Attachment 2





CITY OF VAUGHAN

TRAFFIC CALMING TOOLBOX AND GUIDE

DRAFT

2024

VAUGHAN

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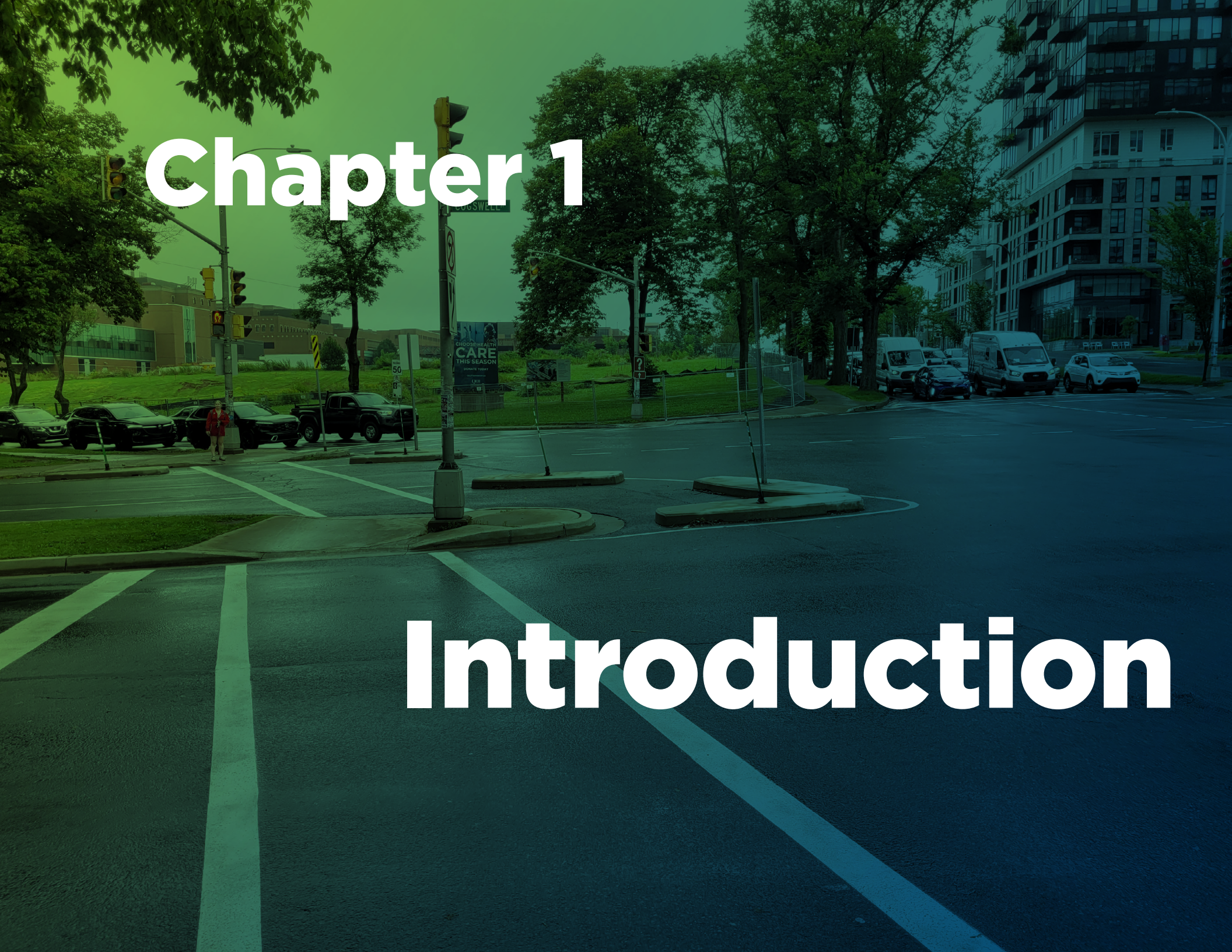


Chapter 1

Introduction

In 2021, Vaughan Council took a significant step forward in transforming our transportation landscape by approving the MoveSmart Mobility Management Strategy. This strategy is designed to create a safer, more efficient, and sustainable transportation system for our city. A cornerstone of this strategy is the Neighbourhood Area Traffic Calming Policy, Design, and Speed Management Plan, which aims to enhance community safety and livability through strategic traffic calming measures.

Safety for all road users is an overarching goal, and addressing speed is fundamental to making streets safer. Vehicular speed increases the likelihood of a serious collision in four ways:

1. Crashes at higher speeds are more forceful and thus more likely to be fatal
2. Drivers traveling at higher speeds have a narrower field of vision
3. Drivers traveling at higher speeds travel further before they can react
4. Vehicles traveling at higher speeds have longer braking distances

Speed management through traffic calming is one of the key elements of a successful complete street, which is designed and functions to enable safe travel by all users of all abilities.

This guide provides a strategic framework for implementing traffic calming measures, reflecting our commitment to creating safer, more vibrant communities for all residents.

In addition to MoveSmart, the City also established a Speed Limit Policy. This policy applies to all City roads within four primary zones. These include rural roads, built up/urban areas, inclusive of school zones, laneways (public owned), and neighbourhood areas. **Appendix A** summarizes the application of the policy in each zone.

What is Traffic Calming?

The City of Vaughan continues to make road safety, active and sustainable travel modes and effective traffic management a top priority. Neighbourhood traffic calming is a key strategy to achieve the City's transportation policies and better meet the residents' expectations. It encompasses a range of techniques and street design elements to mitigate the adverse effects of motor vehicle speed and volume, ultimately enhancing safety for all road users and improving the overall quality of life within communities.

Traffic calming measures involve several different techniques:

Horizontal Deflection: Measures that cause a lateral shift in the travel pattern of vehicles, forcing them to slow down to comfortably navigate the measure.

Intersection Treatments: Measures specifically applied at intersections that may slow vehicular traffic through the intersection. These are different from intersection controls (e.g. signals and stop signs), which are generally implemented to guide traffic flow.

Vertical Deflection: Measures that use vertical (upward) movement of the vehicle to slow down the vehicle speed.

Pavement Markings and Surface Treatments: Measures that use coloured, patterned, or textured materials on the road surface to promote slower vehicle speeds. They can enhance the aesthetic appearance of the street and create a sense of place for the community. They can be applied on the full width of the roadway or at specific areas such as crosswalks, gateways, or intersections.

Access Restrictions: Measures that block or restrict the access of vehicles to certain streets or areas that reduce traffic volumes, deter cut-through traffic, or prohibit turning movements.

Education and Enforcement: Measures that bring awareness about the need to slow down; while they are not physical changes to the roadway, they can be effective with physical traffic calming treatments.

Why Use Traffic Calming Measures?

The purpose of traffic calming is to:

- Reduce vehicular speeds
- Discourage shortcutting
- Improve safety
- Improve the neighbourhood environment

In the past, road design prioritized the fast movement of vehicles, sometimes at the expense of the safety and comfort of pedestrians, cyclists, and even drivers. Traffic calming measures, on the other hand, seek to prioritize the safety of vulnerable road users — including pedestrians, cyclists, children and older adults — by discouraging high-speed driving and deterring non-local traffic from using neighbourhood streets as a shortcut or to bypass congestion on arterial roads. By reducing vehicle speeds and traffic volumes, the frequency and severity of collisions can be reduced, in addition to improving the pedestrian environment of local and collector streets.

Traffic calming measures support community well-being, and it is important to recognize the intangible benefits linked to the improved perception of safety and enhanced quality of life, alongside the measurable and expected improvements. Taking a comprehensive approach that values these measures' tangible and intangible aspects can significantly inform decision-making processes and strong community support.

How to Use This Toolkit and Guide

The Toolbox and Guide provided here focuses mainly on traffic calming plans for retrofitting existing streets, but it can also be used to inform integrated speed and traffic management designs for new street and network designs.

This Guide is intended to be used by City staff, developers, and consultants when planning and designing traffic calming plans, but is also intended to inform residents, in conjunction with the Traffic Calming Policy.

In addition, the Guide emphasizes the transportation implications of traffic calming measures and concepts, which include both driver behaviour and vehicle traffic management. Some measures aim to encourage appropriate driving speeds and reduce hazardous driving behaviour (such as speed cushions), while others aim to alter street access and traffic volumes (such as turn restrictions). Traffic calming supports improved speed compliance, implementation of speed reducations and more comfortable pedestrian environment.

It is important to note that this document is intended as a guide and should be used along with other technical or policy guidance, along with sound engineering judgment. They are not meant to be a complete set of street design guidelines. The specifics of any traffic calming design should adhere to all applicable design and construction standards and specifications of the City of Vaughan.

The guidelines in this document have considered pertinent provincial Acts such as the Accessibility for Ontarians with Disabilities Act (2005) and the Highway Traffic Act (1990), as well as the Transport Association of Canadian Guide to Traffic Calming (2018), and the specifics of any traffic calming design must comply with these Acts.

Those who propose traffic calming plans are encouraged to review the Vaughan's Complete Streets Guide to supplement their knowledge and provide a more comprehensive view of traffic calming implications, as well as solutions for planning and design challenges.

In addition to many City-led road safety and traffic calming programs, the following are examples of programs led by others:

Policy Programs and Guidelines

York Region's Automated Speed Enforcement (ASE) Program

The program was applied to selected school zones. Based on the Highway Traffic Act, it can only be used for community safety zones and school zones. Collected speed data showed a reduction of approximately 10 km/h in operation speeds as well as speed limit compliance increases of approximately 25% when a ASE camera is present.

York Region's Vision Zero Traveller Safety Plan

York Region Vision Zero Traveller Safety Plan aims to reduce severe collisions (those involving injury or death) by 10% over five years. This ambitious target requires bold action supported by partners like the City of Vaughan and York Regional Police. The aspirational goal is to end all severe collisions, which is supported by the Vision Zero approach to road safety.

Refer to the following link for more information: York Region Vision Zero Traveller Safety Plan 2024-2028

Policy Programs and Guidelines

York Regional Police Road Watch Program

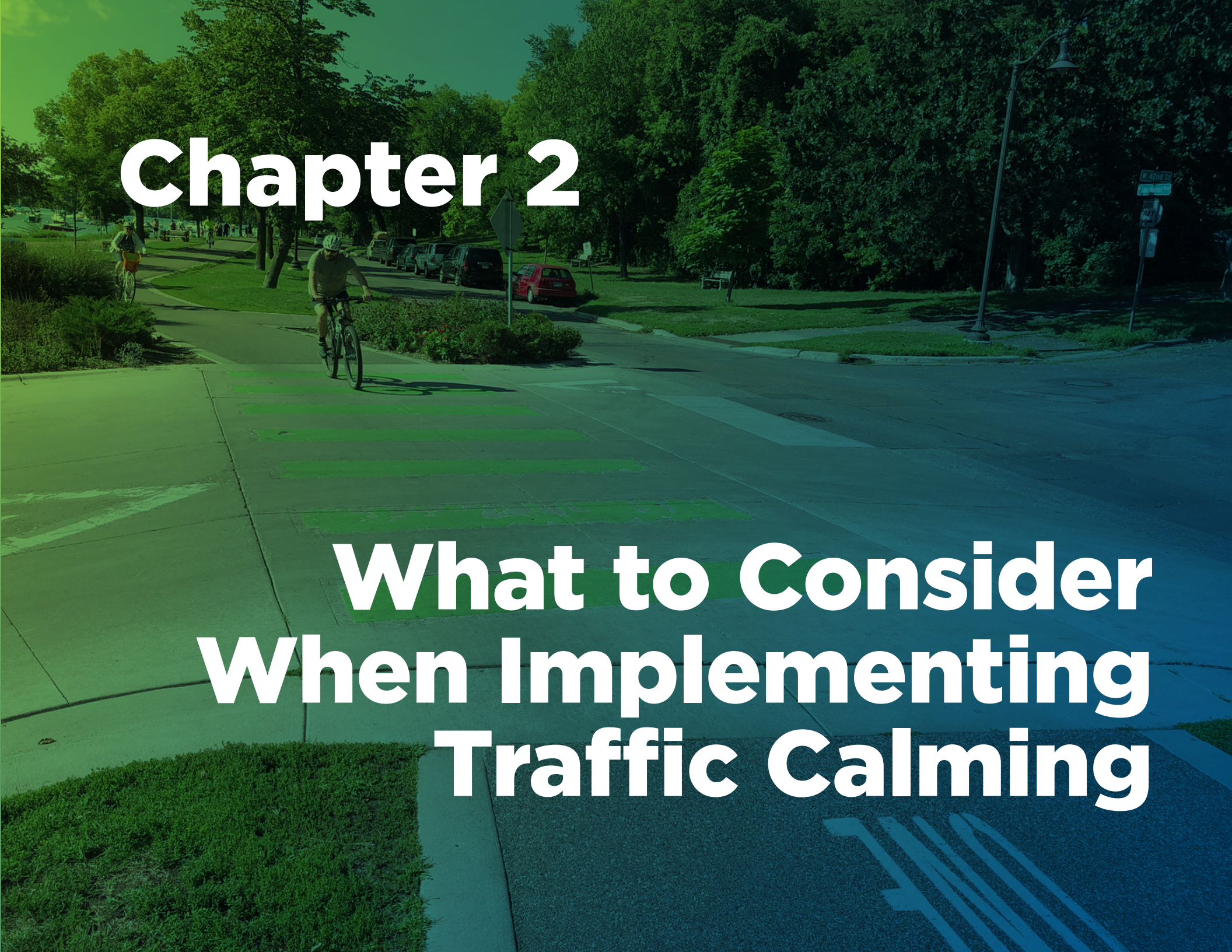
Road Watch is a community-driven program created to allow citizens to report aggressive driving in their community. York Regional Police endeavors to reduce motor vehicle collisions and enhance road safety for all road users and work in collaboration with our citizens to achieve that goal.

Refer to the following link for more information: Road Watch Complaint

Safe Routes to School Program

As part of the Safe Routes program, students of grade eight and above are encouraged to get to their schools by taking transit, walking or biking and these modes of transport are being promoted. This program is collaborative effort from York Region Transportation Services, York Catholic District School Board, York District School Board, and York Region Transit.

Refer to the following link for more information: Active School Travel Program



Chapter 2

What to Consider When Implementing Traffic Calming

Guiding Principles

1	**Identify and quantify the problem.** The perceived nature of a traffic problem can be substantially different from the real situation. Some problems are more significant than others. To select appropriate traffic calming measures, it is important to quantify the extent of the problem. Quantifying also aids residents in understanding the nature and magnitude of the real problem.
2	**Apply traffic calming measures on a neighbourhood-wide basis, not on a localized, site-by-site basis.** Any potential effects on adjacent streets must be considered. These effects might include traffic diverted to other streets, motorists who speed up after passing a traffic calming measure, or changes in turning movements that increase delay at another intersection.
3	**Use self-enforcing measures.** Generally, measures that do not require police enforcement to be effective are preferable. Measures that can be circumvented should be avoided.
4	**Considering all services and street uses.** Input from all stakeholders should be obtained early in the process to avoid impacts on public services and avoid concerns raised by residents and stakeholders about direct and indirect effects associated with traffic calming measures.
5	**Monitor and follow-up.** There is a need to collect comparable traffic volume and speed data before and after implementation to evaluate the effectiveness of the measures and make any adjustments, if needed.

Where Traffic Calming Measures Can Be Applied

Effective traffic calming implementation determines the best combination of measures that result in a net improvement in community safety at a reasonable cost. This guide provides a variety of effective traffic calming measures that can be tailored to the unique characteristics of the city of Vaughan.

Identifying the most suitable locations for traffic calming measures requires a nuanced understanding of local traffic patterns, community needs, and potential safety concerns. High pedestrian activity areas such as schools, parks, and residential neighbourhoods often top the list of priority locations. Additionally, busy intersections, wider streets prone to speeding, and locations with a history of collisions warrant careful consideration.

Technical factors such as driveway locations, drainage, sightlines, or topography may influence the suitability of traffic calming. Transit, waste management, and emergency routes also play a role. By engaging with residents, conducting thorough traffic assessments, and collaborating with local authorities, these critical areas can be identified, and traffic calming solutions can be tailored to ensure the well-being and tranquility of all road users.

While the benefits of traffic calming measures are evident, it is equally important to exercise caution and strategic planning when deciding where to implement them. They should be prioritized on local and collector streets rather than arterial roads meant to carry high traffic volumes. The City's Complete Street Guidelines indicate traffic calming as a high priority on minor collector and local streets with an intensification or community context (**Figure 1**).

Figure 1: Street element priorities based on street class and land use context (City of Vaughan Complete Street Guidelines, 2024)

Street Elements	Arterial				Major Collector				Minor Collector				Local			
	Intensification	Community	Employment	Natural	Intensification	Community	Employment	Natural	Intensification	Community	Employment	Natural	Intensification	Community	Employment	Natural
Goods Movement*	2	3	1	2	2	3	1	3	2	3	1	3	2	3	1	3
On-street Parking	3	3	3	3	3	3	3	3	2	2	2	3	2	2	2	3
Left-turn Lanes	2	2	2	2	2	2	2	3	2	2	3	3	3	3	3	3
Transit Priority Lanes	1	1	1	1	1	1	1	1	2	2	2	3	3	3	3	3
Wider Pedestrian Clearways	1	2	3	3	1	2	3	3	1	2	3	3	1	2	3	3
Frontage Zone	1	2	3	3	1	2	3	3	1	2	3	3	1	2	3	3
Multi-use Path (MUP)	3	3	3	1	3	3	3	1	3	3	2	1	3	3	2	1
Cycle Facility-Clearway Adjacent**	1	1	1	1	1	1	1	1	3	3	2	2	3	3	2	2
Cycle Facility-Travelway Adjacent***	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2
Traffic Calming	3	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1
Transit Stops	1	2	1	3	1	2	1	3	1	2	2	3	1	2	2	3
Wider Crosswalks	1	1	2	3	1	1	2	3	1	1	2	3	1	1	2	3
Planting and Furnishing Zone	1	1	1	2	1	1	1	2	1	1	1	2	1	2	2	2
Green Infrastructure	1	1	2	3	1	1	2	3	1	2	2	3	1	1	2	3

Street Element Priority Legend:

- 1 High Priority
- 2 Medium Priority
- 3 Low Priority

Note:
*Goods movement indicates impact on travel lane widths for large trucks (WB-20).
**Clearway adjacent cycle facilities are separated from the clearway by a buffer (min. 0.6m, see OTM Book 18) and are separated from travelway by planting and furnishing zone.

The City has a responsibility to use limited resources efficiently by focusing on streets where traffic calming can have the greatest impact. This includes streets with documented speeding or traffic-infiltration issues or those adjacent to schools, parks, or other generators of significant pedestrian activity. Additionally, careful consideration is needed on primary emergency response routes and transit routes. There may also be cases when traffic calming is warranted on public laneways and rural roads. This document guides the toolbox of measures available in the City of Vaughan and considerations in selecting the most appropriate traffic calming treatments.

Although much of the focus of this Guide is on retrofitting existing streets with traffic calming measures to address identified problems, most of the measures described in the document can also be used to design new neighbourhoods to enhance the street environment and address potential traffic issues before they occur. Narrow streets, tight turning radii, streetscaping and horizontal deflection are examples of street design elements that naturally calm traffic.

Refer to the Traffic Calming Policy for more information about the process for implementing traffic calming measures in the City of Vaughan.

Measures Not Recommended for Traffic Calming

Some traffic control measures should not be used solely for traffic calming. This includes the following:

All-way stop controls must not be used under the following conditions:

- *As a speed control device (or a traffic calming tool); and*
- *On roads where progressive signal timing exisits*

OMT Book 5, Regulatory Signs, Pg 28

Stop Signs for Intersection Control:

Stop signs are designed to regulate intersections and are typically placed where specific minimum conditions, known as warrants, are met. When stop signs are installed without meeting these warrants, historical data indicates lower compliance levels than locations where warrants are satisfied. Installing stop signs without meeting warrants not only diminishes the effectiveness of the stop sign in question but can also lead to decreased compliance levels at other stop-controlled locations on a broader scale. In OTM Book 5 – Regulatory Signs, the installation conditions and location criteria for the consideration of stop controlled intersections are prescribed. Applicable numerical warrants for stop signs are also included.

Speed Limit Reduction in Isolation:

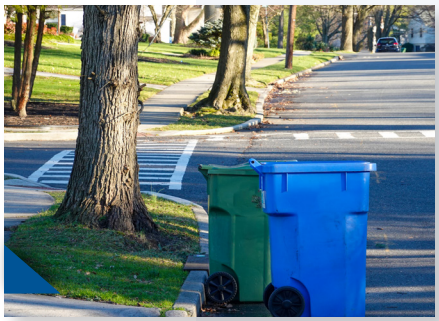
Reducing speed limits on urban streets without considering the road's physical layout generally has a limited influence on driver behaviour. Establishing a speed limit without considering the road's design or purpose may lead to difficulties in enforcement and increased traffic-related risks. When a posted speed limit is lower than the speeds drivers typically operate, most motorists maintain speeds they perceive as reasonable and safe unless consistent police enforcement is in place. The visual and physical cues guiding drivers must align with the posted speed limit to ensure the credibility of the speed limit. It is for this reason that speed reductions in isolation are not enough. It is speed reduction paired with traffic calming measures that are needed to support speed compliance more effectively.

Operational Considerations

Some traffic control measures should not be used solely for traffic calming. This includes the following:

Snow Removal and Storage

- Traffic calming devices such as speed humps, curb extensions, and chicanes can obstruct the movement of snow plows and create an accumulation of snow on the roadway or sidewalks. To avoid this, traffic calming devices should be designed to allow adequate space for snow plows to operate and to facilitate snow storage in appropriate locations. Vertical measures can be marked with a sign to flag and indicate the elevated area to the operator.



