DRAFT REPORT

Multi-Modal Level of Service (MMLOS) Guidelines

Supplement to the TIA Guidelines

Prepared for City of Ottawa
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1 Purpose of Guidelines & Introduction to Multimodal Level of Service

In the past, municipalities often focused on the performance of vehicular traffic in evaluating the level of service (LOS) on streets. Since no comparable LOS measures have been commonly institutionalized for other modes of travel, the tradeoffs between vehicle delay and its impacts on the quality of travel by other modes are often overlooked. That is, the typical outcome of improving level of service is wider roads with more travel lanes, higher vehicle volumes, and faster vehicle speeds. These network modifications often degrade conditions for other modes (i.e. walking and cycling), and this tradeoff is not incorporated into the standard motor vehicle LOS indicator.

However, recognition of the need to provide more multi-modal streets has marked a shift towards establishing performance measures for all modes: cycling, walking, transit and vehicular. This all-in-one evaluation tool is referred to as Multimodal Level of Service (MMLOS), and will allow comparison using similar performance metrics for each mode.

For the purposes of the report, the multimodal level of service is defined as follows:

> *A set of discrete quantitative measures used to describe the convenience and comfort experienced by all roadway users over a particular roadway segment or at a particular intersection.*

This document provides guidance on the application of the City of Ottawa's new MMLOS framework, providing an overview and step-by-step guide to the evaluation of level of service for all modes.

1.1 Background

In late 2013, the City of Ottawa completed a full update to their Transportation Master Plan (TMP). The TMP includes recommendations and actions that support the development of "Complete Streets" as a component of providing safe and efficient roads.

As part of the Complete Street Implementation Framework, one of the tools identified to support the process was the development of an MMLOS framework, which was presented as an action item in the TMP document:

> ***Action 7-3: Use multimodal levels of service to assess road designs and allocate right of way.***

The TMP provides high level direction on how multimodal level of service (MMLOS) will be considered and outlines preliminary measures for each mode – pedestrians, cycling, transit, and motor vehicles. This guideline builds upon the work of the TMP and subsequent research into Multi-Modal Level of Service Indicators to provide a detailed overview of how the multi-modal level of service indicators are to be used and interpreted as part of the transportation impact assessment process.

1.2 Application of MMLOS Guidelines

The MMLOS tools are intended to be applied across a variety of projects that require detailed analysis of transportation impacts. In other words, **whenever a project or study requires the completion of level of service analysis, MMLOS should be applied**. Scenarios that require MMLOS evaluation may include transportation environmental assessments, corridor studies, neighbourhood traffic management studies, or development projects (through the TIA process).

For the latter, the existing Transportation Impact Assessment (TIA) Guidelines provide guidance on transportation reporting requirements for development applications. Depending on the size of the development, there are three types of reports: Transportation Briefs, Transportation Impact Studies, and Community Transportation Studies that review both vehicular and non-auto modes. Only detailed level of service (LOS) procedures for auto modes have been provided in previous TIA Guidelines. This document is intended to supplement, rather than supersede, the TIA Guidelines by providing detailed guidance on the MMLOS methods. The MMLOS is to be applied in a manner consistent with the TIA Guidelines, in other words, whenever a project requires the completion of level of service analysis for a Community Transportation Study, Transportation Brief, or Transportation Impact Study, then MMLOS must also be evaluated.

This document is intended to provide guidance to practitioners (City staff, consultants, etc.) in applying the new MMLOS methodology. It is not intended to provide a detailed background on how and why the specific criteria were selected for each mode. An alternative background report, *Developing Multi-Modal Level of Service Indicators for the City of Ottawa*, provides a more detailed analysis of each evaluation tool and the individual factors used in developing the MMLOS framework.

As the first iteration of the City of Ottawa's MMLOS framework, the methodology is still evolving. Practitioners are encouraged to provide feedback on the process laid out in this report and to consider the application of other parallel processes where appropriate to address and analyze the impact of transportation projects. The City will continue to monitor the results of the framework over time and to adjust and calibrate the individual level of service tools based on experience and local conditions.

Ultimately, the MMLOS is intended to act as tool for evaluating trade-offs and to inform decisions about transportation improvements for all modes in a more thorough way than has previously been possible through conventional, vehicular-focused level of service evaluation. This shift is consistent with the TMP direction to incorporate complete streets principles into guidelines, standards and processes. Further discussion on the evaluation of trade-offs is included in Section 7.

It is important to note that this document is not intended to replace professional judgement about geometry, safety or accessibility considerations. The document is intended to provide guidance rather than to be prescriptive in articulating design elements. This document is far from all-encompassing – practitioners are encouraged to interpret the guidelines as they may relate to non-standard treatments or configurations so long as the original intent of the methodology is maintained.

1.3 Methodological Overview

For each of the travel modes identified in this document, LOS measures are proposed for road segments and signalized intersections. One exception is the vehicular level of service which is evaluated only at intersections, as laid out in the current TIA guidelines.

Road segments are defined as the roadway links between signalized intersections. In some cases it may be necessary to evaluate separate segment LOS scores for each direction of travel.

Only signalized intersections are considered for the intersection LOS measures. In the case of motor vehicle LOS, it is simple to aggregate LOS for all intersection approaches into an overall intersection LOS measure by simply determining the delay per vehicle, or the overall intersection volume to capacity ratio in the case of the City of Ottawa. For the LOS measures related to other modes, however, it is not as straightforward, and accordingly each LOS procedure outlines the strategy to be taken in presenting and evaluating intersection LOS. In many cases, each approach of the intersection will score differently for each mode, and results should be illustrated for each approach.

The MMLOS allows for comparison of modes in order to evaluate trade-offs by assessing the critical parameters that determine the relative attractiveness and comfort for particular mode along a corridor. These factors vary – an overview of each LOS range is presented in Exhibit 1.

Exhibit 1 – LOS Ranges by Mode

MODE	ELEMENT	LEVEL OF SERVICE	
Pedestrians (PLOS)	Segments	*High level of comfort*	*Low level of comfort*
	Intersections	*Short delay, high level of comfort, low risk*	*Long delay, low level of comfort, high risk*
Bicycles (BLOS)	Segments	*High level of comfort*	*Low level of comfort*
	Intersections	*Low level of risk / stress*	*High level of risk / stress*
Trucks (TkLOS)	Segments	*Unimpeded movement*	*Impeded movement*
	Intersections	*Unimpeded movement / short delay*	*Impeded movement / long delay*
Transit (TLOS)	Segments	*High level of reliability*	*Low level of reliability*
	Intersections	*Short delay*	*Long delay*
Vehicles (LOS)	Intersections	*Low lane utilization*	*High lane utilization*

Although the LOS methodology enables trade-offs to be made between modes, it is still important to consider the scales of each mode as independent from one another. In other words, because the level of service tools measure different factors, they do not necessarily cover the same spectrum of conditions. A vehicle experiencing LOS F with high lane utilization will likely encounter long delays and congested conditions. However this does not necessarily represent the lack of comfort, higher risk or stress that LOS F represents for cyclists, or lack of comfort, longer delays or higher risk that LOS F represents for pedestrians. The varying ranges are reflected in the methodologies for each mode, but also in the target table provided in Section 7.

The following sections provide a detailed explanation of the intent, data requirements, and calculation steps for each modal LOS. For further clarity, examples from the Ottawa context are included in Appendix A.

2 Pedestrian Level of Service (PLOS)

2.1 Intent

The primary intent of the Pedestrian Level of Service (PLOS) tool is to evaluate pedestrian comfort, safety and convenience. The segment analysis is based on the quality of pedestrian facilities and impact of adjacent traffic while the intersection methodology considers two factors – delay experienced by pedestrians, and Pedestrian Exposure to Traffic at Signalized Intersections (PETSI). The PETSI approach was originally based on the Charlotte NC Pedestrian LOS at Signalized Intersections methodology, although it has been adapted significantly to better suit the Ottawa context.

It should be noted that there are many additional factors that contribute to pedestrian comfort beyond the effects of the facility and adjacent traffic including lighting, land use / built form, urban design elements and streetscaping, including vegetation and trees. While it is beyond the scope of MMLOS to address all of these elements, appropriate City of Ottawa planning and design documents should be referenced in the design of the boulevard and pedestrian way. This may include specific consideration of street trees and other vegetation / bio-swale options to create Green Street Designs as per the Urban Tree Strategy, or various Road Corridor Planning & Design Guidelines. Street trees and other elements can have a positive effect on the pedestrian environment and other users of the corridor.

2.2 Data Requirements

Data required to evaluate the pedestrian level of service is summarized in Exhibit 2 below.

Exhibit 2 - Data Requirements for Pedestrian Level of Service

SEGMENTS	SIGNALIZED INTERSECTIONS
» Vehicular operating speed » Sidewalk width » Boulevard width » Motor vehicle volume (AADT / lane) » Presence of on-street parking	**Exposure to Traffic** » Street width (number of through lanes to be crossed – with or without a median) and presence of refuge island for crossing pedestrians » Right & left turn conflicts based on phasing (permitted, protected/permitted, protected, prohibited) and pedestrian-only phases (leading pedestrian interval) » Right turn on Red (RTOR) restrictions » Corner radius and type (smart right turn channel, right turn channel with receiving lane) » Crosswalk treatment (transverse marking, zebra stripe markings, textured/coloured crosswalks, raised crosswalks) **Delay** » Cycle length » Pedestrian green time (walk time)

2.3 Methodology

The methodology for evaluating PLOS at a segment level utilizes a look-up table approach based on cross-section and roadway characteristics. Judgement should be applied when determining which section of a corridor to evaluate as representative of the segment. In most cases, sidewalks on both side should be evaluated and documented, however the segment overall score can be taken from the lowest quality facility on that segment. There may be certain land-use designations or policies where sidewalks are required on one side of the street only and therefore only one side of the street is evaluated.

In rural settings where sidewalks are not typically provided and paved shoulders are available for pedestrians to use, several issues are to be considered regarding the suitability of the paved shoulders as pedestrian space:

- Maintenance – Paved shoulders may be maintained differently than sidewalks i.e. they may be partially, rather than fully cleared of snow and debris, or they may be maintained with less priority after snow fall than a sidewalk in an urban area.
- Lack of physical separation – Because paved shoulders are not separated from the travelled way, there is a greater risk of encroachment from vehicles, particularly oversized trucks or trailers can pose a greater risk to pedestrians.

- Potential blockage – Paved shoulders are intended to provide space for vehicles to pull off of a roadway in case of an emergency. As such, they are not designated for pedestrian use only in the same way as a sidewalk.
- Accessibility – Paved shoulders may not meet accessibility requirements as they relate to clear width (which can be impacted by features such as rumble strips) or cross-slope, as it is often more challenging to provide a gentle cross-slopes along rural roads.

For these reasons, paved shoulders are not considered to be a substitute for sidewalks. However, paved shoulders may be the only appropriate and/or available pedestrian facilities in rural settings where pedestrian volumes are low. In recognition of this, paved shoulders may be evaluated based on the existing methodology as if it they are sidewalks but it is recommended that the resulting score be adjusted down one grade to recognize their differences as noted above.

Note that when using the segment look-up table, the sidewalk width which is closest to the actual measured width (within reason) should be used to evaluate the PLOS. i.e. a sidewalk of 1.6m would be rounded down and evaluated as a 1.5m sidewalk.

The intersection PLOS is based on two separate measures:

1. Pedestrian Exposure to Traffic at Signalized Intersections (PETSI), adapted from the City of Charlotte's Pedestrian LOS at Signalized Intersections – evaluated using PETSI scoring tables
2. Average delay to pedestrians crossing the street using the Highway Capacity Manual (HCM) method – evaluated based on a simple equation

The PETSI approach is the most data intensive in that points must be assigned for each element of the intersection. Each approach must be evaluated individually where conditions change and the overall intersection score will be taken from the worst approach.

An overview of the PLOS methodology is provided in Exhibit 3, with look-up and scoring tables provided in the following exhibits: Exhibit 4, Exhibit 5, Exhibit 6 and Exhibit 7.

An example illustrating the application of the PLOS methodology is provided in Appendix A.

