Prioritizing road segments for crosswalk improvements in Saint John, NB

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Abstract

The City of Saint John, NB, much like most cities, is crisscrossed by a network of collector and arterial roads that were built to help move people through the City by car. While very efficient at moving vehicles, these roadways often create barriers to the movement of pedestrians due to high traffic volumes, high speeds, and wide cross-sections. The City wanted to develop a plan to prioritize crosswalk improvements throughout this network and engaged Englobe to undertake the study.

The guiding TAC document for crosswalk infrastructure (the Pedestrian Crossing Control Guide) provides insight on how to evaluate specific locations for minimum crosswalk needs, but does not provide a framework for undertaking a network screening for crosswalk prioritization. A new procedure was developed to identify priority areas for crosswalk improvements across the City's collector and arterial road network as a function of the risk to pedestrians in crossing the road and the estimated demand for crosswalks. Data sources used in this study included the City's GIS platform, traffic counts, and Streetlight Data.

While the procedure developed for the City of Saint John is bespoke to the data that was available at the time of the study, the principals that were used can be readily adapted to other jurisdictions for use in their own network screening for crosswalk improvement prioritization.

Introduction

Much like most cities in North America, the City of Saint John's road network was built with the motor vehicle in mind. The network spans nearly 1,200 lane kilometres of road, including several wide collector and arterial roadways that bisect the community. In recent years, and with the development of the City's Transportation Master Plan, MoveSJ, the City has experienced a culture shift that prioritizes more sustainable modes of transportation, such as walking, cycling, and transit. As a result, City staff have been working towards providing safer and more accessible access for these road users.

A major barrier to access for sustainable transportation modes is the ability to cross from one side of a road to the other, specifically along the many wide collector and arterial roadways within the community. Historically, requests from the public have been the main source of crosswalk installation decisions; however, City Council and staff have committed to a fundamental shift in how future crosswalk installations are prioritized with the goal of reducing safety risk to all road users and increasing usage of sustainable transportation modes.

Project Objectives

The City of Saint John has recognized that introduction of improved data, and analysis of said data, can improve decisions about where and when future crosswalks should be installed. Ultimately, the project had two major objectives:

1. Identify and prioritize the locations along arterial and collector roads where crosswalks would be most beneficial for the movement of Active Transportation users within the City, and
2. For each location, identify the level of crosswalk treatment required based on the location's risk profile.

The discussion in this paper deals with the first of these two objectives, as it presents a novel approach to the identification of crosswalk projects.

Background

With a growing population of over 70,000 residents, the City of Saint John receives an array of citizen requests that ultimately are associated with either improving the safety or access of the various transportation modes. Many of these requests are focused on improving walking access and safety and include requests to install crosswalks that would improve safe travel across City streets.

Crosswalks are expensive infrastructure to both install and maintain. With a current inventory of over 600 crosswalks in the City, and with the City's increased focus on asset management and recognized infrastructure deficit, the cost to operate and maintain crosswalk infrastructure after initially installed can't be ignored.

In addition to the monetary cost of pedestrian infrastructure, there is also a cost of over-installing traffic control devices such as signs, painted lines, or lights associated with crosswalks. It is recognized that overuse of traffic control devices can reduce the priority placed on them by passing motorists, a legitimate cause for concern in areas of increased public safety risk. It is therefore vital that future installations of this infrastructure are prioritized to best serve the community as a whole and to maximize return on investment.