Waste Management

- Many traffic calming devices include road narrowing, curb reduction and maneuvering space reduction that may impact larger track circulation. The design measures should consider the infrequent large vehicles expected to use the road. These vehicles are expected to perform turns while occupying more space compared to design vehicles that only use one lane when performing a turn.
- In narrow streets, drivers of larger vehicles may be required to negotiate the space with other vehicles and slow while passing each other.

Landscaping

- Landscaping can enhance the aesthetic and environmental benefits of traffic calming and provide a buffer between the roadway and the sidewalk.
- Landscaping should be planned and maintained to avoid creating sightline obstructions for drivers, pedestrians, and cyclists, especially at intersections, driveways, and crosswalks. To ensure adequate visibility, landscaping should follow sight triangles guidelines and clear zones for higher speed roads.

Textured Surfaces

- Textured surfaces such as brick, cobblestone, or stamped concrete can create visual and tactile cues for drivers to slow down or delineate different roadway areas.
- When implementing textured surfaces, consider increased wear and tear and difficulty in applying pavement markings. Matching coloured concrete can also be challenging if repairs are needed.
- To address these issues, textured surfaces should be designed and constructed to meet durability, friction, and drainage standards.

Drainage

- Some measures (mostly measures that include vertical deflection) may affect surface drainage and must be considered in the planning and design of a traffic calming plan.
- Locations of catch basins, stormwater inlets, and road elevations should be examined to prevent depressions that may lead to puddles.

Accessibility

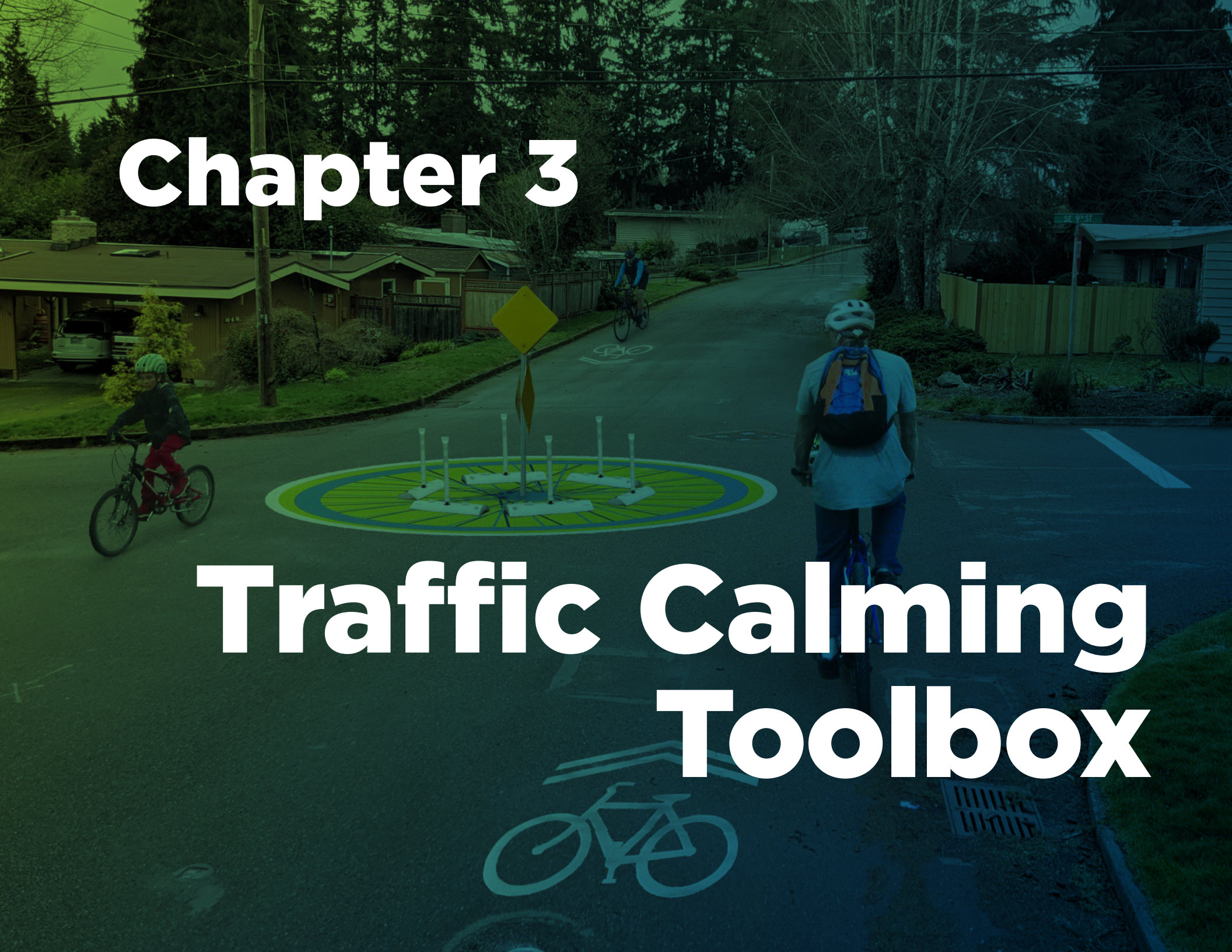
- When implementing traffic calming measures, it is important to consider the needs and preferences of persons with disabilities who may face barriers to accessing and using the transportation system.
- Traffic calming measures should ensure that information and communications are accessible, user-friendly, and compatible with assistive devices or technologies for persons with disabilities.

Cycling

- Traffic calming plans should be compatible with cyclist needs.
- Ensure cyclists can safely pass through, around or over a traffic calming device.
- Traffic calming can improve the comfort of cycling.

Transit, Fire, and Emergency Services Vehicles

- Horizontal deflection devices are favourable, especially on routes where articulated buses operate.
- Speed cushions are preferred over speed humps, as they can accommodate the typical axle widths and wheel spacing for buses, allowing them to pass over unimpeded.
- Speed tables and raised intersections are acceptable if used infrequently and only at key locations, such as near schools or transit hubs.
- Parking should be a sufficient distance from traffic calming measures to avoid hindering bus operation and access.
- The cumulative effect of all traffic calming measures should be considered on transit users, such as accessibility, travel time, and comfort.



Chapter 3

Traffic Calming Toolbox

Measure Selection

[1]Note: A **Crash Modification Factor (CMF)** indicates the proportion of crashes that would be expected after implementing a countermeasure. CMFs with a value less than 1.0 indicate an expected decrease in crashes, and greater than 1.0 indicate an expected increase in crashes.

Example: A particular stop-controlled intersection is expected to experience 5.2 total crashes per year. The City is considering installing a traffic signal and has identified a CMF for installing a traffic signal of 0.56 for total (or "all") crashes. The expected total crashes after installing the signal would be 5.2 x 0.56 = 2.9 total crashes per year (a reduction of 44%).

Table 2: Applicability of Traffic Calming Measures by Road Type

Applicable ✓
Use Caution ✳

	Urban Roads				Laneway	Rural	CMF[1]
	Arterial	Major Collector	Minor Collector	Local			
Level 1 (Quick-Build) Measures							
Centerline Flexible Signs and Curbside Bollards		✓	✓	✓		✳	0.85
Temporary Speed Cushions (Pre-fab Rubber)		✳	✓	✓	✳	✳	0.6
Planters		✳	✳	✓			N/A
Edge Lines	✓	✓	✓	✓		✓	0.93
On-Road Messaging	✓	✓	✓	✓		✓	0.85
Intersection Treatments: Curb Radius Reductions (with Bollards)	✳	✳	✳	✳			0.558
Intersection Treatments: Centerline Hardening (with Pre-fab Rubber)	✳	✓	✓			✳	N/A
Level 1 (Quick-Build) Measures: Specialized Implementations							
Converging Chevrons						✓	0.68
Dragon's Teeth						✓	0.93
Full-Lane/Peripheral Transverse Bars						✓	N/A
Custom Crosswalks	✓	✓	✓	✓			N/A
Level 2 (Permanent, Lower Cost Engineered) Measures							
Permanent Speed Cushions (Asphalt)		✳	✓	✓		✳	0.6
Speed Humps/Tables (Asphalt)		✳	✳	✳	✓		0.6
Centerline Hardening (Concrete)	✓	✓	✓	✳			N/A

Applicable ✓
Use Caution ✳

	Urban Roads				Laneway	Rural	CMF[1]
	Arterial	Major Collector	Minor Collector	Local			
Level 3 (Engineered) Measures: Horizontal Deflection							
Curb Extensions and Chokers	✳	✳	✳	✳			N/A
Chicanes		✳	✳	✓			N/A
Lateral Shifts		✓	✓	✓			N/A
Lane Narrowing	✓	✓	✓	✓		✓	N/A
Raised Median Islands	✓	✓	✓				N/A
Level 3 (Engineered) Measures: Vertical Deflection							
Raised Crosswalks (Mid-Block)		✳	✳	✳			0.55
Level 3 (Engineered) Measures: Intersection Treatments							
Raised Intersections		✳	✳	✳			N/A
Raised Crosswalks and Continuous Sidewalks (Intersection)		✳	✳	✳			0.55
Curb Radius Reductions	✓	✳	✳	✳			0.558
Roundabouts/Mini-Roundabouts/Traffic Circles	✳	✳	✳	✳		✳	0.22 – 0.32
Level 3 (Engineered) Measures: Specialized Implementations							
Gateways	✓	✓	✓	✓		✓	N/A
Textured Pavement	✓	✓	✓	✓			0.52
Rumble Strips						✓	0.56
Access Restrictions: Right-In/Right-Out Islands	✳	✳	✳	✳			N/A
Access Restrictions: Directional Closures and Diverters		✳	✳	✳	✳		N/A
Access Restrictions: Full Closures (School Streets)			✳	✓			N/A
Education and Enforcement							
Radar Message Boards	✓	✓	✓	✓	✓	✓	0.95
Boulevard Signs/Silhouettes	✓	✓	✓	✓	✓	✓	N/A
Education Campaigns	✓	✓	✓	✓	✓	✓	N/A
Active and Safe Routes to School Program	✳	✳	✳	✳			0.85
Community Safety Zones	✓	✓	✓	✓			0.93
Automated Speed Enforcement	✓	✓	✓	✓			N/A

Types of Traffic Calming Measures

The Neighborhood Traffic Calming Policy has expanded its range of traffic calming measures, which are now organized by Levels and include 18 different tools. In addition, the toolbox includes:

- Supplementary educational measures can be used alone or in combination with Level 1, 2 and 3 measures. These include radar message boards, boulevard signage including silhouettes, and education campaigns.
- Enforcement measures such as the Automated Speed Enforcement (ASE) and Community Safety Zones (CSZ) programs can also be implemented.

This toolbox and guide is consistent with Transport Association of Canada/Institute of Transportation Canada engineering and design guidelines.

Level 1 Quick-Build Traffic Calming Measures: These measures are passive, use interim materials, and/or allow rapid implementation. These include flexible signs, temporary speed cushions, planters, and specialized pavement markings.

Level 2 Engineered Traffic Calming Measures: Physical measures involving civil works that are permanent in nature, resulting in physical changes to streets, such as permanent speed cushions. They are typically lower in cost and have a faster timeframe for planning, design, and installation compared to Level 3 measures. These includes temporary asphalt speed cushions.

Level 3 Engineered Traffic Calming Measures: Physical measures involving civil works are permanent in nature and result in physical changes to streets, such as curb extensions. They typically have higher costs and require a longer planning, detailed design, and construction timeline than Level 2 measures. These include curb extensions, engineering intersection treatments, and roundabouts.

Education: Supportive education tools and programs to reinforce desired driver behaviour. These measures can be applied as standalone or combined with Level 1 to 3 measures. Measured include radar message boards, boulevard signage including silhouettes and education campaigns.

Enforcement: Enforcement programs are one of the most effective tools to address speeding. These include Community Safety Zones, Automated Speed Enforcement and York Regional Police reporting tools that reinforce responsible driver behaviour. Community Safety Zones are designated and implemented in accordance with the City's Community Safety Zone Policy. Automated Speed Enforcement (ASE) is used in areas of excessive speed, such as school and community safety zones, to improve road and pedestrian safety.

Level 1 (Quick-Build) Measures

Level 1 Specialized Implementation Measures Consist of:

- Centerline Flexible Signs and Curbside Bollards
- Temporary Speed Cushions (Pre-fab Rubber)
- Planters
- Edge Lines
- On-Road Messaging
- Intersection Treatments: Curb Radius Reductions (With Bollards)
- Intersection Treatments: Centerline Hardening (With Pre-fab Rubber)

Centerline Flexible Signs and Curbside Bollards

Centerline flexible signs and curbside bollards offer a practical solution for speed management. Embedded in the road surface, they can provide information to drivers, such as the posted speed limit or delineate the road's centerline or edge. Their flexibility makes them durable and capable of withstanding impacts from vehicles.

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets
Traffic Conditions	• All traffic volumes
Roadway	• Urban or rural cross-section • Two-lane roadways to achieve lane narrowing

Effectiveness

Speed Reduction — High
Up to 5 km/h

Volume Reduction — Low

Conflict Reduction — Low

CMF: 0.85 ★★★★☆
(Source: Click Here)

Advantages

- ✓ Reduces vehicle speed
- ✓ Reduces conflicts by separating traffic.
- ✓ Is typically not damaged by vehicle impacts, given its collapsibility

Disadvantages

- ✗ May obstruct the movement of heavy vehicles, such as waste collection.
- ✗ May require additional maintenance such as sweeping around the posts and replacement of damaged posts.
- ✗ No parking in the vicinity of posts.

Considerations for Implementation

- Implement in the vicinity of parks and other pedestrian trip generators.
- Avoid blocking driveways or cross streets.
- When implemented in the rural context, these can be used either as a gateway treatment or at 100 m spacing between centerline posts if further measures are required.
- Centerline flexible signs may be paired with a curbside bollard spaced 3.0 m to 3.5 m from the centerline sign. A curbside bollard is only recommended if a minimum of 1.5 m can be maintained between the curb and bollard for cyclists to travel through.
- Typically removed for the winter months, though centerline flexible signs may be maintained year-round where roadways are more than 11 m wide.
- Refer to **In-Road Flexible Sign and Bollard Program Guidelines** in the Appendix for more details.

Temporary Speed Cushions (Pre-fab Rubber)

Speed cushions aim to reduce the speed of vehicles on residential streets. They consist of a series of raised cushions placed across the roadway, creating an obstacle that requires drivers to slow down. Unlike traditional speed humps, temporary speed cushions offer a smoother ride for emergency vehicles and buses, allowing them to navigate between the cushions due to their wider wheelbase. Speed cushions are commonly installed in areas with a high volume of pedestrians or where drivers often exceed speed limits.

Effectiveness

Speed Reduction High

Volume Reduction Med

The amount of traffic diversion depends on the number of measures along the roadway. Traffic may be diverted to parallel streets without traffic calming measures.

Conflict Reduction Med

CMF: 0.6 ★★★☆☆

(Source: Click Here)

Best Implemented In (Applicability)

Road Classification	• Local streets • Collector streets • Speed cushions are less suitable for major collector streets
Traffic Conditions	• Posted speed limit ≤ 50 km/h • All traffic volumes
Roadway	• Urban cross-section – curb and gutter

Advantages

- ✓ Reduces vehicle speed.
- ✓ Reduces traffic volumes.
- ✓ Speed cushions do not affect emergency vehicles' response time.

Disadvantages

- ✗ Seasonal only and requires resources to install and maintain
- ✗ Requires precise construction to ensure correct spacing (in comparison to speed tables).
- ✗ Operational resource requirements for installations.
- ✗ May lead to increased noise levels to adjacent residents due to accelerating and

Temporary Speed Cushions (Pre-fab Rubber)

Considerations for Implementation

- Avoid intersections, driveways, curves, and grades over 8%.
- Locate at least 75m from a traffic signal. Place as a series, in proximity to streetlights
- Requires WA-74 Speed Hump warning sign to alert drivers.
- Consider drainage conditions to avoid ponding.
- For speed cushions, spacing is important and can be 2, 3 or 4 cushions across, depending on the width of the road.
- It is typical to install one speed cushion per travel lane. The optimal width for speed cushions is 1.8 m, narrow enough to accommodate emergency vehicles but wide enough to slow passenger vehicles. The space between the cushions and the curb should be approximately 0.6 m.
- If only two cushions are installed (i.e. one in each direction), the distance between them must be at least 1.5 m to ensure that heavy vehicles do not pass too closely to one another. The gap should not be too wide to allow vehicles to bypass the cushions entirely.
- Consider implementing a series along the corridor for increased effectiveness with a spacing ranging from 80 to 150 m.
- It may be beneficial to start with temporary speed cushions to test out a configuration and make adjustments if necessary. Temporary rubber speed cushions are removed over the winter, whereas, permanent asphalt speed cushions are installed year-round.

Drawing templates are provided for 2 speed cushions and 4 speed cushions. Use the design guidelines and engineering judgment to determine the appropriate number of speed cushions for the roadway. Refer to the City Engineering Standard Drawing for more guidance.

Figure 2: Two Speed Cushions Design

Pilot: Mactier Drive

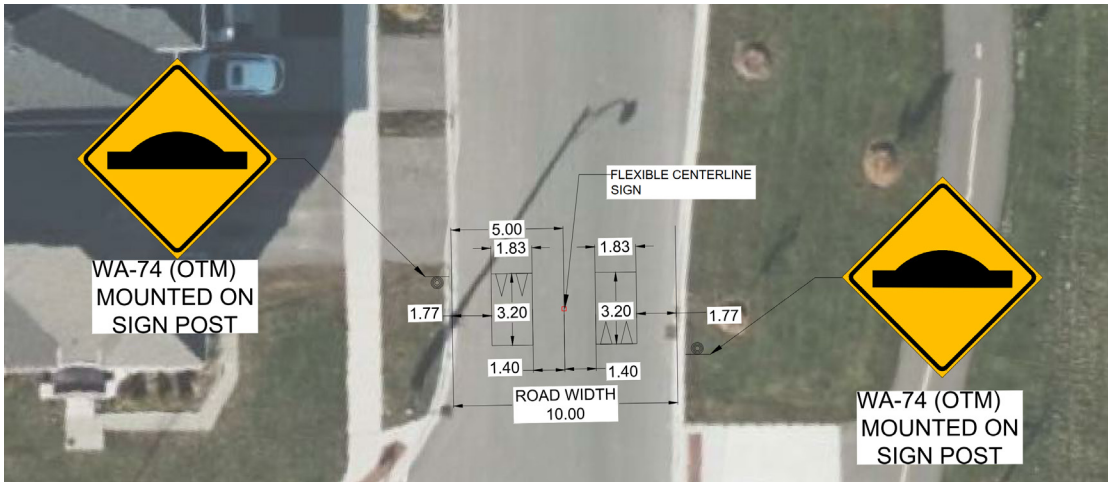
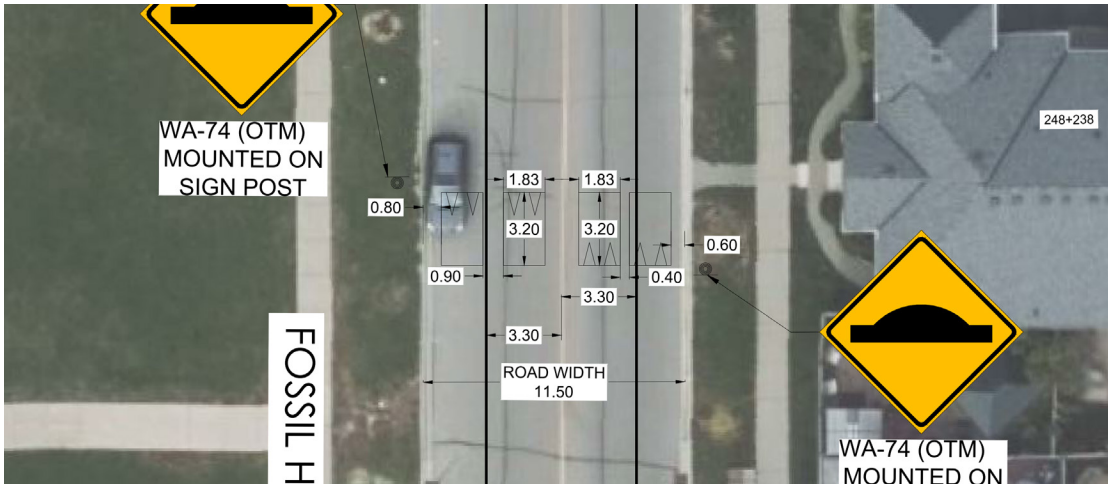


Figure 3: Four Speed Cushions Design

Pilot: Fossil Hill Road



Planters

Effectiveness

Speed Reduction	High
Volume Reduction	Med
Conflict Reduction	Low

CMF: N/A

Seasonal planters narrow the roadway or create S-shaped curves. They are designed to slow down traffic and improve safety by forcing drivers to navigate a narrower space or a winding path.

Advantages

- ✓ Speed reduction.
- ✓ Traffic volume reductions.
- ✓ Improvement to street appearance, if landscaped.

Disadvantages

- ✗ Parking loss.
- ✗ Seasonal only and requires resources to install and maintain.

