Exhibit A to Report Number EITP-21-014

Traffic Calming
Policy

KINGSTON

1 Introduction

The purpose of this policy is to provide an overview of what traffic calming is, where and when it can be best implemented, and the potential impacts (positive and negative) of applying traffic calming measures. The policy includes general considerations that provide context and parameters to consider as part of any traffic calming project. It also outlines the process by which neighbourhood transportation issues, including traffic calming requests, will be reviewed and considered.

This policy is intended to be used alongside other technical and policy guidance, and should be supplemented with sound engineering judgment.

2 Background

In the fall of 2019, City Council adopted the Road Safety Plan (RSP) and Active Transportation Implementation Plan (ATIP), which directed staff to review the City's implementation-based transportation policies. A comprehensive review of the City's traffic calming policy was identified as a priority to determine a more effective means of addressing traffic calming requests.

As such, City Staff in conjunction with CIMA Canada Inc. developed a new Traffic Calming Policy and Guidelines that align with the City's transportation policies and Council's strategic priorities.

3 The Role of Traffic Calming

Speeding and other transportation issues are regularly identified throughout the City's road network, especially along the almost 600 kilometers of local roadways. Many of these issues are a direct outcome of the vehicle-centric roadway design that has been employed for many decades as these roads were constructed. Vehicle-centric design is contrary to the City's current polices, which emphasize and promote the use of active transportation and transit ahead of vehicles. These challenges are not unique to Kingston, and are reflected in most municipalities across Canada.

Traffic calming encompasses the process of encouraging driver behaviour that more closely reflects the transportation policies of the City and better meets the expectations of residents. It includes measures and street design elements aimed at improving safety for all road users, particularly for those walking and cycling, by lowering vehicular operating speeds. These tools, when implemented correctly, can address speed-related concerns at a street or block level. The objective and challenge for effective traffic calming implementation is to determine the best combination of measures that result in a net improvement (both real and perceived) in community safety at a reasonable cost. However, if the approach does not extend to the broader neighbourhood, it can shift the issue to nearby streets rather than addressing the overall speeding concern.

Consequently, traffic calming is most effective when considered as part of a broader, integrated approach to managing transportation-related issues within neighbourhoods and may not be the most appropriate solution for all issues. Depending on the problem definition and surrounding land use, other interventions including pedestrian crossings, all-way stop control, active transportation infrastructure, or more extensive roadway reconstruction may best address the issue.

Most traffic calming measures considered within this policy and the Traffic Calming Guidelines are applicable primarily along Local roadways, which are intended to permit local traffic to access private property and convey traffic to and from the minor collector street system in residential and neighbourhood areas. Local roadways typically have an AADT (Annual Average Daily Traffic) under 1000.

Speeding concerns along Arterial and many Collector roadways are often not appropriately addressed through traffic calming measures. Rather, treatments along collector and arterial roadways are better positioned for consideration within the scope of broader transportation plans, such as the Active Transportation Master Plan and Transportation Master Plan. These projects also need to consider and/or be integrated with other road, water, and sewer renewal projects.

4 What is Traffic Calming?

Traffic calming involves implementing safety measures or programs to reduce speed and encourage safe driving behaviour for the comfort of all road users. A successful traffic calming approach is one that alters a street in such a way that motorists will drive slower and exercise caution, and brings the street closer to its intended use while limiting unintended operational impacts.

To successfully achieve this objective, traffic calming may consider the use of the following measures:

- Installation of special pavement markings and/or signage
- Changes to the roadways surface texture and/or colour
- Changes to the vertical and/or horizontal alignment of the roadway (may require road reconstruction)
- Changes to the travelled portion of the roadway through pavement and/or lane narrowing, such as vertical centre line treatment

Depending on the location, some traffic calming measures can be difficult to implement, or the cost of implementation (monetary and operational) may be incompatible with public expectations and the City's allocated budget. As such, the Traffic Calming Policy and Guidelines are intended to:

- Support the decision-making process from the time that a transportation-related issue is identified to implementation of the selected measure

- Inform residents about the different elements considered as part of the traffic calming process
- Support the allocation of financial resources through an incremental implementation of required traffic calming measures

5 Traffic Calming Principles

The following principles are generally applied by road authorities, including several municipalities in Ontario, when selecting and implementing traffic calming measures. This ensures that appropriate traffic calming measures are selected, that they are compatible with the community's needs, and any potential negative impacts are minimized.

While each situation is unique, the principles of traffic calming are relevant to each situation. Application of these principles will maximize effectiveness of the traffic calming plans and help build community acceptance and support of the final traffic calming plans.

Identify the Real Problem

It is important to identify the real problem so that appropriate traffic calming measures are selected. Traffic issues or road safety issues can be emotional subjects for many people; it is important to keep the issues and problems in perspective to maximize the limited resources on proven problems and not perceived problems.

Investigate and Detail the Problem

Observations, data collection, and review can aid in selecting and designing the most appropriate treatment, including traffic counts, speeds, collision data, and pedestrian usage, while also taking into consideration the adjacent land uses of the subject road, including the presence of schools, parks, and other pedestrian generators.

Maintain and Minimize Impacts on Delivery of Emergency Services

Consideration of emergency services when identifying appropriate traffic calming measures for implementation will minimize delays/impacts to these services, and build support for traffic calming in general. When selecting traffic calming measures, staff will strive to balance the needs of these services with slowing traffic on residential streets. City staff will work with emergency services to ensure that negative impacts resulting from the implementation of traffic calming measures are minimized.

Maintain and Minimize Impacts on Delivery of Public Services

Traffic calming implementations must consider impacts on services such as transit, winter maintenance, street sweeping, waste collection, and school bus services.

Minimize Impacts on Adjacent Residential Streets

Prior to considering traffic calming, any potential negative impact on adjacent streets must be considered. Impacts may include traffic that is diverted to another street, or changes in turning

movements as a result of increased delays at other intersections. These effects will be considered in advance of approval so that traffic calming solutions do not create or exacerbate existing problems.

Target Motorized Vehicles and Not Other Modes

The purpose of traffic calming is to reduce the negative effects of motor vehicles while improving conditions for other road users. Traffic calming measures should be designed to permit cyclists and pedestrians to travel unaffected, while slowing down motor vehicles.

Monitor and Follow-up

As resources allow, comparable traffic volumes, speed, and collision data will be collected before and after implementations. This will help to assess the effectiveness of the tools in a variety of Kingston-based contexts and determine if any adjustments are needed.

6 Policy Direction

6.1 Official Plan (2019)

Section 4.6.11 of the Official Plan requires the preparation of traffic impact analysis or a transportation study as part of any development proposal. This section states the provision of traffic calming measures (if required) as part of recommended improvements necessary to accommodate the proposal.

Section 4.6.15[1] expands the information contained in the Official Plan regarding the use, the need and the type of traffic calming measures as follows:

- Section 4.6.15 (a) traffic calming measures will be used to increase the level of safety and convenience for all users and to improve the surrounding environment by reducing the speed of motorized traffic and reducing the volume of through traffic
- Section 4.6.15 (b) the need for traffic calming measures is determined by the City based on factors such as vehicle speeds, traffic volumes that include active transportation and vehicles, collision history and presence of school zones
- Sections 4.6.15 (c) traffic calming measures may include but are not limited to speed humps, raised crosswalks, curb extensions, speed display devices, mini-roundabouts, sidewalk connections, cycling lanes, median islands, and on-street parking

6.2 Active Transportation Master Plan (2018)

The City of Kingston's Active Transportation Master Plan envisions a 20% active transportation mode share by 2034 and considers the use of traffic calming measures for the provision of a safe system where pedestrians, cyclist, transit users, and motorists can equally participate.

[1] Amended by Law Number 2017-57 OPA Number 50

6.3 Road Safety Plan

The Vision Zero Road Safety Plan identifies several countermeasures which are intended to collectively reduce the incidence or severity of motor vehicle collisions. These initiatives provide a framework to coordinate available resources and plan, prioritize, and implement road safety projects. Part of the recommendations included a review of the City's existing traffic calming policy to determine a more appropriate or expedited means of addressing traffic calming requests.

7 Roadway Classifications

The City's Official Plan (OP) identifies the City's current road network classifications. The OP references the classification of roadways and includes the following definitions:

Arterial Roads

- serve relatively high volumes of intra-urban traffic at medium to moderately high speeds
- link freeways to collector roads
- have limited access from abutting properties
- may have restrictions on stopping, parking and loading during peak hours

Collector Roads

- serve medium volumes of intra-urban traffic at low to medium speeds
- link freeways and arterial roads to the local road system
- permit full access to abutting properties
- have few parking restrictions during peak hours

Local Roads

- serve low volumes of traffic at low speeds
- provide access to collector road system from properties
- permit full access to abutting properties, subject to driveway regulations
- have few parking restrictions during peak hours

The traffic calming measures considered within the proposed policy and guidelines are primarily applicable along Local roads.

