Background

In early 2014, Transportation Services initiated a review of the Division's design guidelines and standards to move our organization in a direction consistent with the transportation departments of many other large North American cities. Roadway design engineers in Canada have historically relied on the Transportation Association of Canada's (TAC) Geometric Design Guide for Canadian Roads (GDGCR) (1999) as the basis for engineering roadway designs. However, most guidelines within this document were developed decades ago, have not been substantially revisited, and have not always fully considered all modes of travel.

While as a part of the TAC GDGCR update attempts are being made to provide separate guidance suitable for urban areas, it has been determined that the City of Toronto would benefit from more context sensitive and in-house engineering design, an approach taken by several other municipalities.

In response, Transportation Services has embarked on updating technical guidance on street design, including the attached guidelines. The guideline is the result of extensive research and consultation with key partners and reviewing relevant policy and design documents such as:

- National Association of City Transportation Officials (2013). Urban Street Design Guide. Island Press, Washington.
- Complete Streets Guidelines of other comparable jurisdictions such as Chicago, Philadelphia, and Boston.
- Ontario Ministry of Transportation. Ontario Traffic Manuals
- Transportation Association of Canada (TAC) (1999). Geometric Design Guidelines for Canadian Roads
- American Association of State Highway and Transportation Officials. (2004). A Policy on Geometric Design of Highways and Streets (5th ed.). Washington, DC: AASHTO.

This guideline is primarily for use by engineering staff to determine **appropriately sized vehicle travel lane widths on Major Arterial, Minor Arterial, and Collector Roads**. This document will eventually be part of a future document containing City of Toronto specific engineering design guidelines for road works.

0.0 Vehicle Travel Lane Width Guidelines

0.1 Introduction

Lane width has a significant impact on the safety and completeness of a street. Research indicates that there is direct relationship between travel speed and lane width. Vehicle lane width is also intricately connected to driver behaviour, sidewalk animation, and safety of all modes of travel.

Historically, passenger vehicles were understood to be the principal mode of transportation on Toronto's roadways. As a result, wider vehicle travel lanes were often favoured to create a more forgiving and comfortable environment for drivers. Today, Toronto's streets and roadways are significantly more heterogeneous. Lane widths must now balance the safety, access, and comfort for all users, including pedestrians, cyclists, transit riders, and drivers.

The primary purpose of this guide is to provide guidance on when and how to reduce current lane widths in order to improve safety and comfort for walking and cycling by reallocating roadway space. This goal supports the City's Official Plan, Bike Plan, Pedestrian Charter, Accessibility Design Guidelines, Streetscape Manual and Walking Strategy.

Due to contextual constraints, standard lane widths cannot be universally applied throughout the City of Toronto. As such, this guide offers a flexible approach that takes into consideration roadway function and/or classification; surrounding land uses; topography; desired vehicular speed; and transportation modes or users when determining appropriate lane widths. This guideline is not meant to recommend whether or not various types of lanes (e.g., bicycle lane, parking lane, left-turn lane) are required on a specific road. The purpose of this guide, and the Excel-based Lane Width Design Tool developed based on this guide, are to ensure appropriate allocation of space within the roadway once the decision about number and types of required lanes has been made.

The lane width guidelines described within this document should be applied to all collector, minor arterial and major arterial roads in the City of Toronto. Local roads typically do not have lane markings except at intersections. As such, the roadway width of laneways and local roads and intersection lane markings on such roads will be addressed in a separate guideline.

The City of Toronto already has guidelines on cycling facilities. This guide complements this and other existing guides by focusing on allocation of the roadway width next to dedicated cycling facilities, and on shared lanes when dedicated cycling facilities are not possible.

0.1.1 Purpose of Vehicle Lanes

Vehicle lanes are intended to perform the following functions:

- Facilitate the movement of people and goods
- Delineate space within the roadway principally dedicated to vehicular traffic
- Control driver behaviour, including vehicular speed
- Provide a safe environment for all road users – cyclists, drivers, transit riders and even pedestrians
- Reduce traffic conflicts between vehicles travelling in the same or opposite direction

0.1.2 Definitions

Within the City of Toronto, there are several vehicle travel lane types. The following section will briefly define each type.

Lane Width Measurements
Lane widths are measured from the face of the curb and centre of lane marking.

