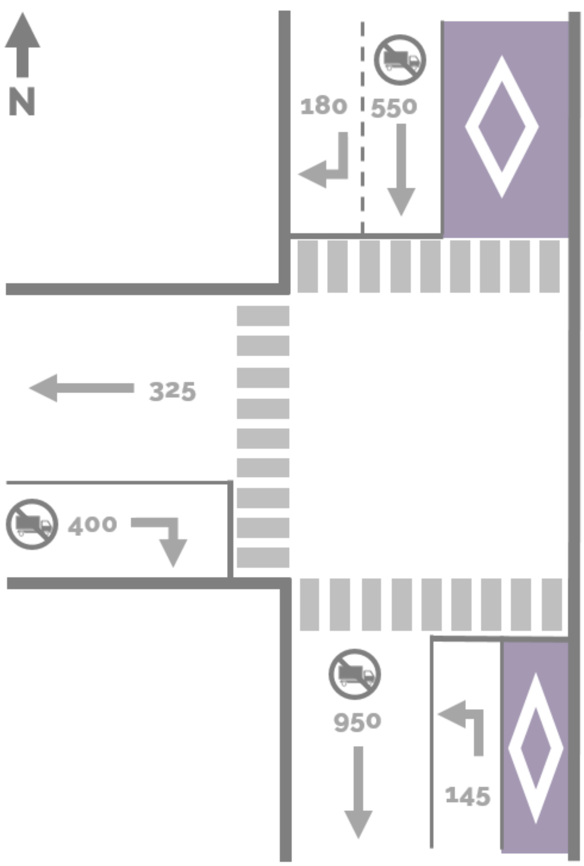


Time: Truck Intersection Delay

This measure refers to the delay experienced by trucks on all movements at an intersection.

The intent for this measure is to ***calculate the average delay experienced by trucks*** in order to determine their level of convenience. The shorter the delay felt by trucks, the more efficient and convenient the trip is for the movement of goods through the intersection.

To calculate this, use applicable traffic-related software or other typical intersection analysis methods to determine the delay for each movement on which trucks are allowed. The delays for movements with trucks permitted on them should then be averaged. As mentioned previously, delays for intersection legs with all vehicles prohibitions (e.g. "transit only") should not be included in this average calculation.



In the example shown on the left (the numbers represent hourly volumes), only the SBR and NBL movements would be included in the truck delay volume-weighted average – the SBT and EBR movements prohibit trucks and the NBT movement is transit only.

Where trucks are permitted on all turning movements, the overall intersection delay can be used. Therefore, this measure can be equivalent to the intersection delay measure for automobiles.

Since delay for vehicular traffic can be calculated for unsignalised intersections as well as signalised ones, this calculation should be performed at both signalised and unsignalised intersections.

Possible ways to improve this measure include: designing smaller intersections to reduce oft-governing pedestrian walking time; optimizing the signal timing to provide more time for truck movements; and shortening cycle lengths.

In reality, when modifying a plan or design for this measure, keep in mind that any optimization of the traffic signal may affect all movements and motorized modes. Additionally, modification of phase or interval lengths should never be done at the sake of compromising the safety of any mode.

Time: Travel Speed/Ideal Speed

This measure compares the actual travel speed for a vehicle travelling on a corridor to the ideal speed (i.e., posted speed limit) for the corridor.

As the speed along the corridor degrades, the LOS for a travelling vehicle also degrades. The intent of the measure is to ***quantify the extent to which vehicular travel along a corridor is smooth and unhindered***.

*Note that this calculation **should be applied at a corridor level only** for sections that are at least 700m in length, dependent on logical breakpoints. The calculation should be calculated for the overall corridor or section and applied identically to all segments within that section / corridor. Consideration of travel speed along short segments is not informative or representative of movement for motorised modes, as delay generally occurs at the intersections at the end of individual segments.*

To calculate this ratio, do the following:

1. Note the posted speed limit for the corridor.
2. Measure the overall corridor distance taken between the inner intersection curbs.
3. Calculate ***freeflow time (s)*** = $\frac{\boldsymbol{segment\ length\ (m)}}{\boldsymbol{posted\ speed\ (\frac{km}{hr})}} \times \mathbf{3.6}$
4. Obtain the approach delay for the segment using conventional traffic analysis methodology and any applicable traffic analysis software
5. Calculate ***congested time (s)*** = $\boldsymbol{approach\ delay\ (s) + freeflow\ time\ (s)}$
6. Calculate ***congested speed (km/hr)*** = $\frac{\boldsymbol{segment\ length\ (m)}}{\boldsymbol{congested\ time\ (s)}} \times \mathbf{3.6}$
7. Calculate ***ratio*** = $\frac{\boldsymbol{congested\ speed\ (km/hr)}}{\boldsymbol{posted\ speed\ (\frac{km}{hr})}}$

The final ratio is the required result for this measure. The closer the value is to 1, the more efficient the travel experience for a vehicle. Note that in mixed traffic conditions (i.e. in cases with no specific dedicated infrastructure for any of the following modes), this ratio will be the same for transit, trucks, and automobiles. Omit this calculation if transit does not travel on the segment.

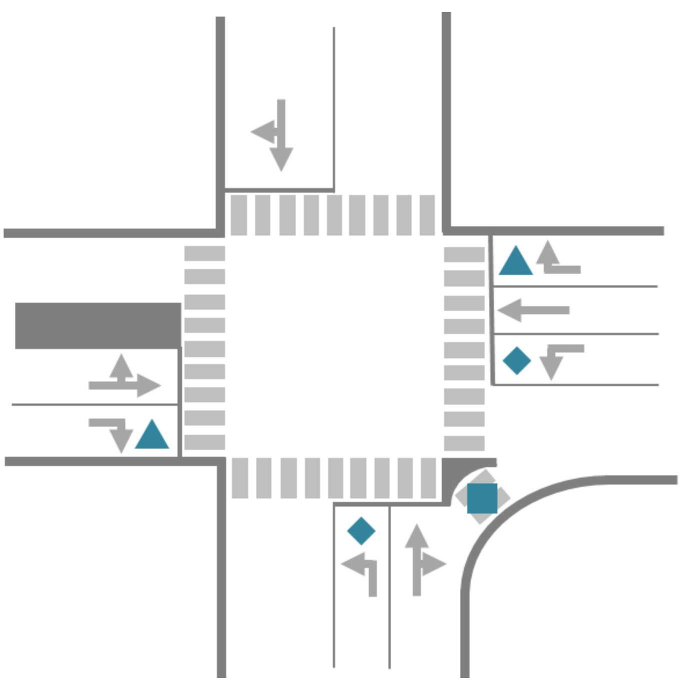
This measure can be improved by lengthening block lengths to minimize the number of intersections in a segment, minimizing the number of uncontrolled active transportation crossings in a segment, and lowering the posted speed limit.

Space: % of Turns with Exclusive Turning Lanes

This is a measure of the number of movements at an intersection that have dedicated turning lanes. The more movements that are served by turning lanes, the simpler it is for vehicles to move safely through the intersection and the more that vehicles can be separated into individual phases to reduce conflicts.

The intent of this measure is to ***quantify the ability of a vehicle to move safely and efficiently through an intersection***.

To calculate, count the total number of movements with exclusive turning lanes at the intersection and divide by the total number of movements. In the example shown below, there are **five** exclusive turning movements for vehicles – 2 left (◆), 2 right (▲), and 1 right turn channel (■) - and 7 movements in total. This would result in a value of **71%** for this measure.



Note that double-left or double-right turning lanes should be counted as **one** turning movement with a turning lane. This is because double turning lanes serve to improve queuing and capacity at an intersection, not safety.

Introducing exclusive left- or right-turning lanes on more approaches to an intersection will improve the score for this measure.

In reality, all intersection designs are subject to relevant HRM design guidelines and should be designed in accordance with the intent and requirements of these guidelines. A redesign of an entire intersection to accommodate exclusive turning lanes will affect other intersection users and may impact the volume-to-capacity ratio and/or delay of the intersection. Additionally, intersection designs should never compromise user safety for the sake of a higher score on this measure.

Space: Midblock V/C Ratio

This measure considers the average volume to capacity ratio (V/C ratio) mid-block for the segment. In traditional traffic engineering principles, the closer the V/C value is to 1, the closer a corridor is to operating at its capacity. Since congestion is never desirable in the car realm, the lower the v/c ratio, the better of an experience for cars.

Therefore, the intent of the measure is to ***quantify the freedom of movement for cars along the segment***.

To calculate this, use applicable traffic-related software, or other typical intersection or corridor analysis methods to determine the average v/c ratio for the segment. Some typically assumed capacities in vehicles per hour per lane (vphpl) are shown below for different road classifications.

Facility Type	Capacity (vphpl)
Major Arterial	1000
Minor Arterial	900
Major Collector	700
Minor Collector	600
Local	500

Possible ways to improve this measure include designing for roadways with more vehicle capacity or diverting traffic volumes from the segment (through network planning, the use of effective TDM, etc.).

In reality, ROW limitations and existing HRM policies that determine the modal priority of a given corridor can prevent improvements to this measure. Refer to governing HRM policies regarding corridor priority and intent. Additionally, the aforementioned "typical capacities" may not be applicable to each roadway in the HRM. Confirm the suitability of the capacities used in your analysis with HRM staff prior to application.

Environment: Turn Prohibitions

This measure refers to the number of turning prohibitions at an intersection. Turning prohibitions at the intersection (whether in effect all-day or limited to certain times of the day) determine how cars can travel through an area.

Therefore, the intent of this is to ***measure the freedom of movement for cars in the area***.

To evaluate this, count the total number of relevant car turning prohibitions for the intersection on all approaches. Note that many turn prohibitions are limited to specific hours of the day. When counting prohibitions, ensure that each counted prohibition is in force during the analysis period.

Lifting turning prohibitions for vehicles at intersections will improve this measure.

Realistically, lifting turning restrictions can have ripple effects on the roadway network (e.g. removing a turning restriction may require the conversation of a one-way street into a two-way street). Time-of-day prohibitions may also be in place to optimize traffic flow and peak period congestion so removing these prohibitions may result in worse traffic overall. Therefore, removal of turning prohibitions may not be possible or beneficial for all cases.

Existing HRM policies that determine the modal priority of a given corridor can also prevent turning prohibitions from being lifted. Furthermore, removing turning restrictions should not be done at the expense of compromising safety of any road or street user.

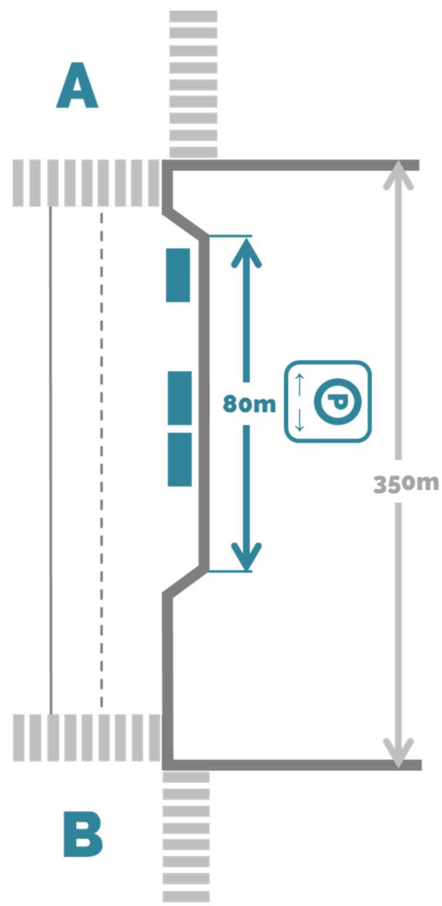
Environment: On-Street Parking Availability

This is a measure of the extent of on-street parking provided by the segment.

As cars carry passengers from one point to another, they must stop somewhere to let the driver and/or passengers exit the vehicle and walk to/into their final destination. Therefore, the more on-street parking space there is along a street, the more opportunities for drivers to stop and access properties along the segment by foot.

The intent of the measure is to ***quantify the convenience for cars along a segment from the perspective of parking***.

To calculate this, measure the total length of all on-street parking spaces along the segment and divide it by the total segment length (measured between inner curbs). In the example to the right, the measure would be equivalent to 23% for the segment AB (80m of parking dedicated space for a 350m segment). Note that there can be multiple parking bays or dedicated zones within the segment. In those case, the sum of all the parking zone lengths would be divided by the segment length.



In environments where on-street parking is generally not necessary (e.g. suburban or rural environments, big box business park with large parking lots, etc.), this measure can be omitted.

Adding on-street parking along a segment will improve this measure.

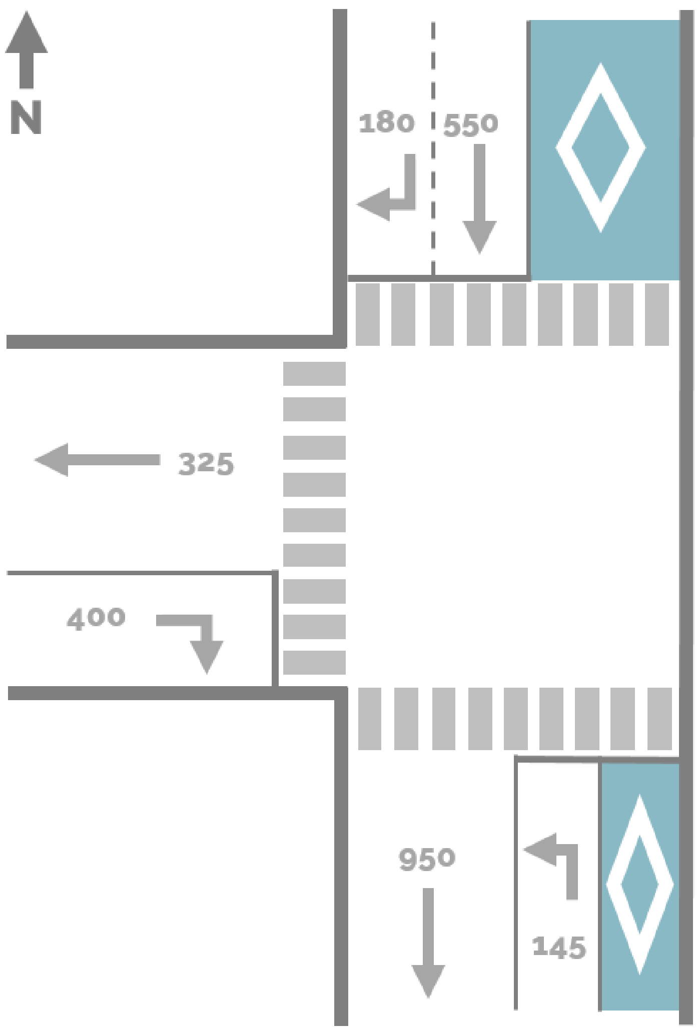
In reality, ROWs may limit the possibility of allowing on-street parking on along a segment. Additionally, all roadway designs and lane widths are subject to relevant HRM design guidelines and by existing policies that determine the modal priority of a given corridor. Road designs should also never compromise user safety for the sake of a higher score on this measure.

Time: Car Intersection Delay

This measure refers to the average delay experienced by cars on all movements at an intersection.

The intent for this measure is to ***calculate the average delay experienced by automobiles*** in order to determine the level of convenience for vehicles. The shorter the delay felt by cars, the more efficient and convenient the trip is for them.

To calculate this, use applicable traffic-related software or other typical intersection analysis methods to determine the delay for each movement on which cars are allowed. The delays for movements permitting cars should then be volume-averaged. As mentioned previously, delays for intersection legs with vehicle prohibitions (e.g. "transit only") should not be included in this average calculation.



In the example shown on the left (the numbers represent hourly volumes), the NBT delay would not be included in the car delay average weighing since cars are prohibited on that movement. All other movements would be included in the calculation. Where cars are permitted on all turning movements, the overall intersection delay can be used. Therefore, this measure can be equivalent to the intersection delay measure for trucks.

Since delay for vehicular traffic can be calculated for unsignalised intersections as well as signalised ones, this calculation should be performed at both signalised and unsignalised intersections.

Possible ways to improve this measure include: designing smaller intersections to reduce oft-governing pedestrian walking time; optimizing the signal timing to provide more time for car movements; and shortening cycle lengths.