Given the role and function of Arterial and Collector roads, speed management along these roads typically requires a different, more comprehensive approach than on Local roads. Arterial roads are designed and built for higher volumes of vehicles, which often also lends itself to higher travel speeds. Managing speed along Arterial roadways in particular requires consistent enforcement and is typically best addressed through longer-term capital planning and policies, such as through the City's Active Transportation Master Plan.

While select tools included in the Traffic Calming Guidelines may be considered as part of broader capital work along Arterial and Collector roads, the Traffic Calming Policy, including the

District-selected street process, will not apply to these types of roads, except in rural hamlets on a case-by-case basis.

8 Neighbourhood Transportation Issue Review Process

The City regularly receives requests and inquiries from residents regarding speeding and other transportation issues throughout the City's neighbourhoods. Each time a neighbourhood transportation issue is received, a general review process is undertaken.

Traffic calming is most effective when considered as part of a broader, integrated approach to managing transportation-related issues within neighbourhoods and may not be the most appropriate solution for all issues. Depending on the problem definition, other interventions including pedestrian crossings, all-way stop control, active transportation infrastructure, or more extensive roadway reconstruction may best address the issue.

The following section outlines the process by which neighbourhood transportation issues will be reviewed, and depending on the problem definition of the issue at hand, how traffic calming measures may be considered as part of this process.

8.1 Context Review

When a neighbourhood transportation issue is raised, the City reviews the existing context, which may include a review of available traffic data, road classifications, solutions previously implemented, existing applicable policy, and planned capital work.

8.2 Primary Problem Definition

Based on the context review, the neighbourhood transportation issue may be categorized into broad primary problem definitions, including pedestrian connection concerns, vehicular speeding concerns, or traffic volume concerns. The scope of the process and associated tools considered within this policy and the guidelines is specific to issues that are primarily defined as vehicular speeding and volume-related concerns on local roadways.

8.3 Determining Potential Next Steps

Based on the problem definition and nature of the request, the issue is documented and may be monitored or scheduled for further assessment. In determining any potential next steps, the following process streams are considered:

District-selected Street

City Councillors can select one local street in their district for a traffic calming implementation each year. These implementations will involve the use of Type I (minor-adjustment) traffic calming measures that aim to slow vehicles down and improve safety and can be installed more quickly and are more easily modified than other traffic calming measures. To be eligible for this process, the selected street must be classified as a Local road, except for rural hamlets, which may be considered on a case-by-case basis.

To facilitate this process, City staff will share information with Councillors regarding neighbourhood transportation concerns raised by residents received by the City, including a list of streets where traffic calming has been requested. Staff will work with Councillors to help determine a suitable location for the intervention in their district and will identify an appropriate Type I implementation plan for the selected street.

Neighbourhood-level Programs

Neighbourhood-level programs and reviews may identify the need for traffic calming interventions. Opportunities to link traffic calming measures would typically be identified as part of a broader plan or program that seeks to address transportation issues or behaviours within a designated area.

One of these programs is the City's Safe Routes to School program, which is designed to make it easier and safer for students to get to and from school using active modes of transportation. The program involves a multi-disciplinary approach, which often includes consideration for traffic calming measures. Traffic volume or speeding-related issues that fall within the scope of neighbourhood areas that are being actively considered as part of the Safe Routes to School program will be captured for review as part of this implementation.

Community-based Initiatives

Community-based initiatives involve the use of tools and programming that are intended to provide stakeholders and residents with an opportunity to participate in improving road safety on local roads within their neighbourhood. Community-based initiatives are intended to be facilitated or made available to interested residents and community groups.

Transportation Implementations and Capital Planning

Transportation issues received and reviewed by the City may be considered as part of longer-term neighbourhood and capital project planning. Typically, the scope of capital implementations would consider the use of Type II (engineered-based) measures, which are more permanent in nature and require significantly more resources, costs and involve more extensive timelines to plan, design, and construct. The City may also consider the use Type I (minor-adjustment) measures to address safety issues as they arise on local roadways through the ongoing review of neighbourhood transportation concerns. In some cases, Type I measures provide an opportunity to test concepts that can inform the design of Type II measures as part of future capital work.

8.4 Community Involvement

Residents living adjacent to where traffic calming is planned will receive information (including detailed plans) about the measures in advance of implementations and will have an opportunity to provide feedback or ask questions about the proposed plans. This communication may also be expanded to include the broader neighbourhood depending on the scale of change that is being proposed. Longer-term transportation plans that include traffic calming components may include public consultation conducted as part of those broader projects.

8.5 Implementation and Monitoring

The City will aim to collect traffic volumes, speed, and collision data before and after implementations as resources allow.

9 Types of Traffic Calming Measures

The traffic calming measures considered as part of this policy are based on current best practices and applicable standards including the Transportation Association of Canada (TAC) Canadian Guide to Traffic Calming Second Edition and customized for Kingston's needs.

To align with the neighbourhood transportation issue review process outlined in the subsequent section, the traffic calming measures considered in this policy have been grouped into three categories based on their intended usage:

- **Type I (Minor-adjustment) measures**: Type I measures are tools that can be more quickly and easily installed. While often temporary or seasonal in nature, these tools are an important step in reducing vehicular speeds and increasing safety for all road users. Examples may include vertical centreline treatments, on-road pavement messaging, or speed display devices.
- **Type II (Engineered-based) measures**: Type II measures are physical changes that are more permanent in nature and typically involve more resources and longer timelines to plan, design and construct. Examples include horizontal changes to the curb or road to narrow or shift a vehicle's path or slow vehicles around a corner, or vertical deflections that are designed to reduce the speed of a motorist as they drive over them.
- **Community-based initiatives**: Community-based initiatives involve tools and programs that residents could implement with support from the City. Examples may include lawn signs, a pace car program, or a 'local-traffic only' initiative.

Each measure within these broader groups is outlined in detail in the Traffic Calming Guidelines.

10 General Considerations

10.1 Accessibility

Selection, design, and implementation of traffic calming measures needs to ensure accessibility. For example, visually impaired pedestrians may have challenges navigating a curb extension if the measure does not include the appropriate elements (e.g. tactile surface and ramps). The development and implementation of traffic calming measures should be consistent with The Accessibility for Ontarians with Disabilities Act (AODA) and industry practices for accessibility and universal design.

The following highlights important considerations for some items related to accessibility that may arise as part of traffic calming projects:

- **Tactile Walking Surface Indicators** – The use and placement of tactile walking surface indicators must be carefully considered when developing a traffic calming plan. For example, measures that adjust curb placement, affect traffic signal operations, adjust cycling or pedestrian crossing locations, and affect bus stops must be context sensitive and comply with AODA standards.
- **Existing Street Design** – Traffic calming measures should consider consistency with existing street design as it relates to the intended function from an accessibility perspective.
- **Accessible Vehicle Roadside Loading / Unloading** – Traffic calming measures should consider existing operations for curbside loading/unloading with regards to accessible vehicles (i.e. buses, taxis, and vans).
- **Colour Contrasting** – Colour contrasting may be used to emphasize the presence of any hazards and the travel path for all road users (particularly those with visual impairment). Colour contrasting is recommended to consider a standardized approach throughout the City where it is implemented.

10.2 Walking and Cycling

Traffic calming designs should consider the needs of and impact on active transportation in balance with overall project objectives. For example, Type II (engineered-based) measures such as speed humps or curb extensions can improve conditions for cyclists by calming vehicular traffic. However, they may also negatively impact cyclists by forcing them into and out of vehicle travel paths.

When developing a traffic calming plan, it is important to consider the context and intended function of the implementation for those travelling using active modes. For illustration purposes, the following highlights examples of active transportation considerations as they relate to traffic calming measures:

- The use of treatments such as curb extensions and pinned curbs reduces crossing distance for pedestrians, improving mutual visibility between motorists and pedestrians as an added benefit
- Vertical deflections are not conducive to bicycle travel in general and should be used carefully, especially for heavy travelled bicycle routes – speed humps, for example, can be cut back at the sides to allow bicycles to pass and facilitate drainage rather than extend to the full width of the road
    - Speed kidneys, in particular, should only be considered at locations where a buffered bicycle lane exists (or will exist) to allow cyclists to proceed unimpeded and to reduce the likelihood of motorists shifting into the buffered bicycle lane to avoid the vertical deflection
- Horizontal deflections should be clearly marked to enable cyclists to identify and anticipate them, and merge as necessary. They can also be used in conjunction with other speed control devices such as speed tables at the narrowing, which allows slower moving motorists to allow cyclists through before trying to pass

- Medians and refuge islands can be valuable along major corridors that present safety issues for cyclists and pedestrians wishing to cross.