Curb Lane
A curb lane on a two-way street is the right most travel lane, typically located adjacent to the curb. A curb lane may be used by road users such as cyclists, drivers and transit vehicles.

The curb lane can also be the travel lane closest to the curb on the right, separated from the physical curb with any parking and/or cycling facility.

On one-way streets, if the left most travel lane facilitates off-peak on-street parking, it too should be considered a curb lane.

Shared Curb Lane
A shared curb lane is a travel lane shared by all roadway users – cyclists, drivers (both cars and trucks), and transit users when there is not a bicycle lane present. Shared lanes with posted speed of 50km/h or less may have sharrows installed.

Sharrows
A "shared lane bicycle pavement marking" used primarily used on roads with moderate to high cyclist volumes where bicycle lanes cannot be provided due to space constraints. Sharrows are intended to indicate the appropriate cyclist position within a shared lane, to alert drivers to the presence of cyclists and to encourage drivers to share the road with cyclists.

Dedicated Cycling Facility
A dedicated cycling facility is an exclusive travel lane for cyclists that provides separation from vehicular traffic in the form of a painted line (white or yellow) painted buffer, flexi-post bollards, raised curb or median, raised surface or other physical separators, such as planters.

Through Lane
A through lane is a travel lane used principally for through traffic on a roadway with at least two travel lanes in each direction. A through lane is accompanied by either a curb lane or another through lane to its right. Where a two-way left turn lane is not provided, the left most through lane may facilitate left turning movements if permitted.

Two-Way Left Turn Lane (Continuous Left Turn Lane)
A two-way left turn lane is a vehicle travel lane located near the centre of the roadway. It is set aside for vehicles making left turns in either direction.

Parking Lane
A lane, located between the curb lane marking and the curb, which is reserved for 24-hour parallel parking. Parking lane design guidelines are not described within the following report and will be outlined separately.

Left-Turn and Right-Turn Lane
Left and right turn lanes facilitate vehicle turning movements at intersections. Design guidelines for such lanes are not described within the following report and will be outlined separately.

0.2 Design Controls

The following lane width design controls have taken into consideration the following assumptions and clearances:

TTC Streetcar Routes
A TTC streetcar ranges in width between 2.54 and 2.65m. TTC streetcar routes require a vehicle lane width of 3.1m from the centreline. On roadways with horizontal curves, lane widths should be wider to accommodate streetcar turning requirements.

TTC Bus Routes
A TTC bus (Orion Hybrid) is 2.6m wide and 3.16m wide, including side view mirrors. A TTC articulated bus is 2.65m wide and 2.97m wide including side mirrors. As such, all curb lanes along designated bus routes should be at least 3.3m, where possible. In cases where buses must regularly operate within a through lane, the target lane width of that lane should also be increased to 3.3m, where possible.

Where a buffered bike lane is present, in constrained right of way and with a posted speed of 40 km/hr or less, a 3.0 m wide curb lane may be permitted when a minimum 0.7m painted buffer is provided between the curb lane and bike lane.

High Pedestrian Activity
Pedestrian activity is a relative and subjective measure and varies significantly by hour of the day and time of year. As a guide, street segments with high ratio of pedestrian crossing volumes to vehicular volumes (greater than or equal to 2 pedestrians to 10 vehicles) or high volume of pedestrian crossings (greater than or equal to 3500 8-hour pedestrian crossings) at the nearest signalized intersections may be considered to have high pedestrian activity. Map 1 in the Appendix illustrates these intersections. A link to the searchable version of the map can be found at:

https://dl.dropboxusercontent.com/u/10524076/Lane_width.html

Other justifiable measures of pedestrian activity may be used as an alternative. Consultation with local Traffic Operations staff and use of more accurate data, if available, is recommended in classifying a street as one with high pedestrian activity.

High Truck Volume
Generally, streets with 800 or more 8-hour through truck volume total in both directions are considered to have high truck volumes. Map 2 in the Appendix illustrates which signalized intersections are classified as high truck volume intersections based on this threshold. A link to the searchable version of the map can be found at https://dl.dropboxusercontent.com/u/10524076/Lane_width.html. However, consultation with local Traffic Operations staff and use of more accurate data, if available, is recommended in classifying a street as one with high truck volume.