In practice, when modifying a plan or design for this measure, keep in mind that any optimization of the traffic signal may affect all movements and motorized modes. Additionally, modification of phase or interval lengths should never be done at the sake of compromising the safety of users of any mode.

Time: Travel Speed/Ideal Speed

This measure compares the actual travel speed for a vehicle travelling on a corridor to the ideal speed (i.e., posted speed limit) for the corridor.

As the speed along the corridor degrades, the LOS for a travelling vehicle also degrades. The intent of the measure is to ***quantify the extent to which vehicular travel along a corridor is smooth and unhindered***.

Note that this calculation ***should be applied at a corridor level only*** *for sections that are at least 700m in length, dependent on logical breakpoints. The calculation should be calculated for the overall corridor or section and applied identically to all segments within that section / corridor. Consideration of travel speed along short segments is not informative or representative of movement for motorised modes, as delay generally occurs at the intersections at the end of individual segments.*

To calculate this ratio, do the following:

1. Note the posted speed limit for the corridor.
2. Measure the overall corridor distance taken between the inner intersection curbs.
3. Calculate ***freeflow time (s)*** = $\frac{\boldsymbol{segment\ length\ (m)}}{\boldsymbol{posted\ speed\ (\frac{km}{hr})}} \times \mathbf{3.6}$
4. Obtain the approach delay for the segment using conventional traffic analysis methodology and any applicable traffic analysis software
5. Calculate ***congested time (s)*** = $\boldsymbol{approach\ delay\ (s) + freeflow\ time\ (s)}$
6. Calculate ***congested speed (km/hr)*** = $\frac{\boldsymbol{segment\ length\ (m)}}{\boldsymbol{congested\ time\ (s)}} \times \mathbf{3.6}$
7. Calculate ***ratio*** = $\frac{\boldsymbol{congested\ speed\ (km/hr)}}{\boldsymbol{posted\ speed\ (\frac{km}{hr})}}$

The final ratio is the required result for this measure. The closer the value is to 1, the more efficient the travel experience for a vehicle. Note that in mixed traffic conditions (i.e. in cases with no specific dedicated infrastructure for any of the following modes), this ratio will be the same for transit, trucks, and automobiles. Omit this calculation if transit does not travel on the segment.

This measure can be improved by lengthening block lengths to minimize the number of intersections in a segment, minimizing the number of uncontrolled active transportation crossings in a segment, and lowering the posted speed limit.

APPENDIX B

CASE STUDIES

B Case Studies

Three case studies have been performed to demonstrate the application of the MMLOS framework. The case studies were selected to demonstrate a range of situations and can be used as a reference when applying the framework on real world projects.

The three case study locations are:

- **Chain Lake Drive** between Washmill Lake Drive/Susie Lake Court and McDonalds/Dairy Queen Mall Entrance
- **Cunard Street** between Robie Street and Agricola Street
- **Herring Cove Road** between Glenora Avenue and Old Sambro Road

Chain Lake Drive

As the main thoroughfare through the Bayers Lake Industrial Park, Chain Lake Drive represents a fairly typical auto-focused corridor connecting a series of big box stores and strip malls in a suburban business/light industrial park. The section of the corridor under consideration is between the signalised intersections at Washmill Lake Drive / Susie Lake Crescent to the south and the mall entrances at McDonalds and Dairy Queen to the north, as shown in **Figure 1**.

Figure 1: *Chain Lake Drive Study Area*

Some details about the study corridor are presented below:

- Length: 350m
- Two signalised intersections
- Two travel lanes per direction, with auxiliary turning lanes added on intersection approaches
- One bus stop per direction (southbound stop in-lane, northbound stop with bus bay)
- Posted maximum speed limit: 50 km/h
- Sidewalk in both directions

Data collected to perform the analysis included:

- AM peak hour traffic counts (2015)
- Signal timing for both study area intersections
- Dimensions (lane, sidewalk, and pedestrian zone widths, block size)
- Intersection geometry and lane allocation
- Average auto operating speed

The study corridor is located in the suburban area of HRM. There are no priority corridors for any modes.

Segment Analysis

There is one segment under consideration for this illustration, between the two signalised intersections. Note that there are two additional T-intersections along this segment where the corridor could be additionally split, if desired. However, the geometry and other characteristics of the Chain Lake corridor are not significantly different on either side of the two intervening intersections, so there would be no benefit to further breaking down the segment analysis. These intersections are considered commercial driveways for this analysis, as they provide access to commercial properties. Segment inputs and measurements are summarised in **Figure 2**.

Pedestrians

- Pedestrian facility width was measured as approximately 1.8m in both directions (LOS B).
- The pedestrian zone includes a small grass buffer on the median side of the sidewalk and generally a grass embankment on the shoulder side. The embankment is generally larger in the northbound direction, whereas there is some encroachment on the southbound side due to a rock wall. The pedestrian zone, taken from the outside edge of the sidewalk to the curb in the vehicle lane is on average 3.2m wide in both the northbound and southbound directions (LOS B).
- The only marked crossings in the study area are at the signalised intersections at either end, so the distance between marked crossings is 350m (LOS F).
- *The overall LOS for pedestrians at the segment level was calculated as LOS C in both directions. This matches the target LOS for suburban areas..*

INTERSECTION Chain Lake/Washmill Lake/Susie Lake **SCENARIO** Existing AM

PEDESTRIANS = LOS D

- 13 uncontrolled conflicts with pedestrians = LOS D
  - ◆ 4 permitted left turns
  - ● 4 right turn on red
  - ▲ 4 right turn on green
  - ■ 1 right turn channel
- Average Pedestrian Crossing = 29.7m = LOS F
- Cycle Length = 90 seconds = LOS C

CYCLISTS = LOS E

- 12 uncontrolled conflicts with cyclists = LOS D
  - ◆ 4 Permitted left turns
  - ● 6 lane changes to make a left turn
  - ▲ 1 RT lane
  - ■ 1 RT channel
- Washmill painted bike lane, all curb lanes < 4m
  - Score = 24% = LOS F
- Cycle Length = 90 seconds = LOS C

TRANSIT = LOS A

- No planned transit priority elements = LOS N/A
- V/C = (0.26+0.34+0.00+0.54)/4 = 0.29 = LOS A
- Delay = (11.8+4.3+0.0+26.3)/4 = 10.6 sec = LOS B

GOODS MOVEMENT = LOS B

- Average Curb Lane Width = 3.9m = LOS B
- (Average Effective Right Turning Radius = 17.5m = LOS B
- Truck Intersection Delay = 19.7 sec = LOS B

AUTOMOBILES = LOS B

- 6 turning lanes for 8 movements = 75% = LOS B
  - ◆ 4 left turn lanes
  - ▲ 1 right turn lane
  - ■ 1 right turn channel
- No turn prohibitions = LOS A
- Intersection Delay = 19.7 sec = LOS B

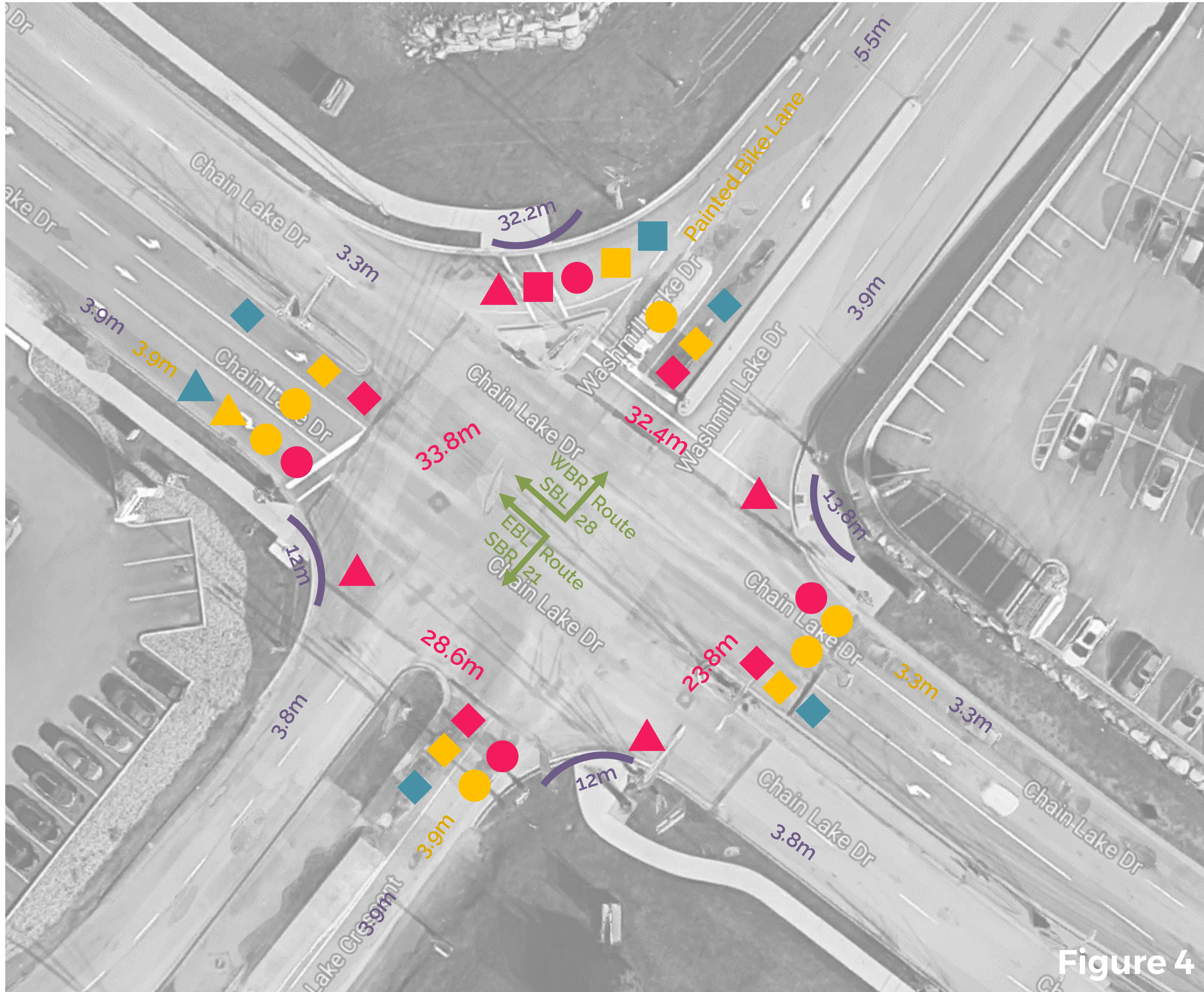


Figure 4

Cyclists

- There are a number of commercial driveways along this segment of Chain Lake Drives: one in the northbound direction and four in the southbound direction. Each of the driveways leads to a lot with at least 50 parking spaces (Commercial High), with one exemption that provides access to a gas station / convenience store / coffee shop with a drive thru and car wash. This location was dubbed "Drive Thrus (high turnover)".
    - In the northbound direction, the one Commercial High driveway counts as three driveways after factors are applied (input the data in the appropriate fields on the "Bicycle Segment Space" tab in the HRM MMLOS spreadsheet). Over a distance of 350m, this equals a driveway density of 8.6/km (LOS B).
    - In the southbound direction, the three Commercial High driveways and one Drive Thru (High Turnover) are equivalent to 13 driveways. Over a distance of 350m, this results in a driveway density of 37.1/km (LOS E).
- There is no bike infrastructure on Chain Lake Drive, which means that cyclists will ride in mixed traffic. This means that the LOS maxes out at D when the combination of volume and speed is low enough and progresses down to LOS F as that combination gets larger.
    - In the northbound direction, there are 450 vehicles during the peak hour, which can be approximated as an AADT of 4,500 vehicles. Multiplying the AADT with an average vehicle operating speed of 60km/h and dividing by 1000, results in a value of 270. The LOS for this section is, therefore, LOS E.
    - In the southbound direction, the combination of AADT (6,300), average vehicle operating speed (60 km/h) and division by 1000 results in a score of 378 in this direction. This results in an LOS E for the cycling environment measure.
- The block length between the two signals is 350m, which results in LOS F in both directions.
- *The overall LOS for cycling in the study area was calculated as LOS D in the northbound direction and LOS E in the northbound direction. The target LOS for cycling in the suburban areas is C, so this segment falls short of the target in both directions, due in large part to the fact that cyclists are in mixed traffic and the combination of automobile speed and volume with long block lengths results in an uncomfortable environment for cyclists.*

Transit

- Transit vehicles operate in mixed traffic with more than one lane per direction along Chain Lake Drive (LOS D).
- In the northbound direction the transit stop is at a bus bay, so 100% of stops in this direction are at a bus lay-by (LOS F). The stop in the southbound direction is on-street, so 0% of stops are at a bus lay-by (LOS A).
- As a single segment shorter than 700m is being analysed, the 'Speed' measure should be ignored for this analysis. Operating speeds for buses (and other motorised modes) are not impacted outside of the signalised intersections at either end of the short segment.

- *The overall LOS for transit is E in the northbound direction and C in the southbound direction. The target LOS for transit in suburban areas is C, so the target is met in the southbound direction, but this segment falls short of the target in the northbound direction.*

Goods Movement

- The average width of the shoulder lane in both directions on Chain Lake Drive is approximately 3.5m in the both directions on Chain Lake Drive (LOS C).
- In a suburban business park like Bayers Lake, there are designated delivery areas for trucks behind most buildings or ample parking lots in front. There are no opportunities for on-street stopping or loading, but there is also no need. The Environment measure of '% no stopping / loading' is therefore not applicable and should be ignored in this case.
- As a single segment shorter than 700m is being analysed, the 'Speed' measure should be ignored for this analysis. Operating speeds for trucks are not impacted outside of the signalised intersections at either end of the short segment.
- *The overall LOS for trucks is C in both directions along this segment. The target LOS for transit in suburban areas is E, so this segment exceeds the target in both directions.*

Automobiles

- The volume to capacity ratio (v/c ratio) is 0.23 (450 vehicles travelling on two lanes with a capacity of 2000) in the northbound direction (LOS A) and 0.31 (626 vehicles travelling on two lanes with a capacity of 2000) in the southbound direction (LOS A).
- In a suburban business park like Bayers Lake, there are ample parking lots in front of businesses. There are no opportunities for on-street parking, but there is also no need. The Environment measure of 'parking availability' is therefore not applicable and should be ignored in this case.
- As a single segment shorter than 700m is being analysed, the 'Speed' measure should be ignored for this analysis. Operating speeds for trucks are not impacted outside of the signalised intersections at either end of the short segment.
- *The overall LOS for cars is A in both directions. The target for LOS in suburban areas is E, so the LOS for cars is well in excess of the target.*

Intersection Analysis

Two intersections are under consideration in this analysis, both are signalised four-way intersections with additional auxiliary turning lanes added to better serve vehicular turning movements. Intersection inputs and measurements are summarised in **Figures 3** and **4**.