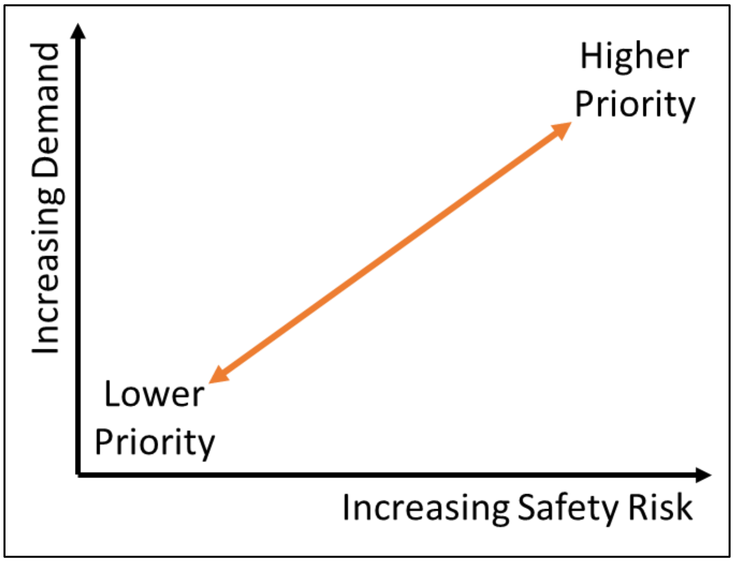
Priority Framework

In order to review the City's arterial and collector road network and prioritize locations for crosswalk improvements, a new analytical framework was required. The existing framework that was closest to the needs of this project is detailed in the Transportation Association of Canada's (TAC) Pedestrian Crossing Control Guide[1]. This guide has two separate frameworks for assessing locations for crosswalks:

- A framework that identifies if a crosswalk is merited at a location, based on specified minimum pedestrian demand, traffic volume, and network connectivity objectives; and
- A framework that selects the minimum type of crosswalk that should be implemented at a location where a crosswalk is merited (as per the previous framework) based on metrics that define the relative safety to pedestrians of crossing at that location (traffic volume, speed limit, and road cross section).

For this project, the goal was to have a framework that would score locations based on their Pedestrian Demand and Pedestrian Safety Risk and rank locations such that locations with high demand and low safety are a higher priority and locations with low demand and high safety are a lower priority. This concept is illustrated in Figure 1.

Figure 1. Priority Framework Concept



Pedestrian Safety Risk

For scoring pedestrian safety risk, the methodology used in the TAC Pedestrian Crossing Control Guide was referred to. The TAC Guide presents a matrix that allows a user to identify the appropriate minimum type of crossing infrastructure based on the Average Annual Daily Traffic volume (AADT) of the roadway, the cross-section configuration, and the posted speed limit. The outputs of the matrix include passive (signs and pavement markings only), active (rectangular rapid flashing beacons and overhead flashing beacons), and pedestrian traffic signal crosswalk infrastructure.

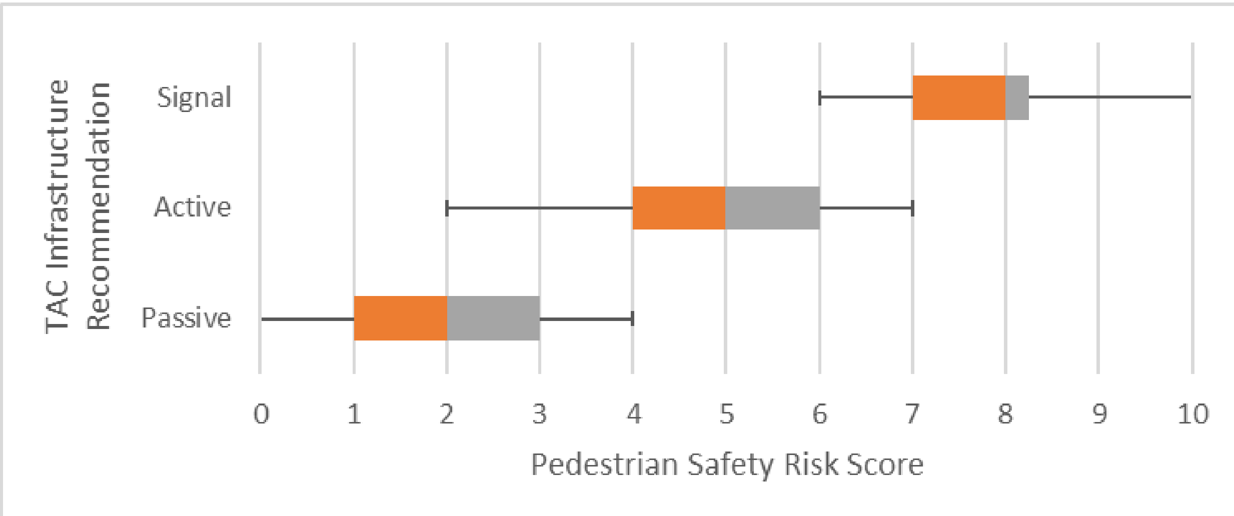
The criteria that the TAC Guide uses to differentiate between the different levels of crosswalk infrastructure are summarized in Table 1. Note that roads with an AADT of less than 1500 vehicles per day (vpd) would not meet the minimum threshold in the Guide to warrant a crosswalk and that roads with a posted speed limit (PSL) of 80 km/h or more are recommended for pedestrian traffic signals at a minimum regardless of the other parameters.