Moderate Cyclist Volume
Generally speaking, two-way volume of 20 or greater cyclists during the peak hour along a street segment is considered to be moderate cyclist volumes. However, consultation with Cycling Infrastructure and District Traffic Operations staff is recommended in classifying the utilization of the subject street by cyclists.

0.3 Vehicle Travvel Lane Width Design

0.3.1 Design Considerations

Pavement Markings
All lane markings must be consistent with the Ontario Traffic Manual – Book 11: Pavement, Hazard and Delineation Markings.

For additional guidance regarding the specifications and placement of sharrows, please refer to the City of Toronto Shared Lane Bicycle Marking Placement Guidelines. Sharrow placement guidance can be found at the following web link:

http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=fe2f0995bbbc1410VgnVCM10000071d60f89RCRD&vgnextchannel=a983970aa08c1410VgnVCM10000071d60f89RCRD

Shared Curb Lanes
In the absence of dedicated cycling facilities, to provide a safer environment for cyclists, the target width of a shared curb lane is 4.3m. In a shared curb lane narrower than 4.0m a driver cannot pass a cyclist safely in the same lane; the overtaking driver would have to encroach into the adjacent lane to leave a safe space between his/her vehicle and the cyclist being overtaken.

The target width for a curb lane that is used as a travel lane during peak periods and for on-street parking during off-peak periods should be 4.3m. This allows for space for cyclists and drivers to share the curb lane and drive side-by-side during peak periods. During off-peak periods when parking is permitted, the 4.3m wide lane enables cyclists to ride in the curb lane between parked cars and the adjacent travel lane. The minimum width for a shared curb lane that can be shared side-by-side by a cyclist and motor vehicle is 4.0m. On roads with a posted speed limit greater than 50 km/h the minimum width of a shared curb lane should be is 4.3m.

A shared curb lane should generally not be greater than 4.3m. Curb lanes wider than 4.3m can encourage drivers to operate in the curb lane when parking is present, negating any benefit for cyclists.

Shared curb lanes can be accompanied by sharrows on roadways with posted speed limits of 50 km/h or less.

Horizontal Curves
On sharply curved sections of urban streets, a designer must use appropriate design tools to determine the level of increase in lane-widths.

0.3.2 Design Methodology

Table 0.3.2.A identifies minimum, target and maximum lane widths for through lanes, curb lanes and two-way left turn lanes for collector, minor arterials, and major arterials.

In all cases, target lane width should be pursued wherever feasible. However, due to a number of contextual constraints, this is not always possible. In response, the chart identifies a number of influencing factors that help rationalize deviating from the target lane width.

In all cases, a single (+) or (-) does not indicate that the target lane width changes to the maximum or minimum dimension. Instead, combination of (+)s and (-)s must be seen as a rationale for deviating from the target lane width in small increments. Selecting the absolute minimum or absolute maximum values, when different from the target, must be accompanied by strong and valid justification by the designer. Minimum/constrained lane widths should only be used where roadway and right of way width is limited.

Future development and intensification (e.g., growth centres/ Avenue Study) or future high order transit lines (e.g., LRT) must be identified. Any expected impacts must be reflected in the influencing factors in the table in order to represent future conditions. For example, an area may currently have very low cyclist volumes, but if future development is expected to increase cycling mode share then lane width decisions should be made assuming moderate cyclist volumes.

An interactive Excel-based Lane Width Design Tool has been developed based on the guideline tables and notes below. The purpose of this design tool is to facilitate easier application of the design principles and recommendations.

The tool can be downloaded using the following web link:

https://dl.dropboxusercontent.com/u/10524076/Lane_width.html

Table 0.3.2.A Lane Width Dimensions and Influencing Factors

			Minimum/Constrained	Target	Maximum	Parking	Transit	Cycling			High Truck Volume/ Designated Truck Route	High Pedestrian Activity	Posted Travel Speed			Land Use				Other	
						Off Peak On Street Parking	Streetcar Tracks	Bus Route	On-Street Bike Lane	Buffered On-Street Bike Lane	Moderate Cyclist Volumes			Less than 40 km/h	40-50 km/h	Greater than 50 km/h	Residential	Commercial	Industrial	Institutional (school, park)	Horizontal Curves	No Buffer Between Sidewalk and Curb Lane
Through Lane	Collector and minor arterial		2.8	3.0	3.3	=	+[1]	=	X	X	X	+	-	-	=	+	-	=	+	-	+	=
	Major arterial			3.2	3.6																	
Curb Lane	Dedicated cycling Facility not present	All road classifications	2.8	4.3	4.3	+	X	+[3]	X	X	+	+[4]	-	-	=	+	-	=	=	=	+	+[5]
	Dedicated cycling facility present	Collector and minor arterial		3.2	3.3		X		+[6]	-[7]	X											
		Major arterial			3.6																	
Two-way Left Turn Lane			2.7	3.0	3.2	=	X	+	=	=	=	+	-	-	=	+	-	=	+	-	+	=