Chain Lake Drive / Mall Entrance (DQ/McDonalds)

Pedestrians

- There are a total of 12 uncontrolled conflict points for pedestrians at the intersection, represented by four permitted left turns, 4 right turns on red, and 4 right turns on green. This represents an LOS of D for the intersection.
- The average crossing width for the intersection is 19.4m (LOS E). Each approach has several approach lanes (2 on the east-west legs, 3 on the north-south legs) and two departing legs on the north-south departing legs and single lanes on the east-west

departing legs. This is overall not a hospitable environment for pedestrians, due mainly to the long distances across Chain Lake Drive.
- The cycle length for the signal is 90 seconds, which represents an LOS of C.
- *The overall LOS for pedestrians is D for the intersection. The target LOS is C in suburban areas, so the intersection does not meet the target.*

Cyclists
- There are 10 uncontrolled conflicts for cyclists at the intersection: four permitted left turns and lane changes required to make a left turn (LOS C).
- There is no cycling infrastructure present, all curb lanes are narrower than four metres, and none of the intersection approaches are priority cycling corridors. The intersection, therefore, scores 0% (LOS F).
- The cycle length for the signal is 90 seconds (LOS C).
- *The overall LOS for cycling is D for the intersection. The target LOS is C in suburban areas, so the intersection does not meet the target.*

Transit
- There are no dedicated transit lanes planned for Chain Lake Drive, so the 'Space' measure can be ignored for transit.
- The v/c ratio for movements involving transit vehicles (northbound through and southbound through only) at this location are 0.46 on average according to analysis via Synchro (LOS A).
- The delay for movements involving transit vehicles (northbound through and southbound through only) at this location are approximately 30 seconds on average according to analysis via Synchro (LOS C).
- *The overall LOS for transit is B for the intersection. The target LOS is C in suburban areas, so the intersection exceeds the target.*

Goods Movement
- The average curb lane width at the intersection is approximately 3.6m (LOS C).
- The average effective right turning radius for trucks is approximately 10.5m for the intersection (LOS F).
- There are no restrictions on truck movements, therefore the overall intersection delay for trucks is equivalent to the overall intersection delay. This was calculated as approximately 28 seconds according to Synchro analysis (LOS C).
- *The overall LOS for trucks is D for the intersection. The target LOS is E in suburban areas, so the intersection exceeds the target.*

INTERSECTION Chain Lake Drive / Dairy Queen **SCENARIO** Existing AM

PEDESTRIANS = LOS D

- 12 uncontrolled conflicts with pedestrians = LOS D
  - ◆ 4 permitted left turns
  - ● 4 right turn on red
  - ▲ 4 right turn on green
- Avg. Pedestrian Crossing = 19.4m = LOS E
- Cycle Length = 90 seconds = LOS C

CYCLISTS = LOS D

- 10 uncontrolled conflicts with cyclists = LOS C
  - ◆ 4 Permitted left turns
  - ● 6 lane changes to make a left turn
- No priority corridors, no infrastructure, all curb lanes < 4m
  - Score = 0% = LOS F
- Cycle Length = 90 seconds = LOS C

TRANSIT = LOS B

- No planned transit priority elements = LOS N/A
- V/C = (NBT+SBT)/2 = (0.18 + 0.73)/2 = 0.46 = LOS A
- Delay = (NBT+SBT)/2 = (22+38.4)/2 = 30.2 sec = LOS C

GOODS MOVEMENT = LOS D

- Average Curb Lane Width = 3.6m = LOS C
-) Average Effective Right Turning Radius = 10.5m = LOS F
- Overall Intersection Delay = 27.9 sec = LOS C

AUTOMOBILES = LOS B

- ● 4 left turn lanes out of 8 movements = 50% = LOS C
- No turn prohibitions = LOS A
- Overall Intersection Delay = 27.9 sec = LOS C

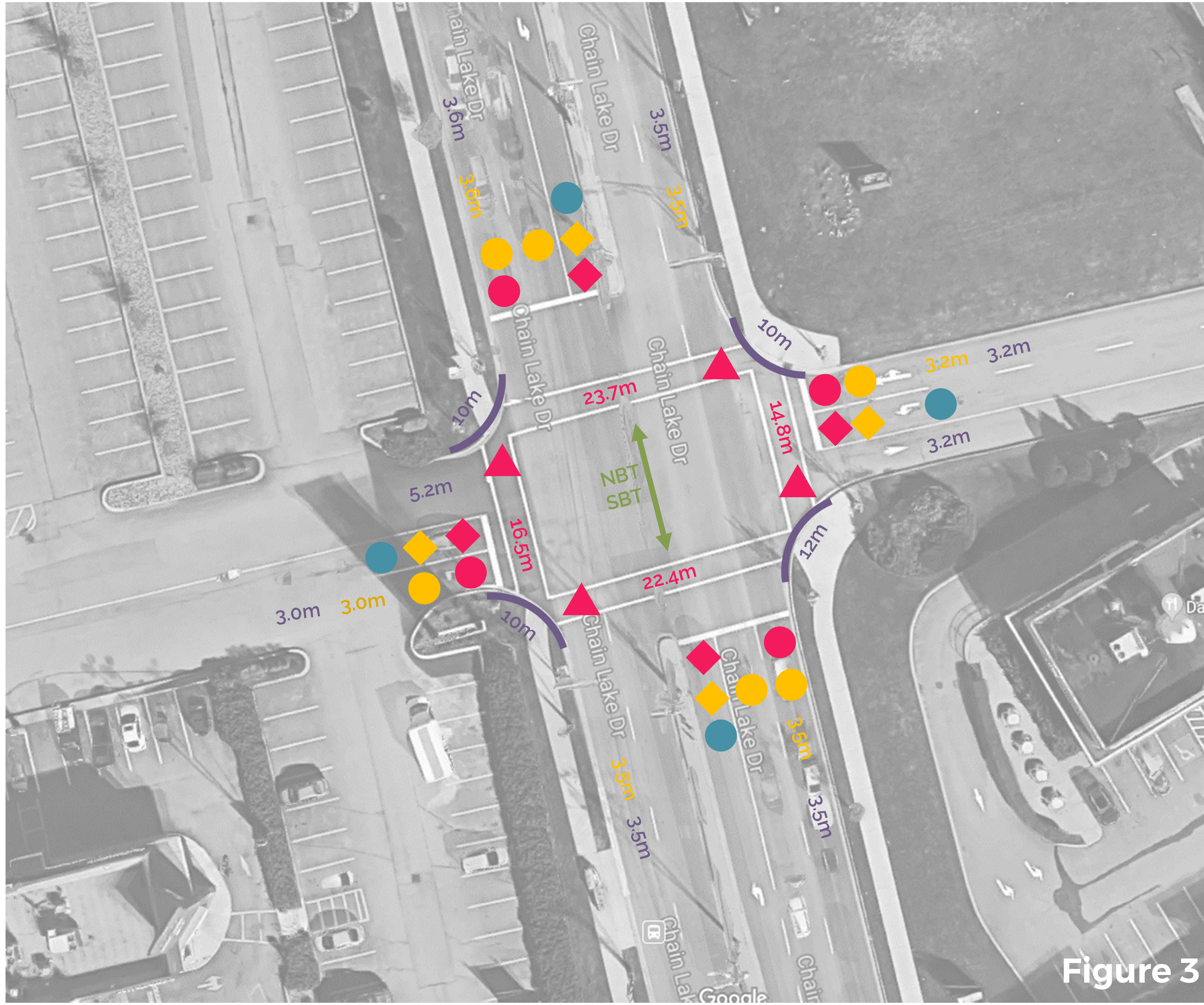


Figure 3

INTERSECTION Chain Lake/Washmill Lake/Susie Lake **SCENARIO** Existing AM

PEDESTRIANS = LOS D

- 13 uncontrolled conflicts with pedestrians = LOS D
  - ◆ 4 permitted left turns
  - ● 4 right turn on red
  - ▲ 4 right turn on green
  - ■ 1 right turn channel
- Average Pedestrian Crossing = 29.7m = LOS F
- Cycle Length = 90 seconds = LOS C

CYCLISTS = LOS E

- 12 uncontrolled conflicts with cyclists = LOS D
  - ◆ 4 Permitted left turns
  - ● 6 lane changes to make a left turn
  - ▲ 1 RT lane
  - ■ 1 RT channel
- Washmill painted bike lane, all curb lanes < 4m
  - Score = 24% = LOS F
- Cycle Length = 90 seconds = LOS C

TRANSIT = LOS A

- No planned transit priority elements = LOS N/A
- V/C = (0.26+0.34+0.00+0.54)/4 = 0.29 = LOS A
- Delay = (11.8+4.3+0.0+26.3)/4 = 10.6 sec = LOS B

GOODS MOVEMENT = LOS B

- Average Curb Lane Width = 3.9m = LOS B
- (Average Effective Right Turning Radius = 17.5m = LOS B
- Truck Intersection Delay = 19.7 sec = LOS B

AUTOMOBILES = LOS B

- 6 turning lanes for 8 movements = 75% = LOS B
  - ◆ 4 left turn lanes
  - ▲ 1 right turn lane
  - ■ 1 right turn channel
- No turn prohibitions = LOS A
- Intersection Delay = 19.7 sec = LOS B

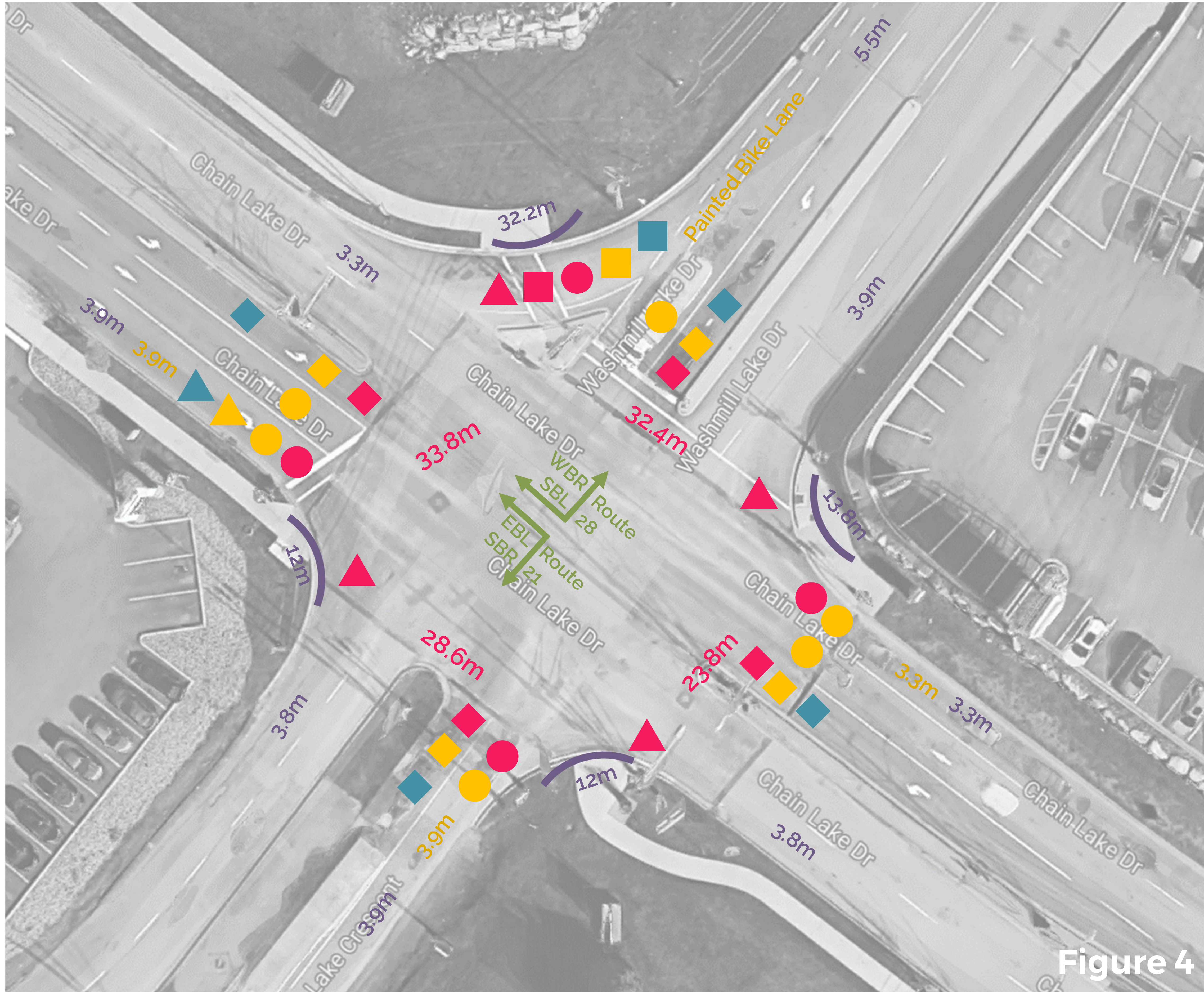


Figure 4

Automobiles

- Four out of eight turning movements at the intersection receive exclusive turning lanes (all left turns). Therefore, 50% of turning movements receive exclusive lanes (LOS C).
- There are no car turning prohibitions at the intersection (LOS A).
- The overall intersection delay is approximately 28 seconds according to Synchro analysis (LOS C).
- *The overall LOS for cars is B for the intersection. The target LOS is E in suburban areas, so the intersection exceeds the target.*

Chain Lake Drive / Washmill Lake Drive-Susie Lake Crescent

Pedestrians

- There are a total of 13 uncontrolled conflict points for pedestrians at the intersection, represented by four permitted left turns, four right turn on red, four right turn on green, and a right turn channel (LOS D).
- The average crossing width for the intersection is approximately 29.7m (LOS F). Three of four legs have five lanes for pedestrians to cross, with the Susie Lake Crescent approach having four lanes, plus a large grass median. Ensure to measure the full path of the pedestrian to enter and exit the intersection along each side and do not discount for medians or other breaks. This means measuring across the right turn channel for two crossings.
- The cycle length for the intersection is 90 seconds (LOS C).
- *The overall LOS for pedestrians is D for the intersection. The target LOS is C in suburban areas, so the intersection does not meet the target.*

Cyclists

- There are 12 uncontrolled conflicts for cyclists at the intersection: 4 permitted left turns, 6 lane changes required to make a left turn, 1 right turn channel, and 1 right turn lane. This represents LOS D.
- There is a painted bike lane on one approach to the intersection in the westbound direction. In the eastbound direction, the bike lane does not begin until 100m to the east, so is not considered at the intersection. Outside of this, there is no other cycling infrastructure. All of the curb lanes outside of the westbound approach are less than 4m wide. The intersection scores 24% (LOS F).
- The cycle length for the intersection is 90 seconds (LOS C).
- *The overall LOS for cycling is E for the intersection. The target LOS is C in suburban areas, so the intersection does not meet the target.*

Transit

- There are no dedicated transit lanes planned for Chain Lake Drive, so the 'Space' measure can be ignored for transit.
- The v/c ratio for movements involving transit vehicles (southbound right, eastbound left, southbound left, and westbound right) at this location are 0.29 on average according to analysis via Synchro (LOS A).

- The delay for movements involving transit vehicles (southbound right, eastbound left, southbound left, and westbound right) at this location are approximately 10.6 seconds according to analysis via Synchro (LOS B).
- *The overall LOS for transit is A for the intersection. The target LOS is C in suburban areas, so the intersection exceeds the target.*

Goods Movement

- The average curb lane width is 3.9m (LOS B).
- The average effective right turning radius for trucks is approximately 17.5m for the intersection (LOS B).
- The overall intersection delay is approximately 19.7 seconds according to Synchro analysis (LOS B).
- *The overall LOS for trucks is B for the intersection. The target LOS is E in suburban areas, so the intersection exceeds the target.*

Automobiles

- There are six turning lanes at the intersection (4 left, 1 right, 1 right turn channel) out of eight turning movements, which results in 75% of turns receiving exclusive lanes. This results in LOS B.
- There are no car turning prohibitions at the intersection (LOS A).
- The overall intersection delay is approximately 19.7 seconds according to Synchro analysis (LOS B).
- *The overall LOS for cars is B for the intersection. The target LOS is E in suburban areas, so the intersection exceeds the target.*

Figures 5 and 6 show the inputs and results described in the text above.

Discussion

At the segment level, the two directions of the road tell slightly different stories. The southbound direction meets or exceeds the target LOS for all modes except for cyclists. For cyclists, the combination of the speed and volume of the cars with a lack of infrastructure, multiple high volume commercial driveways, and long blocks leads to a hostile cycling corridor. In the northbound direction, all LOS targets are met with the exception of transit and cycling. For transit the bus lay-by area (LOS F) improves mid-block performance for cars, but makes the environment less convenient for transit vehicles.

At both intersections the targets are exceeded for all motorised modes, whereas the active transportation modes (walking and cycling) suffer due to the large, complex intersections and no elements that prioritise their needs.