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets (two-way only)
Traffic Conditions	• Posted speed limit ≤ 50 km/h • Minimum 750 veh/day or 100 veh/hr during the peak hour per direction
Roadway	• Urban cross-section – curb and gutter • Maximum two traffic lanes (one in each direction)

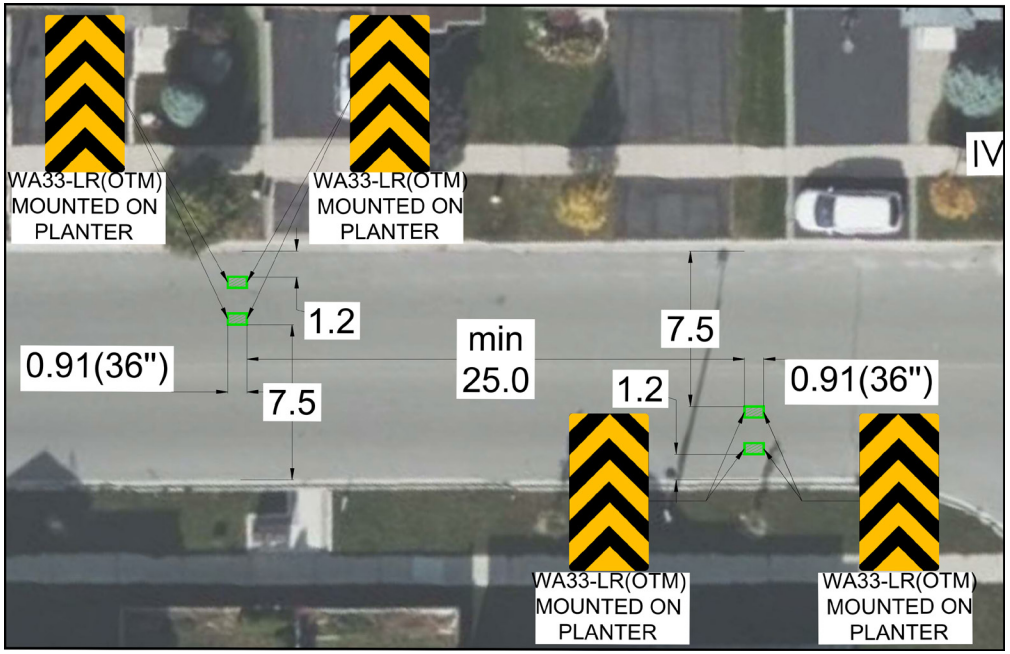
Planters

Considerations for Implementation

- Avoid transit and emergency access routes.
- Try to keep at least 1.5m and preferably 5m from driveways to improve sightlines and not impede vehicles entering and exiting the driveway.
- Implement an object marker sign (Wa-33) to be visible to motorists and plow operators.
- Can be designed for only one direction of travel to pass at one time (typically for local roads) or side-by-side travel (typically for collector roads), depending on the road conditions.
- Parking must be removed inside and within 5.0 m of the planter/chicane.
- Recommended not to add a centerline in locations where planters/chicanes will be implemented. Leaving the area unmarked encourages motorists to negotiate the space.
- If feasible, allow a 1.5m gap from the curb to planter for cyclists to pass unimpeded.

Figure 4: Design Example of Planters Aligned

Figure 5: Design Example of Planters Staggered



Edge Lines (Urban Shoulders)

Effectiveness

Speed Reduction Low
(Recommended with other measures)

Volume Reduction Low

Conflict Reduction Low

CMF: 0.93 ★★★★★
(Source: Click Here)

Edge lines involve painting a line or buffer to visually narrow the travel lanes. A buffer or hatching can also be provided. Edge lines can also serve to provide on-street parking. They should be at least 1.2m from the curb to provide the minimum operating space for cyclists, otherwise they may provide a false sense of security.

Best Implemented In (Applicability)	
Road Classification	• All roadways
Traffic Conditions	• All traffic volumes
Roadway	• Urban cross-section • Rural cross-section

Advantages

- ✓ Reduces vehicle speeds.
- ✓ Could be implemented very rapidly
- ✓ Allows on-street parking, and provides shared space for use of non-motorized traffic.

Disadvantages

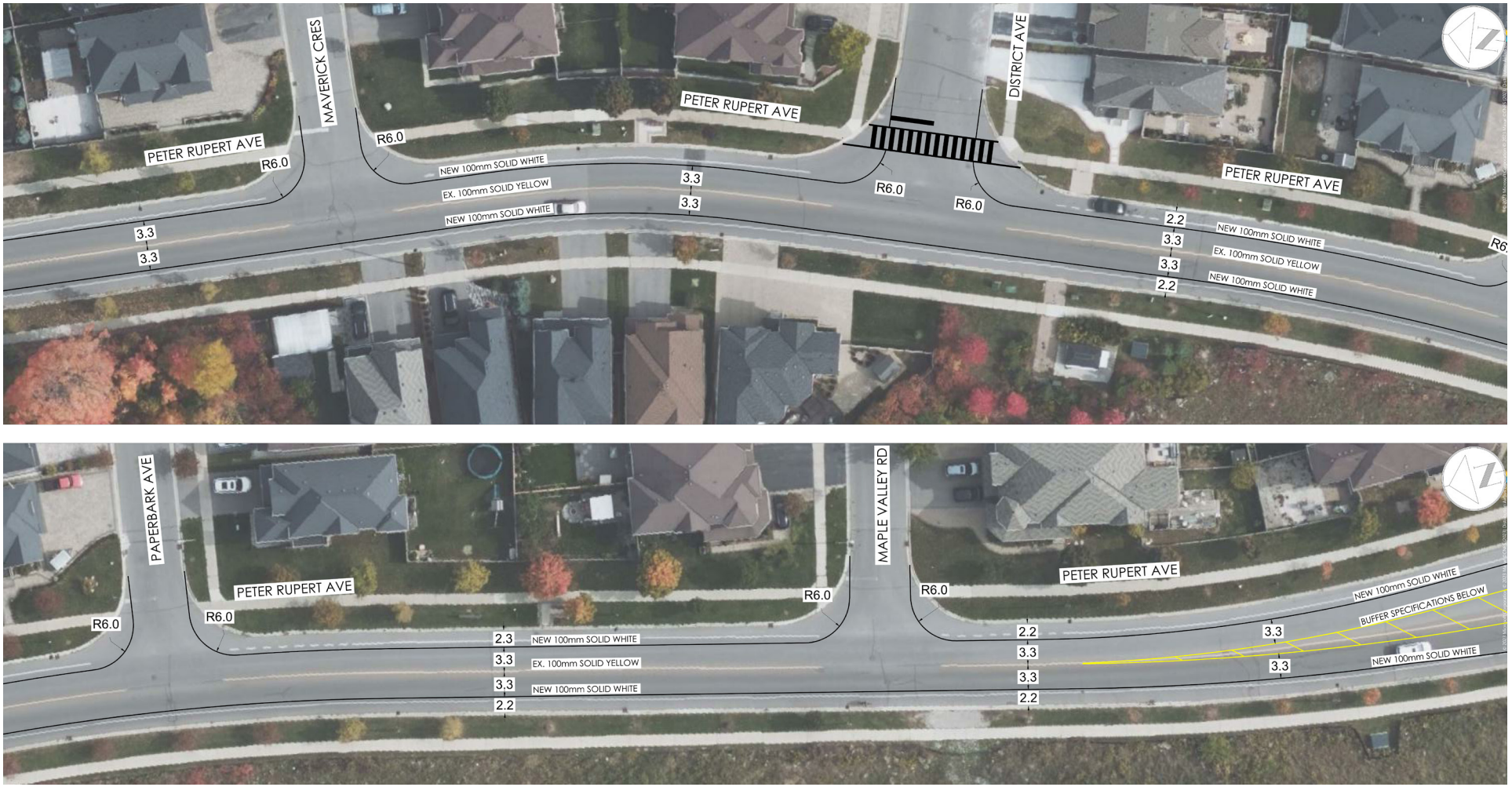
- ✗ Regular maintenance is required for the pavement markings.

Considerations for Implementation

- Recommended to use with a radar message board and/or centerline flexible signs and curbside bollards to enhance the effectiveness.
- When implemented on rural roads, these can narrow the travel lanes (3.0 m recommended width for speeds 50 km/h or less). The edge areas would also serve as space for pedestrians and cyclists if they are of suitable width.
- Refer to the City of Vaughan's Complete Street Guidelines for target lane widths.

Edge Lines

Figure 6: Design Example of Edge Lines (Concept Drawing)



On-Road Messaging

Effectiveness

Speed Reduction Low
(Recommended with other measures)

Volume Reduction Low

Conflict Reduction Low

CMF: 0.85 ★★★☆☆
(Source: Click Here)

On-road pavement markings are painted directly on the roadway to provide drivers with information that would typically be communicated through signage. These markings are more extensive and are positioned in the driver's line of sight for better visibility. Some examples include speed limit indicators, "SLOW," "STOP AHEAD," and more. These pavement markings help enhance road safety by improving driver awareness of potential hazards and encouraging safe driving behaviours.

Best Implemented In (Applicability)	
Road Classification	• All roadways
Traffic Conditions	• All traffic volumes
Roadway	• Urban and rural cross-section

Advantages

- ✓ Reduces vehicle speeds.
- ✓ Could be implemented very rapidly.

Disadvantages

- ✗ Continuous maintenance might be required for the pavement markings.

Considerations for Implementation

- Mainly used as a gateway feature; alerts of entrance to rural and urban communities and in proximity to parks, schools, and other public spaces where children are expected.
- Should be placed in the same location as speed limit signs when no provincial guidance on placement is provided.
- Best paired with other measures that will provide physical intervention and indicate the need to slow down (speed cushions, flex posts, and others can be considered).

Intersection Treatments: Curb Radius Reductions (With Bollards)

A curb radius reduction, also known as a bulb-out or curb extension, involves reducing the turning radius, resulting in a tighter turn at street corners. This reduction forces vehicles to slow down when turning and takes up less space on the street, leading to more space for pedestrians, cyclists, and other road users.

Effectiveness

Speed Reduction — High
(For right-turning vehicles)

Volume Reduction — Low

Conflict Reduction — Med

CMF: 0.558
(Source: TES)

Best Implemented In (Applicability)

Road Classification	• Local streets • Collector streets • Low volume arterial streets (with consideration of buses and heavy vehicles on truck routes)
Traffic Conditions	• All traffic volumes
Roadway	• Urban cross-section – curb and gutter • All number of lanes

Advantages

- ✓ Reduces vehicle speeds.
- ✓ Decreased collision rates.
- ✓ Reduced pedestrian crossing distance, thus reducing exposure and increasing queuing space.

Disadvantages

- ✗ Requires autoturn analysis to confirm feasibility.
- ✗ Adjustments to maintenance operating procedures may be required.
- ✗ Operational resource requirements for installations.

Intersection Treatments: Curb Radius Reductions (With Bollards)

Considerations for Implementation

- A curb radius reduction should aim to introduce the smallest radius required to accommodate a passenger vehicle. Ensure larger, infrequent vehicles can make the turns. This can be verified using swept path analysis.
- A truck apron can be considered where there are high volumes of trucks to narrow the radius for the more frequent passenger vehicles.
- Ensure that it does not affect emergency services.
- Refer to the City of Vaughan's Complete Street Guidelines for target lane widths and curb radii. Target corner radii range from 4.0m to 9.0m, depending on street class and land use.
- Requires autoturn analysis to confirm feasibility. Refer to **Figure 9** & **10** for autoturn analysis examples.

Figure 7: Design Example of Curb Radius Reductions with Bicycle Markings (Concept Drawing)

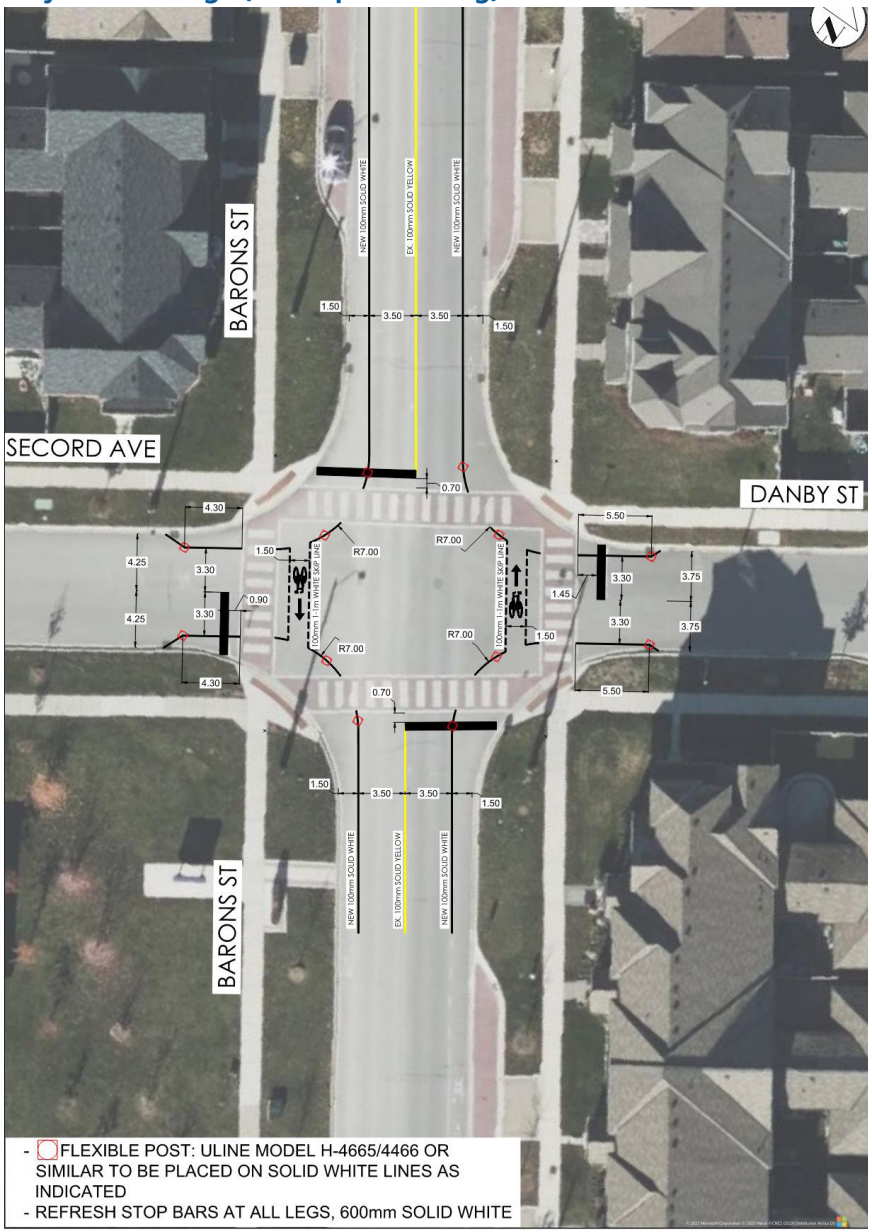


Figure 8: Design Example of Curb Radius Reductions (Concept Drawing)

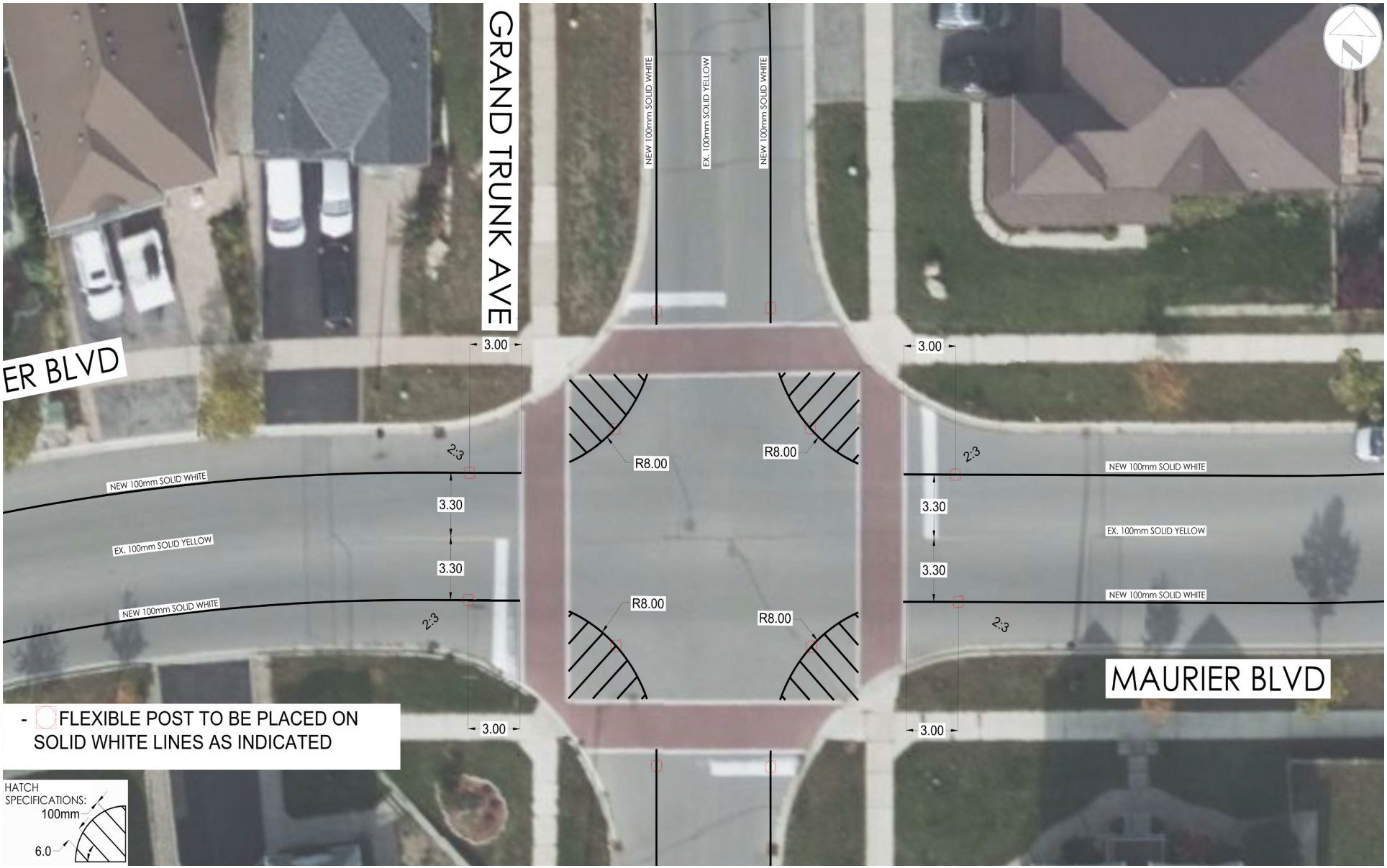


Figure 9: Auto Turn Analysis for Quick-Build Curb Radius Reduction With Design Vehicle (Concept Drawing)

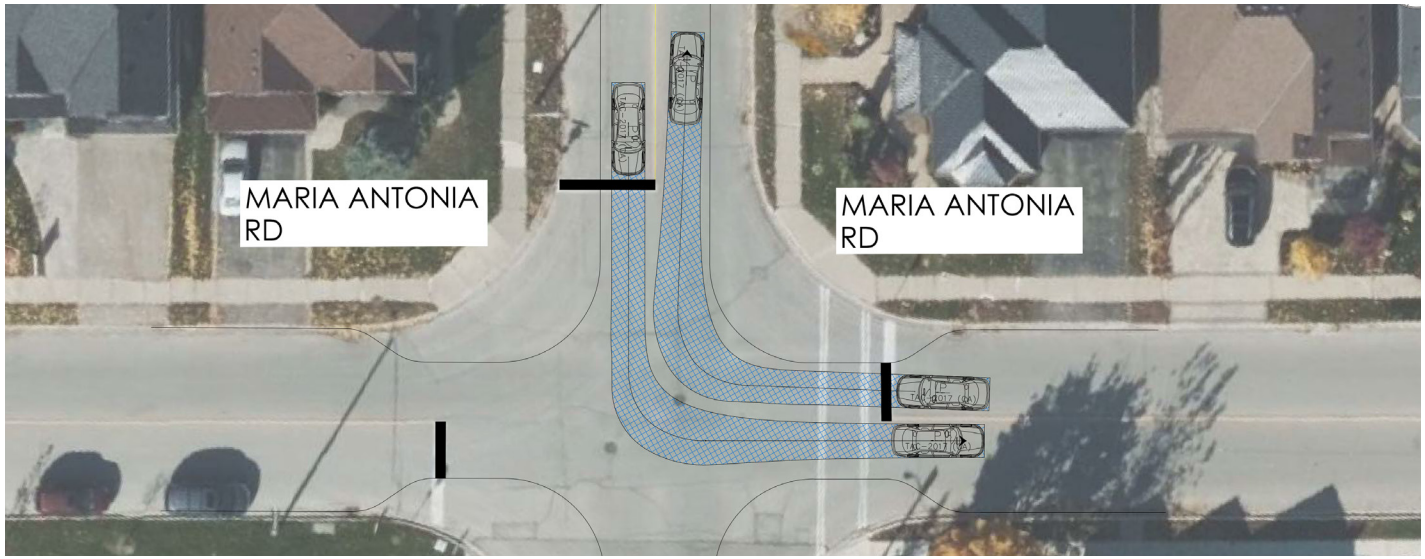
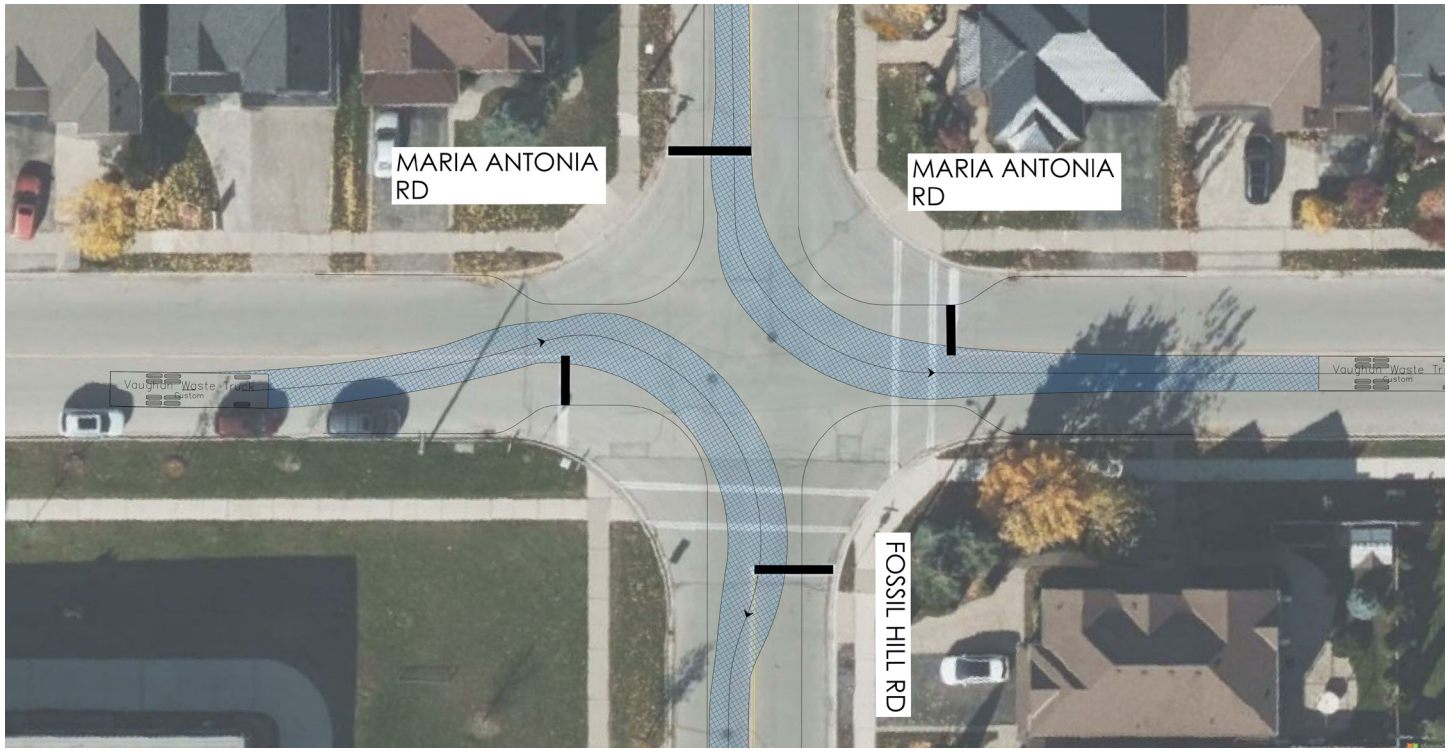


Figure 10: Auto Turn Analysis for Quick-Build Curb Radius Reduction With Control Vehicle (Vaughan's Waste Truck) (Concept Drawing)



Intersection Treatments: Centerline Hardening (With Pre-fab Rubber)

Left-turn centerline hardening is a traffic safety measure designed to encourage drivers to take wider and slower turns when making a left turn. This technique involves installing median extensions or raised pavement markers along the centerline of the road at left turn lanes. By creating a visual cue for drivers, centerline hardening reduces the speed and improves the angle at which they turn. Left-turn centerline hardening is often used in areas with high left-turning traffic, such as at busy intersections or on multi-lane roads.