[1] A through lane containing streetcar tracks must be at least 3.1m wide.
[2] Recommended lane width does not include width of parking space. Increase beyond the target width is intended to reduce risk of "dooring" for cyclists in the bike lane.
[3] On designated TTC bus routes, the target lane width for all lanes used by TTC buses is 3.3m, where possible.
[4] Where a bike lane is present on a road with high truck volumes the curb lane should be widened to the maximum width, where possible.
[5] Wider curb lane in such conditions is preferred in order to add more space between vehicles and pedestrians. However, if the project scope allows for moving the curbs and adequate width for cycling facility is already provided, it is best to increase the width of the boulevard and create a buffered sidewalk rather than widening the curb lane.
[6] When bike lane is present, consider widening bike lane to target width before widening curb lane
[7] Where a bike lane with a minimum buffer of 0.7m is present, the right of way is constrained and posted speed is 40 km/hr or less, a minimum curb lane width of 3.0 m wide may be permitted, regardless of TTC bus route designation.

0.3.3 Other Considerations

In addition to design criteria identified within the Table 3.2 1, determining the appropriate lane width requires a careful consideration of the following roadway and land use characteristics:

- Roadway function and role within the transportation network and land use context;
- Design speed, average speed, and legal speed limits;
- Curbside deliveries and unloading;
- Bridges and crossing points;
- Existing and planned cycle lanes;
- Turning movements of all vehicles;
- Emergency service or transit routes;
- Snow clearing and storage;
- Maintenance;
- Other traffic calming measures – curb extensions; and
- Topography and road camber or curvature.

0.3.4 Additional Opportunities

In many cases, the application of the lane width guidelines will provide an opportunity for reallocating space within the roadway to improve conditions for pedestrians and cyclists and improve safety for all users including drivers.

Some capital works projects may involve moving the curbs. This provides the opportunity to make the roadway potentially narrower or wider if deemed beneficial. Other capital work projects may involve only resurfacing and restriping of the road or reconstructing the curbs at their previous location. This limits the available options for reallocation of roadway space when there is a surplus of pavement and a need to improve conditions for other users/uses.

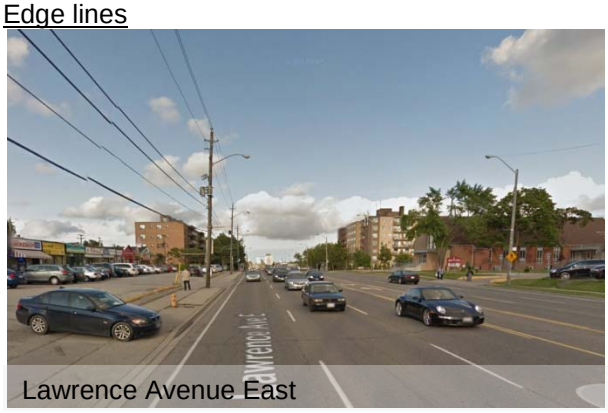
The following elements can be considered by designers as tools for reallocating road space when surplus roadway width is present and moving the curbs is not possible or not necessary