SCENARIO: Chain Lake Drive - Existing Condition - AM Peak Hour | **Area Type: Suburbs**

DIR	McDonalds					CHAIN LAKE DRIVE					Dairy Queen	DIR
	MODE										MODE	
SB	Target	C	C	C	E	E	E	E	C	C	C	Target	NB
	Actual	C	E	C	C	A	A	C	E	D	C	Actual	
	Priority Corridor	No	No	No	No	No	No	No	No	No	No	Priority Corridor	
	Space	Pedestrian Facility Width (m)	Driveway Density	Transit Facility Type	Width of Curb Lane (m)	Midblock V/C Ratio	Midblock V/C Ratio	Width of Curb Lane (m)	Transit Facility Type	Driveway Density	Pedestrian Facility Width (m)	Space	
		1.80 - 1.99	>32 - 40	Mixed Traffic with >1 lane	3.60 - 3.79	< 0.60	< 0.60	3.60 - 3.79	Mixed Traffic with >1 lane	>8 - 16	1.80 - 1.99		
	Environment	Pedestrian Zone Width (m)	Speed x Volume	% of Stops with Bus Lay-bys	% No Stopping / No Loading	On-street Parking Availablity (%)	On-street Parking Availablity (%)	% No Stopping / No Loading	% of Stops with Bus Lay-bys	Speed x Volume	Pedestrian Zone Width (m)	Environment	
		3.00 - 3.49	E	0					> 80%	E	3.00 - 3.49		
	Time	Distance Between Marked Crossings (m)	Block Length	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed	Block Length	Distance Between Marked Crossings (m)	Time	
		> 300	> 300							> 300	> 300		
	SUSIE LAKE										WASHMILL	

Figure 5: *Chain Lake Drive – Segment LOS Results*

SCENARIO:	***Chain Lake Drive - Existing Condition - AM Peak Hour***				
Area Type:	***Suburbs***				
MODE					
CHAIN LAKE / DAIRY QUEEN - Signalized 4-Way					
Target	**C**	**C**	**C**	**E**	**E**
Actual	**D**	**D**	**B**	**D**	**B**
Priority Corridor	No	No	No	No	No
Space	Number of Uncontrolled Conflicts	Number of Uncontrolled Conflicts	% of Transit Priority Measures (of Ideal)	Avg. Curb Lane Width (m)	% of movements with turn lanes
	11-13	8-10		3.60 - 3.79	35 - 60%
Environment	Avg. Crossing Width (m)	Priority Treatments	Transit Movement V/C Ratio	Avg. Effective Curb Radius (m)	Turn prohibitions
	17.5 - 21	< 30%	< 0.60	< 11	0
Time	Cycle Length (sec)	Cycle Length (sec)	Transit Movement Delay	Truck Intersection Delay (sec)	Car Intersection Delay (sec)
	76 - 90	76 - 90	21 - 35	21 - 35	21 - 35
CHAIN LAKE / WASHMILL / SUSIE LAKE - Signalized 4-Way					
Target	**C**	**C**	**C**	**E**	**E**
Actual	**D**	**E**	**A**	**B**	**B**
Priority Corridor	No	No	No	No	No
Space	Number of Uncontrolled Conflicts	Number of Uncontrolled Conflicts	% of Transit Priority Measures (of Ideal)	Avg. Curb Lane Width (m)	% of movements with turn lanes
	11-13	11-13		3.80 - 3.99	60 - 85%
Environment	Avg. Crossing Width (m)	Priority Treatments	Transit Movement V/C Ratio	Avg. Effective Curb Radius (m)	Turn prohibitions
	> 21	< 30%	< 0.60	16 - 18	0
Time	Cycle Length (sec)	Cycle Length (sec)	Transit Movement Delay	Truck Intersection Delay (sec)	Car Intersection Delay (sec)
	76 - 90	76 - 90	11 - 20	11 - 20	11 - 20

Figure 6: *Chain Lake Drive Intersection Results*

Cunard Street

The roadway under consideration for this case study is the section of Cunard Street between Robie Street and Agricola Street on the Halifax Peninsula. This section of Cunard Street has two lanes in each direction with a wide grass and tree median. Also notable is that the street runs along the north edge of the Halifax Common. The intersection of Cunard and Robie Street on the west side is a signalised four-way intersection, whereas the intersection on the east side of the corridor with Agricola Street and North Park Street is a roundabout. The study area is shown in **Figure 7**.

Figure 7: *Cunard Street Study Area*

Some details about the study corridor are presented below:

- Length: 300m
- One signalised intersection, one roundabout
- Two travel lanes per direction, with auxiliary lanes added on intersection approaches
- One bus stop per direction
- Posted maximum speed limit: 50 km/h
- Sidewalk in both directions

Data collected to perform the analysis included:

- AM peak hour traffic counts
- Signal timing
- Dimensions (lane, sidewalk, and pedestrian zone widths, block size)
- Intersection geometry and lane allocation
- Average auto operating speed

The study corridor is located in the "Regional Centre" area of HRM. Robie Street is designated as a priority corridor for transit in the Integrated Mobility Plan.

Two conditions for the intersection of Cunard Street and Robie Street were tested: existing conditions and a second condition based on a concept drawing provided by HRM, shown in **Figure 8**.

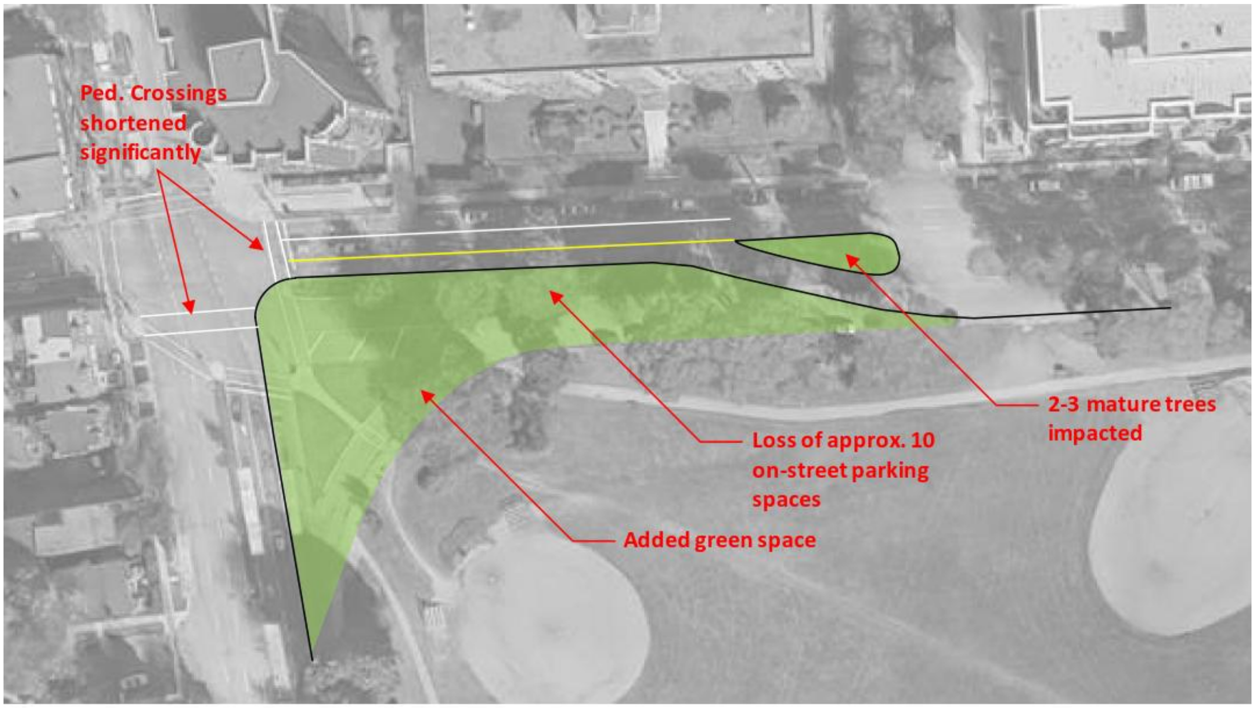


Figure 8: *Robie / Cunard Intersection Concept*

The concept shows a significant change to the southeast corner of the intersection, where the current large right turn channel from northbound Robie to eastbound Cunard has been removed, the eastbound departing leg has been reduced to a single lane, and the grass/tree median was removed for the first 85m of Cunard Street.

It was also assumed that dedicated north-south median bus lanes were implemented on Robie Street according to HRM's recently proposed transit priority measures project for the corridor. These lanes may potentially serve a new Bus Rapid Transit service in the future. This alternate condition was used to demonstrate the simplicity of testing an alternative arrangement of intersection geometry within the MMLOS framework.

In absence of a functional or detailed design, the following was assumed about the resulting geometry:

- Six lane cross-section on Robie is maintained to the south of Cunard
    - Two northbound general vehicle lanes
    - Two southbound general vehicle lanes
    - One northbound and one southbound transit only lane
- General lane width = 3.5m
- Curb lane width = 4m

The lane allocation and geometry is specified further in **Figure 12** as part of the intersection analysis.

Segment Analysis

There is one segment under consideration for this illustration, between the two intersections. Note that there are three additional T-intersections along this segment where the corridor could be additionally split, if desired. There is not a significant difference in the infrastructure along the length of the study area, so separation of the corridor into additional segments would not be of benefit to the analysis. As small, low volume local streets, serving solely residential uses, these have been considered as residential driveways for this analysis. Segment inputs and measurements are summarised in **Figure 9**.

Pedestrians

- Pedestrian facility width was measured as approximately 1.8m (LOS B) in the westbound direction and 2.2m (LOS A) in the eastbound direction.
- In the westbound direction, the pedestrian zone includes a small grass buffer on the median side of the sidewalk. On the shoulder side of the westbound sidewalk, the depth to building faces and fencing varies through the corridor. The pedestrian zone generally measures 3.2m on average across the segment (LOS B). In the eastbound direction, the multi-use path is set far back from the curb and also backs onto the Halifax Common to the south, which means the pedestrian zone width easily exceeds 3.50m (LOS A) along the length of the corridor.
- The only marked crossings in the study area are at the intersections at either end, so the distance between marked crossings is 295m (LOS F).
- *The overall LOS for pedestrians at the segment level was calculated as LOS B in the eastbound direction and LOS C in the westbound direction. The target for the Regional Centre is B, so the eastbound direction meets the target. The westbound direction does not meet the target, due to the long distance between opportunities to safely cross the street.*

Cyclists

- The three local streets along the westbound direction of Cunard Street (Moran, June, and Princess) each represent Residential High Density driveways. In addition, there is a driveway into an underground parking garage near Robie Street, which serves the large apartment building on the corner. These four high activity driveways are equivalent to six driveways over the 295m length. This results in a driveway density of 20.4/km and LOS C for this measure. In the eastbound direction, there are no driveways (LOS A).
- The AADT in the westbound direction can be approximated as 2250 vehicles per day from the 225 AM peak hour vehicles. In combination with the average vehicle operating speed of 60 km/h and dividing the product by 1000, results in a score of 135. As the cyclist is riding in mixed traffic adjacent to parking, this results in an LOS of E (the maximum LOS for this situation). The situation is similar in the eastbound direction where cyclists must ride between moving and parked vehicles. The higher volumes here 505 during the peak hour or 5050 AADT results in a score of 303 for the section or LOS F.

- The average block length in the westbound direction is significantly shorter than in the eastbound direction, due to the intersections with Moran and June Streets. These provide the cyclist opportunities to exit Cunard Street if they do not feel comfortable or if there is a routing advantage. The average block length in the westbound direction is approximately 98 metres (LOS A). Note that Princess Place is not included in this calculation as it is a cul-de-sac and does not provide alternate routing options. In the eastbound direction, there is a curb cut intended for maintenance vehicle access to the Halifax Common, this provides informal access to the multi-use path at the mid-block point for cyclists. This entrance could then be used to cycle through the Common and avoid the roundabout if the cyclist is headed to southbound North Park Street. The average block length in the eastbound direction, therefore is 147m (LOS B)
- *The overall LOS for cycling in the study area was calculated as LOS C in the eastbound direction and LOS D in the westbound direction. The target LOS for cycling in Regional Centre is LOS B, so this segment falls short of the target in both directions.*

SEGMENT Cunard from Robie to Agricola/North Park

SCENARIO Existing AM

PEDESTRIANS = LOS B EB / LOS C WB

- Pedestrian Facility Width
  - North side = 1.8m sidewalk = LOS B
  - South side = 2.2m multi-use path = LOS A
- Pedestrian Zone Width
  - North side = 3.2m = LOS B
  - South side = >3.5m = LOS A
- Distance between marked crossings = 295m = LOS E

CYCLISTS = LOS C WB / LOS D EB

- Driveway Density
  - WB = 20.3/km = LOS C
  - EB = 0/km = LOS A
- Speed x Volume
  - WB = 2.25 x 60 = 135 = LOS E
  - EB = 5.05 x 60 = 303 = LOS F
- Block Length
  - WB = (215+33+47)/3 = 98m = LOS B
  - EB = (150m + 145m)/2= 147m = LOS E

TRANSIT = LOS F EB / WB

- Type of Facility
  - WB = Mixed Traffic + Parking = LOS F
  - EB = Mixed Traffic + Parking = LOS F
- Percent of stops with Bus Lay-By
  - WB = 100% (AM only) = LOS F
  - EB = 100% = LOS F
- Travel Speed / Ideal Speed
  - Segment < 700m = LOS N/A

GOODS MOVEMENT = LOS D WB / LOS E EB

- Average Curb Lane Width
  - WB = 3.5m = LOS D
  - WB = 3.5m = LOS D
- No Stopping / No Loading
  - WB = (33+33+10+37)/295 = 38% = LOS C
  - EB = (52 + 51 + 97) / 295 = 67% = LOS F
- Travel Speed / Ideal Speed
  - Segment < 700m = LOS N/A

AUTOMOBILES = LOS B WB / LOS C EB

- Mid-block V/C (AM)
  - WB = 240 / 1800 = 0.13 = LOS A
  - SB = 505 / 1800 = 0.28 = LOS A
- On-street parking availability
  - WB = (28+23+28+68)/295 = 50% = LOS D
  - EB = (60+35) / 295 = 32% = LOS E
- Travel Speed / Ideal Speed
  - Segment <700m = LOS N/A

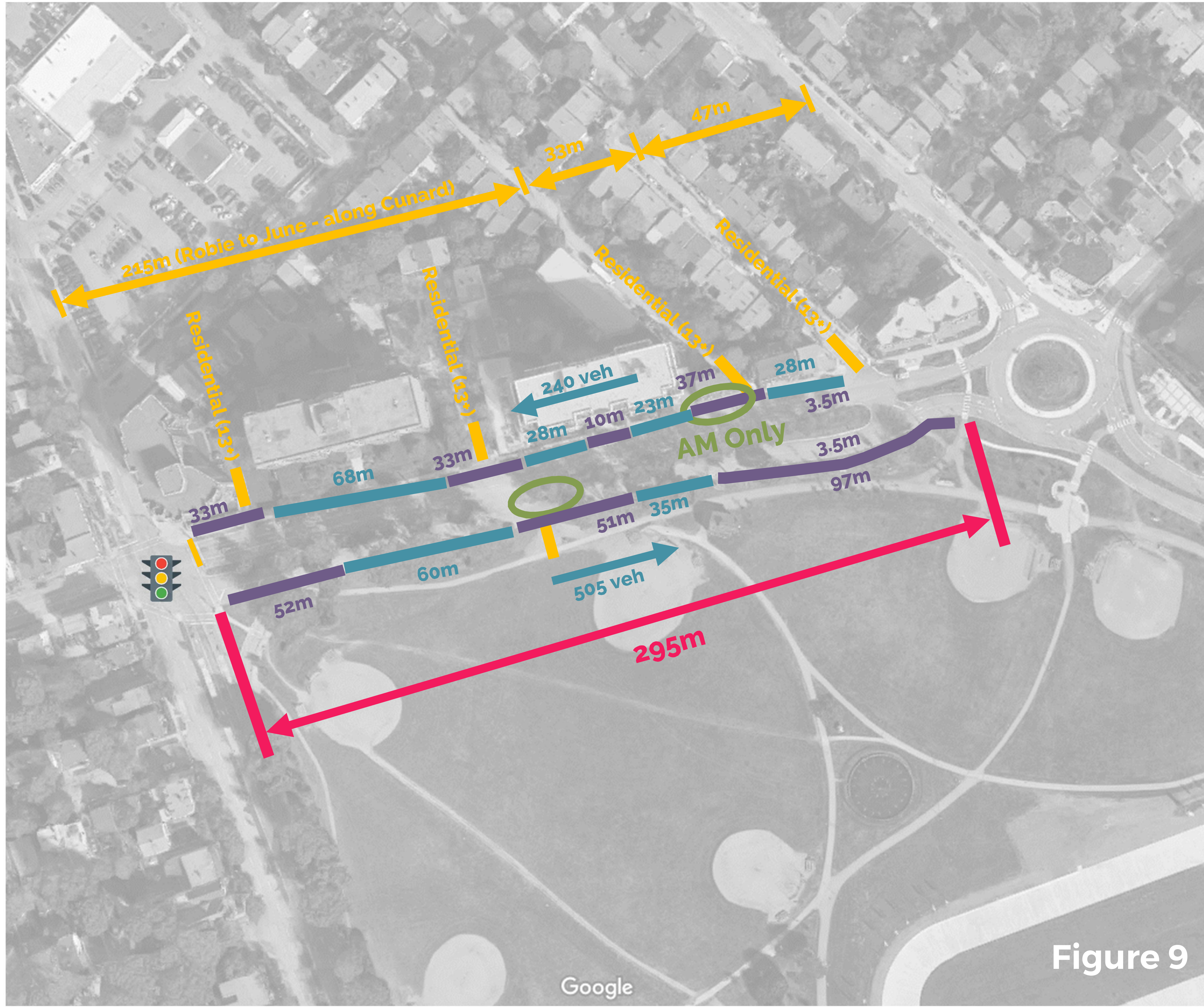


Figure 9

Transit

- Transit vehicles operate in mixed traffic with parking along Cunard Street in both directions (LOS F).
- In both directions on Cunard Street, buses must pull into the parking lane to access the curb to load and unload passengers. They must then pull back into traffic to continue on their route, which represents bus lay-by behaviour. For that reason, these stops were considered bus lay-bys for the analysis. Therefore, 100% of stops in both directions occur in bus lay-bys (LOS F). Note, however, that during the PM peak hour that parking is prohibited in the westbound direction, which means that the bus can stop directly in the curb travel lane, which would represent LOS A.
- As a single segment shorter than 700m is being analysed, the 'Speed' measure should be ignored for this analysis. Operating speeds for buses are not impacted outside of the signalised intersections at either end of the short segment.
- *The overall LOS for transit is F both directions on Cunard Street during the AM peak hour. The target LOS for transit in the Regional Centre is B, so this segment falls short of the target in both directions.*