Effectiveness

Speed Reduction High
(For left-turning vehicles)

Volume Reduction Low

Conflict Reduction Med

CMF: N/A

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets • Arterial streets
Traffic Conditions	• Posted speed limit ≤ 50 km/h • All traffic volumes
Roadway	• Urban cross-section – curb and gutter

Advantages

- ✓ Reduces vehicle speeds.
- ✓ Ensures safer left-turning angles.

Disadvantages

- ✘ Could affect snow-clearing operations.

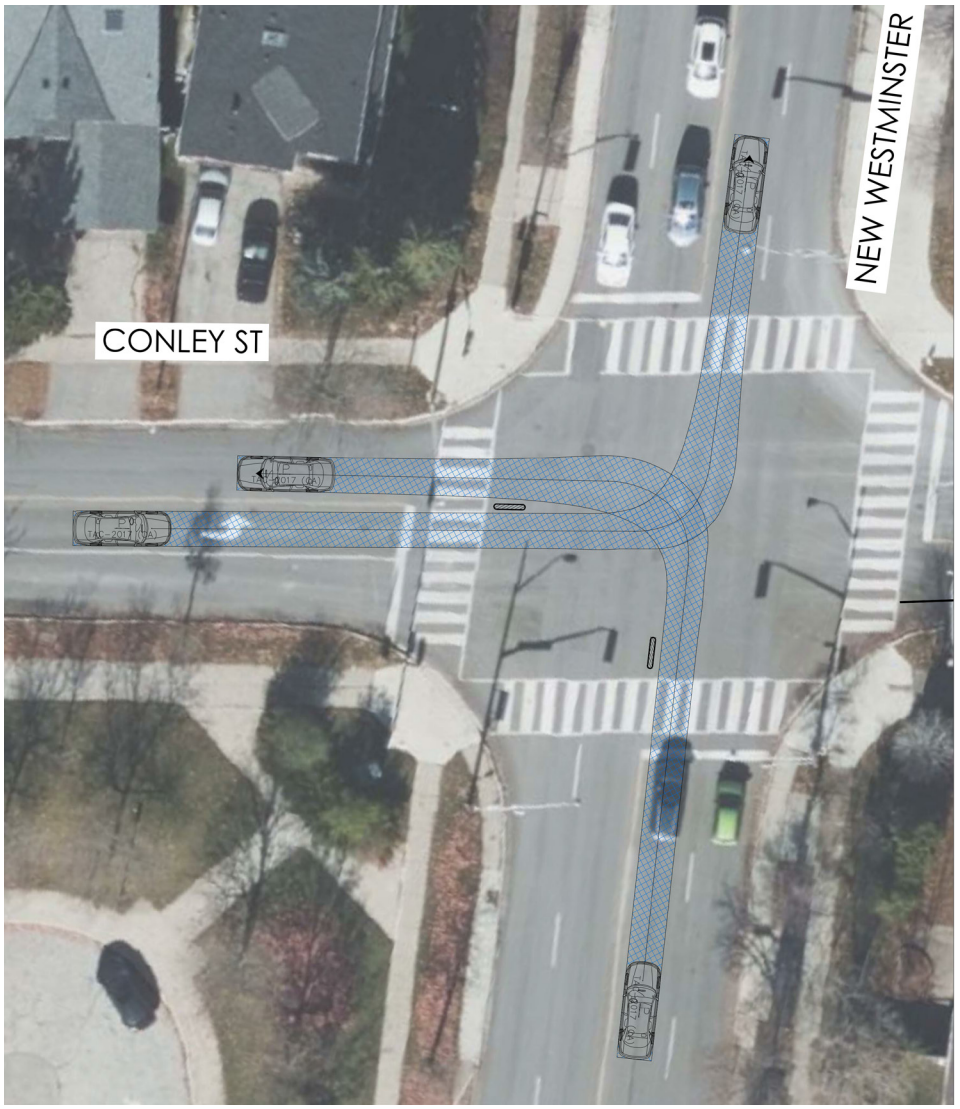
Considerations for Implementation

- A flexible delineator can be placed to alert snow-plow operators.
- These are designed to be mountable by Emergency Services vehicles and trucks.

Intersection Treatments: Centerline Hardening (With Pre-fab Rubber)

Figure 11: Auto Turn Analysis of Centerline Hardening Treatment (Concept Drawing)

Without centerline hardening



With centerline hardening

Level 1 (Quick-Build) Measures: Specialized Implementations

Level 1 Specialized Implementation Measures Consist of:

- Converging Chevrons
- Dragon's Teeth
- Full-Lane Transverse Bars
- Peripheral Transverse Bars
- Custom Crosswalks

Converging Chevrons

Converging chevrons are pavement markings shaped like a forward-facing V, strategically pointing in the direction of roadway travel. Arranged closely together or varying in thickness as distance increases, these markings create an optical illusion of accelerating vehicle speed. The intention is to promptly alert drivers to the need for reduced speed, aligning with the municipality's commitment to promoting road safety and adherence to limits.

Effectiveness

Speed Reduction Low
(Recommended with other measures)

Volume Reduction Low

Conflict Reduction Low

CMF: 0.68 ★☆☆☆☆
(Source: Click Here)

Best Implemented In (Applicability)	
Road Classification	• All roadways
Traffic Conditions	• All traffic volumes
Roadway	• Rural cross-section • Usually two traffic lanes (one in each direction) • Can be considered in urban areas

Advantages

- ✓ Reduces vehicle speed.
- ✓ Can be implemented rapidly.

Disadvantages

- ✗ Speed reduction may decrease over time as drivers get used to it.
- ✗ Requires regular maintenance.
- ✗ Not effective during the months of snowfall.

Considerations for Implementation

- To be used in entrances to rural communities/gateways, freeway ramps, advance of curves to alert drivers to change ahead.
- Best paired with other measures.
- The size of the converging chevrons varies depending on the width of the travel lane.
- Converging chevrons can be spaced 5-10 m apart as a group of 10 chevrons, and painted thinner as distance increases to create the illusion that a vehicle's speed is increasing. This is done to alert the driver of the need to reduce speed.

Dragon's Teeth

Dragon's teeth consist of a sequence of triangular pavement markings positioned along the edge of the travelled lanes. These markings may be depicted with escalating sizes, creating the optical illusion of roadway narrowing. As a visual alteration to the roadway, dragon's teeth notify drivers of their entry into a rural community.

Effectiveness

Speed Reduction Low
(Recommended with other measures)

Volume Reduction Low

Conflict Reduction Low

CMF: 0.93 ★★★☆☆
(Source: Click Here)

Best Implemented In (Applicability)	
Road Classification	• All roadways
Traffic Conditions	• All traffic volumes
Roadway	• Rural cross-section • Usually two traffic lanes (one in each direction) • Can be considered in urban areas

Advantages

- ✓ Has the potential to reduce vehicle speeds.
- ✓ Can be implemented rapidly.

Disadvantages

- ✗ Requires regular maintenance
- ✗ Not effective during the months of snowfall

Considerations for Implementation

- To be used in entrances to rural communities/gateways, freeway ramps, advance of curves to alert drivers to change ahead.
- Each triangular pavement marking in a dragon's teeth application is typically 0.6 m wide, 0.6 m tall, and approximately 1.5 m apart from an adjacent pair of teeth. There is no specific constraint to the number of teeth used, but typically, between 9 and 17 pairs of teeth are used.

Level 1 (Quick-Build) Measures: Specialized Implementations

Full-Lane/Peripheral Transverse Bars

Effectiveness

Speed Reduction Low
(Recommended with other measures)

Volume Reduction Low

Conflict Reduction Low

CMF: N/A

Peripheral transverse bars are a sequence of parallel pavement markings positioned along the edges of the travelled lane widths. These markings, arranged with diminishing spacing as distance extends, generate the visual effect of escalating vehicle speed. The purpose is to promptly draw the driver's attention to the need for speed reduction. Compared to full-lane transverse bars, peripheral transverse bars offer a similar impact while requiring less maintenance of pavement markings.

Best Implemented In (Applicability)	
Road Classification	• All roadways
Traffic Conditions	• All traffic volumes
Roadway	• Rural cross-section • Can be considered in urban areas • Freeway off-ramps; Bridge approaches; Approach to an intersection; Deficient horizontal curves

Advantages

- ✓ Reduces vehicle speed.
- ✓ Can be implemented rapidly.

Disadvantages

- ✗ Requires regular maintenance.
- ✗ Not effective during the months of snowfall.

Considerations for Implementation

- Preferred where edge and centerlines are provided.
- When implemented with a radar message board, the effect is enhanced.
- Peripheral transverse bars should not be greater than 0.3 m in width and should not extend more than 0.5 m into the lane. The recommended spacing between bars varies from 2 to 5 m depending on the desired target speed and the speed differences.

Level 1 (Quick-Build) Measures: Specialized Implementations

Custom Crosswalks

A textured or custom crosswalk is a type of pedestrian crossing with a unique surface pattern or texture designed to enhance visibility for pedestrians and drivers. This surface may include raised bars or dots, different colours or materials, or a combination of these elements.

Effectiveness

Speed Reduction	Low
Volume Reduction	Low
Conflict Reduction	Med

CMF: N/A

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets • Arterial streets • Urban commercial streets
Traffic Conditions	• All traffic volumes, with consideration for buses and heavy vehicles on truck routes
Roadway	• Rural cross-section – curb and gutter • Sidewalks exist along the street

Advantages

- ✓ Enforces pedestrian priority, thus reinforcing pedestrian priority and conflict.
- ✓ Provides high contrast crosswalk, which is more visible for pedestrians with partial sight loss.
- ✓ Enhances the appearance of the street and could serve as a gateway feature with a theme connected to the local community.

Disadvantages

- ✗ Requires regular maintenance.
- ✗ Less effective during the months of snowfall.
- ✗ No consensus on their effectiveness

Considerations for Implementation

- It can be combined with raised intersection/curb radius reduction.
- Refer to TAC research paper: Non-Standard Crosswalk Pavement Markings (2023).

Level 2 (Permanent, Lower Cost, Engineered) Measures

Level 2 Measures Consist of:

- Permanent Speed Cushions (Asphalt)
- Speed Humps/Tables (Asphalt)
- Centerline Hardening (Concrete)

Permanent Speed Cushions (Asphalt)

Effectiveness

Speed Reduction High

(Up to 8 km/h)

Volume Reduction Med

The amount of traffic diversion depends on the number of measures along the roadway. Traffic may be diverted to parallel streets without traffic calming measures.

Conflict Reduction Med

CMF: 0.6 ★★★☆☆

(Source: Click Here)

Permanent speed cushions are a narrower version of a speed hump. They consist of a series of raised cushions placed across the roadway, creating an obstacle that requires drivers to slow down. Unlike traditional speed humps, speed cushions offer a smoother ride for emergency vehicles and buses, allowing them to pass unimpeded due to their wider wheelbase.

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets
Traffic Conditions	• Posted speed limit ≤ 50 km/h • All traffic volumes
Roadway	• Urban cross-section – curb and gutter

Advantages

- ✓ Reduces vehicle speed.
- ✓ Reduces traffic volumes.
- ✓ Speed cushions do not affect emergency vehicles' response times.
- ✓ Speed tables can be used in combination with high-visibility crosswalks.

Disadvantages

- ✗ Could affect snow plowing operations.
- ✗ Requires precise construction to ensure correct spacing (in comparison to speed tables).
- ✗ Increased gas consumption.

Permanent Speed Cushions (Asphalt)

Considerations for Implementation

- Avoid intersections, driveways, curves, and grades over 8%.
- Locate at least 75m from a traffic signal. Place as a series, in proximity to streetlights.
- Requires WA-74 Speed Hump warning sign to alert drivers.
- Consider drainage conditions to avoid ponding.
- For speed cushions, spacing is important and can be 2, 3 or 4 cushions across, depending on the width of the road.
- It is typical to install one speed cushion per travel lane. The optimal width for speed cushions is 1.8 m, narrow enough to accommodate emergency vehicles but wide enough to slow passenger vehicles. The space between the cushions and the curb should be approximately 0.6 m.
- Consider implementing a series along the corridor for increased effectiveness with a spacing ranging from 80 to 150 m. The area of influence of the measure is approximately 60 m.
- Place in proximity to streetlights for better visibility of the speed cushions.
- If only two cushions are installed (i.e. one in each direction), the distance between them must be at least 1.5 m to ensure that heavy vehicles do not pass too closely to one another. The gap should not be too wide to allow vehicles to bypass the cushions entirely.
- It may be beneficial to start with temporary speed cushions to test out a configuration and make adjustments if necessary. Temporary speed cushions tare removed over the winter while permanent speed cushions remain year-round.

Speed Humps/Tables (Asphalt)

A speed hump is an elevated section across the width of a roadway, excluding gutters, that is designed to slow speeds by providing motorist discomfort at high speeds. Similarly, a speed table is an elongated raised speed hump featuring a flat-topped section long enough to elevate the entire wheelbase of a vehicle. These tables may incorporate materials like brick or other textured surfaces on the flat section.

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets • Avoid designated transit and emergency services routes
Traffic Conditions	• Posted speed limit ≤ 50 km/h • All traffic volumes
Roadway	• Urban cross-section – curb and gutter

Effectiveness

Speed Reduction High

(Up to 8 km/h)

Volume Reduction Med

The amount of traffic diversion depends on the number of measures along the roadway. Traffic may be diverted to parallel streets without traffic calming measures.

Conflict Reduction Med

CMF: 0.6 ★★★☆☆

(Source: Click Here)

Advantages

- ✓ Reduces vehicle speed.
- ✓ Reduces traffic volumes.
- ✓ Speed tables can be used in combination with high-visibility crosswalks.

Disadvantages

- × Could affect snow plowing operations.
- × While TAC standards for speed humps have changed such that the geometry is reduced to 80mm height, there still may be an impact on emergency vehicle response times
- × Increased gas consumption.

Considerations for Implementation

- Avoid intersections, driveways, curves, and grades over 8%.
- Speed tables have higher design speeds than speed humps and are preferred on collector roads.
- Locate at least 75m from a traffic signal so that the speed hump/table is not within the decision or braking zones.
- Requires Wa-74 Speed Hump warning sign to alert drivers.
- Consider drainage conditions to avoid ponding.
- Consider implementing a series along the corridor for increased effectiveness with a spacing ranging from 80 to 150 m. The area of influence of the measure is approximately 60 m.
- Place in proximity to streetlights for better visibility of the speed humps.

Permanent Centerline Hardening (Concrete)

Effectiveness

Speed Reduction High

(For left-turning vehicles)

Volume Reduction Low

Conflict Reduction Med

CMF: N/A

Left-turn centerline hardening is a traffic safety measure designed to encourage drivers to take wider and slower turns when making a left turn. This technique involves installing median extensions or raised pavement markers along the centerline of the road at left turn lanes. By creating a visual cue for drivers, centerline hardening reduces the speed and improves the angle at which they turn. Left-turn centerline hardening is often used in areas with high left-turning traffic, such as at busy intersections or on multi-lane roads.

Advantages

- ✓ Reduces vehicle speed.
- ✓ Ensures safer left-turning angles.

Disadvantages

- × Could affect snow plowing operations.

Considerations for Implementation

- A flexible delineator can be placed to alert snow plowing operators.
- Implementation should be subjected to a swept path analysis.
- These are designed to be mountable by Emergency Services vehicles and trucks.

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets • Arterial streets
Traffic Conditions	• Posted speed limit ≤ 50 km/h • All traffic volumes
Roadway	• Urban cross-section – curb and gutter

Level 3 (Engineered) Measures: Horizontal Deflection

Level 3 Horizontal Deflection Measures Consist of:

- Curb Extensions and Chokers
- Chicanes
- Lateral Shifts
- Lane Narrowing
- Raised Median Islands

Curb Extensions and Chokers

Effectiveness

Speed Reduction	Med
Volume Reduction	Low
Conflict Reduction	Low

CMF: N/A

A curb extension is a measure that involves extending the sidewalk or curb into the roadway to reduce the width of the street. A choker has a narrowing on both sides, creating a pinch point. By narrowing the roadway, the extension slows down traffic and makes it safer for pedestrians to cross. Curb extensions can also improve visibility at intersections, making it easier for drivers and pedestrians to see each other and physically restricting parking away from the intersection. Curb extensions can be landscaped, enhancing the aesthetic appeal and adding shade for the street.

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets • Urban arterial streets
Traffic Conditions	• All traffic volumes
Roadway	• Urban cross-section - curb and gutter

Advantages

- ✓ Reduces vehicle speed.
- ✓ Reduces pedestrian crossing distances in the case of a crossing.
- ✓ Enhances the appearance of the street if landscaped.

Disadvantages

- ✗ Could obstruct bike lanes, if any are implemented. Consider ramping the bike lane over and through the extension.
- ✗ Could be a sightline hazard if not properly implemented.
- ✗ Adds a level of complexity for large vehicles navigating it.
- ✗ Potential loss of on-street parking.

Considerations for Implementation

- Additional measures and implementation of multiple chokers/extensions improve effectiveness, and reducing on-street parking helps enhance pedestrians' visibility.
- Drainage and driveway access should be considered.
- Sightlines should be assessed in the presence of landscaping.
- Potential applicability would be context-specific and require more significant planning, design and capital costs that would best be implemented as part of road reconstruction projects and/or new developments.

Chicanes

Effectiveness

Speed Reduction High
(5 to 15 km/h)

Volume Reduction Med

Conflict Reduction Low

CMF: N/A

Chicanes are a type of road feature that involves creating a series (minimum two) of S-shaped curves in a roadway. They are designed to slow down traffic and improve safety by forcing drivers to slow down and navigate a winding path. Chicanes can be created using various materials, such as bollards, curbs or planters, and installed in urban and suburban areas. They can also be used as an effective bicycle protection measure, as they can help to reduce the risk of collisions and improve overall safety.

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets (two-way only)
Traffic Conditions	• Posted speed limit ≤ 50 km/h • Minimum 750 veh/day or 100 veh/hr during the peak hour
Roadway	• Urban cross-section – curb and gutter • Maximum two traffic lanes (one in each direction)

Advantages

- ✓ Speed reduction.
- ✓ Traffic volume reductions.
- ✓ Improvement to street appearance, if landscaped.

Disadvantages

- ✗ Parking loss.
- ✗ Affects the navigation of emergency vehicles and, thus, their response time.
- ✗ Affects maintenance operations like street cleaning and snow plowing.
- ✗ Volumes reduced will be diverted to parallel streets without traffic calming measures.
- ✗ Could encourage motorists to cross centreline. Centre median may be appropriate in some cases.