New or expanded bike lanes

Sheppard Avenue East Bike Lane

Adelaide Street Cycle Track

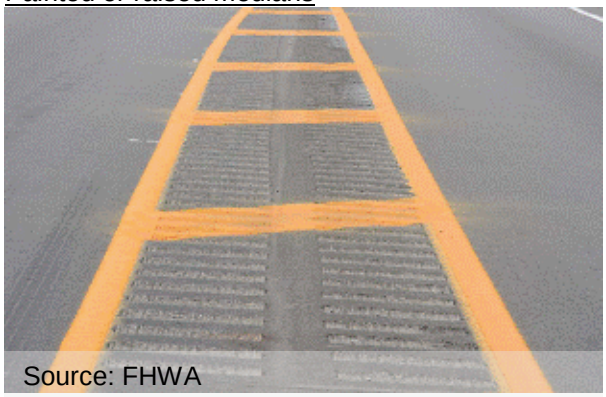
Edge lines



Lawrence Avenue East

Highway 27

Painted or raised medians

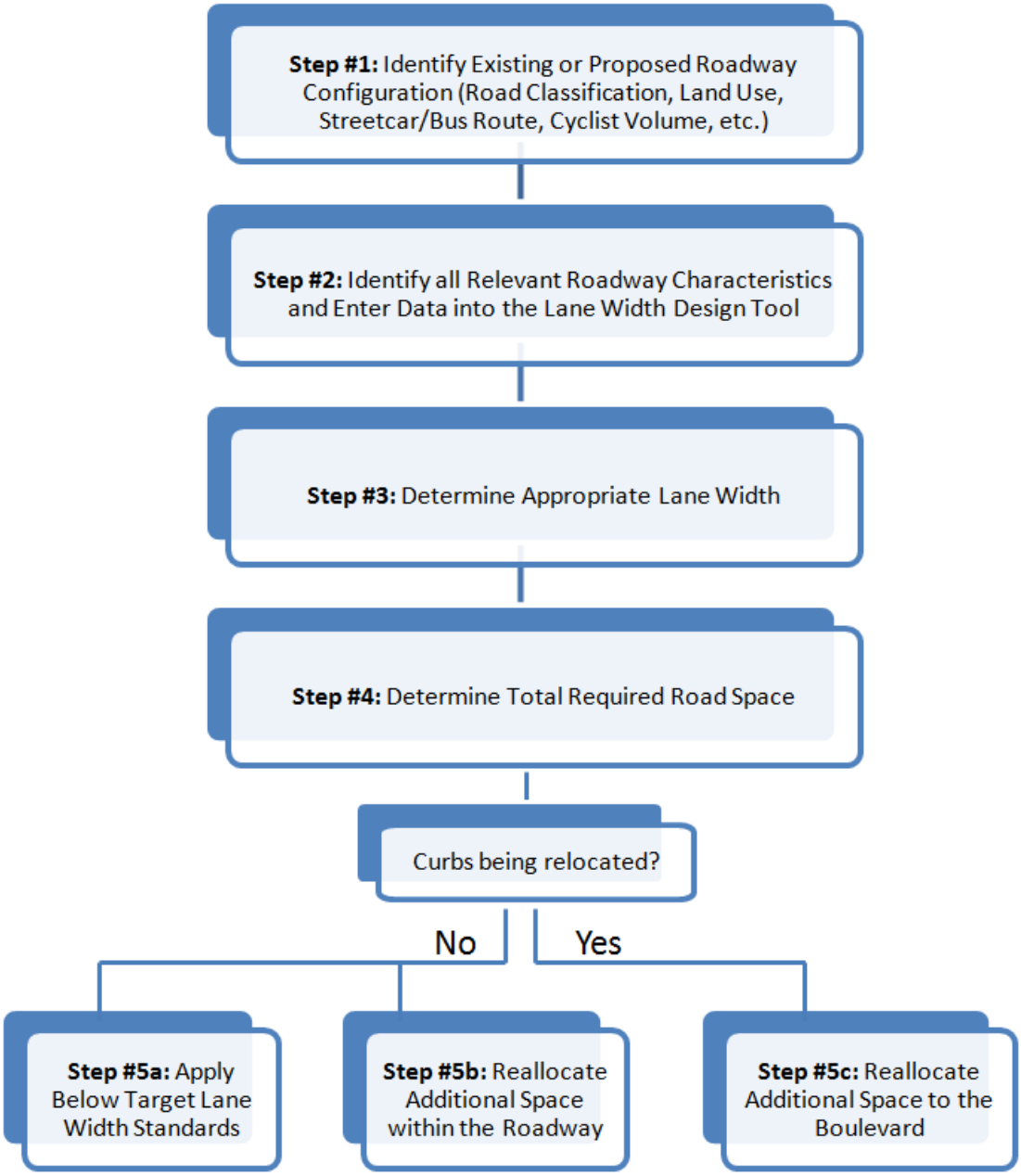


Source: FHWA

Source: Pedbikesafe.org

0.3.5 Design Process

The following section outlines the various steps within the Lane Width Design Process for road resurfacing or road reconstruction projects.