10.3 Kingston Transit

Due to their dimensions, consideration needs to be given to transit vehicles in navigating vertical and horizontal deflections. Horizontal deflection measures are typically preferred over vertical deflections when considering the comfort and convenience of transit passengers. However, it should be noted that horizontal measures alone may not always be sufficient to reduce speeds to desired levels. For example, if a curb extension or choker is designed to provide adequate space for an articulated bus, its effect on reducing the speed of other type of vehicles will be minimal. Alternatively, speed cushions are a measure that can accommodate buses along transit routes because they are designed to slow passenger vehicles while allowing vehicles with larger wheelbases (i.e. buses) to pass unimpeded.

The location of traffic calming measures relative to transit stops also needs to be considered to ensure that they do not impede pedestrians, and remain easily accessible.

To maximize the benefits of a traffic calming plan and minimize the effects on transit services, the following items should be considered:

- The proposed traffic calming plan should avoid a substantial increase in travel times along transit routes
- A recommended operational speed of 25 kilometres per hour or less should be targeted when travelling over traffic calming measures (such as speed tables and raised crosswalks)

The dimensions of transit vehicles and the comfort of transit passengers both need to be considered as part of traffic calming designs in balance with overall project objectives. The following is to be considered in planning traffic calming measures (particularly Type II measures) as it relates to Kingston Transit routes:

Transit Routes Considerations

- All traffic calming measures need to consider turning requirements for buses when designed for implementation along transit routes
- Horizontal deflections (including intersection treatments):
    - Consider opportunities for dual purpose horizontal traffic calming measures, such as bulb-outs providing bus stop treatments at bus stops
    - Consider traffic calming designs to support unimpeded bus operations 36m in advance (upstream) of the bus stop and 18m beyond (downstream)
- Vertical deflections and intersection treatments involving vertical deflections:
    - Vertical deflections will not be considered along Express Transit routes
    - Along local Transit routes, evaluate other types of traffic calming measures prior to considering vertical deflection and/or intersection treatments that include vertical deflections

- If other traffic calming measures are insufficient or not feasible, in consultation with Kingston Transit, consider speed tables, speed cushions, raised intersections, and raised crossings
  - Consider placement of these elements relative to bus stops (target minimum 20m upstream or downstream of bus stops if the stops are not co-located with intersections); this may be dependent upon the movement of bus stops along the route (e.g. stop controls).
  - The flat surface of speed tables and raised crosswalks should be a minimum of 6 metres long
- If vertical deflections are being considered along local transit routes (in accordance with the considerations above), traffic calming plans should not include more than five (5) vertical deflection measures per transit route

- Specialized implementations:
  - Specialized implementations may be considered as part of broader projects and will include consultation with Transit to consider impacts to Local and Express routes. Some measures may include opportunities for Transit priority (e.g. lane reductions), however others such as mini-roundabouts would need to consider turning movements for Transit buses and proximity of transit stops.

10.4 Emergency Services

Although there are safety benefits of traffic calming and speed reduction techniques in reducing the frequency and severity of collisions, especially involving pedestrians and cyclists, there can be impacts to emergency response times with the application of particular traffic calming measures. The challenge is to balance these two considerations. Generally, a single traffic calming installation along an emergency route would not significantly delay a responding emergency vehicle. However, multiple traffic calming measures along a route could cumulatively cause significant delays and can have negative consequences in the emergency outcome.

Depending on the type of traffic calming measure being considered, traffic calming plans should consider consultation with emergency services, and consider the movement of “design vehicles” through the area. These types of considerations are outlined in the Traffic Calming Guidelines for each specific measure.

The following highlights a few design considerations regarding emergency service access when developing traffic calming plans:

Vertical Deflection Measures

- Consider avoiding and/or consult on the placement of speed humps and speed tables on roadways that are classified as designated emergency access routes (i.e. hospital and fire access routes) and any feeder roads located by hospitals.

Horizontal Deflection Measures

- Some measures (i.e. chicanes and raised median islands) can reduce the ability of larger vehicles to maneuver through/around traffic in response situations
- For centre medians, consider implementing periodic depressions to allow emergency vehicles to navigate around obstructions where vehicle queues are a regular occurrence

Emergency Vehicle Dimensions

- Ensure that the dimensions for the largest emergency vehicle (i.e. fire truck) used on City roads are considered
- Consider turning requirements for emergency vehicles

Mountable Curbs

- Avoid introducing barrier curbs in the wheel path along designated emergency access routes and/or where emergency vehicles are expected to make turns at higher speeds

Placement of Signage

- Avoid installing signage at intersections that may fall in the path of turning vehicles where it could be necessary to encroach onto the street-side environment (i.e. locations with tight turns; refer to Section 10.6 for discussion on turning radii)

10.5 Winter Operations and Street Maintenance

Traffic calming designs need to consider the needs of and effects on winter operations and street maintenance in balance with the overall project objectives. The following are elements that should be considered during the implementation of traffic calming measures as well as during their life cycle as it relates to winter operations:

- Considering the additional time required to remove snow from the areas on and around the traffic calming measure
- Using smaller or modified equipment and specific removal procedures (where warranted and if available in Canada; consultation will be undertaken with Public Works in cases where the design/implementation of traffic calming elements may result in changes or need to consider adjustments to removal processes)

Considerations specific to the clearance width of operational vehicles and surface materials are included below.

Clearance Width

- The placement of vertical elements (e.g. poles, signs, landscaping) and abrupt grade changes (e.g. curbs at the edge of the road) should accommodate the City's existing operating vehicle fleet.
- Traffic calming designs should target to provide a minimum clearance width of 1.8 m for sidewalks, separated cycling facilities, and multi-use pathways (e.g. this allows the

accommodation of a 1.5 m wide sidewalk plow with additional 0.15 m side clearances on both sides).

- Where feasible, a 2.0 m or greater clearance width is preferable, particularly on main streets and high-activity streets where active transportation levels are expected to be high.

- Traffic calming designs should also provide a suitable clearance width for roadways that can accommodate the typical width of a snow plow plus 0.25 m buffers on both sides (e.g. a 3.75 m wide snow plow width requires 3.75 m + 2(0.25 m) = 4.25 m clearance width, as illustrated in Figure 1).
- In situations where a suitable clearance width cannot be provided, specialized maintenance equipment may be required.

Surface materials

- Monolithic surfaces (e.g. asphalt and concrete) are preferred over other surfaces (e.g. cobblestone and interlocking) from a maintenance standpoint because they have lower potential to be damaged from freeze/thaw cycles relative to non-monolithic surfaces.
- Non-monolithic surfaces are more difficult to maintain in winter conditions due to irregular surface edges that could be damaged and potentially cause damage to maintenance equipment.

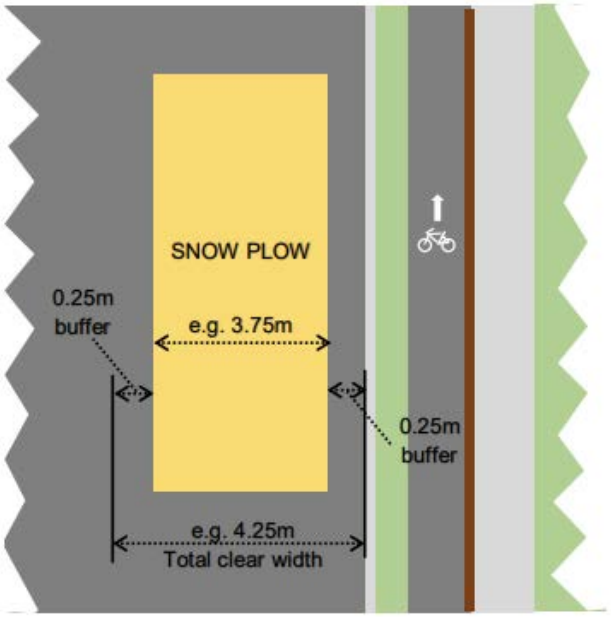


Figure 1: Roadway Clearance Width Requirements for 3.75 m Snowplow

10.6 Turning / Corner Radii

The design of intersections and accesses should target a design that allows service vehicles to comfortably complete required turns and not mount the curb in most, if not all, circumstances.