Chicanes

Considerations for Implementation

- Avoid transit and emergency access routes; driveways should be considered.
- Can be designed for only one direction of travel to pass at one time (typically for local roads) or side-by-side travel (typically for collector roads), depending on the road conditions.
- Recommended not to add a centerline in locations where one-lane chicanes will be implemented. Leaving the area unmarked encourages motorists to negotiate the space.
- To help discourage motorists from cutting across the centerline of a two-lane chicane to avoid deflection, a solid yellow line may be painted to separate opposing traffic, or a raised median island could be installed.
- Parking must be removed inside and within 5.0 m of the chicane.
- Implement an object marker sign (Wa-33) to be visible to motorists and plow operators.
- A two-lane chicane requires a pavement width of at least 12.0 m, and a one-lane chicane requires a pavement width of at least 7.0 m.
- For a chicane to function properly, the offset between the apexes of adjacent chicane islands must be 2.0 m or less. However, if the chicane is lengthened to provide above-minimum widths between adjacent islands, impacts on transit and emergency operations will be reduced at the expense of potentially higher overall travel speeds.
- Stopping Prohibited signs (Rb-55) are required for all chicanes because parking and stopping are not prohibited within the limits of a chicane.
- For a two-way one-lane chicane, a Yield sign (Ra-2) and a Yield to Oncoming Traffic sign (Rb-91) are required in advance of this type of chicane to warn motorists that the roadway narrows and yielding may be necessary.
- It is typical to provide a 1.0 m drainage channel to the curb face when designing chicanes, but it is preferable if drainage can be accommodated without requiring a channel and using just the gutter pan minimum width. However, accommodating cyclists also needs to be considered, such as a 1.5m space for cyclists to pass through or ramp up over the chicane (**Figure 12**).
- A centre median can be added to discourage motorists from crossing the centreline and travelling in a straight path by-passing the chicanes entirely.
- Potential applicability would be context-specific and require more significant planning, design and capital costs that would best be implemented as part of road reconstruction projects and/or new developments.

Figure 12: Chicane with Cycle Track

Lateral Shifts

Effectiveness

Speed Reduction Med

(Depends on length and angle of alignment shift)

Volume Reduction Low

(The amount of traffic diversion depends on the number of measures along the roadway.)

Conflict Reduction Low

CMF: N/A

A lateral shift is a horizontal adjustment in a road which occurs when a typically straight segment is reconfigured through pavement markings or curb extensions, resulting in a curved alignment resembling a 'jog' in the road. This outcome can also be accomplished by incorporating half of a typical chicane. Introducing a lateral shift in road alignment compels drivers to moderate their speed and foster a heightened awareness.

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets
Traffic Conditions	• Posted speed limit ≤ 50 km/h • All traffic volumes
Roadway	• Urban cross-section

Advantages

✓ Reduces vehicle speed.

Disadvantages

✗ Potential loss of on-street parking.

Considerations for Implementation

- Drainage and driveway access should be considered.
- To be avoided on roads with a grade greater than 8%.
- Consideration for providing cycling space on narrow pavement surfaces.
- Should be marked with signs or other objects to be visible to motorists and plow operators.
- A lateral shift of at least one lane width and an angle of deflection of at least 45 degrees is a common industry target.
- Potential applicability would be context-specific and require more significant planning, design and capital costs that would best be implemented as part of road reconstruction projects and/or new developments.

Lane Narrowing

Effectiveness

Speed Reduction *(Up to 10 km/h)* — High

Volume Reduction — Low

Conflict Reduction — Med

CMF: N/A

Lane narrowing involves the reduction of lane widths through the use of pavement markings or other elements such as bicycle lanes, street beautification initiatives, or alterations in pavement texture. The objective is to make drivers perceive the road as less comfortable for higher speeds by narrowing the lanes, ultimately reducing operating speeds.

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets
Traffic Conditions	• All traffic volumes
Roadway	• Urban cross-section • Typically applied on two- and four-lane roadways

Advantages

- ✓ Reduces vehicle speed.
- ✓ Reduces conflicts if lane narrowing is physical.
- ✓ Reduces crossing distances for pedestrians and cyclists.
- ✓ Space can be used to provide cycling facilities in the boulevard.

Disadvantages

- ✗ Catch basins may need to be relocated.
- ✗ May shift centerline/ crown of the road.

Considerations for Implementation

- Effective when physical lane narrowing is implemented rather than pavement markings only.
- Target minimum lane widths as identified in the City of Vaughan's Complete Street Design Guidelines.
- Implementation should be subjected to a swept path analysis.
- Potential applicability would be context-specific and require more significant planning, design and capital costs that would best be implemented as part of road reconstruction projects and/or new developments.

Raised Median Islands

A center median is commonly used on divided roadways. It is typically a concrete or asphalt strip that separates opposing traffic lanes and is raised above the roadway surface. The raised center median serves multiple purposes, such as providing pedestrian refuge, preventing vehicles from crossing into opposing lanes, narrowing travel lanes, reducing conflict points by restricting access and improving the overall safety of the roadway. It provides a physical barrier that can help prevent vehicles from making left turns or U-turns in areas where those maneuvers are prohibited. Raised center medians can vary in width, height, and design depending on the specific traffic conditions.

Effectiveness

Speed Reduction *(3 to 8 km/h)* — Med

Volume Reduction — Low / Med

Conflict Reduction

CMF: 0.64 ★★★☆☆
(Source: Click Here)

Best Implemented In (Applicability)	
Road Classification	• Collector streets • Urban arterials
Traffic Conditions	• All traffic volumes
Roadway	• Urban cross-section – curb and gutter • Rural cross-section • Most effective on roads with two traffic lanes (one in each direction)

Advantages

- ✓ Reduces vehicle speed.
- ✓ Reduces pedestrian crossing distances and thus reduces conflicts.
- ✓ Enhances the appearance of the street if landscaped.
- ✓ Does not affect maintenance operations like snow plowing.

Disadvantages

- ✗ May require additional right-of-way that could result in parking loss.
- ✗ Restricts access to driveways.
- ✗ In constricted space, there may be insufficient space for cyclists.

Raised Median Islands

Considerations for Implementation

- Refer to the City of Vaughan's Complete Street Guidelines for target lane widths.
- Avoid intersections of two local streets.
- Consider combining with other treatments like curb extensions for increased effectiveness.
- Median landscaping should not obstruct pedestrian visibility.
- In cases where the median shifts vehicles closer to the curb, ensure overhead clearance from trees and utility poles for large vehicles.
- Should be marked with signs or other objects to be visible to motorists and plow operators. Each end of a raised median island section must have a Keep Right sign (Rb-25) to guide traffic to the right of the island. An Object Marker (Wa-33L) is considered optional but should be installed at locations where the visibility of raised median islands may be obscured for motorists.
- Raised median islands should have a minimum width of 1.5 m to adequately protect any signing required in the median and provide pedestrians with a minimum refuge area.
- The length of any individual median section at an intersection or midblock crossing should be a minimum of 5.0 m to 7.0 m. Its maximum length should be dependent on local factors such as the location of nearby driveways and adjacent intersections.
- Potential applicability would be context-specific and require more significant planning, design and capital costs that would best be implemented as part of road reconstruction projects and/or new developments.

Level 3 (Engineered) Measures: Vertical Deflection

Level 3 Vertical Deflection Measure Consists of:

- Raised Crosswalk (Mid-block)

Raised Crosswalks (Mid-Block)

A raised crosswalk is a type of pedestrian crossing elevated above the road surface to create a visibly enhanced pedestrian crossing point. This type of crosswalk is often used in areas with high pedestrian traffic. The raised surface helps to slow down vehicles and increases driver awareness of the presence of pedestrians.

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets • Commercial collector streets
Traffic Conditions	• Posted speed limit ≤ 50 km/h • All traffic volumes
Roadway	• Urban cross-section – curb and gutter

Effectiveness

Speed Reduction — High

Volume Reduction — Med

Conflict Reduction — High

CMF: 0.55 ★★★★★
(Source: Click Here)

Advantages

- ✓ Reduces vehicle speed.
- ✓ Increases vehicle yielding and reduces conflict as a result.
- ✓ Adds comfort for pedestrians with mobility devices since there is no change in elevation.

Disadvantages

- ✗ Could affect emergency vehicles response times.
- ✗ Could affect snow-clearing operations.

Considerations for Implementation

- Avoid emergency access routes, which can be used in commercial areas with high pedestrian activity.
- Design should be fully accessible and include Tactile Walking Surface Indicators (TWSIs).
- Requires Ra-4 and Ra4t Pedestrian and Stop for Pedestrians signs on both directions to alert drivers.
- Consider drainage such as catchbasins to avoid ponding.
- Avoid grades greater than 8%.
- A flexible delineator can be placed to alert snow plow operators.
- Avoid on bus routes.
- Locate at least 75m from a traffic signal.
- Accessible landing areas must be provided on each end of the crosswalk.
- Recommended at a controlled crossing such as PXO.
- Can be at an intersection or mid-block location.

Level 3 (Engineered) Measures: Intersection Treatments

Level 3 Vertical Deflection Measures Consist of:

- Raised Intersections
- Raised Crosswalks and Continuous Sidewalks (Intersection)
- Curb Radius Reductions
- Roundabouts/Mini-roundabouts/Traffic Circles

Raised Intersections

A raised intersection features an elevated section of pavement at the center, which forces drivers to slow down and creates a designated crossing point for pedestrians and cyclists. Raised intersections are often used in urban areas or residential neighbourhoods with high pedestrian and bicycle traffic levels. The elevated platform can help to increase safety for all road users, especially pedestrians and cyclists, by reducing vehicle speeds and providing a marked crossing area. They are less effective at stop-controlled intersections since motorists must stop, but they can help improve stop compliance.

Retrofit is not possible.

Effectiveness

Speed Reduction	Med
Volume Reduction	Low
Conflict Reduction	High

CMF: N/A

Best Implemented In (Applicability)

Road Classification	• Local streets • Collector streets • Commercial collector streets
Traffic Conditions	• Posted speed limit ≤ 50 km/h • All traffic volumes
Roadway	• Urban cross-section – curb and gutter • May be more effective for signalized intersections than all-way stop controlled intersections.

Advantages

- ✓ Reduces vehicle speed.
- ✓ Increases vehicle yielding and reduces conflict as a result.
- ✓ Could include aesthetic improvements.

Disadvantages

- ✗ Could affect emergency vehicles response times.
- ✗ Could affect snow clearing operations.

Considerations for Implementation

- A flexible delineator can be placed to alert snow plowing operators.
- Requires the installation of WA-50 Speed Hump sign.
- Retrofit is not possible; must be designed from the beginning.
- Needs to be designed for AODA compliance.

Raised Crosswalks and Continuous Sidewalks

A raised crosswalk is a type of pedestrian crossing elevated above the road surface to create a visibly enhanced pedestrian crossing point. This type of crosswalk is often used in areas with high pedestrian traffic. The raised surface helps to slow down vehicles and increases driver awareness of the presence of pedestrians. The surface of the pedestrian walkway is a flat top at the same level as the sidewalks that provide access to the pedestrian crossing. As such, pedestrians can cross the roadway without encountering curb ramps, and motorists have to ramp over that crossing.

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets • Commercial collector streets
Traffic Conditions	• Posted speed limit ≤ 50 km/h • All traffic volumes
Roadway	• Urban cross-section – curb and gutter

Effectiveness

Speed Reduction	High
Volume Reduction	Med
Conflict Reduction	High

CMF: 0.55 ★★★★★
(Source: Click Here)

Advantages

- ✓ Reduces vehicle speed.
- ✓ Increases vehicle yielding and reduces conflict as a result.
- ✓ Adds comfort for pedestrians with mobility devices since there is no change in elevation.

Disadvantages

- ✗ Could affect emergency vehicles response times.
- ✗ Could affect snow clearing operations.

Considerations for Implementation

- Avoid emergency access routes, which can be used in commercial areas with high pedestrian activity.
- Design should be fully accessible and include Tactile Walking Surface Indicators (TWSIs).
- Consider drainage such as catchbasins to avoid ponding. Catch basins are required on the uphill side of a raised crosswalk.
- Avoid grades greater than 8%.
- A flexible delineator can be placed to alert snow plow operators.
- Avoid on bus routes.
- Locate at least 75m from a traffic signal.
- Accessible landing areas must be provided on each end of the crosswalk.
- Recommended at a controlled crossing such as PXO.
- Can be at an intersection or mid-block location.
- TAC Emerging Practice Briefing: Continuous Sidewalks and Bike Paths: https://www.tac-atc.ca/en/publications/epb-csbp-e

Curb Radius Reductions

A curb radius reduction involves reducing the turning radius, resulting in a tighter turn at street corners. This reduction forces vehicles to slow down when turning and takes up less space on the street, leading to more space for pedestrians, cyclists, and other road users.

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets • Low-volume arterial streets (with consideration of buses and heavy vehicles on truck routes)
Traffic Conditions	• All traffic volumes
Roadway	• Urban cross-section – curb and gutter • All number of lanes

Effectiveness

Speed Reduction High

(For right-turning vehicles)

Volume Reduction Low

Conflict Reduction Med

CMF: 0.558 *(Source: TES)*

Advantages

- ✓ Reduces vehicle speed.
- ✓ Reduced pedestrian crossing distance, thus reducing exposure and increasing queuing space.

Disadvantages

- ✗ Might pose a turning issue for large vehicles, including school buses and waste management vehicles.
- ✗ Adjustments to maintenance operating procedures may be required and lead to relatively high costs.

Considerations for Implementation

- A curb radius reduction should aim to introduce the smallest radius required to accommodate a passenger vehicle. Ensure larger, infrequent vehicles can make the turns. This can be verified with a swept path analysis.
- A truck apron can be considered where there are high volumes of trucks to narrow the radius for the more frequent passenger vehicles.
- Ensure that it does not affect emergency services.
- Can also be designed in conjunction with a curb extension beyond the intersection. To provide proper guidance to drivers and ensure that vehicles are correctly oriented, each curb extension at the intersection should be 5.0 to 7.0 m in length. Curb extensions that serve as bus stops must be long enough to accommodate the longest bus expected to use the street.
- Depending on the visibility of the curb extensions, the installation of Object Markers (Wa-33) may be considered to improve their visibility.
- Refer to the City of Vaughan's Complete Street Guidelines for target lane widths and turning radii. Target corner radii range from 4.0m to 9.0m, depending on street class and land use.

Figure 13: Auto Turn Analysis for Permanent Curb Radius Reduction With Design Vehicle

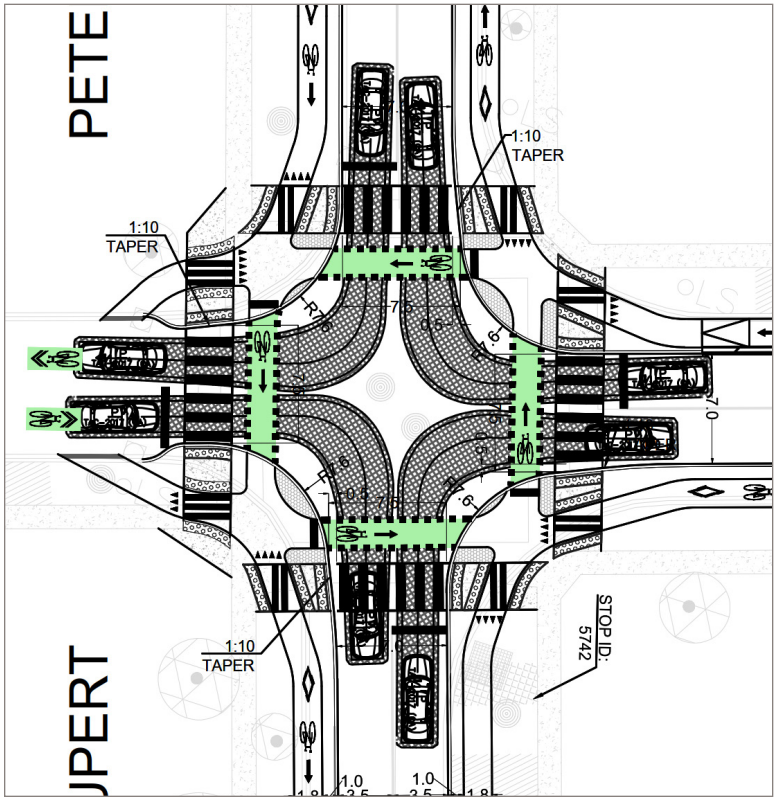
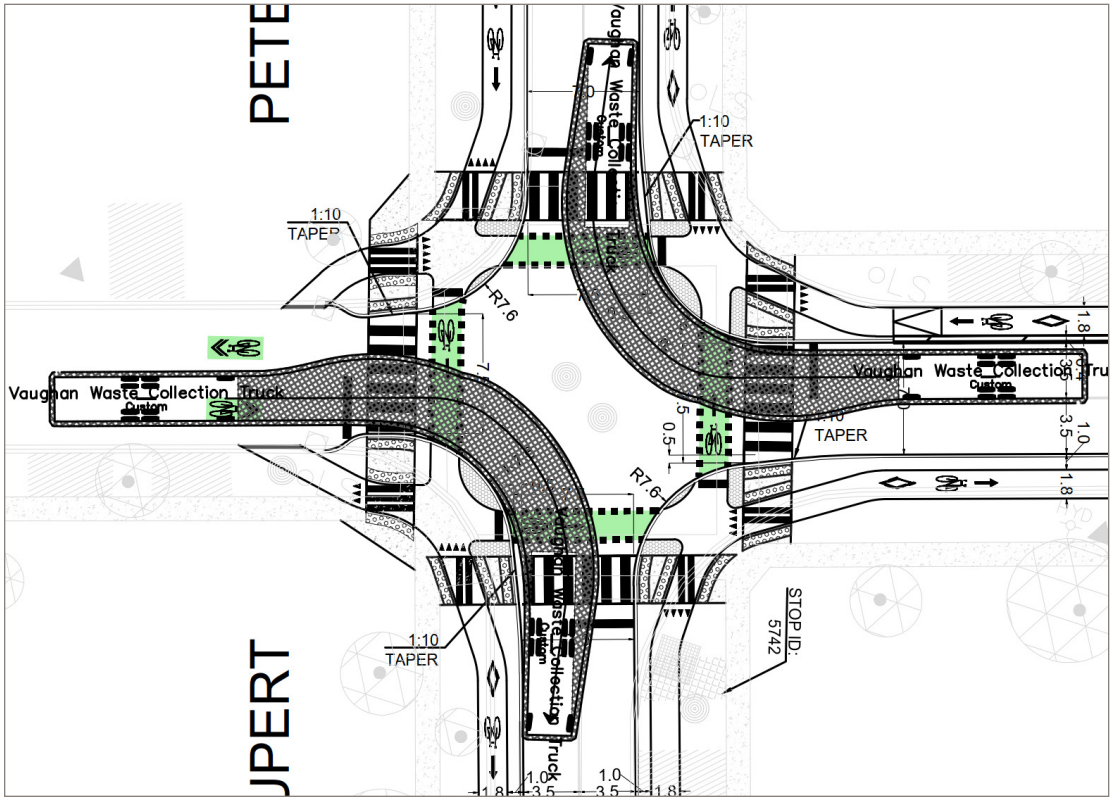


Figure 14: Auto Turn Analysis for Permanent Curb Radius Reduction With Control Vehicle (Vaughan's Waste Truck)



Roundabouts/Mini-Roundabouts/Traffic Circles

Roundabout

Mini-Roundabout

Traffic Circle

Effectiveness

Speed Reduction *(Up to 14 km/h)* — High

Volume Reduction — Low – Med

Conflict Reduction — Med

CMF: 0.22 from stop-controlled to **0.32** from signalized

Stop-controlled: Source

Signalized: Source

★★★☆☆

A mini-roundabout is a type of circular intersection smaller than a standard roundabout. They are typically used in residential neighbourhoods or rural roads to help control traffic and reduce speeds. While mini-roundabouts adhere to the design principles of full-size roundabouts with a smaller diameter (splitter islands and vehicle deflection on all approaches), traffic circles usually lack splitter islands on approaches.

Larger vehicles like trucks or emergency services can mount the truck apron, or traverse the centre island in the case of a mini-roundabout. Roundabouts have the added benefit of reducing the likelihood and severity of crashes, as they eliminate the potential for high-speed right-angle collisions.

Roundabouts/Mini-Roundabouts/Traffic Circles

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets
Traffic Conditions	• Posted speed limit ≤ 50 km/h • Traffic volumes greater than 1500 per day
Roadway	• Urban cross-section – curb and gutter or rural cross-section • Maximum two traffic lanes (one in each direction)

Advantages

- ✓ Reduces vehicle speeds.
- ✓ Decreased collision rates and severity.
- ✓ Could include aesthetic improvements.

Disadvantages

- ✗ Could have minor effects on snow clearing operations.
- ✗ Might pose a navigation issue for large vehicles, including school buses.
- ✗ Some education on how to use them may be required upon initial installation.

Considerations for Implementation

- Avoid intersections with high pedestrian volumes and when collector street traffic volumes are much higher than the intersecting street.
- Sightline consideration when landscaping the roundabout.
- Consider the use of pedestrian priority crosswalks in urban areas.
- An initial screening should be undertaken to determine if a roundabout is feasible based on preliminary costs, intersection spacing, approach grades, and available right-of-way, as a roundabout typically requires more property than a conventional intersection
- In retrofit situations, the construction process for a roundabout tends to be longer, more complex, and more likely to require temporary lane closures and detouring of traffic.
- If feasible, the roundabout alternative should be compared to signalization of the intersection based on traffic operations, safety performance, and construction and life cycle costs. Other less-quantifiable criteria may be looked at such as speed control, conditions for pedestrians and cyclists, accommodation of emergency services and transit vehicles, and access management.

Level 3 (Engineered) Measures: Specialized Implementations

Level 3 Specialized Implementation Measures Consist of:

- Gateways
- Textured Pavement
- Rumble Strips
- Access Restrictions: Right-in/Right-out Islands
- Access Restrictions: Directional Closures and Diverters
- Access Restrictions: Full Closures (School Streets)

Gateways

Effectiveness

Speed Reduction	Med
Volume Reduction	Low
Conflict Reduction	Med

CMF: N/A

A gateway feature encompasses a combination of traffic calming devices designed to establish an entry. These installations delineate transitional zones, such as the interface between commercial or rural areas and urban or rural residential zones, as well as villages or hamlets.