Step 1: Identify Existing or Proposed Roadway Configuration

The first step in the Lane Width Design Process is to identify the number and type of lanes within the identified roadway; for example, a four lane road with a through lane, a curb lane and a buffered bike lane in each direction.

Step 2: Identify all Relevant Roadway and Land Use Characteristics and Enter Data into the Excel-based Lane Width Design Tool

In addition to identifying the roadway configuration, the designer must identify all relevant street context characteristics into the Excel-based Lane Width Design Tool. Relevant street context characteristics include:

- Road Classification
- Land Uses
- Streetcar Route
- Designated Bus Route
- Pedestrian Activity
- Cyclist Volume
- Passenger Vehicle Volume
- Truck Volume
- Posted Speed Limit
- Proximity of Utility Poles
- Vertical and Horizontal Alignment Constraints
- Off-Peak Parking
- 24-Hour On-Street Parking
- High Frequency of Curbside Deliveries
- High Parking Turnover

Step 3: Determine Appropriate Lane Width

Once all the necessary information is entered into the Excel-based Lane Width Design Tool, the proposed target lane widths are provided for each lane type – through lane, curb lane (or shared curb lane), two-way left turn lane, and parking lane.

In addition to these figures, possible ranges of deviation from the proposed target lane width are also provided. These deviations will allow the designer to respond to a number of possible contextual constraints. In such cases, the designer will need to determine the appropriate lane width within the range of deviation and provide a rationale for deviating from the target.

Step 4: Determine Total Required Road Space

Using the outputs generated in Step #3; calculate the total required road space for all vehicular lanes. The results will indicate either a shortage or surplus of space within the existing curb-to-curb width.

Step 5: Allocation of Road Space

For capital works projects that do not involve moving the curbs:

- **Step 5a** should be followed if the results generated during step #4 indicate a shortage of space within the existing roadway width.
- **Step 5b** should be followed if the results generated during step #4 indicate that there is surplus space within the existing roadway (to reallocate to other uses/users).

For capital works projects that involve moving the curbs:

- **Step 5c** should be followed when surplus space identified within step #4 will be allocated to the boulevard.

Existing pedestrian clearway and/or cycling facility and their widths should not be sacrificed for additional vehicular traffic lanes, or lane widths, beyond existing conditions.

Step 5a: Apply Below Target Lane Width Guidelines

Using the output generated in Step #4, compare results to existing roadway dimensions. If the outputs generated during this step indicate that the existing roadway is not wide enough to accommodate the target lane widths generated in Step #2, apply lane widths down to the minimum width. In such cases, it is advisable to begin this process by reducing the two through lanes, followed by the two curb lanes. Achieving target pedestrian clearway and cycling facility widths should be prioritized before achieving target lane widths.

Step 5b: Reallocate Additional Space within the Roadway

Using the output generated in Step #4, compare results to existing roadway width. If the outputs generated during this step indicate that there is additional roadway space within the existing roadway, one of the following three sub-steps should be followed to reallocate this space.

If the additional roadway space is less than 0.5m per direction, allocate all space to the curb lane, up to maximum curb lane.

If the additional roadway space is less than 0.5m per direction and a bike lane in each direction currently exists, allocate road space to enhance cycling infrastructure, either by widening the bike lane or adding/widening a buffer. Please consult with Cyclist Infrastructure & Programs for guidance on appropriate allocation of space to bike lane / buffer.

If the additional roadway space is greater than 0.5m per direction and no bike lanes currently exist, contact other divisions within Transportation Services or the Toronto Parking Authority to determine the various alternatives for allocating this road space. These alternatives will include a bike lane(s), parking lane(s), edge lines/road diet, raised median or two-way left turn lane.