Goods Movement

- The average width of the shoulder lane in both directions on Cunard Street is approximately 3.5m (LOS D). Note that the most likely travel lane for trucks in the westbound direction during the AM peak hour is the middle lane. During the PM peak hour this will be the curb lane, as parking is prohibited.
- Accounting for the space given over to bus stops and near the intersections, the % of the block that prevents stopping and unloading by trucks is approximately 38% in the westbound direction (LOS E) and 65% (LOS F) in the eastbound direction. Note, as well, that there is a designated loading area on westbound Cunard just west of Agricola.
- As a single segment shorter than 700m is being analysed, the 'Speed' measure should be ignored for this analysis. Operating speeds for trucks are not impacted outside of the signalised intersections at either end of the short segment.
- *The overall LOS for trucks is D in the westbound direction and E in the eastbound direction. The target LOS for transit in the Regional Centre is E, so this segment meets or exceeds the LOS target in both directions.*

Automobiles

- The volume to capacity ratio (v/c ratio) is 0.13 (240 vehicles travelling on two lanes with a capacity of 1800) in the westbound direction (LOS A) and 0.28 (505 vehicles travelling on two lanes with a capacity of 1800) in the eastbound direction (LOS A).
- On-street parking is provided in both directions during the AM peak hour (prohibited in the westbound direction during the PM peak period 4-6pm). In the westbound direction, approximately 50% of the block is available for parking (LOS D) and in the eastbound direction approximately 32% of the block is available for parking (LOS E).
- As a single segment shorter than 700m is being analysed, the 'Speed' measure should be ignored for this analysis. Operating speeds for cars are not impacted outside of the signalised intersections at either end of the short segment.

- *The overall LOS for cars is B in the westbound direction and C in the eastbound direction. The target for LOS in the Regional Centre is E, so the LOS for cars is well in excess of the target.*

Intersection Analysis

Two intersections are under consideration in this analysis. The intersection of Cunard Street and Robie Street is a signalised four-way intersection with some additional auxiliary lanes added to better serve vehicular turning movements. The intersection of Cunard Street with Agricola Street and North Park Street is a multi-lane roundabout. **Figures 10, 11,** and **12** summarise the intersection inputs and measurements.

Cunard Street / Agricola Street / North Park Street

Pedestrians

- There are a total of 10 uncontrolled conflict points for pedestrians at the intersection, represented by the approaching and departing lanes on each intersection leg (LOS C) where the pedestrian must at a crosswalk either where vehicles are exiting the roundabout or in advance of the stop bar.
- The average crossing width for the intersection is 17.7m (LOS E). The eastbound approach and northbound approach both have two lanes, whereas the other approaching and departing lanes are limited to 1. The splitter islands on the legs of the roundabout lengthen the overall crossing distance from one edge of the intersection to the other.
- As this location is a roundabout and does not include any signalisation, there is no signal cycle that would result in additional delay. In practice, the pedestrian will be able to approach the intersection, the next approaching vehicle will yield, and the pedestrian is able to cross with very little delay (LOS A).
- *The overall LOS for pedestrians is C for the intersection. The target LOS is B in the Regional Centre, so the intersection does not meet the target.*

Cyclists

- There are three uncontrolled conflicts for cyclists traversing the intersection, represented by the two lane changes that will be required to make a left turn from the eastbound and northbound approaches, and the right turn lane on the eastbound approach that necessitates a lane change to continue straight through the intersection (LOS A).
- There is no cycling infrastructure at the intersection. North/south bike lanes on North Park Street terminate and begin to the south of the intersection, as cyclists are encouraged to 'take the lane' at the roundabout. The intersection scores 20% (LOS F) as two of the approaches have lane widths in excess of four metres.
- The location is a roundabout, so there is no signal. Cyclists may optionally divert to the multi-use path and crosswalks to traverse the intersection, or negotiate the roundabout by taking the appropriate lane. LOS is set to LOS B here to match the delay experienced by cars and trucks, as cyclist should 'take the lane' when travelling through the roundabout.
- *The overall LOS for cycling is D for the intersection. The target LOS is B in the Regional Centre, so the intersection does not meet the target.*

INTERSECTION Cunard / Agricola / North Park **SCENARIO** Existing AM

PEDESTRIANS = LOS C

- 10 uncontrolled conflicts with pedestrians = LOS C
  - ◆ 6 approaching lanes
  - ● 4 departing lanes
- Average Pedestrian Crossing = 17.7m = LOS E
- Cycle Length = Roundabout = LOS A

CYCLISTS = LOS D

- 3 uncontrolled conflicts with cyclists = LOS A
  - ● 2 lane changes to make left turn
  - ▲ 1 RT Lane
- No priority corridors, no infrastructure, north and east approach lanes >4m, south and west approach lanes <4m
  - Score = 15% = LOS F
- Cycle length = Roundabout (Vehicle LOS) = LOS C

TRANSIT = LOS B

- No planned transit priority = LOS N/A
- Transit Movement V/C
  - EBR and NBL
  - V/C = (0.92 + 0.18) / 2 = 0.55 = LOS A
  - Delay = (41.9 + 5.2) / 2 = 23.6 = LOS C

GOODS MOVEMENT = LOS A

- Average Curb Lane Width = 4.1m = LOS A
- (Average Effective Right Turning Radius = 45m+ = LOS A
- Intersection Delay = 20 sec = LOS B

AUTOMOBILES = LOS B

- 2 turning lanes / 8 movements = 25% = LOS D
  - ◆ 1 left turn lane
  - ▲ 1 right turn lane
- No turn prohibitions = LOS A
- Intersection Delay = 20 sec = LOS B

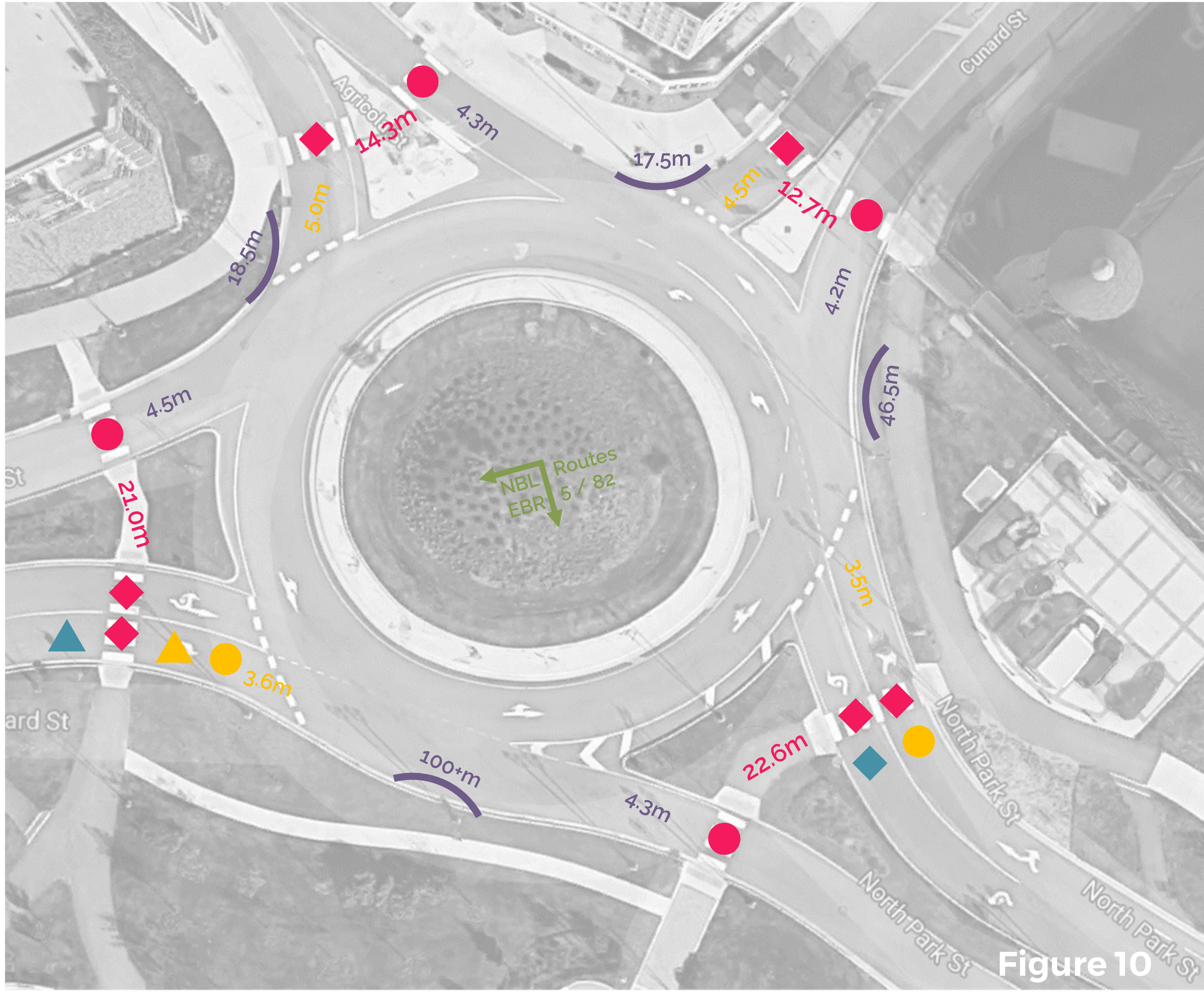


Figure 10

INTERSECTION Cunard / Robie – Existing Layout

SCENARIO Existing AM

PEDESTRIANS = LOS D

- 12 uncontrolled conflicts with pedestrians = LOS D
  - ◆ 3 permitted left turns
  - ● 4 right turn on red
  - ▲ 4 right turn on green
  - ■ 1 right turn channel
- Average Pedestrian Crossing = 31.4m = LOS F
- Cycle Length = 80 seconds = LOS C

CYCLISTS = LOS E

- 11 uncontrolled conflicts with cyclists = LOS D
  - ◆ 3 Permitted left turns
  - ● 6 lane changes to make a left turn
  - ▲ 1 right turn lane
  - ■ 1 right turn channel
- No priority corridors, no infrastructure, Cunard curb lanes < 4m, Robie curb lanes > 4m
  - Score = 20% = LOS F
- Cycle length = 80 seconds = LOS C

TRANSIT = LOS D

- Priority Corridor planned on Robie Street – not in existing condition – 0 of 4 priority lanes = 0% = LOS F
- V/C = (0.80 + 0.80 + 0.25 + 0.40 + 0.27 + 0.73) / 6 = 0.54 = LOS A
- Delay = (27.7 + 27.7 + 15.7 + 15.1 + 18.4 + 21.2) / 6 = 21.0 = LOS C

GOODS MOVEMENT = LOS A

- Average Curb Lane Width = 4.1m = LOS A
- (Average Effective Right Turning Radius = 21.6m = LOS A
- Intersection Delay = 20.5 sec = LOS B

AUTOMOBILES = LOS B

- 5 exclusive turning lanes of 8 turns = 63% = LOS B
  - ◆ 3 exclusive left turn lanes
  - ▲ 1 right turn lane
  - ■ 1 right turn channel
- No turn prohibitions = LOS A
- Intersection Delay = 20.5 sec = LOS B

Figure 11

INTERSECTION Cunard / Robie – Proposed Layout

SCENARIO Existing AM

PEDESTRIANS = LOS D

- 11 uncontrolled conflicts with pedestrians = LOS D
  - ◆ 3 permitted left turns
  - ● 4 right turn on red
  - ▲ 4 right turn on green
- Average Pedestrian Crossing = 15.8m = LOS D
- Cycle Length = 80 seconds = LOS C

CYCLISTS = LOS D

- 7 uncontrolled conflicts with cyclists = LOS B
  - ◆ 3 Permitted left turns
  - ● 3 lane changes to make a left turn
  - ▲ 1 right turn lane
- No priority corridors, no infrastructure, Cunard EB lane < 4m, Cunard WB lane >=4.0m, Robie curb lanes > 4m
  - Score = 30% = LOS E
- Cycle length = 80 seconds = LOS C

TRANSIT = LOS A

- Priority Corridor planned on Robie Street – exclusive median lanes – 4 of 4 priority lanes = 100% = LOS A
- V/C = (0.80 + 0.80 + 0.25 + 0.01 + 0.01 + 0.73) / 6 = 0.43 = LOS A
- Delay = (27.7 + 27.7 + 15.7 + 10 + 10 + 21.2) / 6 = 18.7 = LOS B

GOODS MOVEMENT = LOS C

- Average Curb Lane Width = 3.75m = LOS C
- (Average Effective Right Turning Radius = 13.0m = LOS D
- Intersection Delay = 25 sec = LOS C

AUTOMOBILES = LOS B

- 3 exclusive turning lanes of 8 turns = 38% = LOS C
  - ◆ 2 exclusive left turn lanes
  - ▲ 1 right turn lane
- No turn prohibitions = LOS A
- Intersection Delay = 25 sec = LOS C

Figure 12

Transit

- There are no dedicated transit lanes planned for any of the intersecting corridors, so the 'Space' measure can be ignored for transit.
- The v/c ratio for movements involving transit vehicles (northbound left and eastbound left only) at this location are 0.76, according to analysis via Synchro, which is between 0.70 and 0.79 (LOS C).
- The delay for movements involving transit vehicles at this location are approximately 34.2 seconds according to analysis via Synchro (LOS C).
- *The overall LOS for transit is C for the intersection. The target LOS is B in the Regional Centre, so the intersection does not meet the target.*

Goods Movement

- The average curb lane width for the intersection is 4.1m (LOS A).
- The average effective right turning radius for trucks is greater than 45m for the intersection (LOS A).
- The overall intersection delay is approximately 20 seconds according to Synchro analysis (LOS B).
- *The overall LOS for trucks is A for the intersection. The target LOS is E in the Regional Centre, so the intersection exceeds the target.*

Automobiles

- The intersection features two exclusive turning lanes (LOS E).
- There are no car turning prohibitions at the intersection (LOS A).
- The overall intersection delay is approximately 20 seconds according to Synchro analysis (LOS B).
- *The overall LOS for cars is B for the intersection. The target LOS is E in the Regional Centre, so the intersection exceeds the target.*