This will require appropriate corner radii at intersections and accesses by considering the effective turning radius of service vehicles.

The corner radius is the radius of a curve along a roadway's edge with a full barrier curb, specifically at locations where vehicles need to make turns. The effective turning radius is the radius of the inside curve of turning vehicles, and is governed by all of the physical elements that create a barrier at the roadway's edge that physically limit a vehicle from encroaching beyond the edge of the road. The difference between corner radius and effective turning radius is illustrated in the following figure:

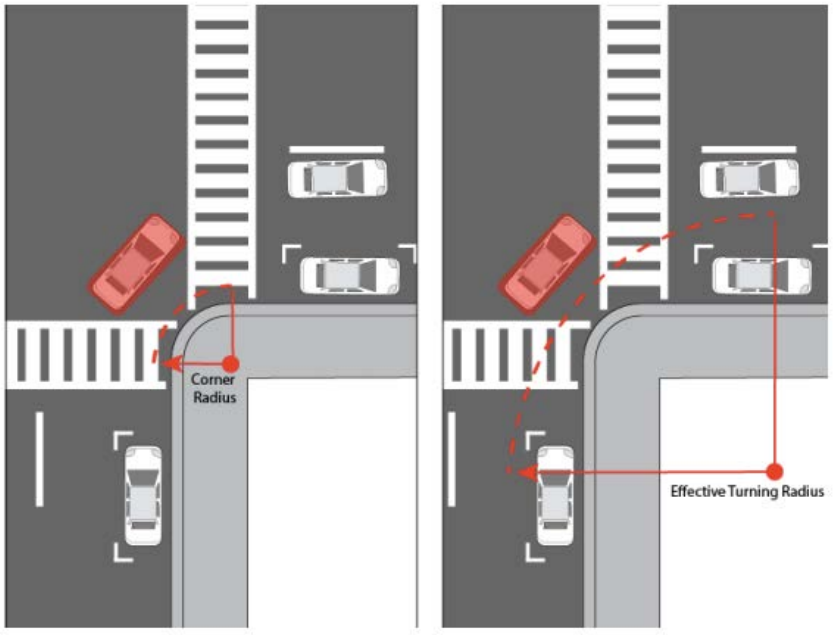


Figure 2: Corner Radius vs. Effective Turning Radius (Source TAC Geometric Design Guide for Canadian Roads)

In a traffic calming context, reducing the effective turning radius typically encourages vehicles to lower turning speeds but may create operational challenges for larger vehicles. The dimensions and operational characteristics of transit vehicles, maintenance equipment, emergency vehicles, school busses, and waste collection vehicles should be considered.

The minimum effective turning radius to be selected when developing designs for traffic calming plans is dependent on the surrounding land use (e.g. residential, commercial, industrial) and road designation (e.g. local, collector, arterial).

The following sections highlight a few design considerations for three types of physical street contexts (i.e. all locations, "unconstrained context", and "constrained context") that should be considered after a minimum effective turning radius is selected. Unconstrained contexts include streets with relatively wide City right-of-ways, a high level of general visibility, limited levels of street-side activity, and/or high operating speeds. Constrained context includes streets with

constrained City right-of-ways, low to moderate levels of general visibility, and/or low to moderate distances between intersections. Depending on the street context, a different target effective turning radius may need to be determined to accommodate various vehicle operations. At any intersection corner where the subject turning radius exceeds the minimum effective turning radius, physical corner radius reductions are typically considered.

The following allows outlines design considerations for turning radii along different street contexts:

All Locations

- Ensure that the design vehicle can make permitted turns:
    - Into large private accesses and onto intersecting streets as necessary using the roadway area intended for vehicular operation
    - Without encroaching onto street-side facilities such as sidewalks, multi-use pathways, transit stop waiting areas, separated cycling facilities, streetscaping, and street furniture

Unconstrained Context

- Aim to reduce the potential for excessive vehicular speed differentials between through and turning traffic (e.g. consider implementing traffic calming measures to reduce operating speeds on the primary street well in advance of the subject turn where the minimum effective turning radius is applied)

Constrained Context

- Consider balancing the objectives of service vehicle operation and traffic calming objectives where they may compete

At locations where physical corner radius reductions are not feasible, visual corner radius reductions that psychologically induce drivers to slow down before turning may be implemented. Examples of visual corner radius reduction measures include mountable curbs or aprons, paint, textured pavement, and/or flexible stake bollards. These measures have the potential to create a traffic calming effect for smaller vehicles, while still allowing larger vehicles to complete the turning maneuver without difficulty.

It is important to clearly indicate to pedestrians and cyclists that the area where these measures are implemented is not intended as a waiting area or a space to reduce crossing distance, as it may create conflicts with large turning vehicles. Crosswalks at the subject location should be extended towards the barrier curb line.

10.7 Streetscaping

Streetscaping elements present on both sides of the roadway can create a narrowing effect that may induce drivers to reduce their speed, however, introducing new streetscaping also needs to be strongly considered from an operational perspective, as it introduces a new asset to be regularly maintained. When considering new streetscaping implementations, low maintenance

options should be reviewed first. This is especially important in areas where grass is being considered without existing grass-cutting routes near by. Small green spaces can be difficult to get to, difficult to maintain and may expose workers to traffic hazards. Low maintenance options like mulch or permeable materials should be considered wherever possible. Caution also needs to be exercised if these elements are installed inside the vehicular right-of-way.

Some traffic calming designs introduce opportunities for streetscaping (i.e. more curbed areas, street beautification) as well as improved stormwater management (i.e. LID improvements). However, the construction of traffic calming measures themselves may also be detrimental to some existing landscaping (i.e. trees when built within or in close vicinity to the root zones).

10.8 Enforcement

At locations where traffic calming measures are implemented but have not been sufficient in changing driver behaviour, police enforcement may be an option. However, it is important to note that enforcement resources are typically quite constrained. The implementation of self-enforcing measures should be considered (where appropriate), including physical changes to roadway characteristics such as speed humps that strongly encourage vehicles to slow down when traversing them, or diverters and directional closures that physically prevent unwanted movements.

10.9 Treatment Selection

Permanent traffic calming solutions may be costly and difficult to maintain once they are implemented. Therefore, it may be beneficial to first explore measures that could result in the desired outcome without requiring permanent, physical changes to the roadway environment. Measures such as removable rubber products (e.g. curbing, speed cushions, humps, tables), flexible bollards, pavement markings, and speed display devices can be implemented or modified relatively easily compared to permanent measures. For example, pinned curbs or flexible bollards could be used to pilot or test changes, or could be used as part of annual programs. If these measures were found to be ineffective or did not provide the desired outcome, alternative approaches or adjustments to the design of permanent changes could be considered.

Some considerations regarding the use of these measures include:

- Ongoing operational and maintenance-related costs and/or resource requirements
- Seasonal installation and removal requirements
- Potential to have similar or higher overall costs than permanent measures
- Level of effectiveness may potentially be lower than permanent measures
- The aesthetic value can be relatively low
- If measures are anchored into existing roadway surfaces, accelerated degradation of the road surface may occur

The selection of appropriate treatment for a roadway is primarily dependent on the City's goals for a specific instance along with any constraints such as cost, scope, general considerations and measure-specific considerations (detailed in the Traffic Calming Guidelines).

Additionally, the traffic calming treatment selection process should also consider:

- Effectiveness in addressing the problem or opportunity
- Effects on users of the corridor (pedestrians, cyclists, transit, etc.)
- Effects on traffic volumes and transportation system efficiency and intersection operations
- Design vehicle considerations (for each particular case, the City should identify the appropriate design vehicle to be considered/designed for)
- Constructability and durability
- Applicability (e.g. is it seasonal or all year round), and maintenance requirements/implications
- Lifecycle costs
- Streetscaping and other considerations

10.10 Traffic Control Measures Not Intended for Traffic Calming Purposes

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

Stop Signs

Stop signs are intended for intersection control and are generally installed in locations where they meet established warrants (i.e. where specific minimum conditions are met). Historically, when placed in locations where warrants have not been met, they generally have received lower compliance levels than in locations where warrants were met. Placing stop signs in locations where warrants have not been met can contribute to eroding the effectiveness of the subject stop sign, and also more broadly may contribute to lower compliance levels at other stop-controlled locations.

Speed Limit Signage in Isolation

Lowering speed limits on City streets without consideration of the physical configuration of the road typically has minimal impact on driver behaviour. Implementing a speed limit that does not consider roadway design or its function may also result in enforcement challenges and increases in traffic hazards. In such cases where a posted speed limit is below operating speeds, most motorists will continue to drive at speeds they feel are reasonable and prudent unless continual police enforcement is present. The visual and physical cues that a driver uses to determine the appropriate travel speed should be consistent with the posted speed limit.