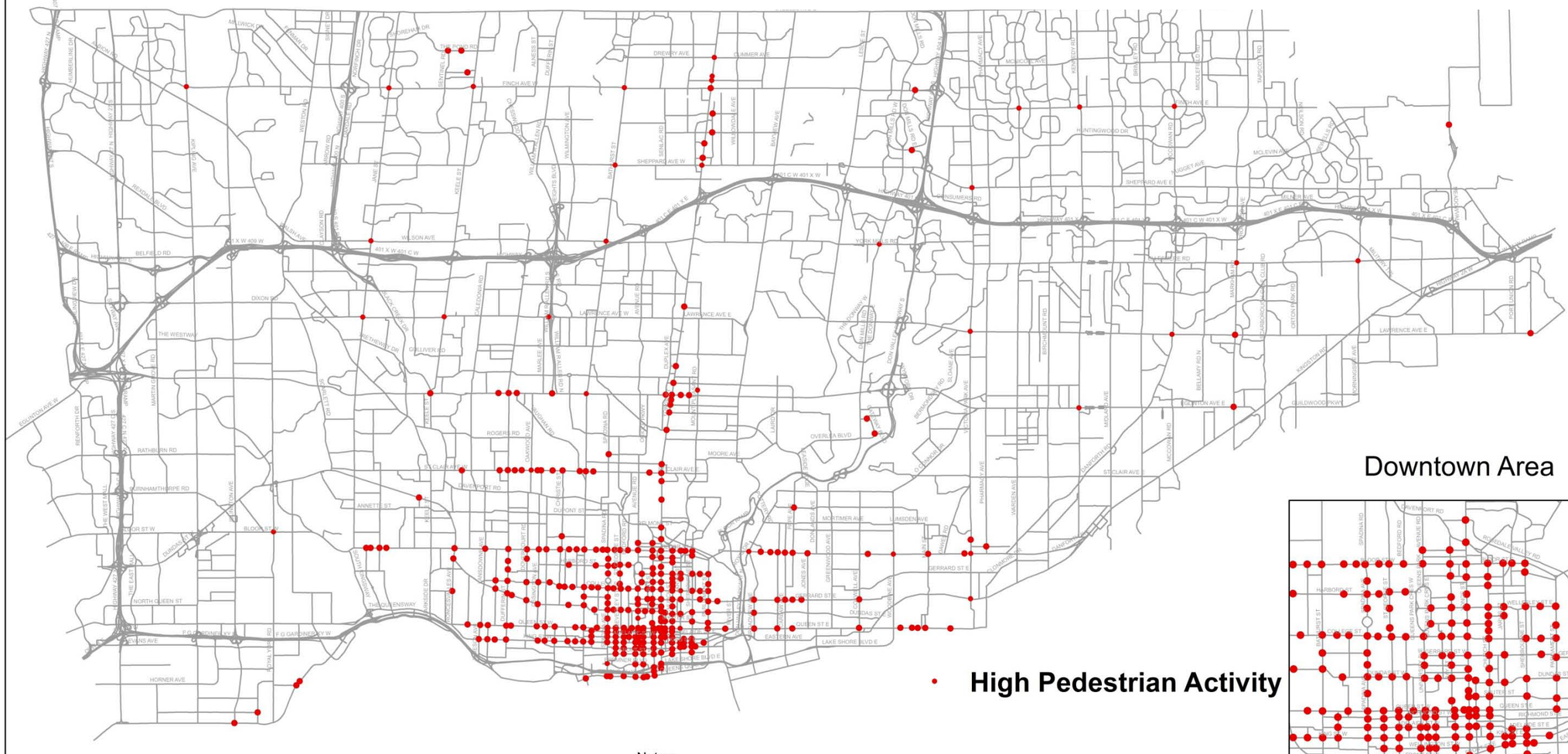
Step 5c: Reallocate Additional Space to the Boulevard

When curbs are being moved, additional roadway space may be reduced by moving the curbs and reallocating the space to the boulevard area as additional sidewalk or a raised bike lane.