Exhibit 3 – PLOS Evaluation Methodology

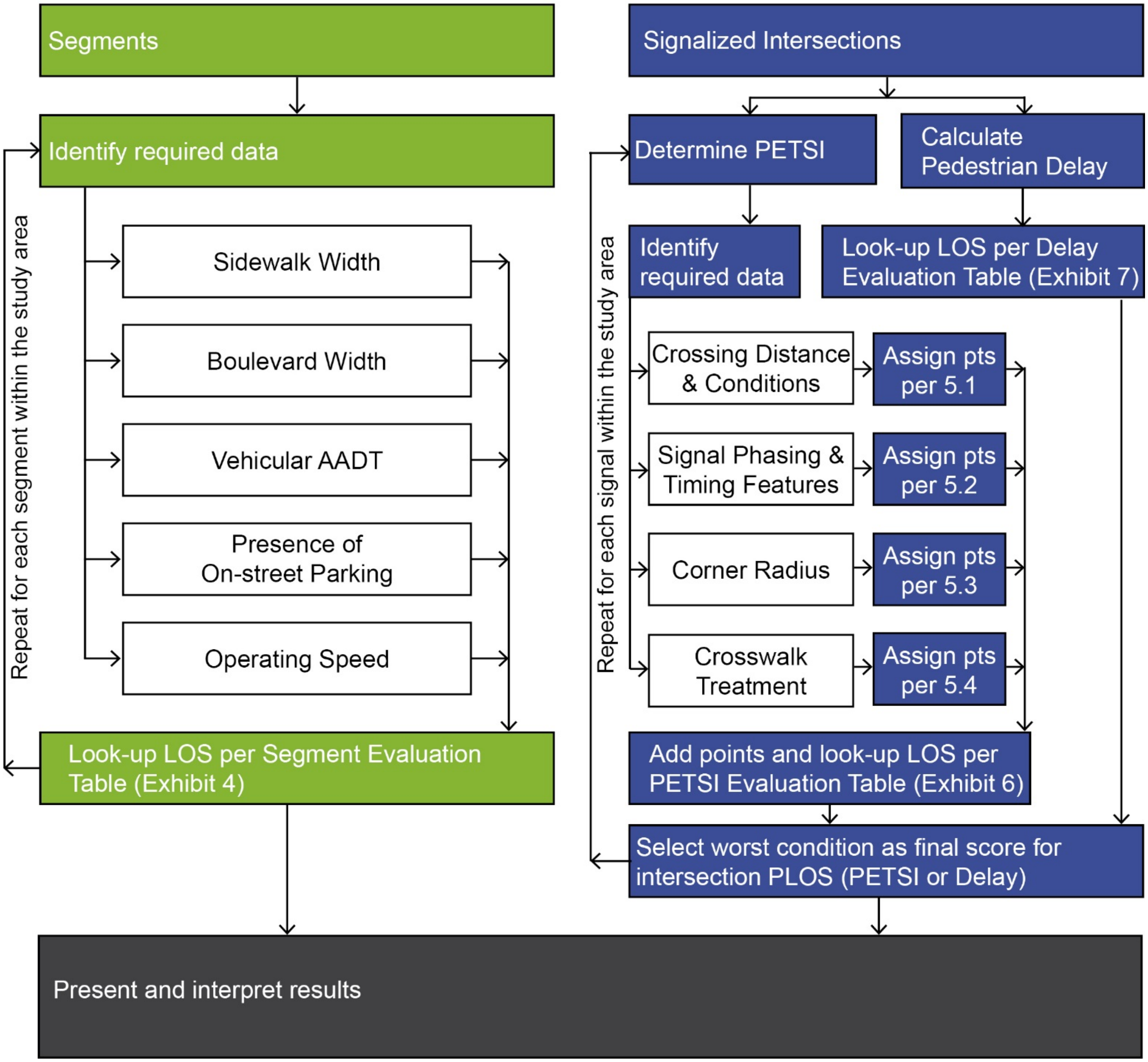


Exhibit 4 – PLOS Segment Evaluation Table

Sidewalk Width (m)	Boulevard Width (m)	Motor Vehicle Traffic Volume (AADT)	Presence of On-street Parking	Segment PLOS			
				Operating Speed (km/h)			
				≤30	>30 or 50	>50 or 60	>60 [1]
2.0 or more	> 2	≤ 3000	N/A	A	A	A	B
		> 3000	Yes	A	B	B	N/A
			No	A	B	C	D
	0.5 to 2	≤ 3000	N/A	A	A	A	B
		> 3000	Yes	A	B	C	N/A
			No	A	C	D	E
	0	≤ 3000	NA	A	B	C	D
		> 3000	Yes	B	B	D	N/A
			No	B	C	E	F
1.8	> 2	≤ 3000	N/A	A	A	A	B
		> 3000	Yes	A	B	C	N/A
			No	A	C	D	E
	0.5 to 2	≤ 3000	N/A	A	B	B	D
		> 3000	Yes	A	C	C	N/A
			No	B	C	E	E
	0	≤ 3000	N/A	A	B	C	D
		> 3000	Yes	B	C	D	N/A
			No	C	D	F	F
1.5	> 2	≤ 3000	N/A	C	C	C	C
		> 3000	Yes	C	C	D	N/A
			No	C	D	E	E
	0.5 to 2	≤ 3000	N/A	C	C	C	D
		> 3000	Yes	C	C	D	N/A
			No	D	E	E	E
	0	N/A		D	E	F [2]	F [2]
<1.5	N/A			F [3]	F [3]	F [3]	F [3]
No sidewalk	N/A			C [4]	F [3]	F [3]	F [3]

Notes:

1. On-street parking not provided on roadways with posted speed of 70 km/h or more
2. Sidewalk must be 1.8 m wide if no separation is provided (curb-face sidewalk) where speeds are high
3. Sidewalk must be 1.5 m wide to meet Provincial accessiblity standards
4. Ottawa Pedestrian Plan, 2014: “all new and reconstructed urban local roads where pedestrian facilities are required in accordance with these policies but no dedicated pedestrian facility is provided, require that roads be designed for a speed of 30 km/h or lower (pending development of a new 30 km/h roadway design standard).” Where a roadway is specifically designed as 'shared space', with appropriate design controls and features, it can achieve LOS A.
5. Where a multi-use path is provided in lieu of sidewalks, the MUP can be evaluated using the same methodology.

Exhibit 5 – PETSI Point Tables

5.1 Crossing Distance & Conditions		
Total travel lanes crossed	No median	With Median (>2.4m)
2	120	120
3	105	105
4	88	90
5	72	75
6	55	60
7	39	45
8	23	30
9	6	15
10	-10	0

Island Refuge	Points
No	-4
Yes	0

5.2 Signal Phasing & Timing Features	
Left turn conflict ("Left_turns")	Points
Permissive	-8
Protected/permissive	-8
Protected	0
No left turn/prohibited	0
Right turn conflict ("Right_turns")	Points
Permissive or yield control	-5
Protected/permissive	-5
Protected	0
No right turn	0
Right turns on red ("RTOR")	Points
RTOR allowed	-3
RTOR prohibited at certain time(s)	-2
RTOR prohibited	0
Leading ped interval? ("LPI")	Points
No	-2
Yes	0

5.3 Corner Radius	
Corner radius	Points
Greater than 25m	-9
> 15m to 25m	-8
> 10m to 15m	-6
> 5m to 10m	-5
> 3m to 5m	-4
Less than/equal to 3m	-3
No right turn	0
Right turn channel with receiving	-3
Right turn "smart channel"	2

5.4 Crosswalk Treatment	
Crosswalk treatment ("Crosswalk")	Points
Standard transverse markings	-7
Textured/coloured pavement	-4
Zebra stripe hi-vis markings	-4
Raised crosswalk	0

Exhibit 6 – PETSI Evaluation Table

Pedestrian Exposure to Traffic LOS	
Points threshold	LOS
≥90	A
≥75	B
≥60	C
≥45	D
≥30	E
<30	F

Exhibit 7 – Pedestrian Delay Evaluation Table

Average Pedestrian Crossing Delay Component

$$\text{Delay} = 0.5 \times \frac{(\text{Cycle Length} - \text{Pedestrian Effective Walk Time})^2}{\text{Cycle Length}}$$

< 10 s per intersection leg	LOS A
≥10 to 20 sec	LOS B
>20 to 30 sec	LOS C
>30 to 40 sec	LOS D
>40 to 60 sec	LOS E
> 60 sec	LOS F

3 Bicycle Level of Service (BLOS)

3.1 Intent

The intent of the Bicycle Level of Service (BLOS) tool is to evaluate both roadway segments and signalized intersections for the level of traffic stress (LTS) experienced by cyclists using the corridor. The methodology, based on a recent Mineta Transportation Institute report (no. 11-19), relates the LTS on a facility to the degree of comfort experienced by a cyclist and targeted users. The City of Ottawa has adapted the tool to allow for comparison with other modes by mapping LTS to level of service A-F as shown in Exhibit 8.

Exhibit 8 – Qualitative descriptions for each LTS score (adapted from MTI Report no. 11-19)

LTS	DESCRIPTION	CATEGORY OF CYCLIST	CITY OF OTTAWA LOS
LTS 1	Presenting little traffic stress and demanding little attention from cyclists, and attractive enough for a relaxing bike ride. Suitable for almost all cyclists, including children trained to safely cross intersections. On links, cyclists are either physically separated from traffic, or are in an exclusive bicycling zone next to a slow traffic stream with no more than one lane per direction, or are on a shared road where they interact with only occasional motor vehicles (as opposed to a stream of traffic) with a low speed differential. Where cyclists ride alongside a parking lane, they have ample operating space outside the zone into which car doors are opened. Intersections are easy to approach and cross.	All ages and skill levels – both children and adults	A
LTS 2	On links, cyclists are either physically separated from traffic, or are in an exclusive bicycling zone next to a well-confined traffic stream with adequate clearance from a parking lane, or are on a shared road where they interact with only occasional motor vehicles (as opposed to a stream of traffic) with a low speed differential. Where a bike lane lies between a through lane and a right turn lane, it is configured to give cyclists unambiguous priority where cars cross the bike lane and to keep car speed in the right-turn lane comparable to bicycling speeds. Crossings are not difficult for most adults.	Most cyclists	B
LTS 3	More traffic stress than LTS 2, yet markedly less than the stress of integrating with multilane traffic, and therefore welcome to many people currently riding bikes in American cities. Offering cyclists either an exclusive riding zone (lane) next to moderate-speed traffic or shared lanes on streets that are not multilane and have moderately low speed. Crossings may be longer or across higher-speed roads than allowed by LTS 2, but are still considered acceptably safe to most adult pedestrians.	Most experienced adult cyclists	C, D based on facility characteristics
LTS 4	A level of stress beyond LTS3.	Very confident cyclists only	E, F based on facility characteristics

Since the LOS methodology is related to the type of cyclists that will be comfortable on certain roads and facilities, it provides support and justification for infrastructure improvements that may attract new riders.

3.2 Data Requirements

Data required to evaluate the bicycle level of service is dependent on the cycling facility / intersection type, as shown in Exhibit 9.

Exhibit 9 – Data Requirements for Bicycle Level of Service by Facility Type

SEGMENTS	SIGNALIZED INTERSECTIONS
Mixed Traffic (No cycling facility) » Street width (total number of lanes in both directions) » Vehicular operating speed **Bike Lanes** » Street width (number of through lanes per direction) » Bike lane width (including marked buffer and paved gutter width) » Parking lane width (where bike lane is adjacent to parking lane) » Vehicular operating speed » Qualitative assessment of commercial deliveries for commercial areas **Physically Separated Bikeway (includes cycle tracks, protected bike lanes and multi-use paths)** » No additional information needed **Unsignalized Crossings** » Presence of median refuge suitable for bicycle storage (≥1.8m wide) » Width of street being crossed (number of lanes in both directions) » Speed limit of street being crossed	**Pocket bike lanes** » Right turn lane characteristics (number of right turn lanes, length of turn lane, turning speed) » Vehicular operating speed » Left turn accommodation (presence of bike box, number of left turn lanes, number of lanes crossed) **Mixed Traffic (No cycling facility)** » Right turn lane characteristics (number of right turn lanes, length of turn lane, turning speed) » Vehicular operating speed » Left turn accommodation (presence of bike box, number of left turn lanes, number of lanes crossed)

Note that the number of lanes as defined for 'Mixed Traffic' is the total number of lanes (both directions), while in the cases of streets with bike lanes the number of lanes is defined in terms of the lanes per direction).

Judgement should be used when adapting the methodology to facility types or configurations not currently provided for in the methodology. Although the methodology was developed for the urban context, certain elements may be relevant in a more rural setting. For example, paved shoulders in the rural context may be evaluated as bike lanes, although they are unlikely to score high due to the high operating speeds on rural roads. This reflects more experienced adult cyclist making use of these facilities, which may be appropriate in the rural context. For unusual conditions such as shared bus / bike lanes, the more conservative conditions should be considered i.e. a shared bus-bike lane would be evaluated as mixed traffic.

3.3 Methodology

The BLOS methodology relies on a 'weakest' link approach. In other words, the most severe corridor / intersection will dictate the overall LOS score. As a result, it is prudent to begin the analysis with the worst section of the corridor (i.e. a street segment with cycle track along most of the corridor except for one block of bike lanes should be analyzed based on the section with the bicycle lanes), in order to understand the critical scores for a segment.

As with the PLOS evaluation, each direction or intersection approach with different facilities must be evaluated separately as part of the segment or signal analysis.

The evaluation methodology is summarized in Exhibit 10, with the corresponding segment and intersection tables provided in Exhibit 11 and Exhibit 12.

An example illustrating the application of the BLOS methodology is provided in Appendix A.