Exhibit B to Report Number EITP-21-014

Traffic Calming
Guidelines

KINGSTON

Traffic Calming Guidelines

Introduction

This document is intended to provide guidance specific to traffic calming measures that may be considered for future implementation in Kingston. These tools are classified as Type I (minor-adjustment), Type II (engineered-based), and community-based, depending on the intended usage of the treatment. The following details are included for each measure:

- Description
- Applicability (based on road type, surrounding environment, ADT, roadway cross-section, etc.)
- Potential benefits (speed and volume reduction)
- Geometric design considerations
- Signing and pavement marking design
- Other considerations (effect on local vehicle access, emergency services, active transportation, etc.)
- Estimated cost (low, medium, or high)

These guidelines should not be interpreted as comprehensive design guidelines. The use of a particular measure is dependent on the scope and goals of the traffic calming projects and constraints of the built environment. Each traffic calming implementation should comply with all relevant City of Kingston design and construction standards and specifications. The traffic calming measures considered as part of these guidelines are based on current best practices and applicable standards including the Transportation Association of Canada (TAC) Canadian Guide to Traffic Calming Second Edition and customized for Kingston's needs.

Types of Traffic Calming

Type I (Minor-adjustment) Measures

Type I (minor-adjustment) measures are effective, low-cost traffic calming tools that can be more quickly and easily installed relative to permanent treatments and can be more easily modified where applicable. While often temporary or seasonal in nature, these tools are an important first step to reduce vehicular speeds and can increase safety for all road users. The Type I measures considered as part of these guidelines include the following:

- Vertical centreline treatments
- Pavement markings
- On-road pavement messaging
- Speed display devices
- Mobile changeable message signs

Type II (Engineered-based) Measures

Type II measures are physical changes that are more permanent in nature and typically involve more resources and longer timelines to plan, design and construct. Type II measures include horizontal deflections, vertical deflections, intersection treatments, cross-sectional treatments, and specialized implementations.

Horizontal Deflections

TAC's Canadian Guide to Traffic Calming defines a Horizontal Deflection as a type of traffic calming measure that causes a lateral shift in the travel pattern of vehicles. This shift forces motorists to slow down to comfortably navigate the measure. The horizontal deflections considered as part of these guidelines include the following:

- Curb extensions
- Raised median islands
- Lateral shift

Vertical Deflections

TAC's Canadian Guide to Traffic Calming defines a Vertical Deflection as a type of traffic calming measures that causes a vertical upward movement of the vehicle. The change in the height of the roadway forces a motorist to slow down in order to maintain an acceptable level of comfort. The vertical deflections considered as part of these guidelines include the following:

- Speed humps / tables
- Speed cushions

Intersection Treatments

From a traffic calming perspective, Intersection Treatments can be defined as a type of traffic calming measure that may slow vehicular traffic through the intersection and improve safety for pedestrians. Intersection treatments considered as part of these guidelines include the following:

- Textured crosswalks
- Raised crosswalks
- Curb radius reductions
- Raised intersections
- Right-in/right-out islands, channelizations etc.
- Vehicular directional closures and diverters

Other Cross-sectional Treatments

This group of treatments are defined as a change to the existing roadway cross-section to fewer or narrower motor vehicle travel lanes, which increases the side friction to the traffic flow and

creates a potential reduction of vehicular speed. Cross-sectional treatments considered as part of these guidelines include the following:

- Lane narrowing
- On-street parking

Specialized Implementations

Specialized implementations include traffic calming-related initiatives that fall outside of the scope of the existing process but could be considered in broader projects or initiatives. The effectiveness of these implementations is highly dependent on the scope of the project and built environment being considered. Specialized implementations considered as part of these guideline include the following:

- Chicanes
- Speed kidneys
- Mini-roundabouts
- Lane reductions
- Textured pavement

Community-based Initiatives

Community-based initiatives involve tools and programs that residents could implement with support from the City. This approach reflects a desire by some residents, community groups, and other stakeholders to address concerns in an area where City-led interventions are not yet planned or committed. Community programs and initiatives considered as part of this guideline include the following:

- Lawn signs encouraging slower driving
- Pace car program
- Local-traffic Implementations
- Park & stride program

Design Considerations

The design of all Traffic Calming Measures shall be subject to the guidelines of the Institute of Transportation Engineers (ITE), TAC Canadian Guide to Traffic Calming, Ontario Traffic Manuals, industry best practices and all relevant City design and construction standards and specifications. The following guidelines and associated sections are relevant to traffic calming design:

Canadian Guide to Traffic Calming

- General considerations
- Raised Crosswalk
- Raised Intersection

- Speed Cushion
- Speed Hump/Table
- Chicanes
- Curb Radius Reduction
- Speed Kidney
- Traffic Circle/Button/Mini-roundabout
- Curb extension/Neckdown/Choker
- On-street Parking
- Raised Median Island
- Road Diet
- Sidewalk Extension / Textured Crosswalk
- Peripheral Transverse Bars
- Several access restrictions measures

Ontario Traffic Manuals (OTMs)

- Book 5
- Book 6
- Book 11
- Book 15
- Book 18

Traffic Calming Toolkit

The following section provides details for each traffic calming measure considered. This includes a general description of each measure, applicability, design/implementation considerations and ranges of costs for initial installation or construction. The following should be noted generally as it relates to these traffic calming measures:

- The measures are generally applicable in block lengths greater than 110m in length
    - If a road segment is less than 110m in length between the start and end of the road or between stop controlled intersections, there is typically not sufficient distance for vehicles to gain speed – therefore, traffic calming measures would likely not be as effective in these instances.
- The toolkit presents ranges of costs for initial installation to aid in the selection of measures for specific streets or projects. For the purposes of these guidelines:
    - “Low” implementation costs are generally considered in the range of less than $10,000 for an installation along a block segment.
    - “Medium” costs are generally considered in the range of $10,000 - $50,000 for an installation along a block segment.
    - “High” costs are generally considered above $50,000 for an installation along a block segment.

- The implementation costs noted above do not include operating and life cycle considerations, which may also need to be considered in the selection of treatments. Line painting applications and bollard installations, as examples, generally have lower initial costs than changes to curbs or pavement, however these measures also require ongoing maintenance and/or reapplications. Equipment such as speed display devices may require repairs over their lifespan (i.e. battery replacement) and eventual replacement of the device itself. For Type II measures, consideration needs to be given to the life cycle of the existing infrastructure in the right-of-way, including changes which may positively or negatively impact the lifespan of these assets.

Type I (Minor-adjustment) Measures

Vertical Centreline Treatment

Description

Vertical centerline treatments involve the use of vertical installations such as flexible post-mounted delineators or raised pavement markers to create a centre median. This gives drivers a perception of lane narrowing and creates a sense of constriction, which can lead to a reduction in operating speed.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban and Rural
- **ADT:** All traffic volumes
- **Cross-Section:** Two-lane bidirectional roadways
- **Grade:** ≤ 8%
- **Locations to Avoid:** Where a delineator may block driveways or cross-streets

Potential Benefits

- **Speed Reduction:** Due to the narrowing effects of the device, speed reduction up to 5 km/h can be achieved.

Design Considerations[1]

Vertical centreline bollards may be paired with a side cycling bollard spaced 3.0 m to 3.6 m from the centreline bollard. A cycling bollard is only recommended if a minimum of 1.5 m can be maintained between the curb and bollard for cyclists to travel through.

Other Considerations

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access, however placement of bollards should consider driveway/accesses and proximity to intersections.
- **Emergency Services:** Consideration required for larger vehicles along narrow roads or in which on-street parking is provided.

[1] Solomon, H., Malone, B., Garcia, J. et al. 2017. Canadian Guide to Traffic Calming, Second Edition. Ottawa, ON: Transportation Association of Canada.

- **Active Transportation:** Due to the road narrowing, drivers must exert extra caution when passing a cyclist along the roadway. Side bollards should only be included when more than 1.5m of clear space is available between the bollard and curb.
- **Parking:** May require removal of on-street parking at the locations of the measures.
- **Maintenance:** Can create challenges for snow plowing and snow removal – typically these measures do not permit sufficient clearance for snowplows to navigate between the bollards and curb.
- **Implementation Cost:** Low

Type I: Converging Chevrons

Description

Converging chevrons are pavement markings painted in the shape of a forward facing "V" pointing in the travel direction of the roadway. The spacing between the chevrons or width of the chevrons can be reduced as distance increases to create the illusion that a motorist's speed is increasing. This is done to alert the driver of the need to reduce their speed.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban and Rural
- **ADT:** All traffic volumes
- **Cross-Section:** Two-lane roadways
- **Grade:** N/A
- **Locations to Avoid:** N/A

Potential Benefits

- **Speed Reduction:** Degree of speed reduction is dependent on the use of other traffic calming measures along the roadway (minimal demonstrated effect if used alone).