Table 1. TAC Guide Crosswalk Infrastructure Criteria

Level	AADT (vpd)	PSL (km/h)	Cross-section
0	1500-4500	≤ 50	1 or 2 lanes
1	4500-9000	60	3 lanes, two-way traffic
2	9000-12000	70	3 lanes, one-way traffic
3	12000-15000	-	Multilane, divided
4	>15000	-	Multilane, undivided

To review how the above criteria relate to crossing infrastructure recommendations, a value was assigned to each criteria level (as shown in the "Level" column in Table 1) with increasing points related to decreasing safety (more traffic, higher speeds, longer crossing distances). All possible criteria combinations were identified and the total score for each criteria combination was found by adding together the three criteria scores. These were then compared to the type of crosswalk infrastructure recommended by the TAC guide for each combination. It was found that the infrastructure recommendations were grouped well by this scoring approach, as illustrated in Figure 2 which shows how combined scores related to infrastructure recommendations. As combined scores increased, indicating areas with increased risk to pedestrians, the recommended crosswalk treatments became more protective of pedestrians. As a result, this combined score approach appears to reasonably rank crosswalk locations by the risk posed to pedestrians and was the approach that was applied in this study.

Figure 2. Pedestrian Safety Risk Score Relation to Crosswalk Infrastructure Recommendation



Crosswalk Demand

In developing a framework for crosswalk demand, it was determined that the demand from pedestrians to cross the road should be estimated as a function of the number of pedestrians walking along the road (potential crosswalk users) and the level of development on both sides of the road (reasons to cross a road). To determine these characteristics for each road segment in the study, 5 variables were defined as follows:

- **AT Score (AT):** An integer from 0 to 5 based on the combined pedestrian and cyclist daily volumes on the corridor, collected using Streetlight Data, with higher values indicating more pedestrian traffic.
- **Land Use Score (LU):** An integer from 0 to 5 based on the adjacent land uses along the corridor, with higher values indicating higher AT trip generating land uses and, therefore, a higher latent demand for AT facilities.
- **Core Areas (C):** A value of 0 or 1 that identifies roads as being within the core urban areas of the City (1) or elsewhere (0).
- **Development on Both Sides of the Road (D):** A value of 0 or 1 that identifies roads as having development on both sides (1) or on one or neither side (0).
- **Transit (T):** A value of 0 or 1 that identifies roads that have transit stops (1) or not (0).

The model used to calculate a crosswalk demand score from the above variables is shown below. The logic behind this formulation was that:

- The existing **(AT)** and latent **(LU)** pedestrian activity should be weighted evenly when determining the number of pedestrians that could walk along a roadway, particularly if the crosswalk infrastructure is improved;
- The resulting value **(AT + LU)** should be multiplied by a factor that represents the likelihood of an individual needing to cross the road;
- For the crossing likelihood factor, the core areas **(C)** and development on both sides **(D)** were weighted evenly to ensure a greater focus was placed on the core areas where pedestrians would be expected to cross more, with transit **(T)** making up a lower share to serve as a differentiating factor between two comparable roadways instead of a definitive factor in prioritizing crosswalks.

$$Demand = (AT + LU)(0.4C + 0.4D + 0.2T)$$

Ranking Process

Given the Safety Risk and Demand scores for all the sites, the priority locations are ranked by adding the two scores together and determining the locations with the highest combined score.

Framework Calibration

It was intended that once the results were determined based on the above framework specification, that a sensitivity analysis could be conducted to better optimize the fit of the model to ensure that the outputs aligned with the team's expectations. This was ultimately not undertaken because the priority sites selected based on the original framework aligned well with expectations, though part of this could be because of the large proportion of segments (27/191) that were identified as "priority segments". Future application of this model should consider calibration as well as specification updates based on the best practices and data that are available at the time of the study.

Data Assembly

Segment Definition

For conducting the crosswalk analysis, it was desirable to identify road segments to conduct the analysis on that had consistent roadway characteristics (cross-section and speed limit) and surrounding land use/context. It was also desirable to create segments that would be long enough to provide multiple crosswalk location opportunities throughout the segment, as opposed to just at the intersections on either end and/or one midblock location.