Exhibit 10 – BLOS Evaluation Methodology

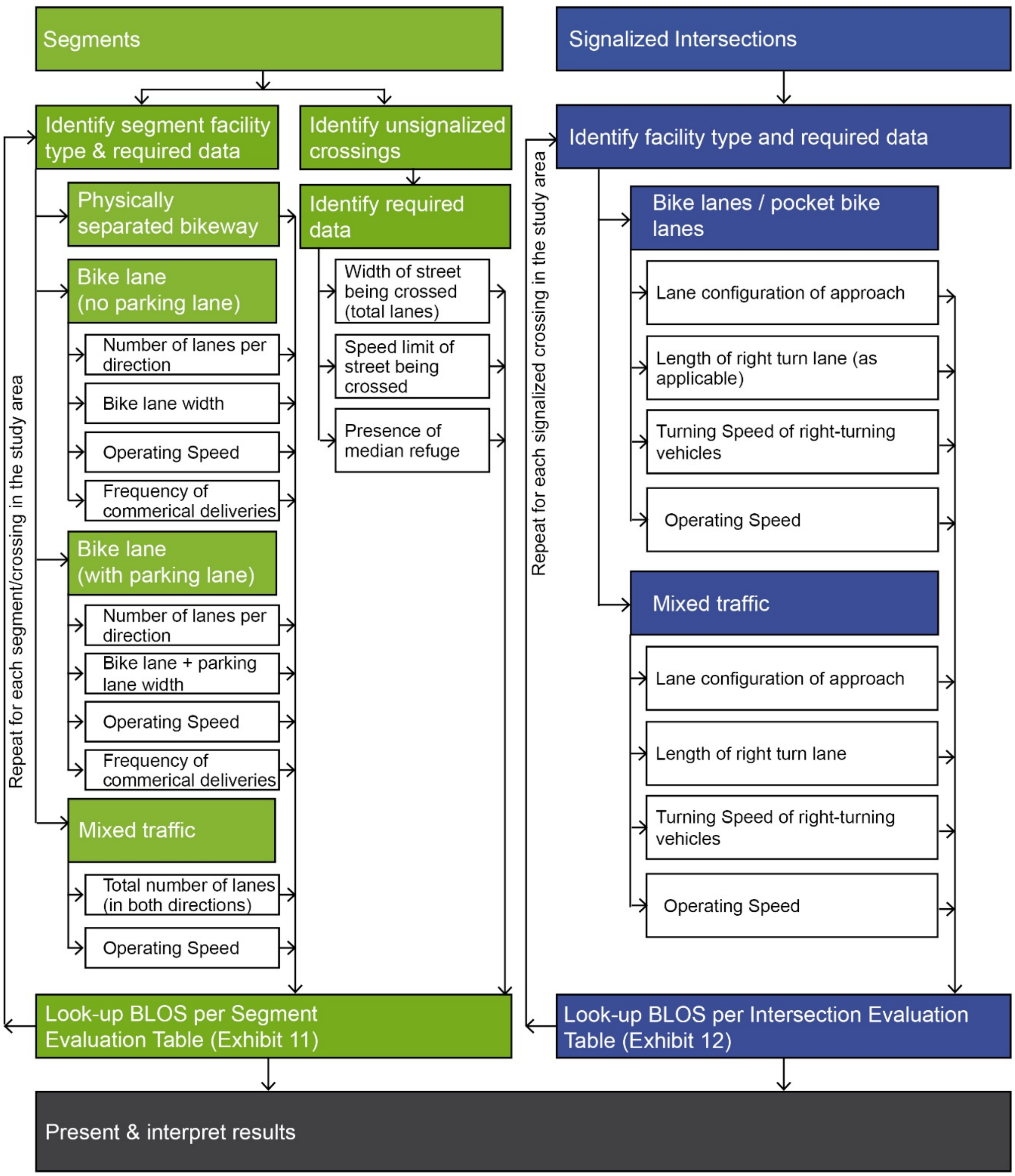


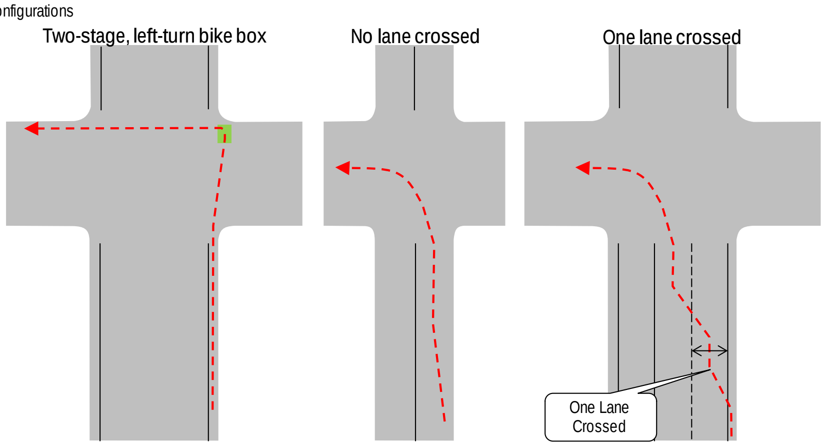
Exhibit 11 – BLOS Segment Evaluation Table

Type of Bikeway		LOS
Physically Separated Bikeway (cycle tracks, protected bike lanes and multi-use paths). Physical separation refers to, but is not limited to, curbs, raised medians, bollards and parking lanes (adjacent to the bike lane along the travelled way i.e. not curbside).		A
Bike Lanes Not Adjacent Parking Lane - Select Worst Scoring Criteria		
No. of Travel Lanes	1 travel lane in each direction	A
	2 travel lanes in each direction separated by a raised median	B
	2 travel lanes in each direction without a separating median	C
	More than 2 travel lanes in each direction	D
Bike Lane Width	≥ 1.8 m wide bike lane (includes marked buffer and paved gutter width)	A
	≥1.5 m to <1.8 m wide bike lane (includes marked buffer and paved gutter width)	B
	≥1.2 m to <1.5 m wide bike lane (includes marked buffer and paved gutter width)	C
Operating Speed	≤ 50 km/h operating speed	A
	60 km/h operating speed	C
	≥ 70 km/h operating speed	E
Bike lane blockage (commercial areas)	Rare	A
	Frequent	C
Bike Lanes Adjacent to curbside Parking Lane - Select Worst Scoring Criteria		
No. of Travel Lanes	1 travel lane in each direction	A
	2 or more travel lanes in each direction	C
Bike Lane and Parking Lane Width	4.5 m wide bike lane plus parking lane (includes marked buffer and paved gutter width)	A
	4.25 m wide bike lane plus parking lane (includes marked buffer and paved gutter width)	B
	≤ 4.0 m wide bike lane plus parking lane (includes marked buffer and paved gutter width)	C
Operating Speed	< 40 km/h operating speed	A
	50 km/h operating speed	B
	60 km/h operating speed	D
	> 70 km/h operating speed	F
Bike lane blockage (commercial areas)	Rare	A
	Frequent	C
Mixed Traffic		
No. of Travel Lanes and Operating Speed	2 travel lanes; ≤ 40 km/h; no marked centerline or classified as residential	A
	2 to 3 travel lanes; ≤ 40 km/h	B
	2 travel lanes; 50 km/h; no marked centerline or classified as residential	B
	2 to 3 travel lanes; 50 km/h	D
	4 to 5 travel lanes; ≤ 40 km/h	D
	4 to 5 travel lanes; ≥ 50 km/h	E
	6 or more travel lanes; ≤ 40 km/h	E
	≥ 60 km/h	F
Unsignalized Crossing along Route: no median refuge		
No. of Travel Lanes on Side Street and Operating Speed	3 or less lanes being crossed; ≤ 40 km/h	A
	4 to 5 lanes being crossed; ≤ 40 km/h	B
	3 or less lanes being crossed; 50 km/h	B
	4 to 5 lanes being crossed; 50 km/h	C
	3 or less lanes being crossed; 60 km/h	C
	4 to 5 lanes being crossed; 60 km/h	D
	6 or more lanes being crossed; ≤ 40 km/h	E
	3 or less lanes being crossed; ≥ 65 km/h	E
	6 or more lanes being crossed; ≥ 50 km/h	F
	4 to 5 lanes being crossed; ≥ 65 km/h	F
Unsignalized Crossing along Route: with median refuge (≥ 1.8 m wide)		
No. of Travel Lanes on Side Street and Operating Speed	5 or less lanes being crossed; ≤ 40 km/h	A
	3 or less lanes being crossed; 50 km/h	A
	6 or more lanes being crossed; ≤ 40 km/h	B
	4 to 5 lanes being crossed; 50 km/h	B
	3 or less lanes being crossed; 60 km/h	B
	6 or more lanes being crossed; 50 km/h	C
	4 to 5 lanes being crossed; 60 km/h	C
	3 or less lanes being crossed; ≥ 65 km/h	D
	6 or more lanes being crossed; 60 km/h	E
	4 to 5 lanes being crossed; ≥ 65 km/h	E
	6 or more lanes being crossed; ≥ 65 km/h	F

Exhibit 12 – BLOS Signalized Intersection Evaluation Table

Bikeway and Intersection Type		LOS
Bike Lanes or higher order facility on a Signalized Intersection Approach		
Right-turn Lane and Turning Speed of Motorists	No impact on LTS (as long as cycling facility remains to the right of any turn lane - otherwise see pocket bike lanes below)	
Cyclist Making a Left-turn and Operating Speed of Motorists (refer to figure)	Two-stage, left-turn bike box; ≤ 50 km/h	A
	No lane crossed, ≤ 50 km/h	B
	1 lane crossed, ≤ 40 km/h	B
	No lane crossed, ≥ 60 km/h	C
	1 lane crossed, 50 km/h	C
	2 or more lanes crossed, ≤ 40 km/h	D
	1 lane crossed, ≥ 60 km/h	E
	2 or more lanes crossed, ≥ 50 km/h	F
	All other single left-turn lane configurations	F
	Dual left-turn lanes (shared or exclusive)	F
Pocket Bike Lanes on a Signalized Intersection Approach		
Right-turn Lane and Turning Speed of Motorists	Right-turn lane introduced to the right of the bike lane and ≤ 50 m long, turning speed ≤ 25 km/h (based on curb radii and angle of intersection)	B
	Right-turn lane introduced to the right of the bike lane and > 50 m long, turning speed ≤ 30 km/h (based on curb radii and angle of intersection)	D
	Bike lane shifts to the left of the right-turn lane, turning speed ≤ 25 km/h (based on curb radii and angle of intersection)	D
	Right-turn lane with any other configurations	F
	Dual right-turn lanes (shared or exclusive)	F
Cyclist Making a Left-turn and Operating Speed of Motorists (refer to figure)	Two-stage, left-turn bike box; ≤ 50 km/h	A
	No lane crossed, ≤ 50 km/h	B
	1 lane crossed, ≤ 40 km/h	B
	No lane crossed, ≥ 60 km/h	C
	1 lane crossed, 50 km/h	C
	2 or more lanes crossed, ≤ 40 km/h	D
	1 lane crossed, ≥ 60 km/h	E
	2 or more lanes crossed, ≥ 50 km/h	F
	All other single left-turn lane configurations	F
	Dual left-turn lanes (shared or exclusive)	F
Mixed Traffic on a Signalized Intersection Approach		
Right-turn Lane and Turning Speed of Motorists	Right-turn lane 25 to 50 m long, turning speed ≤ 25 km/h (based on curb radii and angle of intersection)	D
	Right-turn lane 25 to 50 m long, turning speed > 25 km/h (based on curb radii and angle of intersection)	E
	Right-turn lane longer than 50 m	F
	Dual right-turn lanes (shared or exclusive)	F
Cyclist Making a Left-turn and Operating Speed of Motorists (refer to figure)	Two-stage, left-turn bike box; ≤ 50 km/h	A
	No lane crossed, ≤ 50 km/h	B
	1 lane crossed, ≤ 40 km/h	B
	No lane crossed, ≥ 60 km/h	D
	1 lane crossed, 50 km/h	D
	2 or more lanes crossed, ≤ 40 km/h	D
	1 lane crossed, ≥ 60 km/h	F
	2 or more lanes crossed, ≥ 50 km/h	F
	All other single left-turn lane configurations	F
	Dual left-turn lanes (shared or exclusive)	F

Left-turn Configurations



Notes:

1. Pocket bike lanes are defined as bike lanes that develop near intersections between vehicular right turn lanes on the right side and vehicular through or left lanes on the left side. All other configurations of bike lanes or separated facility that remain against the edge of the curb/parking lane and require right turning vehicles to yield to through cyclists will not impact the level of traffic stress (i.e. are considered to be LOS A).

4 Transit Level of Service (TLOS)

4.1 Intent

The intent of the transit level of service (TLOS) is to evaluate the relative attractiveness of transit in support of the City's aim to ultimately increase transit mode share. The relative attractiveness, for the purposes of TLOS, is evaluated based on transit travel time and the transit priority afforded to transit vehicles based on varying facility types and conditions.

4.2 Data Requirements

The data required to evaluate TLOS is shown in Exhibit 13.

Exhibit 13 – Data Requirements for Transit Level of Service

SEGMENTS	SIGNALIZED INTERSECTIONS
» Level/exposure to congestion delay, friction, and incidents (qualitative assessment) » Average transit travel speed » Posted speed limit » Number of driveways along corridor and approximate crossing volume	» Average Signal Delay

The data source for these attributes may vary depending on the type of project. For existing corridors, free flow and actual speeds could be measured through travel time surveys. For new corridors, or for evaluating modal trade-offs, actual transit speed would need to be modelled through micro-simulations.

In terms of evaluating delay at intersections, the estimation/measurement method (in order of preference) is: field measurement, microscopic simulation (VISSIM, AIMSUM), or macroscopic simulation (Synchro, HCS, analytical/graphical methods e.g. deterministic queuing model).

4.3 Methodology

The TLOS methodology is intended primarily to be applied only along corridors with existing or planned rapid transit or transit priority measures. However, corridors with regular bus routes (without transit priority) can still be evaluated with the current methodology. The extent of analysis required should be determined at the time of the project or development application.

A summary of the methodology is provided in Exhibit 14, with the segment and signal evaluation tables shown in Exhibit 15 and Exhibit 16, respectively.

Note that since the calibration of the methodology is ongoing, thresholds may be subject to future iterations.

An example illustrating the application of the TLOS methodology is provided in Appendix A.

Exhibit 14 – TLOS Evaluation Methodology

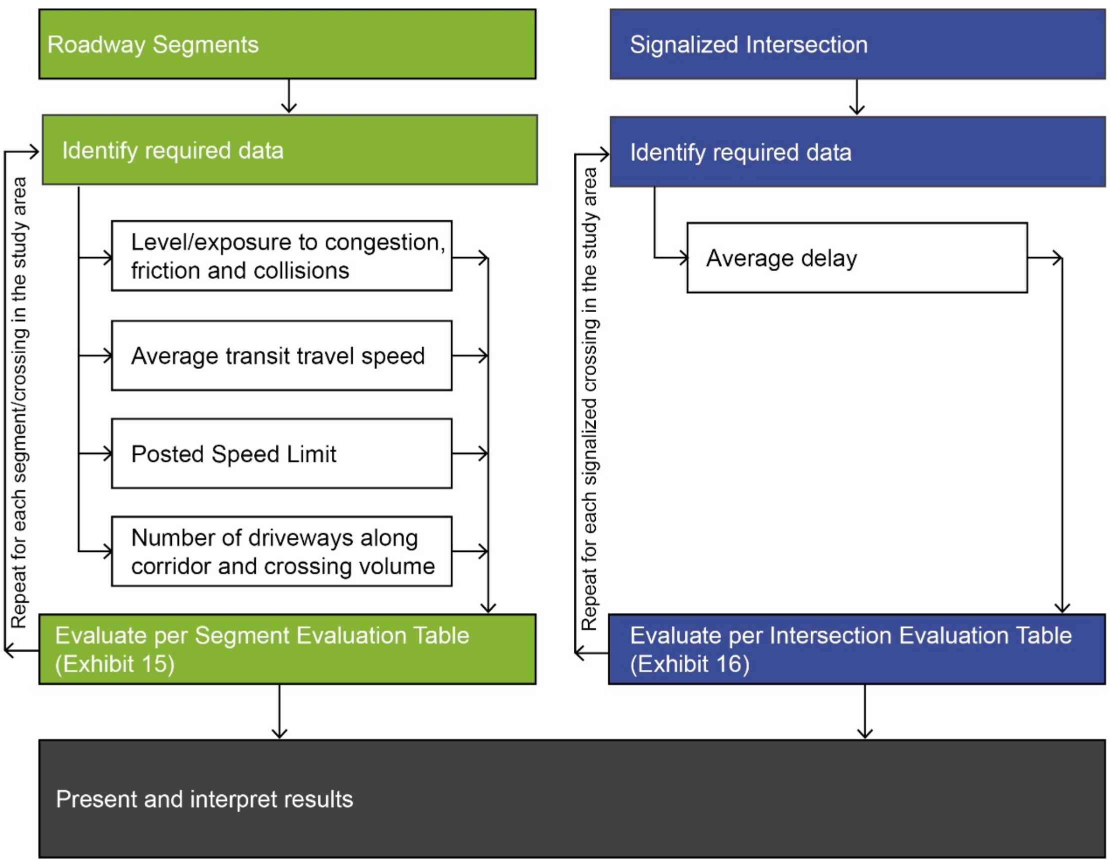


Exhibit 15 - TLOS Segment Evaluation Table

Facility Type		Level/exposure to congestion delay, friction and incidents: Congestion	Friction	Incident Potential	Quantitative Measurement	LOS
Segregated ROW		No	No	No	N/A	A
Bus lane	No/limited parking/driveway friction	No	Low	Low	$C_f \leq 60$	B
	Frequent parking/driveway friction	No	Medium	Medium	$C_f > 60$	C
Mixed Traffic	Limited parking/driveway friction	Yes	Low	Medium	$Vt/Vp \geq 0.8$	D
	Moderate parking/driveway friction	Yes	Medium	Medium	$Vt/Vp \leq 0.6$	E
	Frequent parking/driveway friction	Yes	High	High	$Vt/Vp < 0.4$	F