Best Implemented In (Applicability)	
Road Classification	• All roadways
Traffic Conditions	• All traffic volumes
Roadway	• Urban cross-section • Rural cross-section

Advantages

- ✓ Reduces vehicle speeds.
- ✓ May improve street appearance if designed to do so.

Disadvantages

- ✗ Continuous maintenance might be required for the pavement markings or textured pavement.

Considerations for Implementation

- Place gateways in speed transition zones for a gradual speed reduction.
- Might require pavement markings or textured pavement.
- Gateway entrance treatments may introduce fixed roadside object hazards, requiring compliance with clear-zone, structural, and protection standards.
- Ensure gateways are large enough to capture drivers' attention.

Textured Pavement

Effectiveness

Speed Reduction Low
(Recommended with other measures)

Volume Reduction Low

Conflict Reduction Med

CMF: N/A

Textured pavement refers to a type of roadway surface with a distinctive pattern or texture that stands out from the surrounding area. This contrasting texture is a visual cue for drivers to slow down and exercise caution while driving. The use of textured pavement helps enhance road safety by alerting drivers to potential hazards on the road.

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets
Traffic Conditions	• All traffic volumes (with consideration of surface type where there are buses and heavy vehicles)
Roadway	• Urban cross-section

Advantages

- ✓ Reduces vehicle speeds.
- ✓ Can improve street appearance.

Disadvantages

- ✗ Can be difficult to navigate on a bike.
- ✗ Can cause confusion for pedestrians with sight loss using a cane.
- ✗ Requires regular and costly maintenance.

Considerations for Implementation

- Stamped concrete and asphalt are preferred over unit pavers due to potential maintenance issues.

Rumble Strips

Rumble strips are raised bumps or grooves installed perpendicular to the direction of travel. They are typically used as a traffic safety feature to alert drivers when they are drifting out of their lane or approaching a hazardous or different condition. Transverse rumble strips can be installed at a midblock to prevent speeding or to alert drivers when approaching a pedestrian crossing.

Effectiveness

Speed Reduction	Med
Volume Reduction	Low
Conflict Reduction	Low

CMF: 0.56 ★★★★★
(Source: Click Here)

Best Implemented In (Applicability)

Road Classification	• Arterials • Collectors
Traffic Conditions	• All traffic volumes
Roadway	• Rural cross-section • Usually two traffic lanes (one in each direction)

Advantages

- ✓ Reduces vehicle speeds.
- ✓ Milled rumble strips require minimal to no maintenance.
- ✓ Notifies drivers if diverting off road, depending on placement of the strips.

Disadvantages

- ✗ Can cause a hazard for cyclists.
- ✗ Noise.

Considerations for Implementation

- Avoid locating within a 200 m radius of residential areas due to noise. Preference for locations where regulatory signs were not effective.
- Can be effective on rural roads, ideally in areas with good separation from nearby residences.
- Can be used to insinuate a change in the conditions ahead.
- To be considered when other signage has not been effective.

Access Restrictions: Right-In/Right-Out Islands

A right-in/right-out island is a raised triangular feature positioned at an intersection approach, impeding left turns and through movements to and from the intersecting street or driveway. While left turns and through movements for motor vehicles are restricted, bicycles are generally allowed to execute these movements from the side street. This can be facilitated through gaps or depressions or navigating around the island. The primary purpose of a right-in/right-out island is to deter shortcutting or through traffic.

Effectiveness

Speed Reduction	Low
Volume Reduction	High
Conflict Reduction	High

CMF: N/A

Best Implemented In (Applicability)	
Road Classification	• Local streets • Collector streets • Arterial streets
Traffic Conditions	• All traffic volumes (provided alternative routes exist with sufficient capacity to accommodate diverted traffic)
Roadway	• Urban cross-section – curb and gutter

Advantages

- ✓ Can enhance the appearance of the street if landscaped.

Disadvantages

- ✗ May interfere with snow plowing and garbage collection operations.
- ✗ May restrict access for residents.
- ✗ Adaption time will be required from residents.

Considerations for Implementation

- Ensure appropriate sight lines when designing.
- The right-turn radius into the protected street segment should be chosen such that a divisional island large enough to discourage left-turn effectively and through movements can be implemented.
- Must be in the traffic bylaw.

Access Restrictions: Directional Closures and Diverters

Effectiveness

Speed Reduction Low

Volume Reduction High

(Expected reduction of traffic volumes is proportional to the directional movement to be prohibited.)

Conflict Reduction High

CMF: N/A

A directional closure, also called a modal filter or diverter, is a calming measure that restricts vehicle access in one direction on a street or road using a physical barrier such as a bollard, planter, concrete island or other diverter. It helps to reduce speeds, improve safety, and discourage cut-through traffic in residential areas or create pedestrian-friendly zones in commercial districts. People walking or on bicycles can usually cross the closure in both directions. The primary purpose is to reduce traffic and discourage cut-through traffic through residential areas, school zones, or other areas where non-local traffic is undesirable. By providing a safe and accessible route for pedestrians and cyclists, directional closures can promote active transportation, effectively calm traffic and make streets safer for all road users.

Best Implemented In (Applicability)	
Road Classification	• Local streets at intersections with collector or arterial streets
Traffic Conditions	• <1500 vehicles per day for local streets • Use with caution for low volume collectors (1500-5000 vehicles per day)
Roadway	• Urban cross-section – curb and gutter

Temporary Measure

Access Restrictions: Directional Closures and Diverters

Advantages

- ✓ Reduces vehicle speed.
- ✓ Reduces conflict between users.

Disadvantages

- × May restrict access for residents.
- × Can enhance the appearance of the street if landscaped.
- × May interfere with snow plowing operations.

Considerations for Implementation

- Preferred implementation for vehicles exiting the street.
- Effect on other local streets should be reviewed. Consider a pilot project using quick-build materials to evaluate.
- Ensure that it does not interfere with emergency routes. Consider mountable or passable for emergency vehicles.
- Geometry will be assessed to ensure cyclists maneuver safely. Bicycle channels are typically provided through the diverter at a width of 1.5 m to accommodate the movement of cyclists.
- Encourage use with other measurements (e.g. neighbourhood bikeway) for an enhanced outcome.

Access Restrictions: Full Closures (School Streets)

Effectiveness

Speed Reduction	Low
Volume Reduction	High
Conflict Reduction	High

CMF: N/A

A full closure is a traffic-calming measure that completely blocks off a road or street to all motorized traffic. It is usually achieved using physical barriers like bollards or planters. Full closures are often used in residential areas, school zones, or pedestrian-heavy areas where traffic is deemed unnecessary or unsafe. By eliminating motorized traffic, full closures can create a three-way intersection from a four-way intersection to a three-way or convert a three-way intersection to a non-intersection. Gaps can be provided for cyclists or to allow for emergency vehicles.

Best Implemented In (Applicability)	
Road Classification	• Local streets at intersections or mid-block
Traffic Conditions	• All traffic volumes (provided alternative routes exist with sufficient capacity to accommodate diverted traffic)
Roadway	• Urban cross-section – curb and gutter

Advantages

- ✓ Effective for preventing cut-through traffic.

Disadvantages

- × May interfere with snow plowing and garbage collection operations.
- × May restrict access for residents.
- × May require parking removal.
- × Could interfere with motorists' perception of cyclists who may enter through the barriers.

Considerations for Implementation

- Avoid implementation if the design prevents emergency vehicles from accessing.
- When used at rural intersections – use posts or bollards.
- The effect on other local streets should be reviewed.

Education and Enforcement

Education and Enforcement Measures Consist of:

- Radar Message Boards
- Boulevard Signs/Silhouettes
- Education Campaigns
- Active and Safe Routes to School Program
- Community Safety Zones
- Automated Speed Enforcement

Radar Message Boards

Radar Message Boards (RMB), also known as speed display boards, are electronic devices that use radar technology to detect the speed of a passing vehicle and display that speed on an LED display. They are commonly used in areas where drivers need to be reminded to slow down and can effectively reduce drivers' speed and improve overall road safety. Regular maintenance and calibration are necessary to ensure their reliability. They can also activate a hazard symbol when a predetermined speed threshold is exceeded.

Effectiveness

Speed Reduction Med
(Between 3-14 km/h)

Volume Reduction Low

Conflict Reduction Med

CMF: 0.95 ★★★★☆
(Source: Click Here)

Best Implemented In (Applicability)

Road Classification	• All roadways
Traffic Conditions	• All traffic volumes
Roadway	• Urban cross-section • Rural cross-section

Advantages

- ✓ Reduces vehicle speeds.
- ✓ Less expensive than police enforcement.
- ✓ Portable units can be relocated easily.
- ✓ Increases driver's awareness of their surrounding

Disadvantages

- ✗ Drivers may not respond to its presence over time.
- ✗ May not be accurate on multi-lane roads.
- ✗ Requires regular maintenance.

Radar Message Boards

Considerations for Implementation

- The board needs to be installed on the side of the road facing upcoming traffic.
- Can be rotated to different locations across the City and combined with other quick-build measures such as speed cushions, Centerline Flexible Signs, and Curbside Bollards.
- Can be used in conjunction with manned speed enforcement.
- Effective in work zones, school zones, near shopping centers, and isolated hazard locations like deficient horizontal curves.
- A speed proportional to the speed limit to be used as the trigger speed for activating the sign.
- Ensure clear sightline design; implementation on curves is not recommended.
- Allow for adequate distance and time for the driver's reaction to the sign
- Sign design should limit driver's confusion.
- The active display text must be at least 200 mm high and clearly visible from any part of the approach lanes from distances between 45 m and 200 m.
- In rural areas without raised curbs, the device should ideally be installed 2 to 4 m from the edge of the outer travel lane.
- In urban or residential areas with raised curbs, the device should ideally be placed between 300mm to 2 m from the curb lane.
- Battery life should be considered, solar powered boards are an option, weather should be looked at when implementing these to avoid solar panel coverage.
- Board may be heavy to install.

Boulevard Signs/Silhouettes

Effectiveness

Speed Reduction	Low
Volume Reduction	Low
Conflict Reduction	Low

CMF: N/A

Best Implemented In (Applicability)

Road Classification	• Local, collector, and arterial streets in school zones
Traffic Conditions	• All traffic volumes
Roadway	• Urban cross-section • Rural cross-section

Bollards adorned with children's silhouettes serve as practical reminders for road safety. These markers act as visual guidelines strategically placed in areas where children are often present, prompting drivers to slow down and remain vigilant. The clear message emphasizes adherence to speed limits and responsible driving. By incorporating these silhouettes, communities establish a standard where road safety becomes a shared obligation, highlighting the importance of following regulations. These bollards symbolize a pragmatic approach to shaping driver behaviour and contribute to creating safer streets where children can engage in activities securely.

Advantages

- ✓ Reduces vehicle speeds in combination of other measures.
- ✓ Increases driver's awareness of their surrounding.

Disadvantages

- × Drivers may not respond to its presence overtime if overused.

Boulevard Signs/Silhouettes

Considerations for Implementation

- Keep the sign visible, preferably match to child-height.
- Locate where children are expected – community centers, parks, schools, etc.
- Silhouettes should not obstruct other signs from being visible or cause sightline issues.
- Efficiency is expected to increase with other quick-build measures such as centerline flexible signs and curbside bollards, planters, and temporary speed cushions.

Traffic Data Collection Guidelines for Placing Silhouettes:

- Silhouettes will be placed on collector roads or local roads where traffic data collection meets the criteria for 85th percentile.
- The placement of signage will be near parks, schools, and community centers that children usually visit.
- Signage will not be placed where it may obstruct the sightlines of driveways.
- They will be installed on streetlights or where there is no other street frontage, traffic controls, traffic lights, pedestrian crossings within sightline.
- The sign's height will be between 1.5m and 2.0m from the ground to the bottom of the sign.
- The placement of signage must not block maintenance boxes for associated streetlights.
- The signage will be rotated every 4 weeks.
- Finally, signage may be installed through these guidelines.

Education Campaigns

Targeted education campaigns aim to increase awareness of road safety issues through various initiatives. These campaigns can focus on several types of driver awareness, such as speeding, impaired driving, distracted driving, seatbelt awareness, and aggressive driving. Sometimes, targeted education campaigns are crucial to a comprehensive strategic road safety program.

Effectiveness

Speed Reduction	Low
Volume Reduction	Low
Conflict Reduction	Low

CMF: N/A

Best Implemented In (Applicability)

Road Classification	• Locally, community-wide, jurisdiction-wide
Traffic Conditions	• All traffic volumes
Roadway	• Urban cross-section • Rural cross-section

Advantages

- ✓ Increases driver's awareness.
- ✓ Could be inexpensive when used in parallel with media campaigns.

Disadvantages

- ✗ Drivers may not respond if no speed enforcement is put in place.

Considerations for Implementation

- Should be used in combination with other measures for increased effectiveness.
- Law enforcement should still be carried out.
- Effectiveness is associated with the duration of the campaign.
- Usage of signs as part of the campaign shall consider sightlines.

Active School Travel Program

The Active School Travel Program (AST) is a community-driven initiative to encourage the adoption of active transportation for daily school commutes, concurrently addressing traffic safety concerns.

Effectiveness

Speed Reduction	Low
Volume Reduction	Low
Conflict Reduction	Low

CMF: 0.83 ★★★☆☆

(Source: NHTSA CTW, Chap 8.2.2 Safe Routes to School)

Best Implemented In (Applicability)

Road Classification	• Local streets • Collector streets
Traffic Conditions	• All traffic volumes
Roadway	• Urban cross-section • Rural cross-section

Advantages

- ✓ Increases awareness.
- ✓ Encourages active transportation.

Considerations for Implementation

- Should be implemented in areas where children walk to school and gather for the school bus.
- Programming can supplement any physical changes to the street, such as pavement markings and signage.

School Streets

School Streets is a program that creates a safer, car-free environment in front of schools at the start and end of the school day to prioritize safe walking and cycling conditions for children, parents and school staff. They encourage greater levels of active school travel and independent mobility.

View the resources from 8-80 Cities for more information:
School Streets - 8 80 Cities

Community Safety Zones

A Community Safety Zone (CSZ) is a section of road designated through a by-law where public safety is a special concern, especially near schools, community centers, parks, or other places where people gather. Motorists who speed or break traffic rules in these zones face higher fines and penalties. Signs and pavement markings identify Community Safety Zones to alert drivers to slow down and be careful.

Effectiveness

Speed Reduction	Low
Volume Reduction	Low
Conflict Reduction	Low

CMF: 0.93 ★★★☆☆
(Source: Click Here)

Best Implemented In (Applicability)

Road Classification	• Local streets • Collector streets • Arterial streets
Traffic Conditions	• All traffic volumes
Roadway	• Urban cross-section • Rural cross-section

Advantages

✓ Motorists are likely to become more aware of pedestrians in these areas.

Disadvantages

× Additional measures are required to achieve speed reduction (enforcement, physical measures, education).

Considerations for Implementation

- To be implemented near parks, schools, community centers and other locations where pedestrians are expected.
- Area should be designated through a by-law passed by council.
- Enforcement and education are both vital to the success of the program.
- Review the road network to avoid traffic infiltration.

Automated Speed Enforcement

Speed enforcement is conducted using a camera and a device that measures how fast a certain vehicle is going. If a vehicle breaks the speed limit near the camera, the system takes a picture of the violation. An officer then looks at the picture and mails the vehicle's owner a ticket. The ticket has a picture of the license plate, the offence, and the fine. Usually, the owner of the vehicle gets the ticket within 30 days.

Best Implemented In (Applicability)	
Road Classification	• All roads
Traffic Conditions	• All traffic volumes
Roadway	• Urban cross-section • Rural cross-section

Effectiveness

Speed Reduction	High
Volume Reduction	Med
Conflict Reduction	Low

Advantages

- ✓ Very effective in achieving speed reduction.
- ✓ Minimal police resources required for enforcement.

Disadvantages

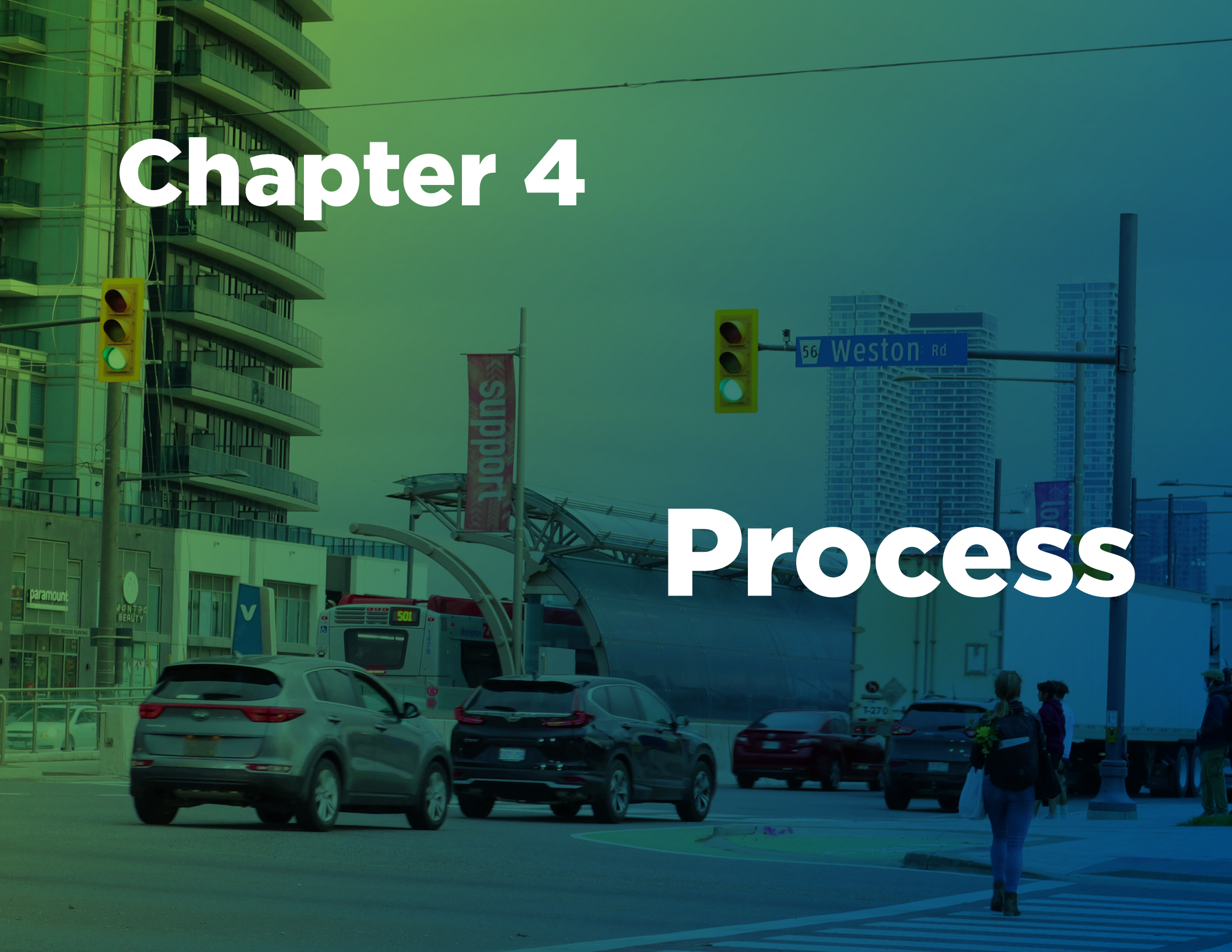
- × Considerable back-end resources to process violations (court staff, prosecutors, etc.)
- × Speed reduction for a short segment of the road; additional measures may be needed to get slower speed for longer segments.
- × May cause traffic diversion to other roads.

Considerations for Implementation

- The system should be properly calibrated and maintained periodically.
- The location of the cameras can be shared with the public and marked with a sign to alert and encourage speed reduction.
- Location to be selected post data collection and an indication of excessive speed in the area.

Chapter 4

Process



Stage 01

Initiation and Issue Validation

Step 1: Identification of traffic calming opportunities through various initiation streams.

Step 2: Screening identifies whether the specific locations can be considered for traffic calming based on road characteristics and other factors.

Stage 02

Candidate Selection

Step 3: Technical assessment based on collected traffic data for volumes and speeds.

Step 4: Candidate projects prioritization. City staff will rank projects in the current intake period and review any potential overlapping projects that could impact the traffic calming measures based on established scoring criteria.

Stage 03

Plan Development

Step 5: Measure selection will determined appropriate traffic calming treatments based on a risk assessment of each candidate's location. Measures may be implemented alone or in combination as part of a bundling of traffic calming measures to manage speed.

Step 6: Design development and cost estimate for implementation

Stage 04

Plan Implementation

Step 7: Implementation based on prioritization scoring and subject to available budget and resources

Step 8: Verification the installations and identify any required adjustments.