Appendix

Signalized Intersections with High Level of Pedestrian Activity

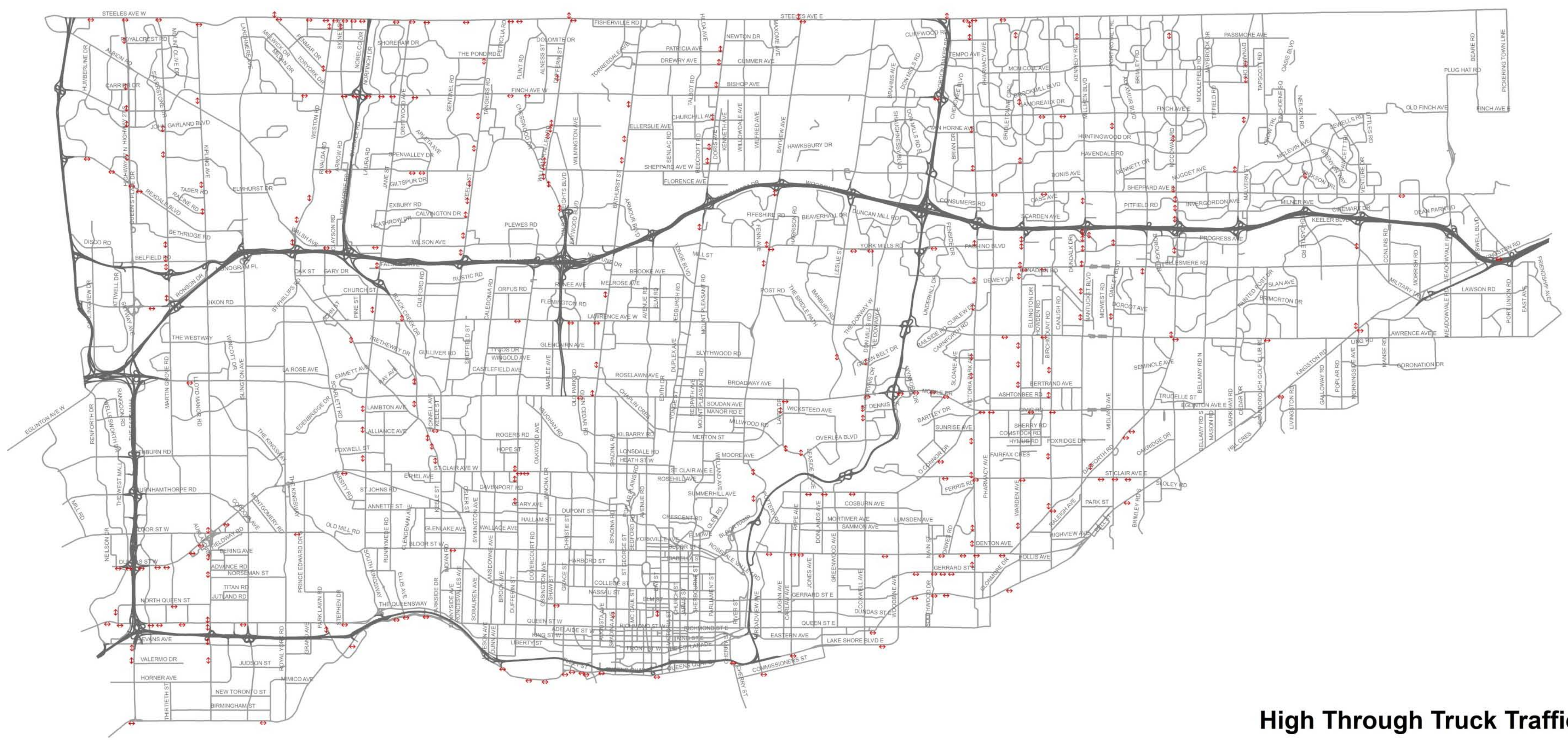
For the most up to date version of this map please visit https://dl.dropboxusercontent.com/u/10524076/Lane_width.html



Notes:
1. Map generated based on intersection turning movement counts extracted in October 2014.
2. For most up to date data please refer to FLOW.
3. Consultation with local Traffic Operations staff and use of more accurate data, if available, is recommended in classifying a street as one with high pedestrian activity levels.
4. Red dots represent intersections with high absolute pedestrian crossing volumes and high ratio of pedestrians and vehicles

Signalized Intersections with High Through Truck Traffic

For the most up to date version of this map please visit https://dl.dropboxusercontent.com/u/10524076/Lane_width.html



High Through Truck Traffic

↔ East-West

↕ North-South

N

0 1.25 2.5 5 7.5 10 Kilometers

Notes:
1. Map generated based on intersection turning movement counts extracted in October 2014.
2. For most up to date data please refer to FLOW.
3. Consultation with local Traffic Operations staff and use of more accurate data, if available, is recommended in classifying a street as one with high truck volume.