Defining the segments for this analysis was done manually through reviewing the City's Street Centreline GIS dataset. The arterial (major and minor) and collector (rural and urban) roadways were reviewed and subdivided based on the above desirable traits with a primary focus on speed limits and land use/context. In some instances, portions of roads were combined if the two separately named roads shared a common alignment (typically breaking at an intersection) and common characteristics. In total 191 segments were identified and coded in GIS for the subsequent analysis.

Framework Data Requirements

The priority framework requires the following data summarized in Table 2 and detailed over the following sections.

Table 2. Priority Criteria and Data Sources

Objective	Priority Criteria	Data Source
Pedestrian Safety Risk	Posted speed limit	GIS
	Daily traffic volume	Traffic counts
	Road cross-section	GIS and Aerial imagery
Crosswalk Demand	Active transportation usage	Streetlight Data
	Adjacent land uses	GIS
	Core areas	Aerial imagery
	Development on both sides	Aerial imagery
	Transit stops	GIS

Posted Speed Limit

Posted speed limit data was extracted from the Street Centreline GIS database. Where there were multiple speed limits within the same segment (due to the length of the segment) a manual review was undertaken to identify the appropriate speed limit for the segment. Each segment was then assigned a score for the posted speed limit, according to the thresholds summarized in Table 3.

Table 3. Posted Speed Limit Data Frequency

Score	PSL (km/h)	Count in Data Set
0	≤ 50	153
1	60	31
2	70	7

Daily Traffic Volume

As part of this study, and a concurrent sidewalk infill analysis, our team collected 24-hour traffic volumes at 40 locations throughout the City; 33 of these locations were on collector or arterial roadways. The traffic counts were collected using a Miovision Scout system. The detailed traffic count results that were collected as part of this project are provided in Appendix A. These data were used to determine the traffic volumes on the specific segments where data were collected and were used to inform on relative traffic volumes for the remainder of the segments. Exact traffic volumes were not estimated for each segment, but rather a score was assigned that categorized each segment as fitting within one of the traffic volume bins that are outlined in Table 4.

Table 4. Daily Traffic Volume Data Frequency

Score	AADT (vpd)	Count in Data Set
0	≤ 4500	99
1	4500-9000	37
2	9000-12000	38
3	12000-15000	6
4	>15000	11

Road Cross-Section

Aerial imagery was used to determine the appropriate cross-section category to apply to each segment. The categories and their framework scores are summarized in Table 5. The cross-section was assigned to be representative of the corridor outside of intersections, where additional lanes may be added to support turning movements.

Table 5. Road Cross-Section Data Frequency

Score	Cross-Section	Count in Data Set
0	1 or 2 lanes	142
1	3 lanes, two-way traffic	10
2	3 lanes, one-way traffic	0
3	Multilane, divided	12
4	Multilane, undivided	27

Active Transportation Usage

The levels of existing pedestrian and cyclist use of the network were estimated through Streetlight Data. Our team identified 50 zones for collecting pedestrian and cyclist data throughout the City that would incorporate many of the known high-traffic areas as well as areas that would be broadly representative of the active transportation traffic in the network. Each zone was created within Streetlight as a custom bi-directional zone for counting pass-through traffic. Zone Activity analyses were run for both bicycle and pedestrian modes on the data period from April 1, 2019 to October 31, 2019 to determine the average daily zone traffic for each mode. Note that 2019 data was used to select a complete year where there were no COVID effects on travel through the City (e.g. reduced tourism).

The resulting daily traffic volumes for pedestrians and cyclists were added together to determine the total daily active transportation users at each zone. Scores were then assigned to each zone based on the thresholds shown in Table 6. For the segments where AT zones were not created, scores were assigned based on network connectivity and the relative context to segments where AT data was collected.

Table 6. Active Transportation Usage Data Frequency

Score	Combined Daily Zone Traffic	Count in Data Set
0	< 500	153
1	500 – 999	16
2	1000 – 1499	9
3	1500 – 1999	5
4	2000 – 2499	3

Adjacent Land Uses

The adjacent land uses data was drawn from the City's Zoning GIS data. The zoning data was joined to the street centreline data to determine the land uses along each segment. Each land use was assigned a score from 0 to 5 based on the volume of pedestrian traffic that would be generated by that land use, as summarized in Table 7. The highest land use score along each segment was identified and assigned as the land use score for the segment.