Notes:

Cf, Conflict Factor = = (Number of driveways x crossing volume) / 1 km

Vt/Vp is the ratio of average transit travel speed to posted speed limit

Exhibit 16 – TLOS Signalized Intersection Evaluation Table

Delay	Typical Location	LOS
0	Grade Separation	A
≤10 sec	High Level TSP	B
≤20 sec		C
≤30 sec		D
≤40 sec	TSP & long cycle length	E
>40 sec	No TSP & long cycle length	F

Note: Delay includes travel time from end of queue to entering the intersection

5 Truck Level of Service (TkLOS)

5.1 Intent

Motor vehicle LOS accounts for trucks by considering the percent of trucks and buses in the traffic volume. However, some elements of roadway segments and intersections clearly affect the ability of trucks to operate with ease. The intent of the truck level of service (TkLOS) is to complement motor vehicle LOS by considering the physical space available for trucks to negotiate corners quickly and easily, and to operate safely within travelled lanes.

The objective of evaluating TkLOS is to facilitate goods movement within the City of Ottawa – however, unlike other modes, the TkLOS need only be applied along truck routes, arterial roads and key delivery access routes, since trucks are not intended to operate on every street. An exception would be within employment or enterprise areas where targets are set for trucks on all streets in these areas, as laid out in Section 7.

Care should be taken when considering the trade-offs between truck level of service and pedestrian/bicycle level of service with respect to the corner radii and turning speed. There is potential for trucks to encroach on pedestrian and cycling facilities if trucks are not accommodated appropriately, which can put vulnerable users at risk. As mentioned in Section 1.2, the MMLOS guidelines do not replace safety or geometric guidance.

5.2 Data Requirements

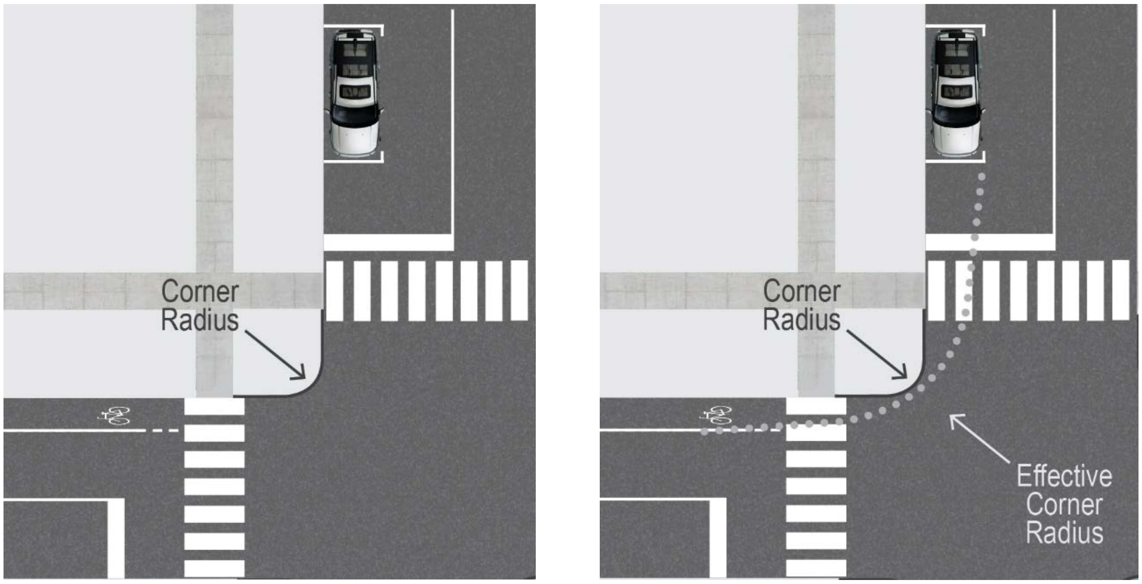
A summary of the data required to evaluate the truck level of service is provided in Exhibit 17.

Exhibit 17 - Data Requirements for Truck Level of Service

SEGMENTS	SIGNALIZED INTERSECTIONS
» Street width (number of through lanes per direction) » Curb lane width (m)	» Effective radius » Number of receiving lanes on departing leg

Note that effective radius is the same as corner radius where trucks must turn from the curbside lane into a departing curbside lane, however where parking lanes or on-street parking lanes are provided adjacent to the travel / turn lanes the effective radius can be determined by placing a simple or compound radius between the edge of the travel lane on the approach and departing legs – refer to Exhibit 18 below.

Exhibit 18 – Effective curb radius



5.3 Methodology

The methodology for evaluating Truck Level of Service is illustrated in Exhibit 19.

For segments, lane width considered in the evaluation should be the curb lane width where lane widths vary between outer and inner lanes. An exception could be made where two major truck routes meet, resulting in heavy truck turning volumes at intersections. In these cases, it may be more conservative to consider the narrowest travel lane, as trucks will need to negotiate across lanes to turning lanes at intersections. If lane widths fall outside of the given threshold, they can be rounded down to the most conservative width i.e. a lane width of 3.25 would be rounded down to 3.2m for the look-up table.

An example illustrating the application of the TkLOS methodology is provided in Appendix A.

Exhibit 19 – TkLOS Evaluation Methodology

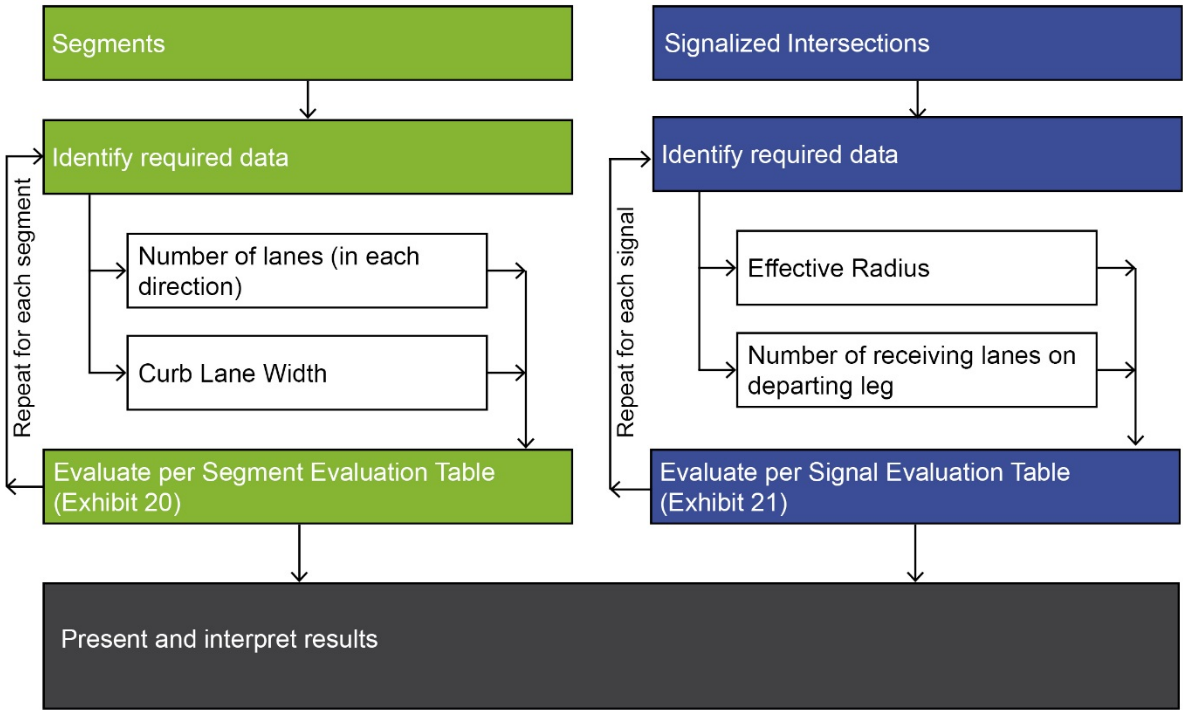


Exhibit 20 – TkLOS Segment Evaluation Table

Curb Lane Width (m)	Only two travel lanes (one in each direction)	More than two travel lanes
>3.7	B	A
≤3.5	C	A
≤3.3	D	C
≤3.2	E	D
≤3	F	E

Exhibit 21 – TkLOS Signalized Intersection Evaluation Table

Effective Corner Radius	One receiving lane on departure from intersection	More than one receiving lane on departure from intersection
< 10m	F	D
10 to 15m	E	B
> 15m	C	A

6 Vehicular Level of Service (LOS)

The following details outlining the evaluation of Vehicular Level of Service are extracted from the 2009 Transportation Impact Assessment Guidelines. As the TIA update is carried out, these parameters may be updated.

6.1 Intersection Capacity Analysis

An evaluation is required of any critical intersection within the study area that will potentially be affected by site generated traffic volumes during any or all of the relevant time periods and scenarios. Summaries are to be provided in tabular format clearly identifying intersection performance under existing and future traffic conditions. Where development is anticipated to proceed in phases or stages, projected performance for all intersections must be documented for the end of each phase.

Detailed output from analysis software is to be provided in an appendix to the report and copies of the electronic files should be provided on CD. Appendix B outlines parameters to be used in operational analysis of signalized intersections.

All volume to capacity (V/C) calculations relating to future conditions should be determined using signal timing optimized for the volume conditions being studied. The V/C ratio for an intersection is defined as the sum of equivalent volumes for all critical movements divided by the sum of capacities for all critical movements assuming that the V/C ratios for critical movements can be equalized. In cases where minimum pedestrian phase times prevent equalizing the level of service for critical movements, then the V/C ratio for the most heavily saturated critical movement should be considered as the V/C ratio for the intersection. Adjustment for the impact of pedestrian activated control is permitted provided detailed supporting analysis including projected pedestrian volumes is provided and discussed in advance with traffic engineering staff.

In the case of planning level or functional design projects, practitioners should undertake a two and a half hour peak period observation of volumes (typically 6:30 – 9:00 AM) to verify that the traffic volumes through the intersections reflect existing demands and to identify unusual operating conditions. For operational studies, peak hour observations are acceptable. Timing of observations and conditions observed should be documented in writing in the report.

LEVEL OF SERVICE	VOLUME TO CAPACITY RATIO
A	0 to 0.60
B	0.61 to 0.70
C	0.71 to 0.80
D	0.81 to 0.90
E	0.91 to 1.00
F	> 1.00

Intersection evaluations should identify:

- Signalized Intersections – V/C ratios for the overall intersection, as defined above, and individual movements; and
- Unsignalized Intersections - Level of service (LOS) where the LOS is between A and E; V/C where capacity is based on gap analysis if intersection LOS is F.

Existing signal timing information such as phasing, pedestrian minimums and clearance intervals must be used as a base to analyze the existing capacity of signalized intersections. This signal timing data should be obtained from the City of Ottawa Traffic Operations Division. Operational design of the signals analyzed should be in accordance with City of Ottawa signal operation practices.

In cases where roadways have closely spaced signals and especially when there are heavy turning movements, the analysis should confirm that storage limitations will not prevent signalized intersections from operating at the predicted V/C ratio.

The City of Ottawa prefers that analysis be completed using the Highway Capacity Software (HCS version 4d or later), or Synchro (version 5 or later). Should a consultant wish to utilize a software package other than those listed above, prior approval must be obtained from the City's Traffic Operations Division.

7 Level of Service Targets

The ultimate objective of developing a MMLOS program is to enable designers, City staff and the public to evaluate and understand transportation choices. The MMLOS framework is not complete until the MMLOS tools are used and presented in relation to each other. Different streets and roads with associated land-use contexts will have varying levels of service for each mode – it is neither possible nor desirable to achieve LOS A for all modes on every street due to finite land resources and limited funding. LOS targets exist as a way to quantify on-the-ground conditions and to identify where higher or lower levels of services are appropriate.

Towards this end, modal level of service targets have been developed. In order to introduce a measure of local context, these targets are presented based on various City of Ottawa Official Plan (OP) land-use designation / policy areas and road classes. The OP designations provide a sense of the surrounding land use, density, commercial activity and in certain cases the function of the roadway (i.e. arterial mainstreet), while road classifications provide a proxy for the vehicular volume and speed of the roadways.