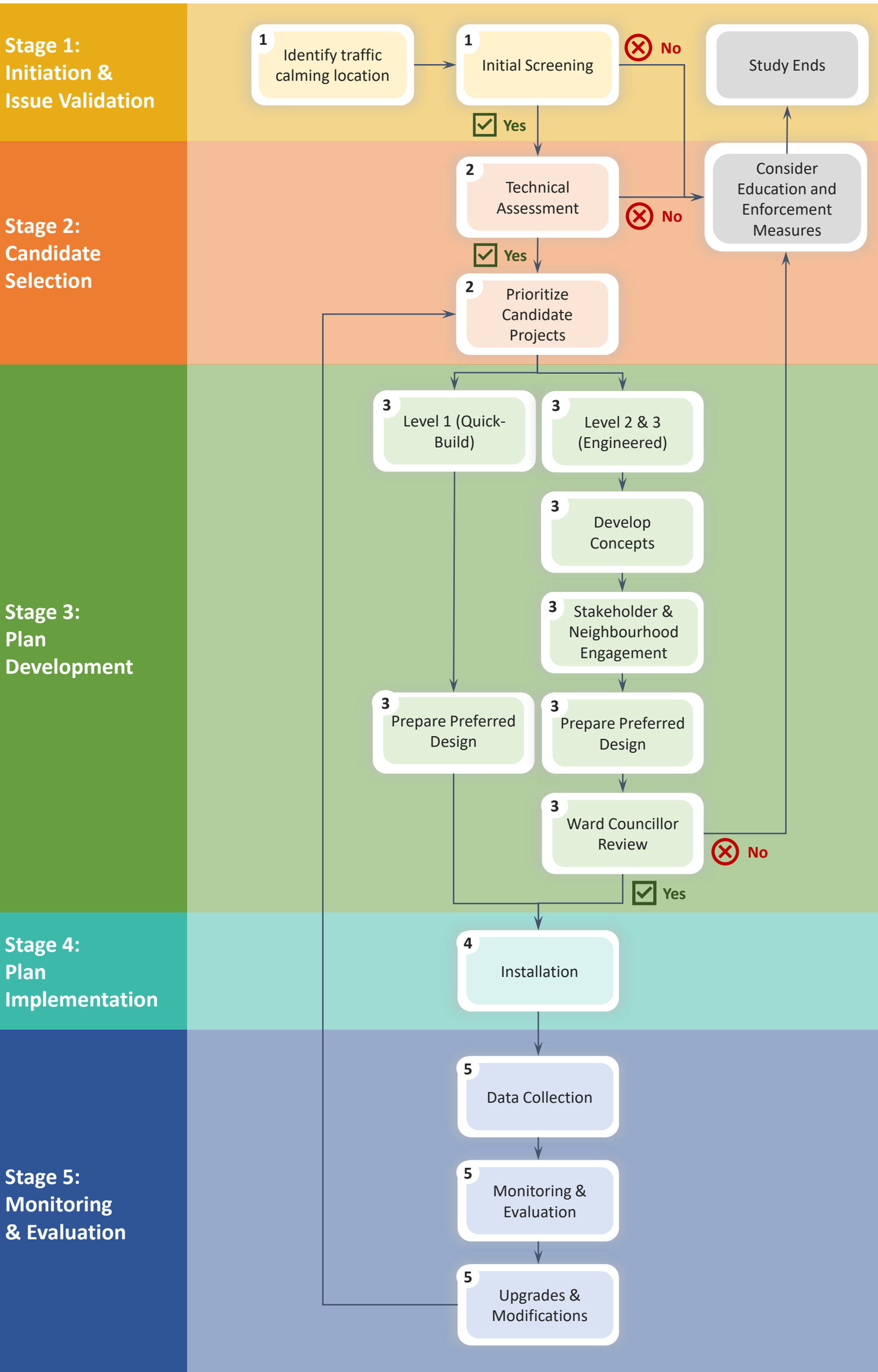
Stage 05

Monitoring and Evaluation

Step 9: Post-installation data collection to assess behaviour change and measure effectiveness

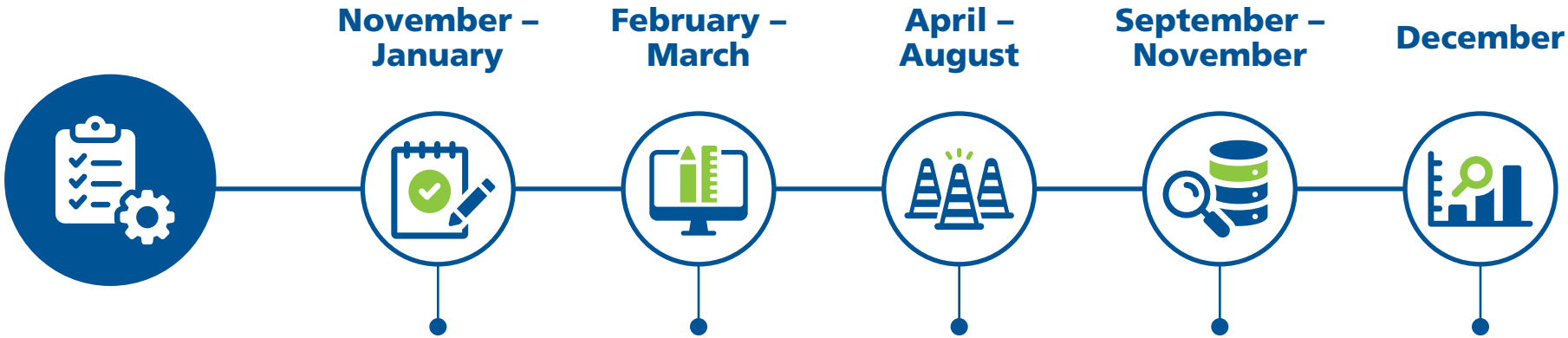
Step 10: Evaluation of traffic calming effectiveness, comparing pre- and post-installation data.

Traffic Calming Process



Traffic Calming Program Time Frame

The traffic calming program steps take place over the following periods:



Request Intake and Issue Validation Period:

Traffic calming requests are accepted and evaluated throughout the year. Any request submitted after October 31st will be considered for candidate project selection on a case-by-case basis, with preferred implementation the following year.

Project Selection Period:

Candidate projects are reviewed and prioritized.

Plan Development For Quick-Build:

Preferred design to be confirmed and secure vendor products.

Implementation:

Install quick-build measures.

Data Collection:

Collect data at least 4-6 weeks from the completion of installation.

Monitoring and Evaluation:

Prepare monitoring and evaluation report for quick-build installations completed in the calendar year and include results in the Annual MoveSmart Mobility report (spring of the following year).

Level 1 & 2

*Level 3 projects are based on upcoming capital works, scope and budget availability.

Monitoring and Evaluation

Following implementation, traffic calming measures will be monitored according to the Traffic Calming Procedures. Follow-up studies will assess effectiveness, and results will be communicated through the Annual MoveSmart Report.

One-time post-installation data collection for speed and traffic volume commences no sooner than four weeks after the installation of traffic calming measures, allowing for a minimum four-week waiting period to facilitate drivers' adjustment to the changes in roadway design and assess reductions in speeds. Data should be collected during typical traffic patterns, e.g., avoid school holidays if the installation is near a school.

There are two types of data:

- **Single-Point Speed Studies:** Identify the range of speeds at a specific location using radar or multi-tube vehicle counters
- **Speed Profiles:** Show the range of speeds found along a street, showing where vehicles speed up or slow down along a corridor. This data is available from third-party providers.

The following metrics should be collected:

- **Average Speed:** The speed at which 50% of motorists are travelling at or below. This is used as an indicator of the speed of a typical driver, rather than the fastest driver.
- **85th Percentile Operating Speed:** The speed at which 85% of motorists are travelling at or below, and is exceeded by the fastest 15% of vehicles. This is used as an indicator to determine if motorists are travelling at an excessive speed along a road in relation to the posted speed.
- **95th Percentile Operating Speed:** Similar to the 85th percentile speed, the 95th percentile is the speed exceeded by the fastest 5% of vehicles. This is used as an indicator of high-end speeding in relation to the posted speed. It determines if motorists are racing along a roadway, and is the speed of which the most significant violators are travelling.
- **Average Daily Traffic (ADT):** The estimate of motor vehicle traffic traveling on the road or laneway, averaged over the number of days of data collection. The ADT is used to confirm that the roadway meets the eligibility criteria for daily traffic volume.

Table 3: Monitoring and Evaluation of Level 1, 2, and 3 Measures

Level 1 Measures	Level 2 and Level 3 Measures
For Level 1 traffic calming measures, the City will evaluate traffic calming effectiveness, comparing pre- and post-installation data. Based on the evaluation results, the City will determine if the location would be a candidate for permanent Level 2 or 3 measures or if any modifications are recommended to maintain Level 1 measures. A decrease in the 85th and 95th percentile speeds from pre- to post-installation that is at or close to target speeds is indicative of effective speed management and a candidate for an upgrade to Level 2 or 3 measures. Public feedback on Level 1 traffic calming measures will be passively collected and included in the evaluation.	The City will evaluate the effectiveness of Level 2 and 3 traffic calming measures after installation and document lessons learned. The City will add the associated traffic calming devices to City's GIS database for inclusion in the asset management process.

Asset Review

An asset evaluation of the City's over 400 traffic calming devices currently in operation, including speed humps, raised crosswalks, bump-outs, curb extensions, intersection medians, roundabouts, and chicanes, was carried out in 2022. The review assessed the physical condition of existing devices, compliance with accessibility standards, as well as the effectiveness of existing measures based on roadway characteristics and local context.

Based on the batch review results, one of the following five actions was recommended for each current traffic calming device:

- **Keep as is:** No issue is identified with the subject device, and no action is required.
- **Repair:** There is physical deterioration that needs to be fixed. The physical deficiency may include cracked pavement, faded pavement markings, or missing or incorrect signage.
- **Relocation:** The device is located at an improper location. For instance, a speed hump located within 75 m of another traffic control device, or conflicting with private driveway access, would be considered for relocation.
- **Replacement:** The device is not considered to an effective traffic calming device or is constructed based on substandard design. For example, a speed hump along an emergency services route would be recommended to be replaced with speed cushions at the end of its lifecycle or time of road renewal.
- **Removal:** The traffic calming measure is found to be ineffective in managing vehicular speed or has created a negative safety impact that cannot be corrected or rehabilitated.

New permanent traffic calming devices (Level 2 and 3) should be added to the City's GIS asset inventory. Values for the evaluation criteria established as part of the asset management review are found in Appendix A. Existing permanent traffic calming measures will remain in place until the asset is subject to a condition assessment and/or lifecycle review, programmed every 5 years.

Appendix A – Speed Limit Policy

Complementing MoveSmart, the City has also established a comprehensive Speed Limit Policy. This policy applies to all City roads within four primary zones: rural roads, built-up/urban areas (including school zones), public laneways, and designated 40 km/h neighbourhood areas. The following table summarizes the application of the policy in each zone, ensuring consistent and effective speed management across Vaughan. **Table 1** summarizes the application of the policy in each zone.

Table 1: Speed Limit Policy Application for Each Zone Type

Primary Zone Type	Policy Application
Rural Roads	Statutory speed limit of 80 km/h until there has been significant redevelopment of the adjacent land use. In tandem with the speed limit policy, rural roads should be reviewed using TAC (2009) Guidelines for Establishing Posted Speed Limits.
Built-up/Urban Areas	Statutory speed limit of 50 km/h on all urban roads. Maximum 40 km/h for roads that meet Criteria "A" and "B" set out in the policy.
School* Zones	Maximum 40 km/h
Public Laneways	Maximum 30 km/h
Neighbourhood Areas	40 km/h speed limit where at least 50% of roads meet criteria of Build-up/Urban areas or School Zones. Potentially applicable to all local and collector roads in urban areas, while not applicable on arterial or major collector roads unless currently posted at 40 km/h.

**Including parks and walkways connected to schools*

Appendix B – Asset Management Evaluation Criteria

Table 1: Evaluation Criteria for Existing Physical Conditions

Evaluation Criteria	Description & Value
Visibility of Pavement Markings	any faded or missing pavement markings *adequate* | *poor* | *n/a*
Visibility/Validity of Signage	any hard-to-see or missing signs, incorrect placement, incorrect or ineffective signage *adequate* | *poor* | *n/a*
Physical Deterioration	any damaged civil elements (e.g., pavement, curb etc.) *adequate* | *poor*
Roadway Curvature/Sightlines	any significant sightline issues *adequate* | *poor*
Grade Change Concern	any obvious grade difference (i.e., grade >8%) *no* | *slight* | *significant*

Table 2: Evaluation Criteria for Design Standard Compliance

Evaluation Criteria	Description & Value
Design Standard Compliance	whether the device complies with ITE/TAC or City design standards *yes* | *no*
Clear Width	whether there is a properly sized gap (i.e., max. 0.5m) between curb face and edge of device, specifically for speed humps and speed cushions *adequate* | *poor* | *n/a*
Tactile Surface Treatment	whether there are proper tactile surface treatments (where necessary) per AODA requirements *yes* | *no* | *n/a*

Table 3: Evaluation Criteria for Local Context

	Evaluation Criteria	Reference	Value
Roadway Characteristics	Roadway Classification	Schedule 9 of City of Vaughan Official Plan	*major arterial* | *minor arterial* | *major collector* | *minor collector* | *local*
	Existing Posted Speed Limit	Google Street View and Neighbourhood 40 Zone maps	numeric, in km/h
	Effective Roadway Width[1]	Measurement from Google Maps	numeric, in metres
	Number of Lanes[1]	Google Maps	numeric
	Average Lane Width[1]	Calculated as roadway width divided by number of lanes	numeric, in metres
	Sidewalk	Google Maps	*no* | *one side* | *two sides*
	Street Parking	Google Maps	*no* | *one side* | *two sides*
	Bike Facility Type[2]	Google Maps	*shared* | *designated* | *protected*
	Transit Route	YRT System Map (November 2022)	*no* | *existing local transit route* | *existing rapid transit route* | *future rapid transit route*
	Emergency Service Route	EMS Route Map	*yes* | *no*
	Control Device[3]	Google Maps	*signal* | *all-way stop control* | *two-way stop control* | *none*
Local Context	Density of Residential or Commercial[4]	Google Maps	*high* | *low* | *commercial*
	Route to School[5]	Google Maps	*yes* | *no*
	Route to Parks/Sport Fields[6]	Google Maps	*yes* | *no*

Notes:

1. *Not include bike lane or parking lane*
2. *As advised by the City, all City roads are defined as shared cycling routes.*
3. *Input is needed only when the device is located at intersection.*
4. *For residential, "high" for residential buildings with a height of more than or equal to three storeys, and "low" for all other residential uses; "commercial" if there are any adjacent commercial uses regardless of density.*
5. *"yes" for locations along school frontage or off-school frontage but <800m from school site*
6. *"yes" for location <800m from park and/or sport fields*

Appendix C
In-Road Flexible Sign and Bollard Program Guidelines

Transportation and Fleet Management Services

January 2024

Overview

As part of the City's role and mandate to build and maintain safe and efficient road systems for all road users, the City's transportation initiatives are in a state of expansionand transition with more urbanization taking place. The framework was laid out as part of the City's *MoveSmart Mobility Management Strategy* and Council motion: *Endorsing Road Safety As A Priority In School Zones And Community Areas*.

The vision of the MoveSmart Mobility Management Strategy is to provide a transportation system that is safer, more efficient, and sustainable. Together with input from the community, the MoveSmart Mobility Management Strategy forms a plan to support the City's commitment to transportation and mobility across the City for all roadusers.

As part of the City's MoveSmart Mobility Management Strategy, a comprehensive Speed Limit policy is also being used as a speed management tool to set and adjustappropriate speed limits throughout the City's street network.

The purpose of this guide is to provide an overview of In-Road Flexible Signs as an alternative traffic calming method and provide guidance for when and where they canbest be used to have the greatest success of reducing driver speeds where they are travelling too fast.

What are In-Road Flexible Signs and Bollards?

In-road flexible signs and bollards are flexible signs or posts installed on the road, between opposing traffic lanes or at the edge of lanes, for traffic calming purposes.They are designed to:

- Have a narrowing effect on the lane or roadway which can give drivers the perception of the need to slow down.
- Serve as supplemental signage to existing roadside speed limit signs to remind motorists to not exceed the posted speed limit, or warning function such as special zone or traffic control devices ahead (for example: yield to pedestrians,school zone, or pedestrian crossing).
- Collapse and rebound if struck by a vehicle, thereby withstand impacts and averting damage to vehicles.

Figure 1 shows the types of flexible signs and placement considerations:

- **Centreline Sign**: 0.3 m wide, 1.2 m high, positioned between opposing lanes
- **Curbside Bollard**: 0.1 m wide, 1.2 m high, positioned between the curb and vehicular travel lane
- **Lane Width:** Target 3.0 to 3.5 m, depending on context

- **Clear Width**: Width between flexible signs, typically 0.2 m less than lane width ifsigns placed directly on lane lines
- **Edge Width**: 1.2 to 2.0 m; could be more if hatched buffer is used; Meets operating space requirements for cyclists
- **Spacing**: 60 m to 120 m depending on the desired speed

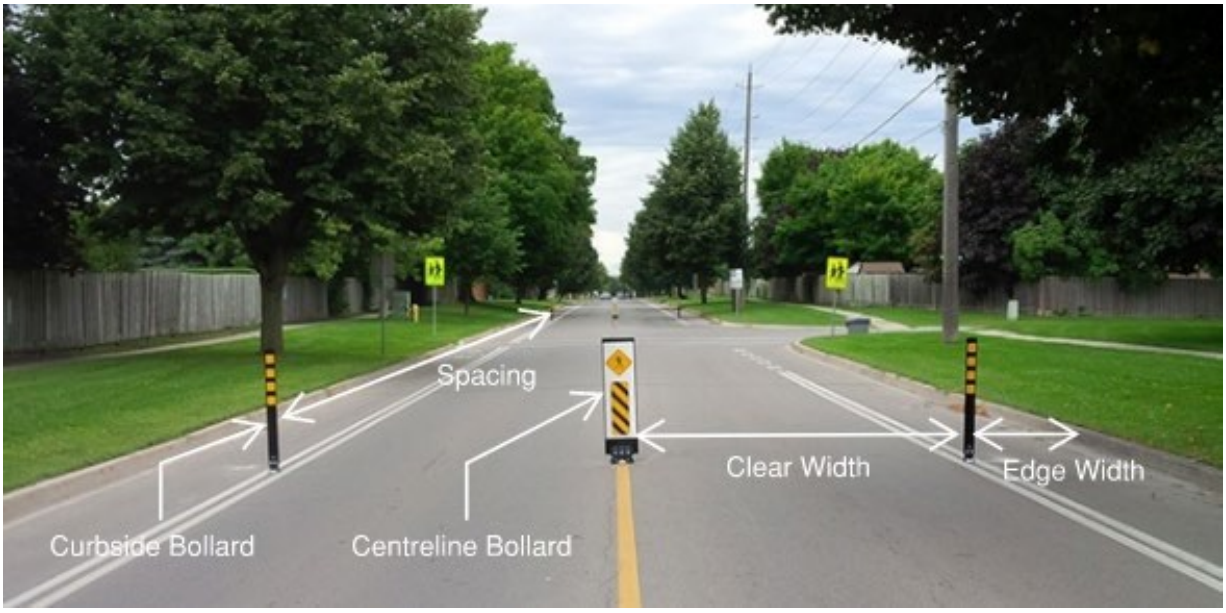


Figure 1: Sign Types and Placement Considerations

1. In-Road Flexible Sign Criteria

If the screening criteria in **Table 1** is satisfied, the design can proceed. Otherwise, it isnot a suitable candidate location.

Table 1: Screening Criteria

Factor	Criteria	Pass	Fail
• Road typology	• Two-lane road with a speed limit ≤ 50 km/h		
• Operating speed	• Existing 85th percentile vehicular operating speeds 7 km/h or more above the posted speed limit.		
• Location	• Within built-up / urban areas, school zones or neighbourhood areas		
• Segment length	• ≥ 150 metres between stop-controlled intersections		
• Overlapping projects	• Ensure the installation does not impact any other near-term planned work on the street in which lane widths may be affected (e.g. new parking, new sidewalk/bike lane, etc.). by contacting the relevant internal/external departments		

Table 2 provides site specific design criteria for sign placement and other considerations.

Table 2: Site Specific Sign Placement

Factor	Criteria	Comments
Driveways	**1.5 m minimum** clearance distance from edge of a residential driveway (See **Figure 2**)	• Based on AutoTURN analysis of turns from residential driveways shown in Appendix A. • This clearance also helps waste collection vehicles get closer to the driveway. • When identifying specific placement and layout of the flexible signs and bollards, conditions to consider include on-street parking activity, proximity to private driveways, and transit stops. While the devices are intended to withstand low-speed impacts, effort should be made to avoid such conflicts.
Intersections	**16.0 m minimum** clearance distance from curb line of an intersection (See **Figure 2**)	• Based on AutoTURN analysis of Heavy Single Unit (HSU) and B-12 bus turns shown in Appendix A. • Turning movement may have been investigated and justified for site specific geometry, if needed.
Lane Widths	**3.0 to 3.5 m** target width, depending on context	• Narrowed lane widths of 3.5 m must be achievable through application of the flexible signs and bollards without impeding transit and service vehicles. It is noted that transit vehicles, EMS, and service vehicles can pass within a 3.0 m lane. The physical width of these vehicles is no more than 2.6 m, and it is it acceptable to allow a mirror to overhang a sign. • For lane widths greater than 3.5 m, the application may not achieve the desired motorist response and it may be preferable to consider other traffic calming measures. • Edge line pavement markings can be implemented prior to edge bollard installation to achieve the desired lane widths. • Local streets often do not have formal lane markings. It is acceptable to add flexible signs without a centreline if the minimum travel width is provided. • Consider space requirements for winter operations if the flexible signs are intended to be left in place year-round.
Horizontal Curves	Flexible signs shall be **installed at the entrance or exit of a horizontal curve** in the road where feasible, with illumination	• Flexible signs placed within or adjacent to a curve are prone to repeated vehicle impacts and reduced asset life. • Avoid installing flexible signs where there could be a potential sight line issue, such as on a steep grade or on curves.
Parking	**2.4 m minimum** from road curb	• Edge bollards are not recommended for streets with heavy parking. An analysis of parking activity should be conducted during data collection. • If there is inadequate width, either eliminate parking in the vicinity of the sign OR try to install the edge bollard where parking is naturally banned (such as at a bus stop or fire hydrant)

Mailboxes	Flexible signs shall be installed 5m from existing and planned Canada postmailboxes.	• Installation of flexible sign shall be restricted from being placed no more than 5m from an existing or planned Canada Post mailbox. • Flexible signs shall be installed in a way that does not obscure the visibility of the existing Canada Post mailbox. • Any flexible sign must provide a clear path of travel to the Canada Post mailbox.
Priority Areas	Install near **parks, schools, seniors' residences, community centers** as part of the MoveSmart Strategy	• Avoid installing flexible signs and edge bollards directly adjacent to potentially busy areas with high parking turnover (such as community mailboxes or adjacent to a school where there is lots of pick-ups/drop-offs). • Installation of flexible signs shall not damage or disrupt nearby services, utilities or infrastructure.