Table 7. Adjacent Land Use Data Frequency

Score	Land Uses	Count in Data Set
0	CAE, EP, FD, IH, IL, IM, PQ, RU, T, US, USL	14
1	CL, CRG, RR, RS	3
2	CG, CM, RGS	2
3	CC, CRC, ID, R1, R2, RL, RP	18
4	CBP, CRC, CW, P, RM	47
5	CFM, CFN, CU, RC, RH	107

Core Areas

The core areas for active transportation connections in the City were defined to be in-line with a prior study by Englobe for the City on Tactile Walking Surface Indicator prioritization. These areas included Uptown, East End Shopping District, North End, University/Hospital Cluster, and Market Place. The data details are summarized in Table 8.

Table 8. Posted Speed Limit Data Frequency

Score	Core Area	Count in Data Set
0	No	172
1	Yes	19

Development on Both Sides

Identifying if there is development on both sides of each segment was done manually using aerial imagery. The threshold used was that if there was any reason why a person may choose to cross the road within the segment, the segment was scored '1'. The data details are summarized in Table 9.

Table 9. Development on Both Sides Data Frequency

Score	Development on Both Sides	Count in Data Set
0	No	44
1	Yes	147

Transit Stops

The presence of transit stops along each segment was identified based on the City's GIS transit stop data. During this study, two portions of the network in Millidgeville and Saint John West were operating under a flex-route system; the formal stops noted through these areas were counted in the same way as the fixed-route stops. The data details are summarized in Table 10.

Table 10. Transit Stop Data Frequency

Score	Transit Stops	Count in Data Set
0	No	44
1	Yes	147

Priority Segments

The scoring was completed for all 191 segments, and these detailed results are provided in Appendix B. Some general results include that:

- The highest combined score for a location was **Lansdowne Ave.** between Visart St. and the Route 1 Ramps, which had a Safety Risk Score of 7/10 and a Demand Score of 9/10 (for a Combined Score of 16/20).
- Two locations had a Demand Score of 10/10 (**King St.** from Water St. to Charlotte St. and **Sydney St.** from Union St. to Princess St.).
- The highest Safety Risk Score was 8/10. There were five locations with this score (**Bayside Dr.** from Mt. Pleasant Ave. E. to Grandview Ave., **Chesley Dr.** from Douglas Ave. to the Harbour Passage Trail, the **Courtney Bay Causeway** from Crown St. to Bayside Dr., **Fairville Boulevard** from the Route 1 EB Off Ramp to Kierstead Rd., and **Fairville Boulevard** from Kierstead Rd. to Harding St. W.)

The scope of this project included identifying 20-30 segments for a more in-depth review of crosswalk infrastructure. In reviewing the data, it was found that the most reasonable cut-off score for identifying priority segments was a Combined Score of 8/20 as there were 28 segments that met this criterion. Of these 28 segments, 3 had either a Demand Score or Safety Risk Score of 0/10 and were therefore excluded from the priority segments list. The remaining 25 priority segments are summarized in alphabetical order in the list below and illustrated in Figure 3:

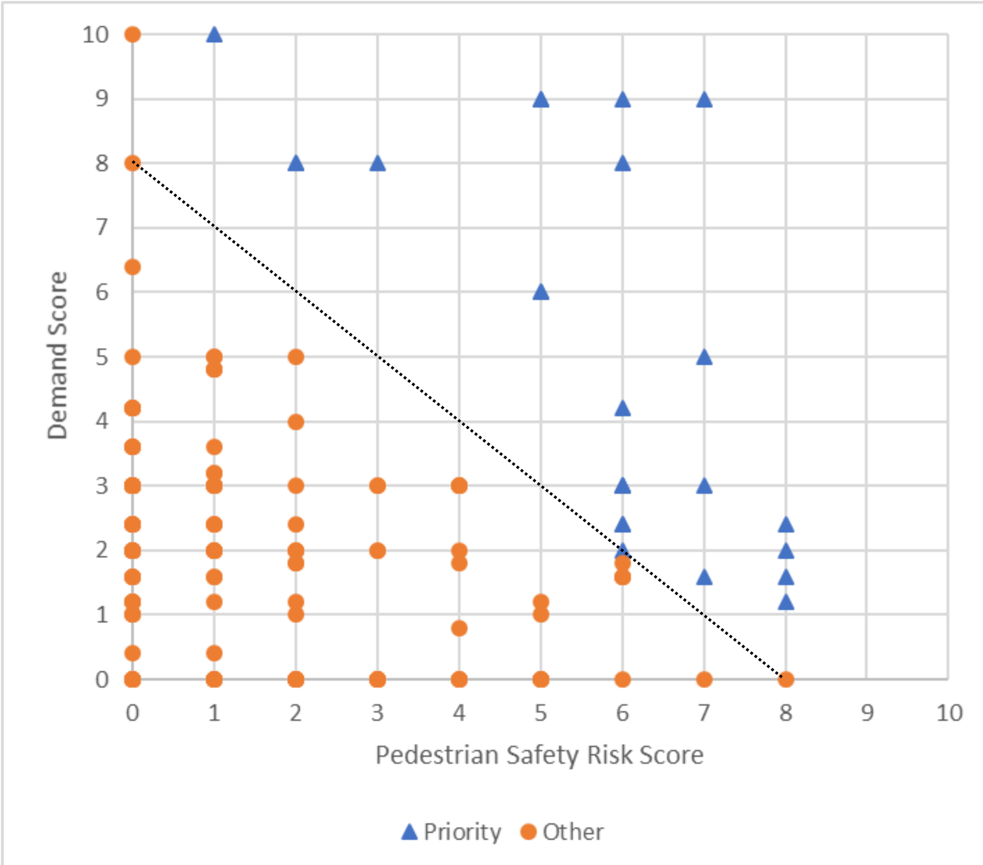
— **Bayside Dr.** from Mt. Pleasant Ave. E. to Loch Lomond Rd.
— **Bayside Dr.** from Mt. Pleasant Ave. E. to Grandview Ave.
— **Bridge Rd.** from Reversing Falls Bridge to Main St. W.
— **Chesley Dr.** from Douglas Ave to Harbour Passage Trail
— **Chesley Dr.** from Harbour Passage Trail to Route 1 Ramps
— **City Rd.** from Hay Market Square to Garden St.
— **Crown St.** from Union St. to Hay Market Square
— **Fairville Blvd.** from Kierstead Rd. to Harding St. W.
— **Fairville Blvd.** from Kierstead Rd. to Route 1 WB Off Ramp
— **King St.** from Water St. to Charlotte St.
— **Lansdowne Ave.** from Visart St. to Route 1 Ramps
— **Loch Lomond Rd.** from 1180 Loch Lomond Rd. to Eldersley Ave.
— **Main St.** from Douglas Ave. to Paradise Row
— **McAllister Dr.** from Rothesay Ave. to Hubert St.
— **McAllister Dr.** from Hubert St. to Loch Lomond Rd.
— **Retail Dr.** from Westmorland Rd. to Rothesay Ave.
— **Rothesay Ave.** from Retail Dr. to Russell St.
— **Rothesay Ave.** from McAllister Dr. to Rothesay Rd.
— **Saint Patrick St.** from Union St. to King St.
— **Station St.** from Smythe St. to Garden St.
— **Union St.** from Smythe St. to Coburg St.
— **Union St.** from Wentworth St. to Crown St.
— **Union St.** from Coburg St. to Wentworth St.
— **Westmorland Rd.** from Braemar Dr. to Ellerdale St.
— **Westmorland Rd.** from Ellerdale St. to Loch Lomond Rd.

Figure 3. Priority Crosswalk Segments (blue)

Source: Google Earth

Figure 4 shows the overall distribution of safety risk and demand scores on the 191 segments. The dotted line represents where the combined score would be 8, dividing the priority segments (blue triangle) from the other segments (orange circle).

Figure 4. Segment Score Distribution



Based on the above results, the priority segments were reviewed in detail to create a roadmap for crosswalk improvements in the City. This process generally followed the guidance provided by the TAC Pedestrian Crossing Control Guide. In addition, a meeting was held with the Saint John Ability Advisory Committee and City staff to identify priorities for accessibility improvements through the priority segments.

References

[1] Montufar, J., Patmore, K., and Bahar, G."Pedestrian Crossing Control Guide: Third Edition" *Transportation Association of* Canada. 2018.