7.1 Modal Targets by Official Plan Designation/Policy Area

In the following Exhibit 22, targets for the **minimum desirable** level of service are presented by mode. Efforts should be made to exceed these minimum targets whenever possible, without negatively impacting the ability to achieve the minimum targets for other modes. As noted in Section 1.3, although the LOS methodology enables trade-offs to be made between modes, it is still important to consider the scales of each mode as independent from one another. In other words, because the level of service tools measure different factors, they do not necessarily cover the same spectrum of conditions. A vehicle experiencing LOS F with high lane utilization will likely encounter long delays and congested conditions. However this does not necessarily represent the lack of comfort, higher risk or stress that LOS F represents for cyclists, or lack of comfort, longer delays or higher risk that LOS F represents for pedestrians. Accordingly, targets may appear to be more generous for some modes than for others.

These targets refer to a number of City of Ottawa plans and schedules including:

- Official Plan Amendment #150, Schedules and Secondary Plans
- Transportation Master Plan
- Ottawa Pedestrian Plan
- Ottawa Cycling Plan
- City of Ottawa Truck Routes

The most up to date version of these documents can be referenced online through the City's website when considering the targets.

It is important to reiterate that these targets must cover a wide range of conditions (i.e. varying built form and context) and therefore should be considered to provide broad guidance rather than absolute cut-offs. At the same time, these targets represent a best effort at encapsulating City policies and plans, and provide a more realized vision for future street planning and design. Over time these targets are likely to shift as they are better calibrated to reflect outcomes and initiatives.

In applying the targets, the most specific targets always apply where there is overlap between designations and policy areas. For example, where a traditional main street runs through an area that is also designated in the general urban area, the traditional main street targets will apply along that corridor. In any case where a specific policy area applies, it will override the targets for the land use designation.

Where the targets cannot be achieved, a summary or rationale for why the targets are not achieved should be documented for a project or study. Mitigation measures may be required as appropriate.

7.2 Making Trade-offs & Interpretation of Results

The target-setting process builds in the opportunity to understand how trade-offs can be made to support the goals and policies laid out in the OP. There are two outcomes to consider when trying to meet or exceed the minimum targets:

- Targets are not intended to create excessively wide corridors along new or relatively unconstrained rights-of-way. The implementation of MMLOS must also be considered in relation to many other factors driving street and roadway design, including urban design considerations and built form characteristics. Extremely wide roads throughout the city that achieve LOS A for all modes are neither desirable nor achievable.
- In constrained environments, the MMLOS framework is intended to enable decisions to be made about which modes are prioritized. It will help guide, support and justify decisions to provide high quality facilities for certain modes, even at the expense of LOS for others.

In addition to examples illustrating the application individual level of service methodologies, examples are provided in Appendix A to demonstrate how results from the MMLOS can be interpreted and trade-offs considered. Note that these hypothetical examples are intended to be illustrative only, and should not be considered to provide design guidance. Professional technical knowledge, judgement and site specific context should always be primary considerations in determining facility types along a given route.

7.3 Presentation of Results

Results should be presented in tabular form, summarizing results for each mode by intersection approach and roadway segment or direction, as appropriate. The results are not intended to be amalgamated into one overall intersection, segment or corridor score, since some of the modes require a more fine-grained analysis than traditional vehicular LOS. Instead, the results are presented for each mode, broken down to varying levels of detail based on the methodological requirements.

A sample summary table is included in Appendix C.

Exhibit 22 – Minimum Desirable MMLOS Targets by Official Plan Policy/Designation & Road Class

OP Designation / Policy Area	Road Class	PLOS	Bicycle - BLOS				Transit - TLOS [3]			Truck - TrLOS		Auto - LOS [4]
			Cross-town Bikeway	Spine Route	Local Route	Elsewhere	Rapid Transit Corridor	TP - Continuous Lanes	TP - Isolated Measures	Truck Route	Other	
Land-Use Designation												
Central Area	Arterial	A	A	C	B	D	A	C	D	D	E	E
	Collector	A	A	B	B	D	A	C	D	D	No target	E
	Local	A	A	B	B	D	A	C	D	E	No target	E
Developing Community	Arterial	C	B	C	B	D	B	C	D	D	No target	D
	Collector	C	B	C	B	D	B	C	D	D	No target	D
	Local	C	B	C	B	D	B	C	D	N/A	No target	D
Employment Area	Arterial	C	B	C	C	E	B	C	D	B	D	D
	Collector	C	B	C	C	E	B	C	D	B	D	D
	Local	C	B	D	C	No target	B	C	D	D	E	D
Entreprise Area	Arterial	C	B	C	B	D	B	C	D	B	E	D
	Collector	C	B	C	B	D	B	C	D	B	E	D
	Local	C	B	C	B	No target	B	C	D	D	No target	D
General Rural Area	Arterial	No target	N/A	D	D	No target	N/A	N/A	N/A	C	E	D
	Collector	No target	N/A	D	D	No target	N/A	N/A	N/A	C	No target	D
	Local	No target	N/A	D	D	No target	N/A	N/A	N/A	No target	No target	D
General Urban Area	Arterial	C	B	C	B	D	B	C	D	D	E	D
	Collector	C	B	C	B	D	B	C	D	D	No target	D
	Local	C	B	C	B	D	B	C	D	N/A	No target	D
Mixed Use Centre	Arterial	C	A	C	B	D	B	C	D	D	E	D
	Collector	C	A	B	B	D	B	C	D	D	No target	D
	Local	C	A	B	B	D	B	C	D	N/A	No target	D
Village	Arterial	C	B	C	B	D	N/A	N/A	N/A	D	No target	D
	Collector	C	B	C	B	D	N/A	N/A	N/A	D	No target	D
	Local	C	B		B	D	N/A	N/A	N/A	N/A	No target	D
Traditional Main Street	Arterial	B	A	C	C	D	B	C	D	D	E	D
	Collector	B	A	C	C	D	B	C	D	D	No target	D
Arterial Main Street	Arterial	C	B	C	D	D	B	C	D	D	E	D
All Other Designations	Arterial	D	B	C	C	D	B	C	D	D	No target	D
	Collector	D	B	C	C	D	B	C	D	D	No target	D
	Local	D	B	C	C	D	B	C	D	N/A	No target	D
Policy Area [2]												
Within 600m of a rapid transit station	Arterial	A	A	C	B	D	A	C	D	D	E	E
	Collector	A	A	B	B	D	A	C	D	D	No target	E
	Local	A	A	B	B	D	A	C	D	N/A	No target	E
Within 300m of a school	Arterial	A	A	C	B	D	A	C	D	D	E	E
	Collector	A	A	B	B	D	A	C	D	D	No target	E
	Local	A	A	B	B	D	A	C	D	N/A	No target	E

1. This table indicates the minimum desirable target. Efforts should be made to exceed these minimum targets whenever possible, without negatively impacting the ability to achieve the minimum targets for other modes .
2. Where a policy area applies to a project or area, the modal targets should reflect the policy area targets regardless of the land use designation.
3. Transit targets are intended to be applied only for streets with a proposed or existing transit route.
4. Auto LOS is based on the two and a half hour peak period.
5. Minimum guidelines as dictated by City policy must be maintained, regardless of MMLOS targets.
N/A - Not applicable

8 Glossary

Bike Lane Width – The bike lane width is defined as a measurement taken perpendicular to the curb from the center of the bike lane pavement marking to the face of curb, i.e. includes the gutter width. In the case where a bike lane is adjacent to a parking lane, the measurement will be taken from the centre of the parking lane pavement marking. In cases where a painted buffer is provided, the width of the buffer is added to the width of the bike lane used in the evaluation.

Boulevard width – Boulevard width is measured as the distance between the back of the curb and the nearest edge of the sidewalk.

Effective Corner Radius – The effective corner radius considers the additional space afforded to turning vehicles by non-vehicular travel lanes between the turn lane on the departing and receiving legs of an intersections (refer to Section 5.3).

Vehicular operating speed – The operating speed is the actual operating speed of vehicles travelling along a corridor. This is often assumed to be equivalent to the posted speed, however depending on the operating conditions and design controls, the operating speed can be significantly higher or lower than the posted speed.

Peak Period – For the purposes of evaluating vehicular level of service (LOS), a two and a half hour peak period is to be used. The peak period typically considered is the morning peak period between 6:30 AM & 9:00 AM.

Physically Separated Bikeway - A separated bicycle facility can be delineated with a number of treatments including bollards, curbs, grade separation or parking lanes located between the bikeway and adjacent travel lanes. Note that small sections without physical separation may be acceptable where they are provided to allow cyclists to access turning / travel lanes in advance of intersections or at driveways where appropriate conflict markings are provided.

Pocket Bike Lane – A pocket bike lane is a small section of bike lane that develops near an intersection between vehicular right turn lanes on the right side and vehicular through or left lanes on the left side. As a result of traffic on both sides, these pocket bike lanes are considered to be more stressful for cyclists than bicycle lanes adjacent to the curb or parking lanes.

Segregated ROW (as referenced in the Transit Level of Service) – A segregated right of way for transit implies some physical separation is provided between transit travel lanes and general purpose travel lanes – whether it is through curb barriers or planting or separated by grade. An example of a segregated ROW for transit within the road ROW is Chapman Mills between Beatrice Drive and Woodroffe Avenue.

Shared Space – "A street or place designed to improve pedestrian movement and comfort by reducing the dominance of motor vehicles and enabling all users to share the space rather than follow the clearly design rules implied by more conventional designs." (UK Department for Transport Local Transport Note 1/11 – Shared Space, 2011, p. 6).

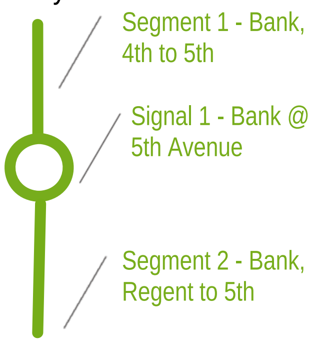
Sidewalk Width – For the purposes of PLOS, sidewalk width should be measured as the clear width available for pedestrian space. While spot encroachments may be acceptable, any repeating fixed feature, such as hydro poles, within the sidewalk will narrow the space available. The clear width is the wider portion of the sidewalk to one side of the fixed feature.

Appendix A: Examples

MMLOS Modal Summary Page

Project:	PLOS Example Illustration
Corridor:	Bank Street (Glebe)
Year / Scenario:	2012

Study Area:



Overall Route Score

D

Segment Summary

Segment 1

Street	Bank
From	4th
To	5th
Year / Condition	2012
Direction	Northbound-Southbound
MMLOS Mode	PLOS

Segment 1 Score

C

Segment 2

Street	Bank
From	Regent
To	5th
Year / Condition	2012
Direction	Northbound-Southbound
MMLOS Mode	PLOS

Segment 2 Score

C

Signal Summary

Signal

Street	Bank Street
@	5th Street
Approach	
Year / Condition	2012 - After implementation of cycle tracks
MMLOS Mode	PLOS

Signal 1 Score

D

Notes:
Segments have the same treatment in both the northbound and southbound directions, so only one segment evaluation is needed for each block.

MMLOS Segment Evaluation

Street	Bank
From	4th
To	5th
Year / Condition	2012
Direction	Northbound-Southbound
MMLOS Mode	PLOS

Segment Score

C

Photo / Proposed Cross-Section (where available):

Evaluation Criteria:

Sidewalk Width (m)	Boulevard Width (m)	Motor Vehicle Traffic Volume (AADT)	Presence of On-street Parking	Segment PLOS			
				Operating Speed (km/h)			
				≤30	>30 or 50	>50 or 60	>60 [1]
2.0 or more	> 2	≤ 3000	N/A	A	A	A	B
		> 3000	Yes	A	B	B	N/A
			No	A	B	C	D
	0.5 to 2	≤ 3000	N/A	A	A	A	B
		> 3000	Yes	A	B	C	N/A
			No	A	C	D	E
	0	≤ 3000	NA	A	B	C	D
		> 3000	Yes	B	B	D	N/A
			No	B	C	E	F
1.8	> 2	≤ 3000	N/A	A	A	A	B
		> 3000	Yes	A	B	C	N/A
			No	A	C	D	E
	0.5 to 2	≤ 3000	N/A	A	B	B	D
		> 3000	Yes	A	C	C	N/A
			No	B	C	E	E
	0	≤ 3000	N/A	A	B	C	D
		> 3000	Yes	B	C	D	N/A
			No	C	D	F	F
1.5	> 2	≤ 3000	N/A	C	C	C	C
		> 3000	Yes	C	C	D	N/A
			No	C	D	E	E
	0.5 to 2	≤ 3000	N/A	C	C	C	D
		> 3000	Yes	C	C	D	N/A
			No	D	E	E	E
	0	N/A		D	E	F [2]	F [2]
<1.5	N/A			F [3]	F [3]	F [3]	F [3]
No sidewalk	N/A			C [4]	F [3]	F [3]	F [3]

Notes:
Example is intended to be illustrative only and may not reflect actual conditions. Both directions are evaluated at once since the cross-section is consistent across the corridor. Sidewalk width is based on the effective width after accounting for hydro poles, etc.

MMLOS Segment Evaluation

Street	Bank
From	Regent
To	5th
Year / Condition	2012
Direction	Northbound-Southbound
MMLOS Mode	PLOS

Segment Score

C

Photo / Proposed Cross-Section (where available):

Evaluation Criteria:

Sidewalk Width (m)	Boulevard Width (m)	Motor Vehicle Traffic Volume (AADT)	Presence of On-street Parking	Segment PLOS – Operating Speed (km/h): ≤30	>30 or 50	>50 or 60	>60[1]
2.0 or more	> 2	≤ 3000	N/A	A	A	A	B
		> 3000	Yes	A	B	B	N/A
			No	A	B	C	D
	0.5 to 2	≤ 3000	N/A	A	A	A	B
		> 3000	Yes	A	B	C	N/A
			No	A	C	D	E
	0	≤ 3000	NA	A	B	C	D
		> 3000	Yes	B	B	D	N/A
			No	B	C	E	F
1.8	> 2	≤ 3000	N/A	A	A	A	B
		> 3000	Yes	A	B	C	N/A
			No	A	C	D	E
	0.5 to 2	≤ 3000	N/A	A	B	B	D
		> 3000	Yes	A	C	C	N/A
			No	B	C	E	E
	0	≤ 3000	N/A	A	B	C	D
		> 3000	Yes	B	C	D	N/A
			No	C	D	F	F
1.5	> 2	≤ 3000	N/A	C	C	C	C
		> 3000	Yes	C	C	D	N/A
			No	C	D	E	E
	0.5 to 2	≤ 3000	N/A	C	C	C	D
		> 3000	Yes	C	C	D	N/A
			No	D	E	E	E
	0	N/A		D	E	F[2]	F[2]
<1.5	N/A			F[3]	F[3]	F[3]	F[3]
No sidewalk	N/A			C[4]	F[3]	F[3]	F[3]

Notes:
Example is intended to be illustrative only and may not reflect actual conditions. Both directions are evaluated at once since the cross-section is consistent across the corridor. Sidewalk width is based on the effective width after accounting for hydro poles, etc.