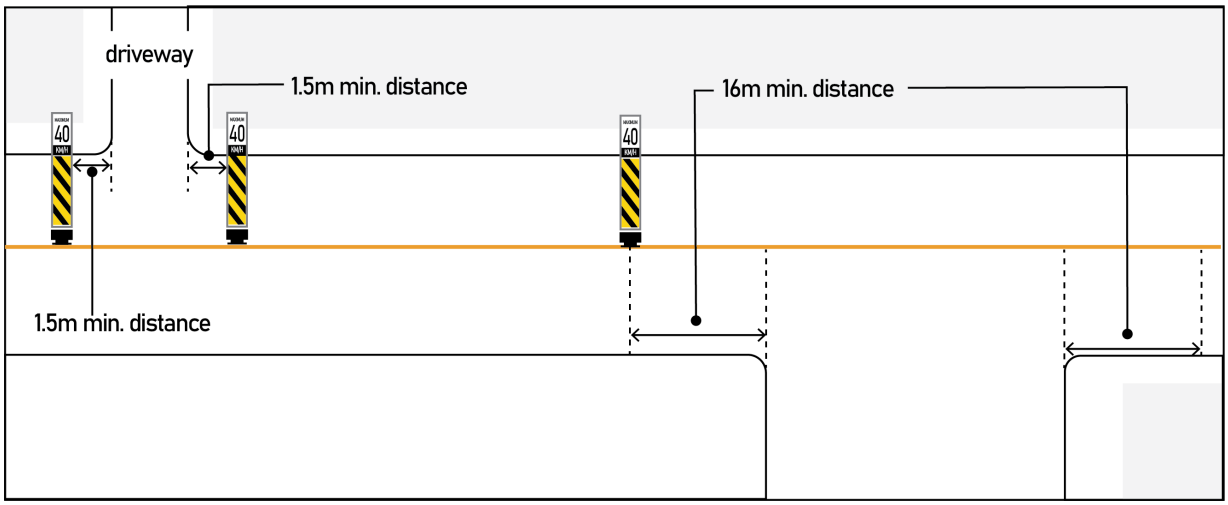


Figure 2: Minimum Distance from Driveways and Intersections

1.1 Winter Screening Criteria

1) **A minimum pavement width of 11.5m, assuming the center line is centered,** is recommended, accounting for parking areas, snow islands around flexible signs, and curb snow banks.

Monitoring and clearing of snow on the heavily shaded south and west side of the roadway is recommended, as lack of sun exposure may result in increased snow bank intrusion onto roadways.

2) Flexible signs should be set back at least **16.0m from intersection crosswalks** to avoid impacting pedestrian crossing due to snow islands.

3) A **16.0m set back from driveways** is recommended for flexible signs, as snow islands may impact accessibility into driveways.

4) Only centreline flexible signs will be considered during the winter months due to snow clearing requirements.

2. Scenarios

Table 3 and **Figure 3** show various configurations for installation of in-road flexible signs for traffic calming purposes.

Table 3: Road Configuration Scenarios

Scenario	Road Width	Configuration
1 – no parking lane	6.0 – 8.5 m	• 3 m – 4.25 m travel lanes • Centreline flexible sign • If edge bollards are installed, cyclists should be positioned inthe centre of the lane with traffic as there is insufficient operating space for cyclists in an edge lane. • An alternative configuration is having two edge bollards with two-way traffic in between and without centreline flexible sign
2 – no parking lane with edge line (or bike lane) on one side	7.5 – 9.0 m	• 3.0 m - 3.5 m travel lanes and 1.5 m – 2.0 m edge line (or bike lane) on one side with curbside flexible sign on one or both sides • An alternative configuration is having two edge bollards with two-way traffic in between and without centreline flexible sign
3 – edge lines orbike lanes on both sides	9.0 – 12.0 m	• 3.0 m - 3.5 m travel lanes and 1.5 m – 2.5 m edge lines or bike lanes on both sides • Centreline flexible sign and two edge bollards
4 – parking lanes on bothsides	11.0 – 12.0 m	• 3.1 m - 3.5 m travel lanes with parking lanes on both sides • Centreline flexible sign • Edge bollard while maintaining a minimum 2.4 m width for parkingwhere parking utilization is not heavy

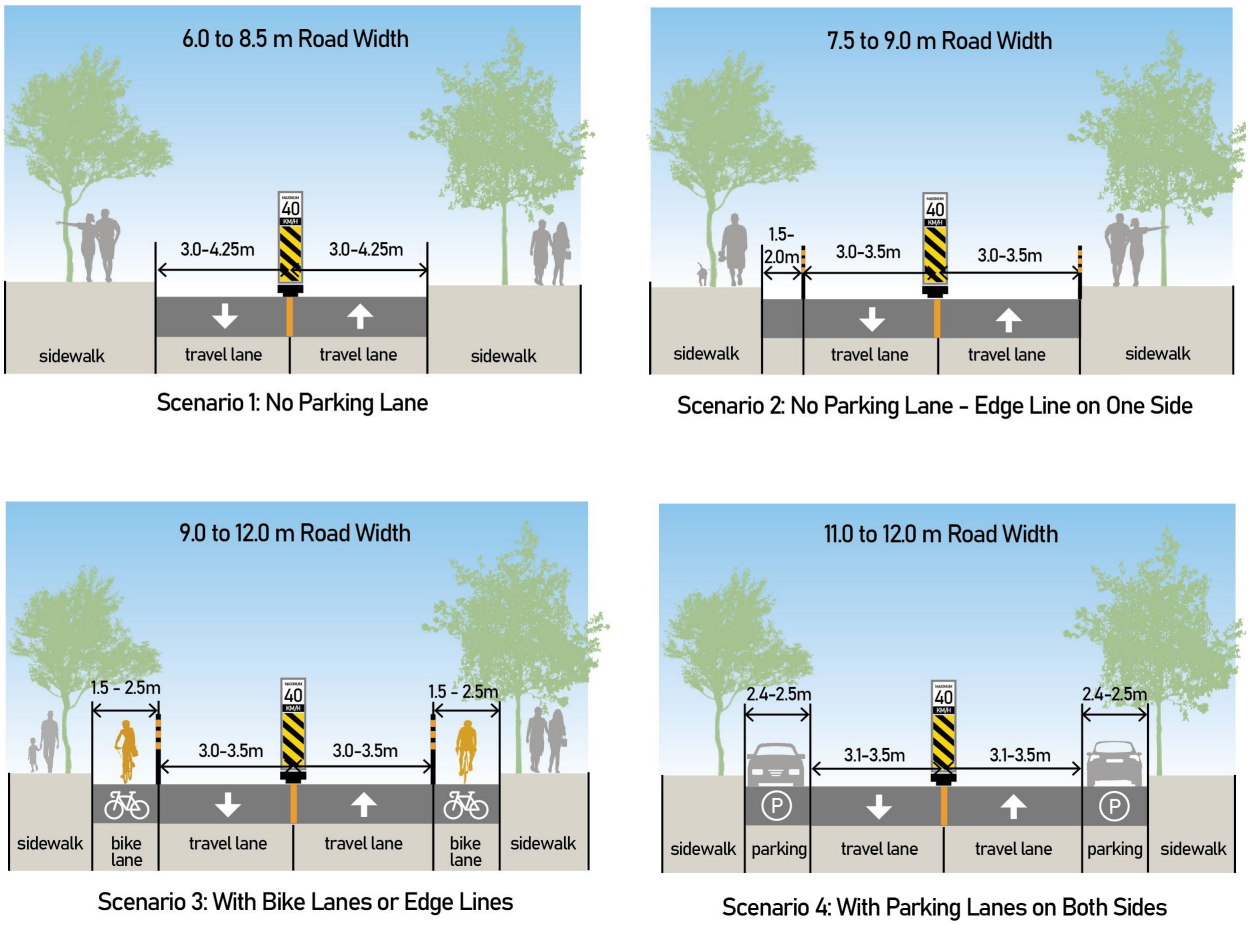


Figure 3: Road Configuration Scenarios

3. Monitoring and Evaluation

- Prior to installation of flexible signs and additional traffic calming measures, speed and volume data is to be collected at peak hours and weekend times, including parking activity.
- Data collection locations shall be consistent with pre- and post- installation of flexible signs.
- Once flex signs and supplementary signage/pavement markings have been installed, an evaluation of effectiveness is to be conducted after 60 days including:
    - A follow-up speed and volume study at the location at peak hours and weekends.
    - Comparison of existing and post speed data to determine effectiveness.

Table 4 provides some suggested measures of effectiveness to compare pre- and post-installation of flexible signs for traffic calming purposes.

Table 4: Measures of Effectiveness

KPI	Before	After	Difference	% Change
Average Speed				
85th Percentile Speed				
95th Percentile Speed				
Average Daily Traffic				

Metrics:

- **Average Speed**: The speed at which 50% of motorists are travelling at or below. This is used as an indicator of the speed of a typical driver, rather than the fastest driver.
- **85th Percentile Operating Speed**: The speed at which 85% of motorists are travelling at or below, and is exceeded by the fastest 15% of vehicles. This is used as an indicator to determine if motorists are travelling at an excessive speed along a road in relation to the posted speed.
- **95th Percentile Operating Speed**: Similar to the 85th percentile speed, the 95th percentile is the speed exceeded by the fastest 5% of vehicles. This is used as an indicator of high-end speeding in relation to the posted speed. It determines if motorists are racing along a roadway and is the speed of which the most significant violators are travelling.
- **Average Daily Traffic (ADT)**: The estimate of motor vehicle traffic traveling on the road or laneway, averaged over the number of days of data collection. The ADT is used to confirm that the roadway meets the eligibility criteria for daily traffic volume.

Appendix A – Swept Path Analysis

Driveways

The minimum offset from driveways to centreline flexible signs is recommended to be **1.5 m**, based onthe movements shown below:

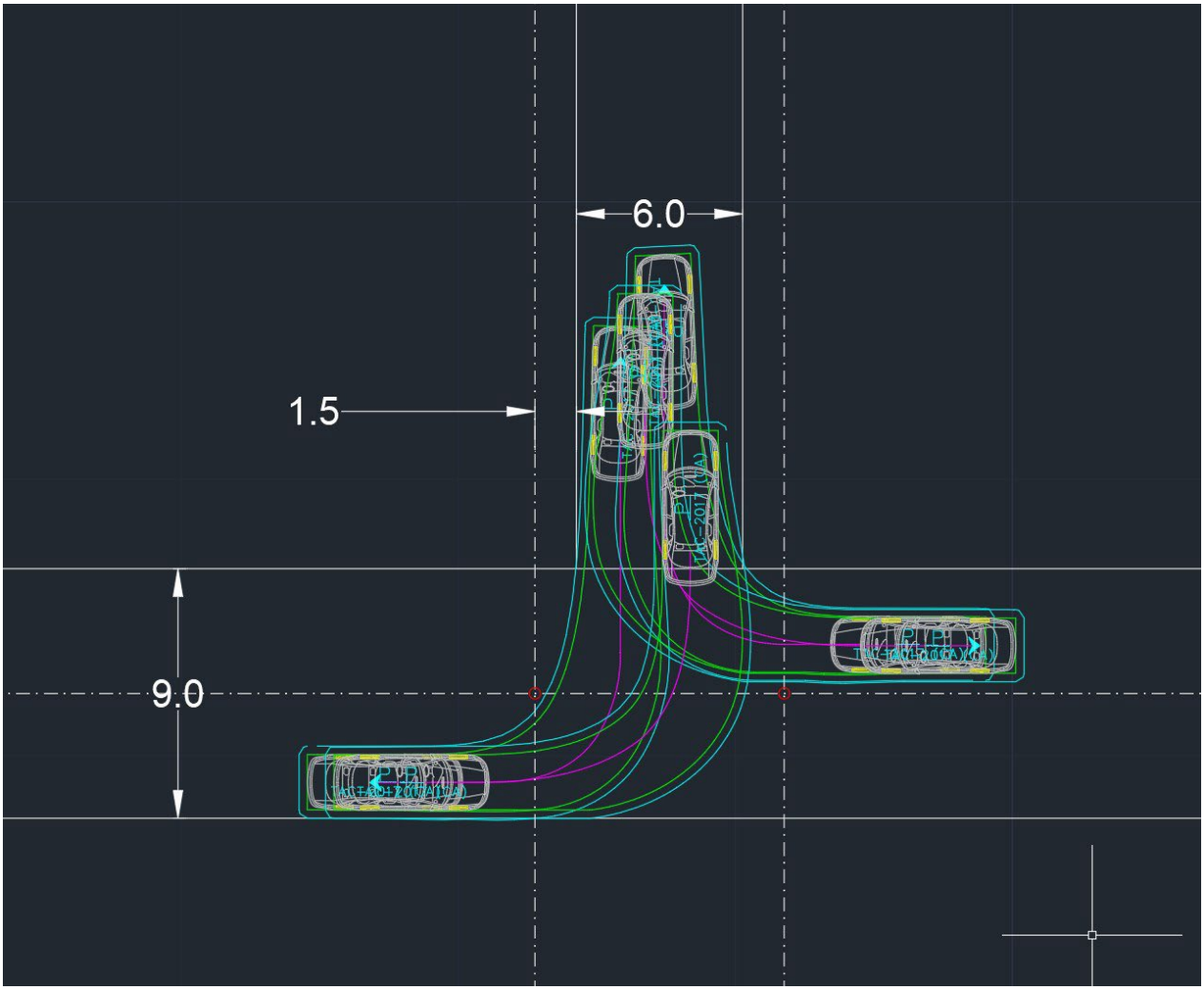


Figure A-1: Swept path analysis showing passenger vehicle completing turn from 6.0 m wide driveway to 9.0 m wide roadway with centreline flexible signs offset 1.5 m from the edge of driveway.

Intersections

The recommended offset from intersections is 16 m, measured from curb line. Below is the swept path analysis for a Heavy Single Unit (HSU) truck and B-12 bus, showing turns made at 10 km/h within this distance.

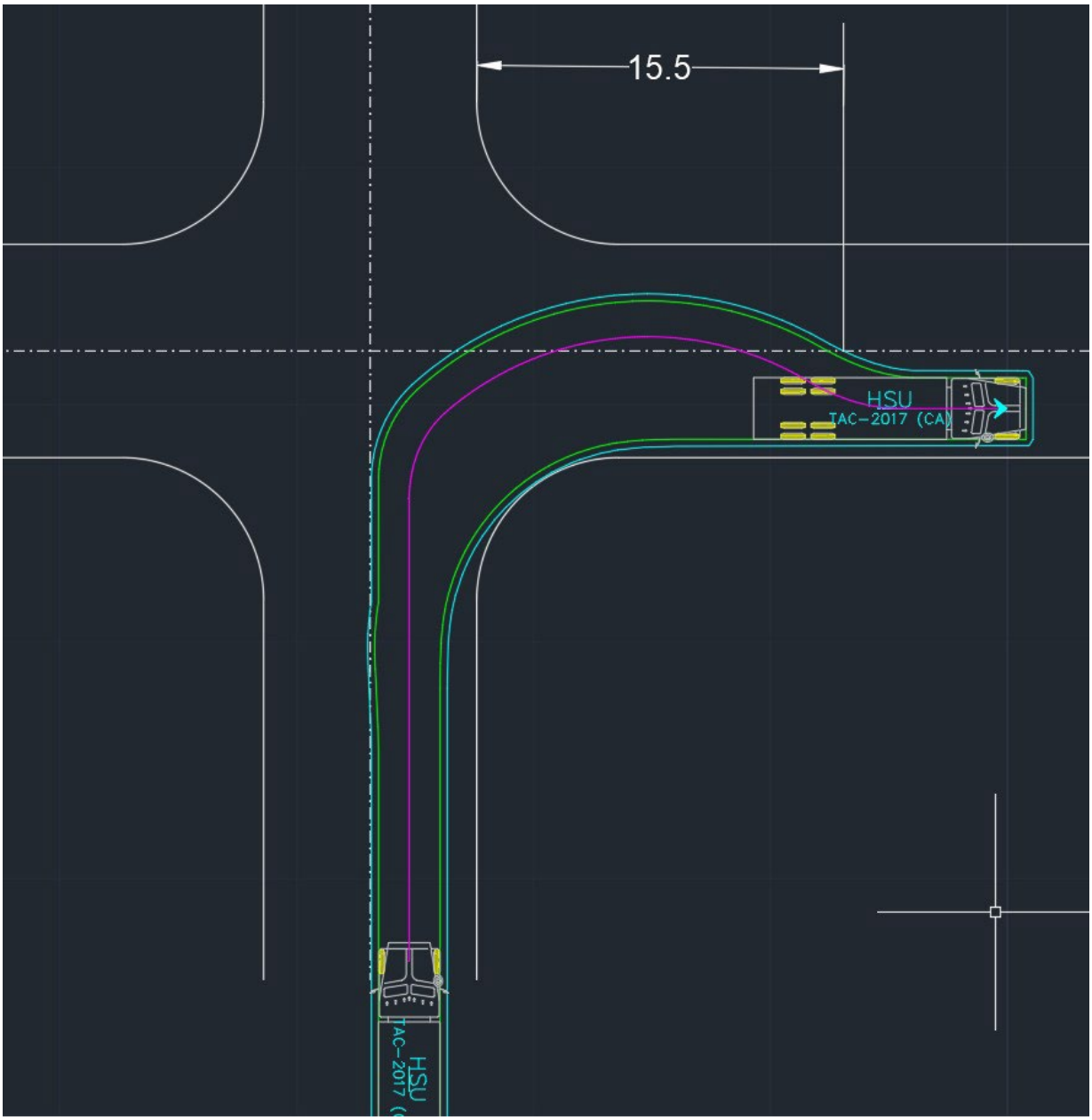


Figure A-2: Swept path analysis showing Heavy Single Unit (HSU) vehicle completing turn within 16 m offset from the curb line.

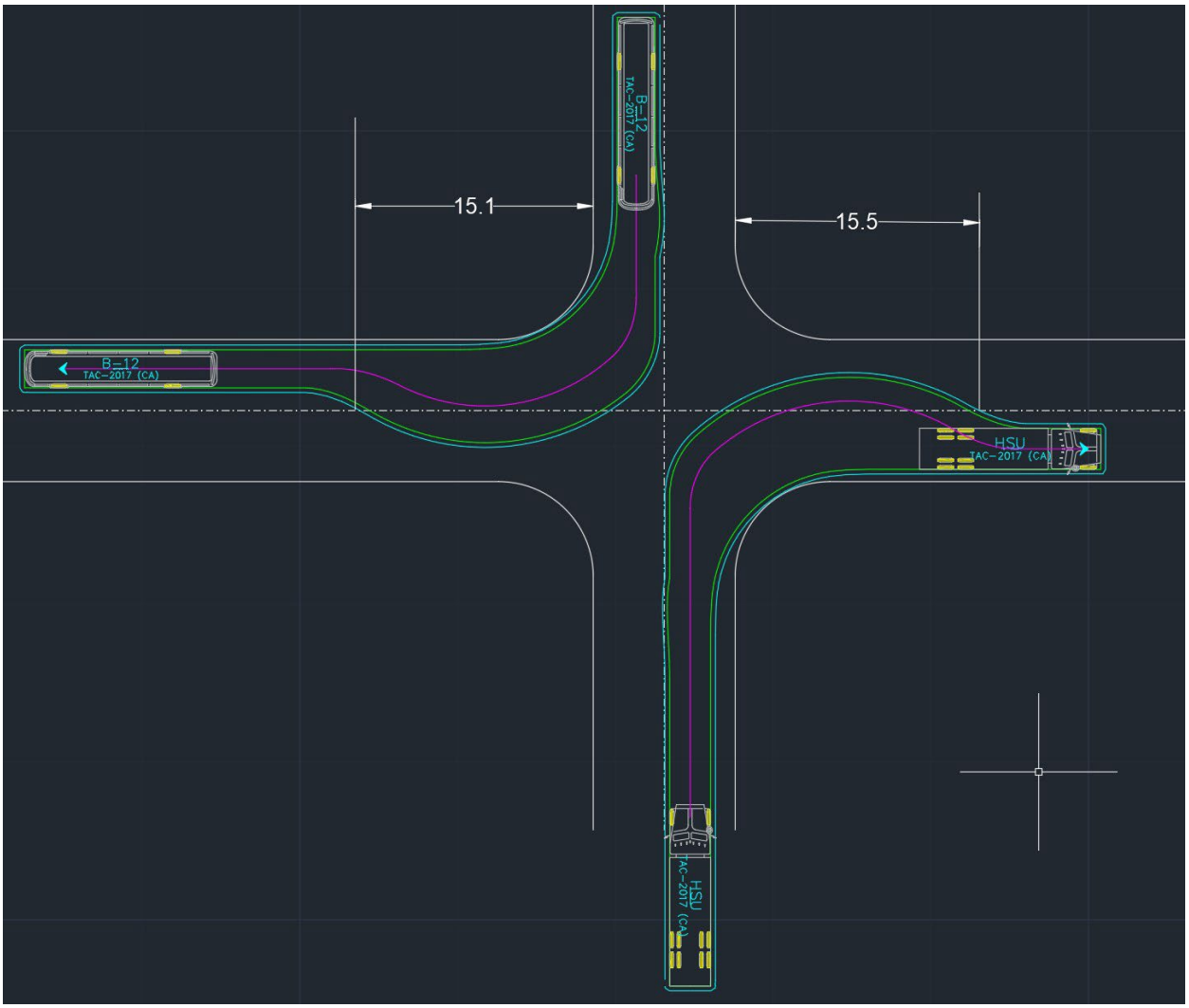


Figure A-3: Swept path analysis showing B-12 bus completing turn within 16 m offset from the curb line