Cunard Street / Robie Street – Existing Layout

Pedestrians

- There are a total of 12 uncontrolled conflict points for pedestrians at the intersection, represented by three permitted left turns, four right turns on red, and four right turns on green, and one right turn channel (LOS D).
- The average crossing width for the intersection is approximately 31.4m (LOS F). Crossing the southern and eastern legs of the intersection are particularly long with five to six lanes to cross plus medians. Additionally, the large right turn channel for northbound right vehicles adds significant distance to the crossing for pedestrians from one edge of the intersection to the other.
- The intersection in partially actuated, but has a natural cycle length of 80 seconds (LOS C).
- *The overall LOS for pedestrians is D for the intersection. The target LOS is B in the Regional Centre, so the intersection does not meet the target.*

Cyclists

- There are 11 uncontrolled conflict points for cyclists, represented by the three permitted left turns, six lane changes required to make a left turn, one right turn lane, and one right turn channel (LOS C).
- There is no cycling infrastructure on any leg of the intersection, but two approaches (Robie NB and SB) feature lane widths greater than four metres, so the intersection scores 20% (LOS F).
- The cycle length for the signal is 80 seconds (LOS C).
- *The overall LOS for cycling is E for the intersection. The target LOS is B in the Regional Centre, so the intersection does not meet the target.*

Transit

- Robie Street is designated as a transit priority corridor in the IMP. HRM currently plans to designate one northbound and one southbound lane for transit. The current layout of the intersection does not include these lanes, so 0% of ideal transit lanes are achieved (LOS F).
- The v/c ratio for movements involving transit vehicles at this location are 0.54 on average according to analysis via Synchro (LOS A).
- The average delay for movements involving transit vehicles at this location are approximately 21.0 seconds according to analysis via Synchro (LOS C).
- *The overall LOS for transit is D for the intersection. The target LOS is A for a transit priority corridor in the Regional Centre, so the intersection does not meet the target.*

Goods Movement

- The average curb lane width is 4.1m (LOS A).
- The average effective right turning radius for trucks is approximately 21.2m for the intersection (LOS A). Note that this includes the large northbound right-turn channel, which has a radius of approximately 46.5m.
- The overall intersection delay is approximately 20.5 seconds according to Synchro analysis (LOS B).
- *The overall LOS for trucks is A for the intersection. The target LOS is E in the Regional Centre, so the intersection exceeds the target.*

Cars

- The intersection features exclusive three left turn lanes, a westbound right turn lane, and the large right turn channel, so five of eight (63%) turning movements have exclusive turn lanes (LOS C).
- There are no car turning prohibitions at the intersection (LOS A).
- The overall intersection delay is approximately 20.5 seconds according to Synchro analysis (LOS B).
- *The overall LOS for cars is B for the intersection. The target LOS is E in the Regional Centre, so the intersection exceeds the target.*

Cunard Street / Robie Street – Proposed Layout

Pedestrians

- There are a total of 11 uncontrolled conflicts at the intersection represented by three permitted left turns, four right turns on red, and four right turns on green.
- The average crossing width for the intersection is approximately 15.8m (LOS D). Crossing distances are significantly reduced on the southern and eastern legs of the intersection, which has reduced the average crossing distance by almost half. However, the intersection is still generally large for pedestrians with six lanes to cross on Robie Street at the intersection.
- It was assumed that the cycle length would remain at 80 seconds (LOS C).
- *The overall LOS for pedestrians is D for the intersection, which is unchanged from the existing condition. The target LOS is B in the Regional Centre, so the intersection does not meet the target. While the crossing distance is significantly improved, the intersection is still generally large due to the cross-section of Robie Street.*

Cyclists

- There are seven uncontrolled conflicts at the intersection (LOS C) due to three permitted left turns, three lane changes required to make a left turn, and one right turn lane (which necessitates a lane change for cyclists to travel straight through the intersection).
- There is no cycling infrastructure, so cyclists must ride in mixed traffic on all legs of the intersection. Curb lane widths on northbound Robie Street and westbound Cunard Street were assumed to be four metres. The intersection scores 20% (LOS F).
- The cycle length for the signal is 80 seconds (LOS C).
- *The overall LOS for cycling is D for the intersection. The target LOS is B in the Regional Centre, so the intersection does not meet the target.*

Transit

- Robie Street is designated as a transit priority corridor in the IMP. This scenario assumes that the designated transit lanes have been constructed, 100% of ideal transit lanes are achieved (LOS A).
- The v/c ratio for movements involving transit vehicles at this location will be significantly reduced, as north-south transit vehicles move in designated transit lanes. The average LOS decreases to 0.43 for movements with transit vehicles (LOS A).
- The delay for movements involving transit vehicles at this location are approximately 19 seconds according to analysis via Synchro (LOS B).
- *The overall LOS for transit is A for the intersection. The target LOS is A for a transit priority corridor in the Regional Centre, so the intersection meets the target.*

Goods Movement

- The average curb lane width is 3.75m (LOS B).
- The average effective right turning radius for trucks is approximately 13.0m for the intersection (LOS D). The removal of the large northbound right turn channel drastically reduces the average right turning radius for the intersection

- The overall intersection delay is approximately 25 seconds according to Synchro analysis (LOS C).
- *The overall LOS for trucks is C for the intersection. The target LOS is E in the Regional Centre, so the intersection exceeds the target.*

Cars

- Three of eight turning movements are served by exclusive turning lanes (38%), which results in LOS C.
- There are no car turning prohibitions at the intersection (LOS A).
- The overall intersection delay is approximately 25 seconds (LOS C).
- *The overall LOS for cars is B for the intersection. The target LOS is E in the Regional Centre, so the intersection exceeds the target.*

Figures 13 and 14 show the inputs and LOS results described in the text above.

SCENARIO: Cunard Street - Existing Condition - AM Peak Hour											Area Type:	Regional Centre
MODE												MODE
DIR	AGRICOLA										NORTH PARK	DIR
WB Target	B	B	B	E	E	CHAIN LAKE DRIVE	E	E	B	B	B	Target EB
Actual	C	C	F	D	B		C	E	F	D	B	Actual
Priority Corridor	No	No	No	No	No		No	No	No	No	No	Priority Corridor
Space	Pedestrian Facility Width (m)	Driveway Density	Transit Facility Type	Width of Curb Lane (m)	Midblock V/C Ratio		Midblock V/C Ratio	Width of Curb Lane (m)	Transit Facility Type	Driveway Density	Pedestrian Facility Width (m)	Space
	1.80 - 1.99	>16 - 24	Mixed Traffic + Parking	3.40 - 3.59	< 0.60		< 0.60	3.40 - 3.59	Mixed Traffic + Parking	0 - 8	>=2.00	
Environment	Pedestrian Zone Width (m)	Speed x Volume	% of Stops with Bus Lay-bys	% No Stopping / No Loading	On-street Parking Availablity (%)		On-street Parking Availablity (%)	% No Stopping / No Loading	% of Stops with Bus Lay-bys	Speed x Volume	Pedestrian Zone Width (m)	Environment
	3.00 - 3.49	E	> 80%	50% - 59%	40% - 59%		20% - 39%	> 60%	> 80%	F	>= 3.50	
Time	Distance Between Marked Crossings (m)	Block Length	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed		Travel Speed / Ideal Speed	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed	Block Length	Distance Between Marked Crossings (m)	Time
	249-300	< 100								100 - 149	249-300	
ROBIE											ROBIE	

Figure 13: *Cunard Street – Segment LOS Results*

SCENARIO:	Cunard Street - Existing Condition - AM Peak Hour				
Area Type:	**Regional Centre**				
MODE					
CUNARD / AGRICOLA / NORTH PARK - Roundabout					
Target	B	B	B	E	E
Actual	C	D	B	A	B
Priority Corridor	No	No	No	No	No
Space	Number of Uncontrolled Conflicts	Number of Uncontrolled Conflicts	% of Transit Priority Measures (of Ideal)	Avg. Curb Lane Width (m)	% of movements with turn lanes
	8-10	< 6		>= 4.00	10 - 35%
Environment	Avg. Crossing Width (m)	Priority Treatments	Transit Movement V/C Ratio	Avg. Effective Curb Radius (m)	Turn prohibitions
	17.5 - 21	< 30%	< 0.60	> 18	0
Time	Cycle Length (sec)	Cycle Length (sec)	Transit Movement Delay	Truck Intersection Delay (sec)	Car Intersection Delay (sec)
	< 60	76 - 90	21 - 35	11 - 20	11 - 20
CUNARD / ROBIE - Signalised (Existing Layout)					
Target	B	B	A	E	E
Actual	D	E	D	A	B
Priority Corridor	No	No	Yes	No	No
Space	Number of Uncontrolled Conflicts	Number of Uncontrolled Conflicts	% of Transit Priority Measures (of Ideal)	Avg. Curb Lane Width (m)	% of movements with turn lanes
	11-13	11-13	< 30%	>= 4.00	60 - 85%
Environment	Avg. Crossing Width (m)	Priority Treatments	Transit Movement V/C Ratio	Avg. Effective Curb Radius (m)	Turn prohibitions
	> 21	< 30%	< 0.60	> 18	0
Time	Cycle Length (sec)	Cycle Length (sec)	Transit Movement Delay	Truck Intersection Delay (sec)	Car Intersection Delay (sec)
	76 - 90	76 - 90	21 - 35	11 - 20	11 - 20
CUNARD / ROBIE - Signalised (Proposed Layout)					
Target	B	B	A	E	E
Actual	D	D	A	C	B
Priority Corridor	No	No	Yes	No	No
Space	Number of Uncontrolled Conflicts	Number of Uncontrolled Conflicts	% of Transit Priority Measures (of Ideal)	Avg. Curb Lane Width (m)	% of movements with turn lanes
	11-13	6-7	90 - 100%	3.60 - 3.79	35 - 60%
Environment	Avg. Crossing Width (m)	Priority Treatments	Transit Movement V/C Ratio	Avg. Effective Curb Radius (m)	Turn prohibitions
	14 - 17.5	30 - 49%	< 0.60	13 - 14	0
Time	Cycle Length (sec)	Cycle Length (sec)	Transit Movement Delay	Truck Intersection Delay (sec)	Car Intersection Delay (sec)
	76 - 90	76 - 90	11 - 20	21 - 35	21 - 35

Figure 14: *Cunard Street Intersection Results*

Discussion

At the segment level, Cunard Street meets or exceeds the targets for cars and trucks moving through the area, which is not surprising. The mid-block capacity of two lanes per direction is more than enough to accommodate the volume in either direction during the AM peak hour. Additionally, the wide, treed median with an increased cross-section compared to the west of Robie Street and east of Agricola / North Park generally results in a fast-moving segment for motorised travel, as drivers feel a sense of 'widening' and of a facility designed with an increased focus on moving motorised vehicles. This is echoed in the lack of infrastructure for cycling, which forces cyclists to travel between fast moving and parked cars, which is a hostile environment. Pedestrian infrastructure is generally good, though the distance between marked crossings is too long. A marked and actuated mid-block crossing at Princess Place would help alleviate this.

The roundabout at Cunard / Agricola / North Park meets or exceeds the targets for cars and trucks. Wide entry and exit lanes and larger turning radii on the south half of the intersection create an easy environment for trucks to navigate. Transit vehicles move generally along the heaviest movements in the intersection with no dedicated facilities. The main issue for pedestrians is the size of the intersection, as crossing distances are fairly long from one side of the intersection to the other on the western and southern legs. For cyclists, the main issue is that they must negotiate the intersection in mixed traffic, which is not comfortable for all ages and abilities. Cyclists can optionally dismount and walk through the intersection, which is not ideal.

The intersection at Cunard Street and Robie Street functions very well for cars and trucks in its current state. The intersection features many exclusive turning lanes, delays are low, and the turning radii are largely acceptable for trucks (though exaggerated by the very large right turn channel from the southern leg). For active transportation users, the intersection is currently very large and complex to navigate with very long crosswalks and no dedicated cycling infrastructure. Transit conditions are not ideal as vehicles must travel in mixed traffic, despite low delays and v/c ratios for transit movements.

Implementation of the proposed concept for the Cunard and Robie Street intersection provides some improvement for transit and cyclists. Transit service is raised to LOS A through addition of the dedicated north-south transit lanes, which is logical. Cycling LOS moves up from an E to a D, due mainly to the inclusion of four metre lanes in the revised intersection. There is still no specific infrastructure for cyclists in the proposed condition. The pedestrian LOS does not change, despite a drastic reduction in crossing distance with the new layout, as Robie Street, at six lanes, still keeps the overall crossing distance high. The pedestrian LOS is also being hampered by a significant number of uncontrolled conflicts. Trucks do see a degradation to LOS C, but this still in excess of the target LOS value of E in the Regional Centre. And the LOS for cars is unchanged, which indicates that the current intersection could be further reduced in scale with no significant impacts to automobile travel. As the truck and car LOS are still in excess of the target, while active transportation is still under target, further modifications will be necessary and possible to reach the targets set for the area.

The intersection could be moved further towards the targets through prohibition of the northbound and southbound left turns. This would reduce the southern crossing distance for pedestrians, remove two uncontrolled conflicts for pedestrians and cyclists, and remove the need for cyclists to change lanes to make a northbound left turn. In addition, this would help to simplify signal phasing related to having left turning vehicles crossing over the transit only lanes, which would create a safety issue without protected phasing. These changes would worsen the LOS for cars and goods movement, while improving active transportation modes.

Herring Cove Road

As one of the main thoroughfares through the communities to the south of the Armdale Roundabout, Herring Cove Road is an important corridor for movement through the communities and a major connection to the Halifax Peninsula. The study area for this examination extends from Glenora Avenue in the north to Old Sambro Road in the south, as shown in **Figure 15**.

Figure 15: *Herring Cove Road Study Area*

Some details about the study corridor are presented below:

- Length: 800m
- One signalised intersection (Old Sambro Road)
- One stop-controlled intersection (Glenora Avenue)
- One travel lane in the southbound direction north of Highfield Street
- Two travel lanes in the southbound direction south of Highfield Street
- One travel lane in the northbound direction
- Two bus stops in the southbound direction (one with a bus bay)
- Two northbound bus stops where the bus pulls onto a paved shoulder
- Posted maximum speed limit: 50 km/h
- Sidewalk on the west side of the road only

Data collected to perform the analysis included:

- AM peak hour traffic counts
- Signal timing
- Dimensions (lane, sidewalk, and pedestrian zone widths, block size)
- Intersection geometry and lane allocation
- Average auto operating speed

The study corridor is located in the suburban area of HRM. There are no priority corridors.

Segment Analysis

There are two segments under consideration for this illustration, between the two intersections. Note that there are additional intersections along this segment where the corridor could be additionally split, if desired. These are not included in the analysis to simplify the illustration of the process. **Figures 16 and 17** summarise the corridor inputs and measurements for the two segments.

The corridor is split into two segments for this analysis, as the southbound direction has a single lane between Glenora and Highfield and two lanes between Highfield and Old Sambro, which is a significant change to the infrastructure.