MMLOS Signal Evaluation

Main Street	Bank Street
Minor Street	5th Street
Approaches	All (see below)
Year / Condition	2012
Direction	All (see below)
MMLOS Mode	PLOS

Overall Intersection Score

D

North

5.1 Crossing Distance & Conditions		
Median?		
N		
Total Travel lanes crossed		
4	88 pts	
Island refuge?		
N	-4 pts	
5.2 Signal Phasing & Timing Features		
Left turn conflict		
Permissive	-8 pts	
Right turn conflict		
Permissive or yield control	-5 pts	
Right turns on Red		
RTOR allowed	-3 pts	
Leading ped interval		
No	-2 pts	
5.3 Corner Radius		
> 3m to 5m	-4 pts	
Right turn		
No channelization	0 pts	
5.4 Crosswalk Treatment		
Standard transvervse markings	-7 pts	
TOTAL PETSI SCORE	55 pts	
DELAY SCORE	4.8 sec	
Cycle length		
60		
Pedestrian Effective Walk Time		
36		

PETSI Score	Delay Score
D	A
Overall Approach Score	D

East Approach

5.1 Crossing Distance & Conditions	
Median?	
N	
Total Travel lanes crossed	
3	105 pts
Island refuge?	
N	-4 pts
5.2 Signal Phasing & Timing Features	
Left turn conflict	
Permissive	-8 pts
Right turn conflict	
Permissive or yield control	-5 pts
Right turns on Red	
RTOR allowed	-3 pts
Leading ped interval	
No	-2 pts
5.3 Corner Radius	
> 3m to 5m	-4 pts
Right turn	
No channelization	0 pts
5.4 Crosswalk Treatment	
Standard transvervse markings	-7 pts
TOTAL PETSI SCORE	72 pts
DELAY SCORE	17.64 sec
Cycle length	
60	
Pedestrian Effective Walk Time	
14	

PETSI Score	Delay Score
C	B
Overall Approach Score	C

South Approach

5.1 Crossing Distance & Conditions	
Median?	
N	
Total Travel lanes crossed	
4	88 pts
Island refuge?	
N	-4 pts
5.2 Signal Phasing & Timing Features	
Left turn conflict	
Permissive	-8 pts
Right turn conflict	
Permissive or yield control	-5 pts
Right turns on Red	
RTOR allowed	-3 pts
Leading ped interval	
No	-2 pts
5.3 Corner Radius	
> 3m to 5m	-4 pts
Right turn	
No channelization	0 pts
5.4 Crosswalk Treatment	
Standard transvervse markings	-7 pts
TOTAL PETSI SCORE	55 pts
DELAY SCORE	4.8 sec
Cycle length	
60	
Pedestrian Effective Walk Time	
36	

PETSI Score	Delay Score
D	A
Overall Approach Score	D

West Approach

5.1 Crossing Distance & Conditions	
Median?	
N	
Total Travel lanes crossed	
2	120 pts
Island refuge?	
N	-4 pts
5.2 Signal Phasing & Timing Features	
Left turn conflict	
Permissive	-8 pts
Right turn conflict	
Permissive or yield control	-5 pts
Right turns on Red	
RTOR allowed	-3 pts
Leading ped interval	
No	-2 pts
5.3 Corner Radius	
> 3m to 5m	-4 pts
Right turn	
No channelization	0 pts
5.4 Crosswalk Treatment	
Standard transvervse markings	-7 pts
TOTAL PETSI SCORE	87 pts
DELAY SCORE	17.64 sec
Cycle length	
60	
Pedestrian Effective Walk Time	
14	

PETSI Score	Delay Score
B	B
Overall Approach Score	B

Notes:
Example is intended to be illustrative only and may not reflect actual conditions.

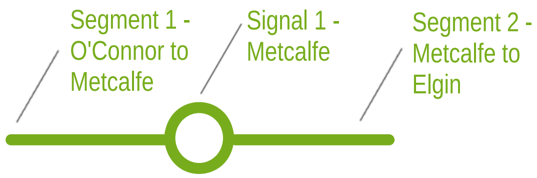
MMLOS Modal Summary Page

Project: BLOS Example Illustration

Corridor: Laurier Avenue

Year / Scenario: 2012 - After implementation of cycle tracks

Study Area:



Overall Route Score

A

Segment Summary

Segment 1

Street	Laurier Avenue
From	O'Connor
To	Metcalfe
Year / Condition	2012 - After implementation of cycle tracks
Direction	Eastbound / Westbound
MMLOS Mode	BLOS

Segment 1 Score

A

Segment 2

Street	Laurier Avenue
From	Metcalfe
To	Elgin
Year / Condition	2012 - After implementation of cycle tracks
Direction	Eastbound / Westbound
MMLOS Mode	BLOS

Segment 1 Score

A

Signal Summary

Signal 1

Street	Laurier Avenue
@	Metcalfe Street
Approach	Eastbound / Westbound
Year / Condition	2012 - After implementation of cycle tracks
MMLOS Mode	BLOS

Signal 1 Score

A

MMLOS Segment Evaluation

Street	Laurier Avenue
From	O'Connor Street
To	Metcalfe Street
Year / Condition	2012 - After implementation of cycle tracks
Direction	Eastbound / Westbound
MMLOS Mode	BLOS

Segment Score

A

Photo / Proposed Cross-Section (where available):

Evaluation Criteria:

Type of Bikeway		LOS
Physically Separated Bikeway (cycle tracks, protected bike lanes and multi-use paths). Physical separation refers to, but is not limited to, curbs, raised medians, bollards and parking lanes (adjacent to the bike lane along the travelled way i.e. not curbside).		A
Bike Lanes Not Adjacent Parking Lane - Select Worst Scoring Criteria		
No. of Travel Lanes	1 travel lane in each direction	A
	2 travel lanes in each direction separated by a raised median	B
	2 travel lanes in each direction without a separating median	C
	More than 2 travel lanes in each direction	D
Bike Lane Width	≥ 1.8 m wide bike lane (includes marked buffer and paved gutter width)	A
	≥ 1.5 m to <1.8 m wide bike lane (includes marked buffer and paved gutter width) Not applicable - physically separated bikeway provided along the segment	B
	≥ 1.2 m to <1.5 m wide bike lane (includes marked buffer and paved gutter width)	C
Operating Speed	≤ 50 km/h operating speed	A
	60 km/h operating speed	C
	≥ 70 km/h operating speed	E
Bike lane blockage (commercial areas)	Rare	A
	Frequent	C
Bike Lanes Adjacent to curbside Parking Lane - Select Worst Scoring Criteria		
No. of Travel Lanes	1 travel lane in each direction	A
	2 or more travel lanes in each direction	C
Bike Lane and Parking Lane Width	4.5 m wide bike lane plus parking lane (includes marked buffer and paved gutter width)	A
	4.25 m wide bike lane plus parking lane (includes marked buffer and paved gutter width)	B
	≤ 4.0 m wide bike lane plus parking lane (includes marked buffer and paved gutter width) Not applicable - physically separated bikeway provided along the segment	C
Operating Speed	≤ 40 km/h operating speed	A
	50 km/h operating speed	B
	60 km/h operating speed	D
	≥ 70 km/h operating speed	F
Bike lane blockage (commercial areas)	Rare	A
	Frequent	C
Mixed Traffic		
No. of Travel Lanes and Operating Speed	2 travel lanes; ≤ 40 km/h; no marked centerline or classified as residential	A
	2 to 3 travel lanes; ≤ 40 km/h	B
	2 travel lanes; 50 km/h; no marked centerline or classified as residential	B
	2 to 3 travel lanes; 50 km/h	D
	4 to 5 travel lanes; ≤ 40 km/h	D
	4 to 5 travel lanes; ≥ 50 km/h Not applicable - physically separated bikeway provided along the segment	E
	6 or more travel lanes; ≤ 40 km/h	E
	≥ 60 km/h	F
Unsignalized Crossing along Route: no median refuge		
No. of Travel Lanes on Side Street and Operating Speed	3 or less lanes being crossed; ≤ 40 km/h	A
	4 to 5 lanes being crossed; ≤ 40 km/h	B
	3 or less lanes being crossed; 50 km/h	B
	4 to 5 lanes being crossed; 50 km/h	C
	3 or less lanes being crossed; 60 km/h Not applicable - no unsignalized crossings along the corridor	C
	4 to 5 lanes being crossed; 60 km/h	D
	6 or more lanes being crossed; ≤ 40 km/h	E
	3 or less lanes being crossed; ≥ 65 km/h	E
	6 or more lanes being crossed; ≥ 50 km/h	F
	4 to 5 lanes being crossed; ≥ 65 km/h	F
Unsignalized Crossing along Route: with median refuge (≥ 1.8 m wide)		
No. of Travel Lanes on Side Street and Operating Speed	5 or less lanes being crossed; ≤ 40 km/h	A
	3 or less lanes being crossed; 50 km/h	A
	6 or more lanes being crossed; ≤ 40 km/h	B
	4 to 5 [illegible] Not applicable - no unsignalized crossings along the corridor	B
	3 or less [illegible]	B
	6 or more lanes being crossed; 50 km/h	C
	4 to 5 lanes being crossed; 60 km/h	C
	3 or less lanes being crossed; ≥ 65 km/h	D
	6 or more lanes being crossed; 60 km/h	E
	4 to 5 lanes being crossed; ≥ 65 km/h	E
	6 or more lanes being crossed; ≥ 65 km/h	F

Notes:
Segment has the same treatment in both the eastbound and westbound directions, so only one evaluation is needed. Although the physical barrier of the separated cycling facility is dropped at certain points along the corridor, these treatments occur only at isolated spots (i.e. driveways) in order to highlight conflict zones and over short segments, therefore the section is considered to be a physically separated facility. This illustrates the need for judgement in applying the evaluation criteria.

MMLOS Segment Evaluation

Street	Laurier Avenue
From	Metcalfe Street
To	Elgin Street
Year / Condition	2012 - After implementation of cycle tracks
Direction	Eastbound / Westbound
MMLOS Mode	BLOS

Segment Score

A

Photo / Proposed Cross-Section (where available):

Evaluation Criteria:

Type of Bikeway		LOS
Physically Separated Bikeway (cycle tracks, protected bike lanes and multi-use paths). Physical separation refers to, but is not limited to, curbs, raised medians, bollards and parking lanes (adjacent to the bike lane along the travelled way i.e. not curbside).		A
Bike Lanes Not Adjacent Parking Lane - Select Worst Scoring Criteria		
No. of Travel Lanes	1 travel lane in each direction	A
	2 travel lanes in each direction separated by a raised median	B
	2 travel lanes in each direction without a separating median	C
	More than 2 travel lanes in each direction	D
Bike Lane Width	≥ 1.8 m wide bike lane (includes marked buffer and paved gutter width)	A
	≥ 1.5 m to <1.8 m wide bike lane (includes marked buffer and paved gutter width)	B
	≥ 1.2 m to <1.5 m wide bike lane (includes marked buffer and paved gutter width)	C
Operating Speed	≤ 50 km/h operating speed	A
	60 km/h operating speed	C
	≥ 70 km/h operating speed	E
Bike lane blockage (commercial areas)	Rare	A
	Frequent	C
Bike Lanes Adjacent to curbside Parking Lane - Select Worst Scoring Criteria		
No. of Travel Lanes	1 travel lane in each direction	A
	2 or more travel lanes in each direction	C
Bike Lane and Parking Lane Width	4.5 m wide bike lane plus parking lane (includes marked buffer and paved gutter width)	A
	4.25 m wide bike lane plus parking lane (includes marked buffer and paved gutter width)	B
	≤ 4.0 m wide bike lane plus parking lane (includes marked buffer and paved gutter width)	C
Operating Speed	≤ 40 km/h operating speed	A
	50 km/h operating speed	B
	60 km/h operating speed	D
	≥ 70 km/h operating speed	F
Bike lane blockage (commercial areas)	Rare	A
	Frequent	C
Mixed Traffic		
No. of Travel Lanes and Operating Speed	2 travel lanes; ≤ 40 km/h; no marked centerline or classified as residential	A
	2 to 3 travel lanes; ≤ 40 km/h	B
	2 travel lanes; 50 km/h; no marked centerline or classified as residential	B
	2 to 3 travel lanes; 50 km/h	D
	4 to 5 travel lanes; ≤ 40 km/h	D
	4 to 5 travel lanes; ≥ 50 km/h	E
	6 or more travel lanes; ≤ 40 km/h	E
	≥ 60 km/h	F
Unsignalized Crossing along Route: no median refuge		
No. of Travel Lanes on Side Street and Operating Speed	3 or less lanes being crossed; ≤ 40 km/h	A
	4 to 5 lanes being crossed; ≤ 40 km/h	B
	3 or less lanes being crossed; 50 km/h	B
	4 to 5 lanes being crossed; 50 km/h	C
	3 or less lanes being crossed; 60 km/h	C
	4 to 5 lanes being crossed; 60 km/h	D
	6 or more lanes being crossed; ≤ 40 km/h	E
	3 or less lanes being crossed; ≥ 65 km/h	E
	6 or more lanes being crossed; ≥ 50 km/h	F
	4 to 5 lanes being crossed; ≥ 65 km/h	F
Unsignalized Crossing along Route: with median refuge (≥ 1.8 m wide)		
No. of Travel Lanes on Side Street and Operating Speed	5 or less lanes being crossed; ≤ 40 km/h	A
	3 or less lanes being crossed; 50 km/h	A
	6 or more lanes being crossed; ≤ 40 km/h	B
	4 to 5 [illegible]	B
	3 or les[illegible]/h	B
	6 or more lanes being crossed; 50 km/h	C
	4 to 5 lanes being crossed; 60 km/h	C
	3 or less lanes being crossed; ≥ 65 km/h	D
	6 or more lanes being crossed; 60 km/h	E
	4 to 5 lanes being crossed; ≥ 65 km/h	E
	6 or more lanes being crossed; ≥ 65 km/h	F

Annotations on the table (Bike Lanes Not Adjacent Parking Lane – Bike Lane Width / Operating Speed; Bike Lanes Adjacent to curbside Parking Lane – Width / Operating Speed; Mixed Traffic): Not applicable - physically separated bikeway provided along the segment

Annotations on the table (Unsignalized Crossing along Route: no median refuge; with median refuge): Not applicable - no unsignalized crossings along the corridor

Notes:
Segment has the same treatment in both the eastbound and westbound directions, so only one evaluation is needed.