Design Considerations:[2]

The size of the converging chevrons varies depending on the width of the travel lane. However, the following equation can be used as a guideline to determine the spacing between each chevron:

$$L = v_1 * t_b + \frac{(v_1^2 - v_2^2)}{2a}$$

FIGURE 148. EQUATION. DECREASING VELOCITY LINEAR EQUATION

Where:

L = distance between successive pair of transverse bar pairs $pair_1$ and $pair_2$ (ft)
v_1 = speed at pair 1 (ft/s) (speed at the first pair is the transition zone speed; speed at the last pair is the entrance posted speed limit)
v_2 = speed at pair 2
t_b = perception reaction time (0.5 s)
a = deceleration rate (ft/s^2)

Other Considerations

[2] https://www.fhwa.dot.gov/publications/research/safety/15030/009.cfm

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access.
- **Maintenance:** Due to the nature of the elements used to implement this treatment, its implementation will require recurring maintenance/reapplication.
- **Implementation Cost:** Low

Type I: Dragon's Teeth

Description

Dragon's teeth are a series of triangular pavement markings along the edge of the travelled lanes. They may be painted with increasing size to give the impression of roadway narrowing. They provide a visual change of the roadway and are commonly used to alert drivers that they are entering a rural community.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban and Rural
- **ADT:** All traffic volumes
- **Cross-Section:** Primarily rural 2 lane (one in each direction)
- **Grade:** N/A
- **Locations to Avoid:** N/A

Potential Benefits

- **Speed Reduction:** Degree of speed reduction is dependent on the use of other traffic calming measures along the roadway (minimal demonstrated effect if used alone).

Design Considerations:[3][4]

Each triangular pavement marking in a dragon's teeth application is typically 2 ft wide, 2 ft tall, and spaced approximately 5 ft 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.

Other Considerations

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access.
- **Maintenance:** Due to the nature of the elements used to implement this treatment, its implementation will require recurring maintenance/reapplication.
- **Implementation Cost:** Low

[3] https://intrans.iastate.edu/app/uploads/2018/03/updated_rural_traffic_calming_w_cvr2.pdf
[4] https://www.sabre-roads.org.uk/wiki/index.php?title=Dragon%27s_teeth

Type I: Full-Lane Transverse Bars

Description

Full-lane transverse bars are a series of parallel pavement markings which extend across most of the travelled lane width. The series of markings may be placed closer together with distance to create the illusion that a vehicle's speed is increasing to alert the driver of the need to reduce speed. Full-lane transverse bars are typically used on approaches to intersections, bridges, and deficient horizontal curves.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban and Rural
- **ADT:** All traffic volumes
- **Cross-Section:** N/A
- **Grade:** N/A
- **Locations to Avoid:** N/A

Potential Benefits

- **Speed Reduction:**
  Degree of speed reduction is dependent on the use of other traffic calming measures along the roadway (minimal demonstrated effect if used alone).

Design Considerations:[5]

The TAC Canadian Guide to Traffic Calming provides design guidance for peripheral transverse bars that may be referred to when implementing full-lane transverse bars. As such, full-lane transverse bars should not be greater than 0.3 m in width, and the recommended spacing between bars varies depending on the desired target speed and the speed differences. More details specific to spacing between sequential pairs of full-lane transverse bars measured upstream from the point at which the desired speed is to be achieved (ranging between 30 km/h to 80 km/h) are provided in the TAC Canadian Guide to Traffic Calming under design guidelines for peripheral transverse bars.

Other Considerations

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access.
- **Maintenance:** Due to the nature of the elements used to implement this treatment, its implementation will require recurring maintenance/reapplication.
- **Implementation Cost:** Low

[5] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

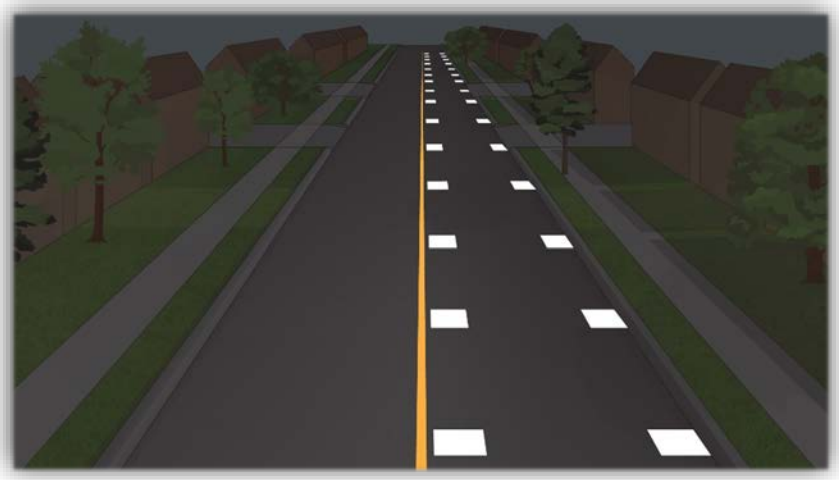
Type I: Peripheral Transverse Bars

Description

Peripheral transverse bars are a series of parallel pavement markings along the edge of the travelled lane widths. The series of markings may be placed closer together with distance to create the illusion that a vehicle's speed is increasing. Peripheral transverse bars are like full-lane transverse bars, but require less maintenance of the markings.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban and Rural
- **ADT:** All traffic volumes
- **Cross-Section:** N/A
- **Grade:** N/A
- **Locations to Avoid:** N/A



Potential Benefits

- **Speed Reduction:** Degree of speed reduction is dependent on the use of other traffic calming measures along the roadway (minimal demonstrated effect if used alone).

Design Considerations:[6]

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 depending on the desired target speed and the speed differences. Details regarding spacing between sequential pairs of peripheral transverse bars measured upstream from the point at which the desired speed is to be achieved (ranging between 30 km/h to 80 km/h) are provided in the TAC Canadian Guide to Traffic Calming.

Other Considerations

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access.
- **Maintenance:** Due to the nature of the elements used to implement this treatment, its implementation will require recurring maintenance/reapplication.
- **Implementation Cost:** Low

[6] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

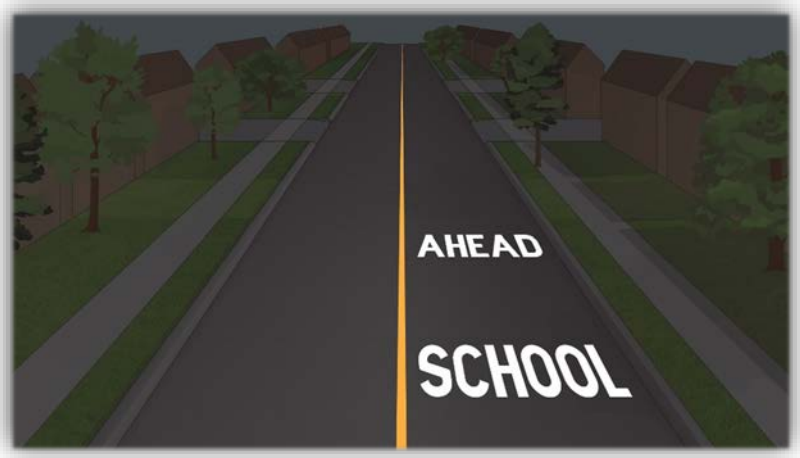
Type I: On-Road Sign Pavement Markings

Description

On-road 'sign' pavement markings provide information that would typically be communicated to drivers through posted signage but are instead painted on the roadway to provide a larger image directly in the driver's line of sight. These markings may be used as a gateway to alert drivers they are entering a school zone, school crossing, or neighbourhood. Examples include the set speed limit (i.e. 40 km/h), 'SLOW', or 'School Ahead'.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban and Rural
- **ADT:** All traffic volumes
- **Cross-Section:** N/A
- **Grade:** N/A
- **Locations to Avoid:** N/A



Potential Benefits

- **Speed Reduction:** Degree of speed reduction is dependent on the use of other traffic calming measures along the roadway (minimal demonstrated effect if used alone).