Glenora Avenue to Highfield Street

Pedestrians

- Sidewalk width was measured as approximately 1.5m (LOS D) in the southbound direction. There is no sidewalk in the northbound direction (LOS F).
- There is a grass buffer between the sidewalk and the roadway in the northbound direction. The pedestrian zone width is approximately 3.1m (LOS B). There is no pedestrian zone in the northbound direction (LOS F).
- The nearest marked crossing to the south of the crossing at Glenora is 580m south at Mont Street (LOS F).
- *The overall LOS for pedestrians at the segment level was calculated as LOS D the southbound direction and LOS F in the northbound direction. The target LOS in suburban areas is C, so the target is not met in either direction.*

Cyclists

- In the southbound direction, there are five low density residential driveways and one medium commercial driveway. These are equivalent to 4.5 driveways. Over a segment of 130m, this results in a driveway density of 34.6 (LOS E). In the northbound direction there are four low density residential and two medium density residential driveways, which results in a driveway density of 30.8/km (LOS D).
- The average operational speed for vehicles was approximately 60km/h and cyclists ride in mixed traffic, which caps the LOS at a maximum of D. Multiplying the speed by the AADT (3580 SB / 4700 NB) results in scores of 215 SB and 282 NB. This results in LOS E in both directions.
- Block length is 130m (LOS B) in both directions.
- *The overall LOS for cycling in the study area was calculated as LOS D in both directions. The target LOS for cycling in suburban areas is C, so this segment does not meet the target.*

SEGMENT Herring Cove from Glenora to Highfield

SCENARIO Existing AM

PEDESTRIANS = LOS D SB, LOS F NB

- Pedestrian Facility Width
  - SB = 1.5m = LOS D
  - NB = No facility = LOS F
- Pedestrian Zone Width
  - SB = 3.1m = LOS B
  - NB = No facility = LOS F
- Distance between marked crossings
  - SB = 580m = LOS F
  - NB = 580m = LOS F

CYCLISTS = LOS D SB / NB

- Driveway Density
  - SB = 34.6/km = LOS E
  - NB = 30.8/km = LOS D
- Speed x Volume
  - SB = 60 x 3.58 = 215 = LOS E
  - NB = 60 x 4.70 = 282 = LOS E
- Block length
  - SB = 130m = LOS B
  - NB = 130m = LOS B

TRANSIT = LOS D SB / NB

- Transit Facility Type
  - SB = Mixed traffic with 1 lane = LOS E
  - NB = Mixed traffic with 1 lane = LOS E
- Percent of stops with Bus Lay-By
  - NB = No stops = LOS N/A
  - SB = No stops = LOS N/A
- Travel Speed / Ideal Speed
  - SB = 75% = LOS C
  - NB = 100% = LOS A

GOODS MOVEMENT = LOS A SB/NB

- Average Curb Lane Width
  - SB = 4.5m = LOS A
  - NB = 4.0m = LOS A
- Percent No Stopping / No Loading
  - Suburban arterial road with commercial loading zones = LOS N/A
- Travel Speed / Ideal Speed
  - SB = 75% = LOS C
  - NB = 100% = LOS A

AUTOMOBILES = LOS A SB/NB

- Mid-block V/C
  - SB = 358/900 = 0.40 = LOS A
  - NB = 470/ 900 = 0.52 = LOS A
- % On-street Parking Availability
  - Suburban arterial with commercial parking lots, residential driveways and parking lots = LOS N/A
- Travel Speed / Ideal Speed
  - SB = 75% = LOS C
  - NB = 100% = LOS A

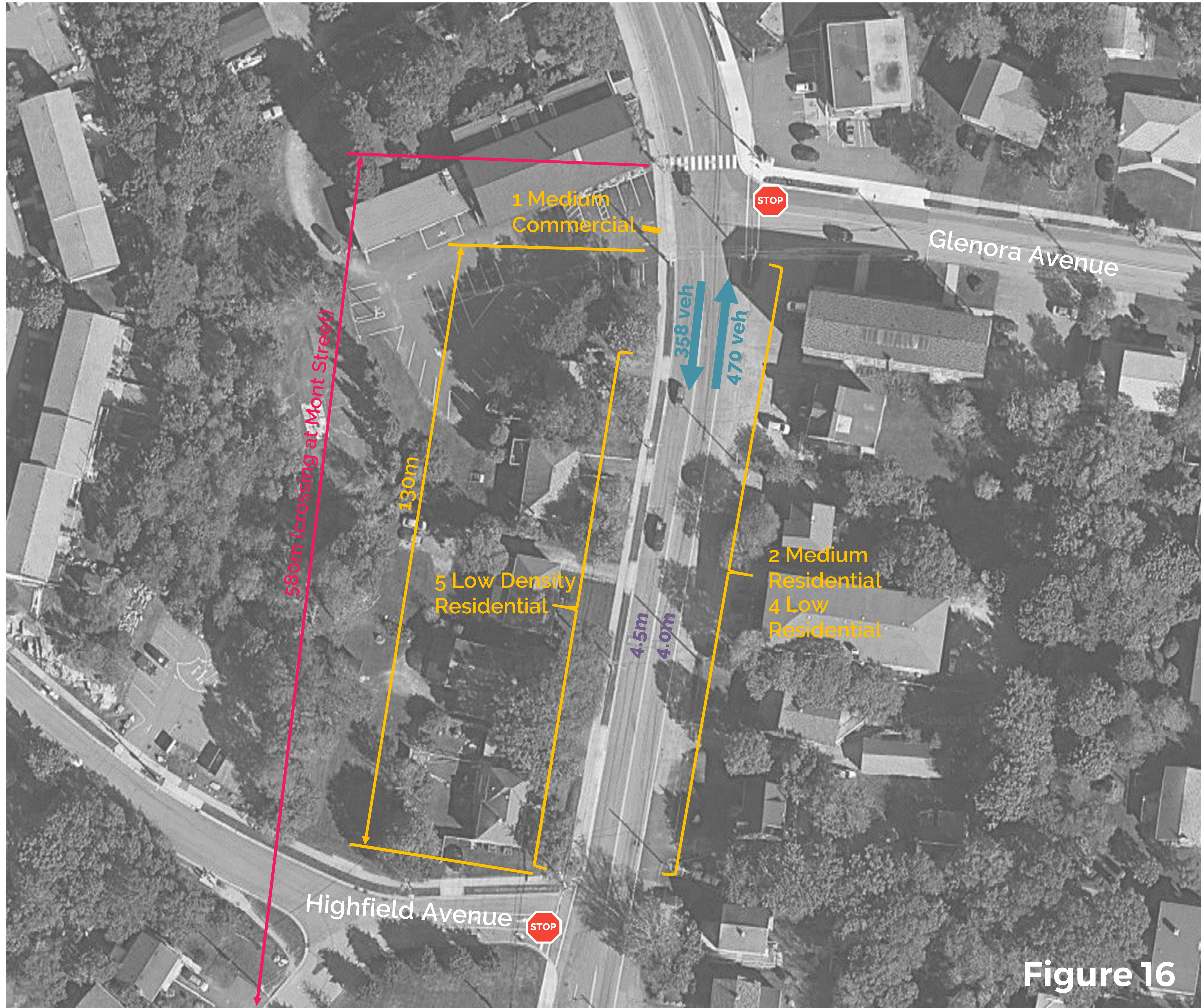


Figure 16

SEGMENT Herring Cove from Highfield to Old Sambro **SCENARIO** Existing AM

PEDESTRIANS = LOS E SB / LOS F NB
- Pedestrian Facility Width
  - SB = 1.5m = LOS D
  - NB = No Facility = LOS F
- Pedestrian Zone Width
  - SB = 2.5m = LOS D
  - NB = No Facility = LOS F
- Distance between marked crossings
  - SB = (580+210)/2 = 395m = LOS F
  - NB = (580+210)/2 = 395m = LOS F

CYCLISTS = LOS E SB / NB
- Driveway Density
  - SB = 43.7/km = LOS F
  - NB = 21.5/km = LOS C
- Speed x Volume
  - SB = 60 x 4.62 = 277 = LOS E
  - NB = 60 x 4.70 = 282 = LOS E
- Block Length
  - SB = (316+105+125+82)/4 = 157m = LOS C
  - NB = (430+221)/2 = 326m = LOS F

TRANSIT = LOS D SB / NB
- Transit Facility Type
  - SB = Mixed traffic with >1 lane = LOS D
  - NB = Mixed traffic with 1 lane = LOS E
- Percent of stops with Bus Lay-By
  - SB = 50% = LOS D
  - NB = 100% = LOS F
- Travel Speed / Ideal Speed
  - SB = 75% = LOS C
  - NB = 100% = LOS A

GOODS MOVEMENT = LOS C SB, LOS A NB
- Width of Curb Lane
  - SB = 3.4m = LOS D
  - NB = 4.0m = LOS A
- Percent No Stopping / No Loading
  - Suburban arterial road with commercial loading zones = LOS N/A
- Travel Speed / Ideal Speed
  - SB = 75% = LOS C
  - NB = 100% = LOS A

AUTOMOBILES = LOS B SB, LOS A NB
- Mid-block V/C
  - SB = 462/1800 = 0.26 = LOS A
  - NB = 470/ 900 = 0.52 = LOS A
- On-street Parking Availability
  - Suburban arterial with commercial parking lots, residential driveways and parking lots = LOS N/A
- Travel Speed / Ideal Speed
  - SB = 75% = LOS C
  - NB = 100% = LOS A

Figure 17

Transit

- Transit vehicles operate in mixed traffic in one lane along the segment (LOS E).
- There are no transit stops in this segment, so the '% bus stops with bus bays' can be ignored.
- As the overall study area is greater than 700m in length, the travel speed / ideal speed measure should be calculated *for the whole study corridor*. The freeflow travel time between Glenora and Old Sambro at the posted maximum speed limit of 50km/h is approximately 58 seconds. The southbound approach to the intersection with Old Sambro Road was shown to have 18.8 seconds of delay for the average vehicle. This results in a congested travel time southbound through the corridor of 76.8 seconds or a congested travel speed of 37.8 km/h. The ratio of travel speed to ideal speed, therefore is 37.8/50 = 0.76. The southbound corridor, therefore, operates at LOS C. In the northbound direction, there are no traffic controls north of Old Sambro, therefore the freeflow and congested travel times are equivalent, which is a ratio of 1.0 (LOS A).
- *The overall LOS for transit is D in the both directions. The target LOS for transit in suburban areas is C, so this segment falls short of the target.*

Goods Movement

- The average width of the shoulder lane in both directions on Herring Cove Road is in excess of 4m in both directions on this segment (LOS A).
- In a mainly residential area like this corridor, there is little to no call for on-street delivery of goods and commercial land uses typically have abundant parking, so the '% no stopping / loading' measure can be ignored.
- As the overall study area is greater than 700m in length, the travel speed / ideal speed measure should be calculated *for the whole study corridor*. The freeflow travel time between Glenora and Old Sambro at the posted maximum speed limit of 50km/h is approximately 58 seconds. The southbound approach to the intersection with Old Sambro Road was shown to have 18.8 seconds of delay for the average vehicle. This results in a congested travel time southbound through the corridor of 76.8 seconds or a congested travel speed of 37.8 km/h. The ratio of travel speed to ideal speed, therefore is 37.8/50 = 0.76. The southbound corridor, therefore, operates at LOS C. In the northbound direction, there are no traffic controls north of Old Sambro, therefore the freeflow and congested travel times are equivalent, which is a ratio of 1.0 (LOS A).
- *The overall LOS for trucks is A in the both directions. The target LOS for trucks in suburban areas is E, so this segment exceeds the target.*

Automobiles

- The volume to capacity ratio (v/c ratio) is 0.52 (470 vehicles travelling on one lane with a capacity of 900) in the northbound direction (LOS A) and 0.40 (358 vehicles travelling on one lane with a capacity of 900) in the southbound direction (LOS A).
- In a mainly residential area like this corridor, there is little to no call for on-street parking and commercial land uses typically have abundant parking, so the 'parking availability' measure can be ignored.

- As the overall study area is greater than 700m in length, the travel speed / ideal speed measure should be calculated *for the whole study corridor*. The freeflow travel time between Glenora and Old Sambro at the posted maximum speed limit of 50km/h is approximately 58 seconds. The southbound approach to the intersection with Old Sambro Road was shown to have 18.8 seconds of delay for the average vehicle. This results in a congested travel time southbound through the corridor of 76.8 seconds or a congested travel speed of 37.8 km/h. The ratio of travel speed to ideal speed, therefore is 37.8/50 = 0.76. The southbound corridor, therefore, operates at LOS C. In the northbound direction, there are no traffic controls north of Old Sambro, therefore the freeflow and congested travel times are equivalent, which is a ratio of 1.0 (LOS A).
- *The overall LOS for cars is A in both directions. The target for LOS in suburban areas is E, so the LOS for cars is well in excess of the target.*

Highfield Street to Old Sambro Road
Pedestrians

- Sidewalk width was measured as approximately 1.5m (LOS D) in the southbound direction. There is no sidewalk in the northbound direction (LOS F).
- There is no buffer between the sidewalk and the roadway in the northbound direction. The pedestrian zone width is approximately 2.5m (LOS D). There is no pedestrian zone in the northbound direction (LOS F).
- The nearest marked crossings are 580m to the north of Mont Street and 210m to the south, which results in an average distance between crossings of 395m (LOS F).
- *The overall LOS for pedestrians at the segment level was calculated as LOS E the southbound direction and LOS F in the northbound direction. The target LOS in suburban areas is C, so the target is not met.*

Cyclists

- There are many driveways in both directions along this segment. In the southbound direction there are a mix of residential and commercial entrances, equivalent to 29.5 driveways over the 675m, which is a driveway density of 43.7/km (LOS F). In the northbound direction, the majority of the driveways are for single family homes, with one medium density residential driveway and one medium density commercial property. This is equivalent to 14.5 driveways over 650m or a driveway density of 21.5/km (LOS D).
- Cyclists ride in mixed traffic in both directions on Herring Cove Road, which limits the LOS to a maximum of D. With an operating speed of 60 km/h and an AADT of approximately 4620, this results in a score of 277 in the southbound direction (LOS E). In the northbound direction the operating speed is 60 km/h and the AADT is 4700, which results in a score of 282 (LOSE E).
- The southbound direction between Highfield Avenue and Old Sambro Road features to local cross streets (Mont, Layton) that can provide options to cyclists with respect to comfort and routing. The resulting average block length is 157m (LOS C). In the northbound direction, the only significant local cross street is McMullen. The resulting average block length is 326m (LOS F).

- *The overall LOS for cycling in the study area was calculated as LOS E in both directions. The target LOS for cycling in suburban areas is C, so this segment does not meet the target.*

Transit

- Transit vehicles operate in mixed traffic in two lanes along Herring Cove Road southbound (LOS E) and mixed traffic in one lane (LOS E) northbound.
- There are two bus stops southbound along this segment: one in the curb lane and one at a bus bay. Therefore the % of stops with bus lay-bys is 50% (LOS D). There are two bus stops in the northbound direction both on paved shoulders outside of the travel lane, so the % of bus lay-bys is 100% (LOS F).
- As the overall study area is greater than 700m in length, the travel speed / ideal speed measure should be calculated *for the whole study corridor*. The freeflow travel time between Glenora and Old Sambro at the posted maximum speed limit of 50km/h is approximately 58 seconds. The southbound approach to the intersection with Old Sambro Road was shown to have 18.8 seconds of delay for the average vehicle. This results in a congested travel time southbound through the corridor of 76.8 seconds or a congested travel speed of 37.8 km/h. The ratio of travel speed to ideal speed, therefore is 37.8/50 = 0.76. The southbound corridor, therefore, operates at LOS C. In the northbound direction, there are no traffic controls north of Old Sambro, therefore the freeflow and congested travel times are equivalent, which is a ratio of 1.0 (LOS A).
- *The overall LOS for transit is D in both directions. The target LOS for transit in suburban areas is C, so this segment falls short of the target in both directions.*

Goods Movement

- The average width of the shoulder lane in the southbound direction on Herring Cove Road is approximately 3.4m (LOS D). The northbound lane width is approximately 4.0m on average (LOS A).
- In a mainly residential areas like this corridor, there is little to no call for on-street delivery of goods and commercial land uses typically have abundant parking, so the '% no stopping / loading' measure can be ignored.
- As the overall study area is greater than 700m in length, the travel speed / ideal speed measure should be calculated *for the whole study corridor*. The freeflow travel time between Glenora and Old Sambro at the posted maximum speed limit of 50km/h is approximately 58 seconds. The southbound approach to the intersection with Old Sambro Road was shown to have 18.8 seconds of delay for the average vehicle. This results in a congested travel time southbound through the corridor of 76.8 seconds or a congested travel speed of 37.8 km/h. The ratio of travel speed to ideal speed, therefore is 37.8/50 = 0.76. The southbound corridor, therefore, operates at LOS C. In the northbound direction, there are no traffic controls north of Old Sambro, therefore the freeflow and congested travel times are equivalent, which is a ratio of 1.0 (LOS A).
- *The overall LOS for trucks is C southbound and A northbound. The target LOS for transit in suburban areas is E, so this segment exceeds the target in both directions.*

Automobiles

- The volume to capacity ratio (v/c ratio) is 0.52 (470 vehicles travelling on one lane with a capacity of 900) in the northbound direction (LOS A) and 0.26 (462 vehicles travelling on two lanes with a capacity of 1800) in the southbound direction (LOS A).
- In a mainly residential areas like this corridor, there is little to no call for on-street parking and commercial land uses typically have abundant parking, so the 'parking availability' measure can be ignored.
- As the overall study area is greater than 700m in length, the travel speed / ideal speed measure should be calculated *for the whole study corridor*. The freeflow travel time between Glenora and Old Sambro at the posted maximum speed limit of 50km/h is approximately 58 seconds. The southbound approach to the intersection with Old Sambro Road was shown to have 18.8 seconds of delay for the average vehicle. This results in a congested travel time southbound through the corridor of 76.8 seconds or a congested travel speed of 37.8 km/h. The ratio of travel speed to ideal speed, therefore is 37.8/50 = 0.76. The southbound corridor, therefore, operates at LOS C. In the northbound direction, there are no traffic controls north of Old Sambro, therefore the freeflow and congested travel times are equivalent, which is a ratio of 1.0 (LOS A).
- *The overall LOS for cars is B in the southbound direction and A in the northbound direction. The target for LOS in suburban areas is E, so the LOS for cars is well in excess of the target.*

Intersection Analysis

Two intersections are under consideration in this analysis: the intersection at Glenora is a stop-controlled T-intersection and the intersection at Old Sambro Road is a signal-controlled T-intersection. **Figures 18** and **19** summarise the intersection inputs and measurements.