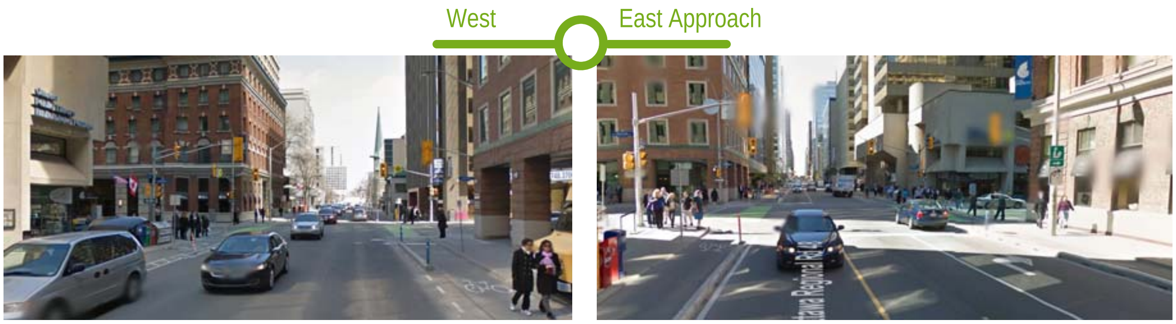
MMLOS Signal Evaluation

Main Street	Laurier Avenue
Minor Street	Metcalfe Street
Approaches	East / West
Year / Condition	2012 - After implementation of cycle tracks
Direction	Eastbound / Westbound
MMLOS Mode	BLOS

Signal Score

A

Photo / Proposed Cross-Section (where available):



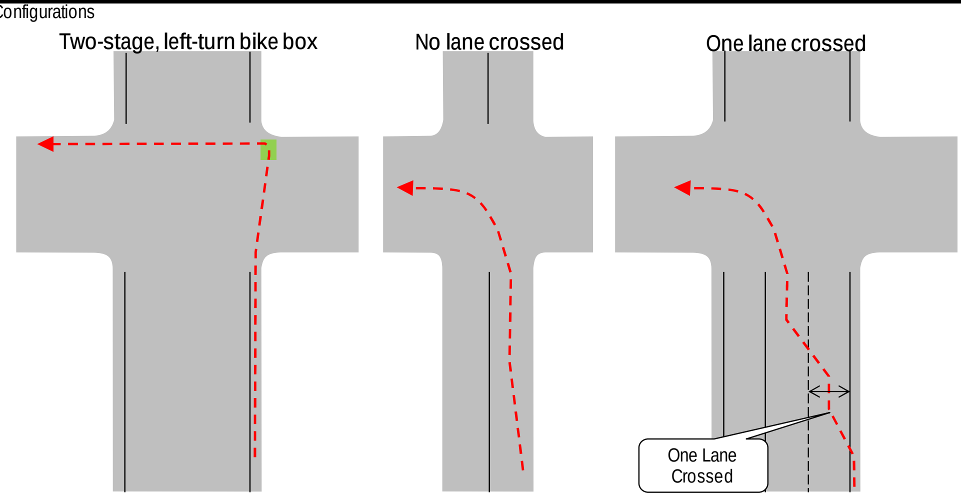
West Approach

East Approach

Right turn lane is provided to the left of the cycling facility

Bikeway and Intersection Type		LOS
Bike Lanes or higher order facility on a Signalized Intersection Approach		
Right-turn Lane and Turning Speed of Motorists	No impact on LTS (as long as cycling facility remains to the right of any turn lane - otherwise see pocket bike lanes below)	
Cyclist Making a Left-turn and Operating Speed of Motorists (refer to figure)	Two-stage, left-turn bike box; ≤ 50 km/h	A
	No lane crossed, ≤ 50 km/h	B
	1 lane crossed, ≤ 40 km/h	B
	No lane crossed, ≥ 60 km/h	C
	1 lane crossed, 50 km/h	C
	2 or more lanes crossed, ≤ 40 km/h	D
	1 lane crossed, ≥ 60 km/h	E
	2 or more lanes crossed, ≥ 50 km/h	F
	All other single left-turn lane configurations	F
	Dual left-turn lanes (shared or exclusive)	F

Left-turn Configurations

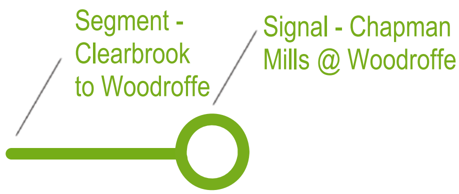


Notes:

Note that although cyclists have the option of using the bike boxes or making a vehicular left, the segment is evaluated using the bike boxes since this is an option for less confident riders. Both directions have the same treatment, so both directions are evaluated at the same time.

MMLOS Modal Summary Page

Project:	TLOS Example Illustration
Corridor:	Chapman Mills
Study Area:	Clearbrook to Woodroffe



Overall Route Score

B

Segment Summary

Segment 1

Street	Chapman Mills
From	Clearbrook
To	Woodroffe
Year / Condition	2015
Direction	Eastbound / Westbound
MMLOS Mode	TLOS

Segment 1 Score

A

Signal Summary

Signal 1

Street	Chapman Mills
@	Woodroffe
Approach	Eastbound / Westbound
Year / Condition	2015
MMLOS Mode	TLOS

Signal 1 Score

B

Notes:
Segment has the same treatment in both the eastbound and westbound directions, so only one evaluation is needed.

MMLOS Segment Evaluation

Street	Chapman Mills
From	Clearbrook
To	Woodroffe
Year / Condition	2015
Direction	Eastbound / Westbound
MMLOS Mode	TLOS

Segment Score

A

Photo / Proposed Cross-Section (where available):

Evaluation Criteria:

Facility Type		Level/exposure to congestion delay, friction and incidents			Quantitative Measurement	LOS
		Congestion	Friction	Incident Potential		
Segregated ROW		No	No	No	N/A	A
Bus lane	No/limited parking/driveway friction	No	Low	Low	$C_f \leq 60$	B
	Frequent parking/driveway friction	No	Medium	Medium	$C_f > 60$	C
Mixed Traffic	Limited parking/driveway friction	Yes	Low	Medium	$Vt/Vp \geq 0.8$	D
	Moderate parking/driveway friction	Yes	Medium	Medium	$Vt/Vp \leq 0.6$	E
	Frequent parking/driveway friction	Yes	High	High	$Vt/Vp < 0.4$	F

Notes:
Example is intended to be illustrative only and may not reflect actual conditions. Both directions are evaluated at once since both directions have the same facility.

MMLOS Signal Evaluation

Main Street	Chapman Mills
Minor Street	Woodroffe
Approaches	Eastbound / Westbound
Year / Condition	2015
MMLOS Mode	TLOS

Signal Score

B

East Approach

Delay	Typical Location	LOS
0	Grade Separation	A
≤10 sec	High Level TSP	B
≤20 sec		C
≤30 sec		D
≤40 sec	TSP & long cycle length	E
>40 sec	No TSP & long cycle length	F

Note: Delay includes travel time from end of queue to entering the intersection

West Approach

Delay	Typical Location	LOS
0	Grade Separation	A
≤10 sec	High Level TSP	B
≤20 sec		C
≤30 sec		D
≤40 sec	TSP & long cycle length	E
>40 sec	No TSP & long cycle length	F

Note: Delay includes travel time from end of queue to entering the intersection

Notes:

Example is intended to be illustrative only and may not reflect actual conditions. Both eastbound and westbound directions are evaluated at once since both directions experience the same delay.

MMLOS Modal Summary Page

Project: TkLOS Example Illustration

Corridor: Merivale

Year / Scenario: 2015

Study Area:

Overall Route Score

A

Segment Summary

Street	Merivale
From	Jamie Avenue
To	Hunt Club Road
Year / Condition	2015
Direction	Northbound-Southbound
MMLOS Mode	PLOS

Segment 1 Score

A

Signal Summary

Street	Merivale
@	Hunt Club
Approach	All (see below)
Year / Condition	2015
MMLOS Mode	TkLOS

Signal 1 Score

A

Notes:
Segments have the same treatment in both the northbound and southbound directions, so only one segment evaluation is needed for each block.

MMLOS Segment Evaluation

Street	Merivale
From	Jamie
To	Hunt Club
Year / Condition	2015
Direction	Northbound-Southbound
MMLOS Mode	TkLOS

Segment Score

A

Photo / Proposed Cross-Section (where available):

Evaluation Criteria:

Curb Lane Width (m)	Only two travel lanes (one in each direction)	More than two travel lanes
>3.7	B	A
≤3.5	C	A
≤3.3	D	C
≤3.2	E	D
≤3	F	E

Notes:
Example is intended to be illustrative only and may not reflect actual conditions. Both directions are evaluated at once since the lane widths are consistent across the corridor.

MMLOS Signal Evaluation

Main Street	Merivale
Minor Street	Hunt Club
Approaches	All (see below)
Year / Condition	2015
MMLOS Mode	TkLOS

Overall Intersection Score

A

North Approach

Effective Corner Radius	One receiving lane on departure from intersection	More than one receiving lane on departure from intersection
< 10m	F	D
10 to 15m	E	B
> 15m	C	A

Overall Approach Score: **A**

East Approach

Effective Corner Radius	One receiving lane on departure from intersection	More than one receiving lane on departure from intersection
< 10m	F	D
10 to 15m	E	B
> 15m	C	A

Overall Approach Score: **A**

South

Effective Corner Radius	One receiving lane on departure from intersection	More than one receiving lane on departure from intersection
< 10m	F	D
10 to 15m	E	B
> 15m	C	A

Overall Approach Score: **A**

West Approach

Effective Corner Radius	One receiving lane on departure from intersection	More than one receiving lane on departure from intersection
< 10m	F	D
10 to 15m	E	B
> 15m	C	A

Overall Approach Score: **A**

Notes:
Example is intended to be illustrative only and may not reflect actual conditions.

Trade-off Evaluation Scenario A: Centre Street Revitalization

As part of the City's ongoing capital program, ten blocks of a main artery in the heart of a thriving commercial district, Centre Street, are due for reconstruction. In order to determine which modes the new cross-section should prioritize, an analysis is carried out of the existing conditions, and the MMLOS targets are reviewed for cross-section requirements.

A summary of the site conditions and basic context are provided in Exhibit 23**.**

Exhibit 23 – Centre Street Site Context

ROADWAY	DESIGNATION	SPEED	CONSIDERATIONS
Centre Street	Traditional Mainstreet	50 km/hr	▪ Centre street is an arterial road with one lane in each direction plus a parking lane on both sides ▪ Centre Street is identified as part of the cycling spine network ▪ This segment of Centre Street is located within 500m of a rapid transit station ▪ A parallel rapid transit route exists within 500m of the segment ▪ A feeder transit route with isolated transit priority measures is identified along the corridor ▪ A laneway is available off the main thoroughfare to facilitate deliveries to businesses (Centre is not designated as a truck route)

Based on a thorough analysis of current conditions on segments and at intersections, the following conditions are shown to exist for the prevailing peak period of analysis (refer to Exhibit 24).

Exhibit 24 – Centre Street Existing Conditions

PLOS	BLOS	TLOS	TKLOS	LOS
C	F	D	E	C

Referring to the MMLOS target table presented in Section 7.1, the following are the modal targets based on the prevailing conditions (refer to Exhibit 25).

Exhibit 25 – Centre Street Modal Targets & Sample Facilities Required

PLOS	BLOS	TLOS	TKLOS	LOS
B	C	D	E	D

After developing an 'ideal' cross-section based on the above targets , it becomes obvious that not all of the targeted conditions can be accommodated within existing right-of-way and pavement width constraints while maintaining or exceeding the existing LOS for each mode. Given the need for trade-offs, MMLOS can assist in the development of alternative options.

A variety of scenarios are identified for the reconstruction in an effort to achieve the minimum desired targets:

- Traffic calming – Lanes are narrowed slightly, and corner radii are reduced – as a result, the operating speed of the road is reduced. Additional boulevard width is provided to allow for improved street furniture to be provided.
- Road diet – In this scenario, bike lanes are added to the cross-section. In order to accommodate the bike lanes, a parking lane is removed, and lanes are narrowed slightly. Pedestrians are provided with additional sidewalk width and boulevard.
- Intersection improvements – In this scenario, intersection improvements are provided to enhance the pedestrian crossing experience and to accommodate bicycle turning movements more comfortably. The package of improvements includes prohibiting RTOR, but due to better signal coordination of the corridor, the vehicular and transit delays are minimized.

Exhibit 26 – Impacts of various scenarios for Centre Street reconstruction

SCENARIO	PLOS	BLOS	TLOS	TKLOS	LOS
Existing	C	E	D	E	C
Targeted LOS	B	C	D	E	D
Traffic Calming	B	C	D	E	D
Road Diet	B	B	E	E	E
Signal Modifications	B	D	D	E	D

With the following summary of the impacts of each scenario, a decision can be made that is based on a complete picture of the desired improvements. In this case, the traffic calming scenario achieves or exceeds the minimum desirable targets for every mode.

The MMLOS acts as a tool for understanding how improvements impact all moves – but the framework is not intended to dictate one particular design or treatment option to be applied everywhere. As shown in Exhibit 26, there are a variety of techniques that can be used to compromise in the development of the cross-section elements, and the MMLOS framework provides a realized tool for assessing trade-offs.