Other Considerations

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access.
- **Enforcement:** It is important to note that the implementation of any form of pavement markings is not enforceable as per the Highway Traffic Act – unless used in conjunction with other types of traffic calming measures (i.e. community safety zones).
- **Maintenance:** Due to the nature of the elements used to implement this treatment, its implementation will require recurring maintenance/reapplication. Visibility of these measures may be significantly reduced during winter (snow/ice cover and removal due to winter maintenance activities).
- **Implementation Cost:** Low

Type I: Speed Display Devices

Description

A speed display device is a pole-mounted device equipped with radar speed detector and an LED display. The devices can detect the speed of an approaching vehicle and display it back to the driver. The objective of the speed display device is to improve road safety by making drivers aware of their speed, evoking voluntary speed compliance. Speed display devices are most effective on single lane roads and can be used upstream of staffed speed enforcement.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban and Rural
- **ADT:** All traffic volumes (measure may be less effective or less accurate on heavily trafficked roads)
- **Cross-Section:** N/A (measure may be less effective or less accurate on multi-lane roads)
- **Grade:** N/A
- **Locations to Avoid:** N/A

Potential Benefits

- **Speed Reduction:** Speed reduction between 3 and 14 km/h can be achieved.

Design Considerations:[7][8]

The active display text must be a minimum of 200 mm high and should be 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.

Other Considerations

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access.
- **Enforcement:** Speed display devices may lose their effectiveness if there is no perception of enforcement – they are much more effective when used in conjunction with staffed speed enforcement downstream.

[7] Ontario Traffic Manual Book 10 – Dynamic Message Signs, Ministry of Transportation of Ontario, December 2007.
[8] Ontario Traffic Manual Book 1B – Sign Design Principles, Ministry of Transportation of Ontario, July 2001.

- **Maintenance:** Due to the nature of the elements used to implement this treatment, its implementation requires recurring maintenance. Consideration should be given to asset replacements/life cycle management for this technology.
- **Implementation Cost:** Low to Medium

Type I: Mobile Changeable Message Signs

Description

Mobile changeable message signs are electronic roadside warning signs with an illuminated screen that displays messages related to road safety. The purpose of these signs is to alert drivers to reduce their travel speed as they approach specific conditions or hazards ahead.

Applicability

- **Road Type:** Local Roads
- **Environment:** Urban and Rural
- **ADT:** All traffic volumes
- **Cross-Section:** N/A
- **Grade:** N/A
- **Locations to Avoid:** N/A

Potential Benefits

- **Speed Reduction:** Speed reduction up to 10 km/h can be achieved

Design Considerations:[9][10]

Mobile changeable message signs are to be placed such that the messages are visible to approaching motorists for at least 200 m.

In areas with no pedestrians, install the sign between 1.5 m and 2.5 m from the other edge of the outer lane (if no curbs are present) or from the curb line (if raised curbs are present) to the bottom of the sign. In areas with pedestrians, install the sign 2 m to 3 m from the ground elevation (measuring from the base of the signpost to the bottom of the sign).

In rural areas without raised curbs, install the measure between 2 m and 4 m from the edge of the outer travel lane. In urban or residential areas with raised curbs, install the measure between 30 cm and 2 m from the curb lane.

Other Considerations

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access.
- **Maintenance:** Due to the nature of the elements used to implement this treatment, its implementation requires periodic inspection and maintenance.
- **Implementation Cost:** Low to Medium

[9] Ontario Traffic Manual Book 10 – Dynamic Message Signs, Ministry of Transportation of Ontario, December 2007.
[10] Ontario Traffic Manual Book 1B – Sign Design Principles, Ministry of Transportation of Ontario, July 2001.

Type II (Engineered-based) Measures: Horizontal Deflections

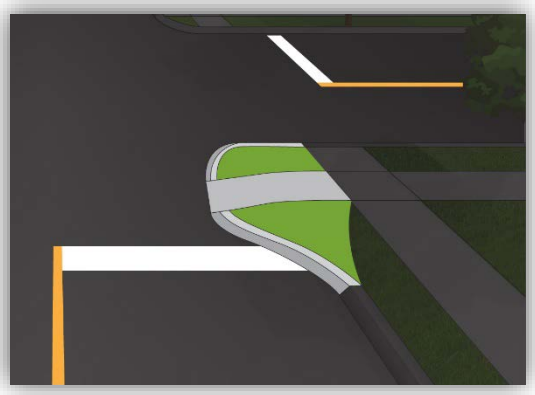
Curb Extension

Description

A curb extension (also known as a neckdown, choker, curb bulb, or bulb-out) is a horizontal intrusion of the curb into the roadway, resulting in a narrow section of roadway. The curb is extended on one or both sides of the roadway to reduce its width. The purpose of a curb extension is to reduce vehicle speeds, reduce crossing distance for pedestrians, increase visibility of pedestrians, and prevent parking close to an intersection.

Cycle-friendly bulb-outs can be considered as an alternative to traditional curb extensions in areas with higher bicycle volumes or when a cycling facility is part of the right-of-way. Cycle-friendly bulb-outs are horizontal projections of curbs into roadways that provides space for cyclists to ride over or through them.

Curb modifications may be required when installing cycle-friendly bulb-outs. A cycle-friendly bulb-out located at-grade and flush with the adjacent sidewalk allows cyclists to ride over it if a mountable curb is installed. Similarly, a cycle-friendly bulb-out located at-grade with a roadway and an adjacent median allows cyclists to ride through it, creating separation between cyclists and motor traffic.



Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban
-
- **ADT:** All traffic volumes
- **Cross-Section:** Max. 2 lane roadway
- **Grade:** ≤ 8%
- **Locations to Avoid:** N/A

Potential Benefits

- **Speed Reduction:** Speed reduction of up to 8 km/h can be achieved.

Geometric Design Considerations[11]

Curb extensions are commonly implemented at intersections to reduce roadway width on one or both streets. Curb extensions may also be located midblock on one or both sides of a street to reduce roadway width.

To maximize effectiveness, the lane width approaching an intersection is typically reduced to 3.0 m. If local conditions allow, a minimum approach lane width of 2.5 m can be used. However, the departure lane width should remain at 3.0 m, resulting in a minimum total lane width of 5.5

[11] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

m. When curb extensions are used on diagonally opposite corners of an intersection, a minimum clear offset of 5.0 m is required.

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.

At a midblock curb extension, 3.0 m lane widths are typical, but a minimum of 2.75 m lanes can be used if local conditions allow, resulting in a minimum total lane width of 5.5 m. Midblock curb extensions should also be long enough to accommodate a potential crosswalk and possible transitions in elevation, resulting in a desirable minimum length of 7.0 m.

Provision for turning movements made by emergency, service, and transit vehicles must be considered when designing a curb extension. Depressed curbs may be used to accommodate these vehicles, but potential risks to pedestrians should be evaluated.

Signing and Pavement Marking Design Considerations[12]
Depending on the visibility of the curb extensions, the installation of Object Markers (Wa-33) may be considered to improve their visibility. Object Markers should be installed in areas with heavy snowfall at the leading edge of each curb extension and at locations where there may be any concern regarding the sudden introduction of a curb extension into the roadway. Consideration can also be given to using bollards with reflective striping as an alternative to Object Markers.

Other Considerations

- **Local Vehicle Access:**
    - Implementation of this type of traffic calming measure does not affect local traffic access
    - Large vehicles such as long trucks and busses may need to cross into oncoming travel lanes to conduct turns at intersections with curb extensions
- **Emergency Services:** No significant impact on emergency service response times.
- **Active Transportation:**
    - Reduces pedestrian crossing distance / improves mutual visibility between pedestrians and motorists (if crosswalks are installed between curb extensions), which may reduce pedestrian-vehicle conflicts
    - Consider cyclists during the design process (i.e. curb extensions may impact dedicated cycling facilities)
    - Cyclists can feel squeezed closer to vehicles as motorists may attempt to overtake them at narrowing points
    - Curb extensions can be hazardous for drivers and cyclists if they are not designed and maintained properly – depressions or off-road connections for

[12] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

cyclists to navigate around or over curb bumpouts may be considered along cycling routes

- **Parking:** Requires removal/restriction of on-street parking at the locations of the curb extensions.
- **Maintenance:**
  - Can create constraints and challenges for snow plowing and snow removal. Potential for impacts such as snowplow damage to grass, trees, and curb extensions, and/or increased costs for winter maintenance (e.g. if snow removal required).
  - Roadway's effective width can be significantly reduced during winter months, dependent on the design and snow removal/winter control activities for the area. Consideration can be given to temporary restrictions such as parking restrictions if required during winter months to facilitate this change and maintain winter control activities.
  - Consideration required for existing drainage elements such as catch basins, concrete channels, gutters, inlets, and trench drains.
- **Streetscaping:** Landscaped curb extensions can improve the appearance of a street; however, opportunities may be limited depending on the scope and size of the curb extensions.
- **Implementation Cost:** Low to Medium

Type II: Raised Median Island

Description

A raised median island is a physical barrier located in the median between two directions of traffic and are typically installed on two-way roadways. Median islands narrow the roadway causing motorists to slow down. They may be used as a pedestrian crossing refuge as well.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban and Rural
- **ADT:** All traffic volumes
- **Cross-Section:** Most effective on 2 lane roadways (one each direction)
- **Grade:** ≤ 8%
- **Locations to Avoid:** N/A

Potential Benefits

- **Speed Reduction:** Speed reductions between 3 and 8 km/h can be achieved.