Herring Cove Road / Glenora Avenue

Pedestrians

- There are a total of 3 uncontrolled conflict points for pedestrians at the intersection (LOS A), as follows:
    - One uncontrolled left turn from southbound Herring Cove Road to eastbound Glenora Avenue
    - One uncontrolled right turn from northbound Herring Cove Road
    - One right turn from Glenora Avenue (conflicts with east-west pedestrians)
- The average crossing width for the intersection is 22.3m (LOS F). Note that of the three possible crossings, only two are provided (north and east crossings). The intersection is penalised as it forces pedestrians attempting to cross the southern leg of the intersection to travel significant extra distance across the eastern, northern, and western sections.
- The intersection has stop control on the minor leg and only has crosswalk markings on one crosswalk (LOS C).

- *The overall LOS for pedestrians is C for the intersection. The target LOS is C in suburban areas, so the intersection meets the target.*

Cyclists

- There is one uncontrolled conflict with cyclists – the southbound left turn from Herring Cove Road, which would cross over the path of a northbound cyclist (LOS A).
- There is no bike infrastructure at the intersection. All curb lanes are 4.0m or greater. The intersection scores 40% (LOS E).
- The intersection is stop-controlled with one lane per direction on the major street (LOS C).
- *The overall LOS for cycling is C for the intersection. The target LOS is C in suburban areas, so the intersection meets the target.*

Transit

- There are no dedicated transit lanes planned for this section of Herring Cove Road, so the 'Space' measure can be ignored for transit.
- The v/c ratio for movements involving transit vehicles (northbound through and southbound through only) at this location are less than 0.6 according to analysis via Synchro (LOS A).
- The delay for movements involving transit vehicles (northbound through and southbound through only) at this location are less than ten seconds according to analysis via Synchro (LOS A).
- *The overall LOS for transit is A for the intersection. The target LOS is C in suburban areas, so the intersection exceeds the target.*

Goods Movement

- The average curb lane width for the intersection is 5.0m (LOS A).
- The average effective right turning radius for trucks is approximately 10.8m for the intersection (LOS F).
- The overall intersection delay is less than ten seconds according to Synchro analysis (LOS A).
- *The overall LOS for trucks is B for the intersection. The target LOS is E in suburban areas, so the intersection exceeds the target.*

Automobiles

- There are no turning lanes at the intersection (LOS F).
- There are no car turning prohibitions at the intersection (LOS A).
- The overall intersection delay is less than 10 seconds according to Synchro analysis (LOS A).
- *The overall LOS for cars is C for the intersection. The target LOS is E in suburban areas, so the intersection exceeds the target.*

INTERSECTION Herring Cove Road / Glenora Avenue **SCENARIO** Existing AM

PEDESTRIANS = LOS C

- 3 uncontrolled conflicts with pedestrians = LOS A
  - ◆ 1 uncontrolled left turn
  - ● 1 uncontrolled right turn
  - ▲ 1 right turn from Glenora across east-west crosswalk
- Average Pedestrian Crossing = (13.1 + 12.4 + (13.1 + 12.4 + 15.9))/3 = 22.3m = LOS F
- Cycle Length = TWSC with one major leg marked = LOS C

CYCLISTS = LOS C

- 1 uncontrolled conflict with cyclists = LOS A
  - ◆ 1 permitted left turn (SBL)
- No priority corridors, no infrastructure, all curb lanes >= 4m
  - Score = 40% = LOS E
- Cycle Length = TWSC with one lane per direction on major street = LOS C

TRANSIT = LOS A

- No planned transit priority measurements = LOS N/A
- V/C = (0.05 + 0.30) / 2 = 0.18 = LOS A
- Delay = (1.6 + 0.0) / 2 = 0.8 sec = LOS A

GOODS MOVEMENT = LOS B

- Average Curb Lane Width = 5.0m = LOS A
- (Average Effective Right Turning Radius = 10.8m = LOS F
- Truck Delay = 3.1 sec = LOS A

AUTOMOBILES = LOS C

- Percent of movements with turn lanes = 0% = LOS F
- No turn prohibitions = LOS A
- Intersection Delay = 3.1 sec = LOS A

Figure 18

INTERSECTION Herring Cove Road / Old Sambro Road **SCENARIO** Existing AM

PEDESTRIANS = LOS C

- 6 uncontrolled conflicts with pedestrians = LOS B
    - ◆ 2 permitted left turns
    - ● 2 right turn on red
    - ▲ 2 right turn on green
- Average Pedestrian Crossing = 18.4m = LOS E
- Cycle Length = 75 seconds = LOS B

CYCLISTS = LOS D

- 3 uncontrolled conflicts with cyclists= LOS A
    - ◆ 1 Permitted left turn
    - ● 2 lane changes to make a left turn
    - ▲ Disregard EB right turn lane – no EB through movement
- Herring Cove curb lanes < 4m, Old Sambro curb lane = right turn lane
    - Score = -7% = LOS F
- Cycle Length = 75 seconds = LOS B

TRANSIT = LOS A

- No planned transit priority measurements = LOS N/A
- V/C = (0.38 + 0.38 + 0.26) / 3 = 0.34 = LOS A
- Delay = (18.8 + 18.8 + 5.2) /3 = 14.3 sec = LOS B

GOODS MOVEMENT = LOS B

- Average Curb Lane Width = 4.5m = LOS A
- (Average Effective Right Turning Radius = 12.8m = LOS D
- Delay = 19.5 seconds = LOS B

AUTOMOBILES = LOS B

- 3 turning lanes for 4 movements = 75% = LOS B
    - ◆ 2 left turn lanes
    - ▲ 1 right turn lane
- No turn prohibitions = LOS A
- Delay = 19.5 seconds = LOS B

Figure 19

Herring Cove Road / Old Sambro Road

Pedestrians

- There are a total of 6 uncontrolled conflict points for pedestrians at the intersection (LOS B):
    - Two permitted left turns
    - Two right turns on red
    - Two right turns on green
- The average crossing width for the intersection is 18.4m (LOS E).
- The cycle length is 75 seconds (LOS B).
- *The overall LOS for pedestrians is C for the intersection. The target LOS is C in suburban areas, so the intersection meets the target.*

Cyclists

- There are three uncontrolled conflicts for cyclists at the intersection:
    - One permitted left turn (northbound left from Herring Cove Road)
    - Two curb lanes to cross to make a left turn (through lane on Herring Cove Road, right turn lane on Old Sambro Road)
    - At a four leg intersection, the exclusive right turn lane on the eastbound approach would also count as an uncontrolled conflict for cyclists, as they must change lanes across vehicle traffic to travel straight through the intersection. For a T-intersection, this is not the case. Cyclists can remain in this lane to turn right or change into the left turn lane to make the left, which is already accounted for. Therefore, the right turn lane conflict on the eastbound approach can be ignored.
- There is no cycling infrastructure present. The curb lanes on Herring Cove Road are less than four metres and the curb lane on Old Sambro Road is greater than four metres. The intersection scores 13% (LOS F).
- The cycle length of the signal is 75 seconds (LOS B).
- *The overall LOS for cycling is D for the intersection. The target LOS is C in suburban areas, so the intersection does not meet the target.*

Transit

- There are no dedicated transit lanes planned for this section of Herring Cove Road, so the 'Space' measure can be ignored for transit.
- The v/c ratio for movements involving transit vehicles (northbound through, southbound through, and southbound right) at this location are less than 0.6 on average according to analysis via Synchro (LOS A).
- The delay for movements involving transit vehicles (northbound through, southbound through, and southbound right) at this location are approximately 14.3 seconds according to analysis via Synchro (LOS B).
- *The overall LOS for transit is A for the intersection. The target LOS for transit in suburban areas is C, so the intersection exceeds the target.*

Goods Movement

- The average curb lane width for the intersection is 4.5m (LOS A).

- The average effective right turning radius for trucks is approximately 12.8m for the intersection (LOS D).
- The overall intersection delay is approximately 19.5 seconds according to Synchro analysis (LOS B).
- *The overall LOS for trucks is B for the intersection. The target LOS is E in suburban areas, so the intersection exceeds the target.*

Automobiles

- There are three turning lanes out of six movements (50%) at the intersection (LOS B).
- There are no car turning prohibitions at the intersection (LOS A).
- The overall intersection delay is approximately 19.5 seconds according to Synchro analysis (LOS B).
- *The overall LOS for cars is B for the intersection. The target LOS is E in suburban areas, so the intersection exceeds the target.*

Figures 20 and **21** show the inputs and results described in the text above.

Discussion

At the segment level, as would be expected of a main thoroughfare through a suburban residential area, the LOS targets for motorised modes (cars and trucks) exceed the targets set for the area. As they have not been prioritised historically, active transportation modes and transit are not overly well-served at the segment level. The LOS target is met for cyclists, but, with any increase in automobile volume, this would move below the target, as cyclists ride in mixed traffic. This would be true of a PM peak hour analysis for cyclists, as the automobile volume is approximately 60% higher during the PM peak hour. Transit is not well served along the corridor, as the vehicles travel in mixed traffic and must generally use bus lay-bys / paved shoulders to board and alight passengers. Pedestrians are an afterthought in the current arrangement, as sidewalks are of minimal width on the west side of the corridor and non-existent on the east side. The distances between marked crossings of the corridor are also set very far apart for pedestrians.

At the intersection level, all modes are well served at both intersections according to the targets, with the exception of bikes at the Herring Cove Road / Old Sambro Road intersection (LOS D). This is due mainly to the fact that both intersections have three legs, which reduces the number of uncontrolled conflicts for pedestrians and cyclists and allows the cycle length to be short.

SCENARIO: Herring Cove Road - Existing Condition - AM Peak Hour | **Area Type: Inner Suburb**

HERRING COVE ROAD

GLENORA – HIGHFIELD

DIR: SB

MODE					
Target	C	C	C	E	E
Actual	D	D	D	B	B
Priority Corridor	No	No	No	No	No
Space	Pedestrian Facility Width (m)	Driveway Density	Transit Facility Type	Width of Curb Lane (m)	Midblock V/C Ratio
	1.50 - 1.64	>32 - 40	Mixed traffic with 1 lane	>= 4.00	< 0.60
Environment	Pedestrian Zone Width (m)	Speed x Volume	% of Stops with Bus Lay-bys	% No Stopping / No Loading	On-street Parking Availablity (%)
	3.00 - 3.49	E			
Time	Distance Between Marked Crossings (m)	Block Length	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed
	> 300	100 - 149	0.71 - 0.80	0.71 - 0.80	0.71 - 0.80

DIR: NB

					MODE
	E	E	C	C	C	Target
	A	A	D	D	F	Actual
	No	No	No	No	No	Priority Corridor
Space	Midblock V/C Ratio	Width of Curb Lane (m)	Transit Facility Type	Driveway Density	Pedestrian Facility Width (m)
	< 0.60	>= 4.00	Mixed traffic with 1 lane	>24 - 32	<1.25
Environment	On-street Parking Availablity (%)	% No Stopping / No Loading	% of Stops with Bus Lay-bys	Speed x Volume	Pedestrian Zone Width (m)
				E	<2.00
Time	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed	Block Length	Distance Between Marked Crossings (m)
	0.91 - 1.00	0.91 - 1.00	0.91 - 1.00	100 - 149	249-300

HIGHFIELD – OLD SAMBRO

DIR: SB

Target	C	C	C	E	E
Actual	E	E	D	C	B
Priority Corridor	No	No	No	No	No
Space	Pedestrian Facility Width (m)	Driveway Density	Transit Facility Type	Width of Curb Lane (m)	Midblock V/C Ratio
	1.50 - 1.64	> 40	Mixed Traffic with >1 lane	3.40 - 3.59	< 0.60
Environment	Pedestrian Zone Width (m)	Speed x Volume	% of Stops with Bus Lay-bys	% No Stopping / No Loading	On-street Parking Availablity (%)
	2.50 - 2.75	E	41% - 60%		
Time	Distance Between Marked Crossings (m)	Block Length	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed
	> 300	150 - 199	0.71 - 0.80	0.71 - 0.80	0.71 - 0.80

DIR: NB

Target	E	E	C	C	C
Actual	A	A	D	E	F
Priority Corridor	No	No	No	No	No
Space	Midblock V/C Ratio	Width of Curb Lane (m)	Transit Facility Type	Driveway Density	Pedestrian Facility Width (m)
	< 0.60	>= 4.00	Mixed traffic with 1 lane	>16 - 24	<1.25
Environment	On-street Parking Availablity (%)	% No Stopping / No Loading	% of Stops with Bus Lay-bys	Speed x Volume	Pedestrian Zone Width (m)
			> 80%	E	<2.00
Time	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed	Travel Speed / Ideal Speed	Block Length	Distance Between Marked Crossings (m)
	0.91 - 1.00	0.91 - 1.00	0.91 - 1.00	> 300	> 300

OLD SAMBRO

***Figure 20:** Herring Cove Road – Segment LOS Results*

SCENARIO: Herring Cove Road - Existing Condition - AM Peak Hour

Area Type: Inner Suburb

MODE					
HERRING COVE / GLENORA - Stop-Controlled T					
Target	C	C	C	E	E
Actual	C	C	A	B	C
Priority Corridor	No	No	No	No	No
Space	Number of Uncontrolled Conflicts	Number of Uncontrolled Conflicts	% of Transit Priority Measures (of Ideal)	Avg. Curb Lane Width (m)	% of movements with turn lanes
	< 6	< 6		>= 4.00	< 10%
Environment	Avg. Crossing Width (m)	Priority Treatments	Transit Movement V/C Ratio	Avg. Effective Curb Radius (m)	Turn prohibitions
	> 21	30 - 49%	< 0.60	< 11	0
Time	Cycle Length (sec)	Cycle Length (sec)	Transit Movement Delay	Truck Intersection Delay (sec)	Car Intersection Delay (sec)
	76 - 90	76 - 90	0 - 10	0 - 10	0 - 10
HERRING COVE / OLD SAMBRO - Signalised T					
Target	C	C	C	E	E
Actual	C	D	A	B	B
Priority Corridor	No	No	No	No	No
Space	Number of Uncontrolled Conflicts	Number of Uncontrolled Conflicts	% of Transit Priority Measures (of Ideal)	Avg. Curb Lane Width (m)	% of movements with turn lanes
	6-7	< 6		>= 4.00	60 - 85%
Environment	Avg. Crossing Width (m)	Priority Treatments	Transit Movement V/C Ratio	Avg. Effective Curb Radius (m)	Turn prohibitions
	17.5 - 21	< 30%	< 0.60	13 - 14	0
Time	Cycle Length (sec)	Cycle Length (sec)	Transit Movement Delay	Truck Intersection Delay (sec)	Car Intersection Delay (sec)
	61 - 75	61 - 75	11 - 20	11 - 20	11 - 20

Figure 21: *Herring Cove Road Intersection Results*