Trade-off Evaluation Scenario A: Centre Street Revitalization

As part of the City's ongoing capital program, ten blocks of a main artery in the heart of a thriving commercial district, Centre Street, are due for reconstruction. In order to determine which modes the new cross-section should prioritize, an analysis is carried out of the existing conditions, and the MMLOS targets are reviewed for cross-section requirements.

A summary of the site conditions and basic context are provided in Exhibit 23**.**

Exhibit 23 – Centre Street Site Context

ROADWAY	DESIGNATION	SPEED	CONSIDERATIONS
Centre Street	Traditional Mainstreet	50 km/hr	▪ Centre street is an arterial road with one lane in each direction plus a parking lane on both sides ▪ Centre Street is identified as part of the cycling spine network ▪ This segment of Centre Street is located within 500m of a rapid transit station ▪ A parallel rapid transit route exists within 500m of the segment ▪ A feeder transit route with isolated transit priority measures is identified along the corridor ▪ A laneway is available off the main thoroughfare to facilitate deliveries to businesses (Centre is not designated as a truck route)

Based on a thorough analysis of current conditions on segments and at intersections, the following conditions are shown to exist for the prevailing peak period of analysis (refer to Exhibit 24).

Exhibit 24 – Centre Street Existing Conditions

PLOS	BLOS	TLOS	TKLOS	LOS
C	F	D	E	C

Referring to the MMLOS target table presented in Section 7.1, the following are the modal targets based on the prevailing conditions (refer to Exhibit 25).

Exhibit 25 – Centre Street Modal Targets & Sample Facilities Required

PLOS	BLOS	TLOS	TKLOS	LOS
B	C	D	E	D

After developing an 'ideal' cross-section based on the above targets , it becomes obvious that not all of the targeted conditions can be accommodated within existing right-of-way and pavement width constraints while maintaining or exceeding the existing LOS for each mode. Given the need for trade-offs, MMLOS can assist in the development of alternative options.

A variety of scenarios are identified for the reconstruction in an effort to achieve the minimum desired targets:

- Traffic calming – Lanes are narrowed slightly, and corner radii are reduced – as a result, the operating speed of the road is reduced. Additional boulevard width is provided to allow for improved street furniture to be provided.
- Road diet – In this scenario, bike lanes are added to the cross-section. In order to accommodate the bike lanes, a parking lane is removed, and lanes are narrowed slightly. Pedestrians are provided with additional sidewalk width and boulevard.
- Intersection improvements – In this scenario, intersection improvements are provided to enhance the pedestrian crossing experience and to accommodate bicycle turning movements more comfortably. The package of improvements includes prohibiting RTOR, but due to better signal coordination of the corridor, the vehicular and transit delays are minimized.

Exhibit 26 – Impacts of various scenarios for Centre Street reconstruction

SCENARIO	PLOS	BLOS	TLOS	TKLOS	LOS
Existing	C	E	D	E	C
Targeted LOS	B	C	D	E	D
Traffic Calming	**B**	**C**	**D**	**E**	**D**
Road Diet	B	B	E	E	E
Signal Modifications	B	D	D	E	D

With the following summary of the impacts of each scenario, a decision can be made that is based on a complete picture of the desired improvements. In this case, the traffic calming scenario achieves or exceeds the minimum desirable targets for every mode.

The MMLOS acts as a tool for understanding how improvements impact all moves – but the framework is not intended to dictate one particular design or treatment option to be applied everywhere. As shown in Exhibit 26, there are a variety of techniques that can be used to compromise in the development of the cross-section elements, and the MMLOS framework provides a realized tool for assessing trade-offs.

Appendix B: Acceptable Parameters for Operational Analysis of Signalized Intersections

B1 Operational and Timing Standards for Signalized Intersections

GENERAL TIMING STANDARDS	
Maximum cycle length for analysis	• 120 sec
Minimum green time	• 10 sec for side street through movements • 5 sec for left-turn phases
Vehicle clearance	• Must consist of amber and all red display. Duration in accordance with Ontario Traffic Manual Book 12.
PEDESTRIAN PHASES	
Minimum walk time	• 7 sec
Walking speed	• 1.2 m/sec; 1.1 m/sec if near old age home, school or shopping centre
Pedestrian clearance	• Must be sufficient to allow crossing from curb to curb (including central medians). Includes vehicle clearance time in accordance with Ontario Traffic Manual Book 12.
Median storage	• If centre median storage for pedestrians is provided, then the minimum walk time must be of sufficient duration to allow a crossing from the curb to the far side of the median plus one lane. The pedestrian clearance interval must be of sufficient duration to permit the longest crossing from the median to the curb. Use of the median for pedestrian refuge shall only be considered in consultation with TPO staff.
AUXILIARY TURN LANE PHASING	
Overlap left-turn	• In cases where left-turn phasing is required for opposing left-turn movements and one of the movements is much heavier than the opposing movement, consideration should be given to early termination of the arrow indication for the lighter left-turn movement in order to permit an earlier commencement of the conflicting through movement. Appropriate vehicle clearance displays must be provided for all left-turn phases. Proper account must be made for lost time resulting from these clearances.
Protected only left-turn phasing	• Protected only left-turn phasing must be used when conditions are such that an undue hazard might result if permissive phasing were used. This is normally considered to be the case with a double left turn.
Shared lane operation	• All movements permitted from a shared use lane must operate on the same signal phase.
Dual right/left-turn movements	• Conflicting pedestrian movements should not be permitted simultaneously with dual right/left-turn movements. Normally, dual right turns will also require signalization.
Right/Left-turn arrows	• A right/left-turn arrow shall not be displayed at the same time that a conflicting pedestrian movement is permitted.
INTERSECTION SPACING AND MINIMUM STORAGE LENGTHS	
Visibility	• As per the requirements of the Ontario Traffic Manual, Book 12, signalized intersections should be a minimum of 120 metres apart, centreline to centreline, to ensure adequate visibility of the signal heads.
Through vehicle storage between intersections	• Signalized intersections must be sufficiently spaced to ensure that storage is available to accommodate 1.5 times the average number of vehicles arriving on each red indication during the heaviest hour (assuming an average vehicle length of 7 metres).
Storage lane lengths	• Left-turn storage lanes must be long enough to accommodate 1.5 times the average number of arrivals per cycle in the heaviest hour. Where double left turn lanes are in use, calculations should assume a 45%/ 55% distribution of traffic between the lanes. • Right-turn storage lanes must be long enough to permit right-turning traffic to clear the maximum queue of through vehicles that is anticipated to accumulate during the red indication. All calculations must assume an average vehicle length of 7 metres.
PARAMETERS FOR INTERSECTION ANALYSIS	
Heavy vehicle equivalent	• Heavy vehicles or buses 1.7
Saturation flow rate	• The maximum assumed ideal unadjusted saturation flow rate shall not exceed 1800 passenger cars per hour of green per lane, unless a higher or lower rate can be justified by the Consultant through data.

Appendix C: Sample MMLOS Summary Table

Multi-Modal Level of Service Data Entry Form
Project Example 1
Major Street Corridor - 2015 Existing Conditions

INTERSECTIONS		Street A				Street B				Street C				Street D			
		NORTH	SOUTH	EAST	WEST	NORTH	SOUTH	EAST	WEST	NORTH	SOUTH	EAST	WEST	NORTH	SOUTH	EAST	WEST
Pedesrian	Lanes	5	3	6	6	2	2	4	4		2	5	5	3	3	5	5
	Median	No	No	No	No	No	No	No	No		No	No	No	No	No	No	No
	Island Refuge	No	No	No	No	No	No	No	No		No	No	No	No	No	No	No
	Conflicting Left Turns	Prot+Perm	Permitted	Prot+Perm	Permitted	Permitted	Permitted	Permitted	Permitted		Permitted	Permitted	Permitted	Permitted	Permitted	Permitted	Permitted
	Conflicting Right Turns	Permitted	Permitted	Permitted	Permitted	Permitted	Permitted	Permitted	Permitted		Permitted	Permitted	Permitted	Permitted	Permitted	Permitted	Permitted
	RTOR?	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed		Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
	Ped Leading Interval?	no	no	no	no	no	no	yes	yes		no	no	no	no	no	no	no
	Corner Radius (largest)	10-15m	5-10m	10-15m	10-15m	10-15m	5-10m	10-15m	5-10m		5-10m	5-10m	5-10m	5-10m	5-10m	5-10m	5-10m
	Crosswalk Type	Zebra Stripe Markings	Zebra Stripe Markings	Zebra Stripe Markings	Zebra Stripe Markings	Zebra Stripe Markings	Zebra Stripe Markings	Zebra Stripe Markings	Zebra Stripe Markings		Zebra Stripe Markings	Zebra Stripe Markings	Zebra Stripe Markings	Zebra Stripe Markings	Zebra Stripe Markings	Zebra Stripe Markings	Zebra Stripe Markings
	Level of Service	E (40)	C (74)	F (23)	F (23)	B (88)	B (89)	D (56)	D (57)		B (89)	E (41)	E (41)	C (74)	C (74)	E (41)	E (41)
		F				D				E				E			
Cyclist	Type of Bikeway	Mixed Traffic	Mixed Traffic	Mixed Traffic	Mixed Traffic	Mixed Traffic	Mixed Traffic	Mixed Traffic	Mixed Traffic		Mixed Traffic	Mixed Traffic	Mixed Traffic	Mixed Traffic	Mixed Traffic	Mixed Traffic	Mixed Traffic
	Turning Speed (25km to 80km/h)	Slow	Slow	Slow	Slow	Slow	Slow	Slow	Slow		Slow	Slow	Slow	Slow	Slow	Slow	Slow
	Right Turn Storage Length	>50m	0-25m	25-50m	25-50m	0m	0m	0m	0m		0m	0m	0m	0m	0m	0m	0m
	Dual Right Turn?	no	no	no	no	no	no	no	no		no	no	no	no	no	no	no
	Shared Through-Right?	no	yes	no	no	yes	yes	yes	yes		yes	yes	yes	yes	yes	yes	yes
	Bike Box?	no	no	no	no	no	no	no	no		no	no	no	no	no	no	no
	Number of Lanes Crossed for Left Turns	2+	1	2+	2+	0	0	1	1		0	2+	1	1	1	2+	2+
	Operating Speed on Approach	50-59km/h	<=40 km/h	50-59km/h	50-59km/h	41-49 km/h	41-49 km/h	50-59km/h	50-59km/h		41-49 km/h	50-59km/h	50-59km/h	41-49 km/h	41-49 km/h	50-59km/h	50-59km/h
	Dual Left Turn Lanes?	no	no	no	no	no	no	no	no		no	no	no	no	no	no	no
	Level of Service	F	F	F	F	B	B	D	D		B	F	D	D	D	F	F
		F				D				F				F			
Transit	Average Signal Delay	20 Sec	20 Sec	10 Sec	10 Sec	10 Sec	20 Sec	20 Sec	20 Sec		30 Sec	40 Sec	30 Sec	30 Sec	30 Sec	30 Sec	30 Sec
	Level of Service	F	B	F	D	A	A	A	A		D	E	D	D	D	D	D
		F				A				E				D			
Truck	Turning Radius (smallest)	10-15m	<10m	>15m	<10m	<10m	<10m	<10m	<10m		<10m	<10m	<10m	<10m	<10m	<10m	<10m
	Number of Receiving Lanes	2+	2+	2+	2+	2+	2+	1	1		2+	1	1	2+	2+	1	1
	Level of Service	B	D	A	D	D	D	F	F		D	F	F	D	D	F	F
		D				F				F				F			
Auto	Level of Service	C				E				D				D			

SEGMENTS		Street A	Section 1	Section 2	Section 3	Street B	Section 1	Section 2	Section 3	Street C	Section 1	Section 2	Section 3	Street D	Section 1	Section 2	Section 3
Pedesrian	Sidewalk Width		2.0m+	2.0m+	2.0m+			2.0m+	2.0m+			2.0m+			2.0m+	2.0m+	1.8m
	Boulevard Width		0.5-2m	2m+	0.5-2m			0.5-2m	0.5-2m			0.5-2m			0.5-2m	2m+	0.5-2m
	AADT		>3000	>3000	>3000			>3000	>3000			>3000			>3000	>3000	>3000
	On-Street Parking		no	yes	yes			yes	yes			yes			yes	yes	no
	Operating Speed		<= 30 km/h	31-50 km/h	51-60 km/h			31-50 km/h	31-50 km/h			31-50 km/h			51-60 km/h	51-60 km/h	51-60 km/h
	Level of Service		A	B	C			B	C			B			C	B	E
				C				C				B				E	
Cyclist	Number of Travel Lanes (per direction)			2				2				2				2	
	Type of Bikeway		Mixed Traffic	Mixed Traffic				Mixed Traffic				Mixed Traffic				Mixed Traffic	
	Bike Lane Width		N/A	N/A				N/A				N/A				N/A	
	Operating Speed		<= 40 km/h	50 km/h				50 km/h				50 km/h				50 km/h	
	Bike Lane Blockages																
	Unsignalized Lane Crossings (no median)		2	2				2				2				2	
	Unsignalized Lane Crossings (median >1.8m)																
	Sidestreet Operating Speed		41-49 km/h	41-49 km/h				41-49 km/h				41-49 km/h				41-49 km/h	
	Level of Service		B	D	F			D				D				D	
				D				D				D				D	
Transit	Facility Type			Mixed Traffic				Bus lane				Mixed Traffic				Mixed Traffic	
	Friction / Congestion / Incident Potential			Vt/Vp ≥ 0.8				Cf ≤ 60				Vt/Vp ≥ 0.8				Vt/Vp ≤ 0.6	
	Level of Service			D				B				D				E	
				D				B				D				E	
Truck	Lane Width (3, 3.3, 3.5, >3.7)		3.5m	3.5m	3.5m			3.5m				3.5m				3.5m	
	Travel Lanes per Direction		2+	2+	2+			2+				2+				2+	
	Level of Service		A	A	A			A				A				A	
				A				A				A				A	
Auto	Level of Service	B				C				C				D			

*Applies only where conditions are the same in both directions