Geometric Design Considerations[13]

The width of a single lane adjacent to a raised median island should ideally not exceed 3.5 m, recommended to target minimum lane width of 3.3m. 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. If raised median islands are being used in conjunction with a midblock crosswalk, a minimum width of 1.5 m should be provided between islands (i.e. within the crosswalk area).

Raised median islands should have a minimum width of 1.5 m to adequately protect any signing required in the median and to provide pedestrians with a minimum refuge area.

Signing and Pavement Marking Design Considerations[13]

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.

[13] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

Additionally, Stopping Prohibited signs (Rb-55) are required within the area of the raised median island to preserve lane widths and maintain traffic flow.

If raised median islands are being used at midblock crosswalk locations (e.g. controlled crossings), Pedestrian Crossover signs (Ra-4) must be installed.

Other Considerations

- **Local Vehicle Access:** May restrict access to driveways (from one direction only).
- **Emergency Services:** Consideration for larger vehicles along narrow roads. Implementation to consider design vehicle movements along corridor.
- **Active Transportation:**
    - Raised median islands can function as a pedestrian refuge, which may result in reduced pedestrian-vehicle conflicts
    - As a result of the narrowed roadway, cyclists and vehicular traffic will share the same travel lane in cases where dedicated cycling facilities are not provided
- **Parking:** Typically requires restricting on-street parking in the vicinity.
- **Maintenance:** Can create constraints and challenges for snow plowing and snow removal. Consideration must be given to the lane width and size of the plow/maintenance vehicles that would be servicing the area of the installation.
- **Streetscaping:** Aesthetic benefits if well-maintained planting within the raised median island is incorporated, however opportunities may be limited depending on the scope and size of the median.
- **Implementation Cost:** Low to Medium

Type II: Lateral Shift

Description

A lateral shift involves the redesign of a straight section of road with pavement markings or curb extensions to create a curve in the road, similar to a chicane, which the driver must navigate around. The purpose of a lateral shift is to increase a driver's awareness as they negotiate it, effectively reducing their operating speed. In some cases, a lateral shift may involve the redesign of a road (depending on the existing right-of-way/constraints).

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban
- **ADT:** All traffic volumes
- **Cross-Section:** N/A
- **Grade:** ≤ 8%
- **Locations to Avoid:** N/A

Potential Benefits

- **Speed Reduction:** A lateral shift can slow traffic by encouraging a driver to moderate vehicle speed through a single shift in roadway alignment (i.e. using curb extensions or pavement markings). The degree of speed reduction (or the final speed) depends on the length of the alignment shift, as well as the volume and distribution of traffic.
- **Volume Reduction:** Amount of traffic diversion is dependent on the number of measures along the roadway.

Design Considerations[14]

A typical lateral shift is simply one half of a typical chicane. The design considerations and dimensions are therefore similar to a typical chicane (see Design Considerations for a Chicane). A lateral shift of at least one-lane width and an angle of deflection of at least 45 degrees is a common industry target.

Other Considerations

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access.
- **Emergency Services:**
    - A lateral shift may affect emergency service response times – sufficient roadway width should be maintained to facilitate the movement of fire apparatus and other large vehicles.

[14] https://safety.fhwa.dot.gov/speedmgt/ePrimer_modules/module3.cfm

- **Active Transportation:** Dedicated cycling facilities have potential to be affected; design should consider this (e.g. if cycling facilities can be re-directed off-road through this area).
- **Enforcement:** Additional enforcement is not typically required, however implementation of this type of traffic calming measure may incite sharp cornering, braking and acceleration, and other aggressive driving behaviour.
- **Parking:** May require removal of on-street parking at the location of the lateral shift.
- **Maintenance:**
    - Can create constraints and challenges for snow plowing and snow removal, which may require specialized vehicles
    - Consideration should be given for existing drainage elements such as catch basins, concrete channels, gutters, inlets, and trench drains
    - Not anticipated to impact above- and below-grade utilities
    - May require careful consideration of the alignment and presence of at-grade utilities
- **Streetscaping:**
    - Low maintenance streetscaping can considered in the design of traffic calming measures that intrude the roadway
    - Attention needs to be given to appearance to counter potential for visual clutter (i.e. signs or landscaping on curb extensions)
- **Implementation Cost:** Medium to High

Type II (Engineered-based) Measures: Vertical Deflections

Speed Hump/Table

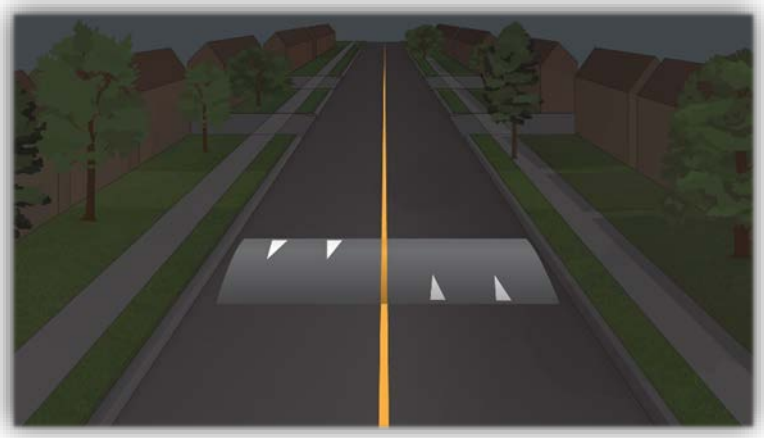
Description

Speed humps are a vertical structure spanning across the width of a roadway (excluding gutters) designed to slow vehicle speeds. Speed humps are typically installed in series. Motorist discomfort is dependent on the size of the speed hump and the speed they are travelling.

Speed tables are speed humps with an extended flat top that can typically fit the length of a passenger vehicle across its width. Speed tables have higher design speeds than speed humps and maintain a smoother ride for larger vehicles. Speed tables are typically preferable on collector roads.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban
- **ADT:** All traffic volumes
- **Cross-Section:** 2 lanes (one each direction) but can be used on one-way streets
- **Grade:** ≤ 8%
- **Locations to Avoid:**
    - Designated emergency access routes
    - Small turning radius curves and other areas with limited sight distance
    - Intersections
    - Driveways
    - Transit stops (placement of speed table/hump should be at least 25 m in advance of bus stops)
    - Traffic signals (locate at least 75 m distance from traffic signals so that the speed hump/table is not within the decision or braking zones).



Potential Benefits

- **Speed Reduction:** Speed reduction between 6 and 13 km/h can be achieved
- **Volume Reduction:** Volume reduction between 15% and 27% can be achieved. Amount of traffic diversion is dependent on the number of measures along the roadway. Traffic may be diverted to parallel streets without traffic calming measures

Geometric Design Considerations[15]

Speed humps and speed tables have similar configurations spanning across the entire width of a roadway except that speed tables typically have a flat top section 3.0 m long that is 80 mm high, which is more suitable for roads with higher design speeds. Speed humps/tables typically have lengths of 4.0 m or 7.0 m (measured in the direction of travel) when installed on local and collector streets, respectively. The vertical transition that is required at each end of a retrofit speed hump/table can be keyed into the existing pavement to minimize any damage to, and by, snow plowing equipment.

To effect slower vehicle speeds over a longer distance, speed humps/tables should be installed in series. For example, a spacing of 80 m to 150 m is recommended to maintain an 85th percentile operating speed between 40 and 48 km/h.

Signing and Pavement Marking Design Considerations[15]

A Speed Hump warning sign (Wa-74) facing oncoming traffic should be installed directly adjacent to the hump/table to alert drivers of the vertical deflection. If sign or speed hump/table visibility is obscured, Speed Hump warning signs with distance tabs may be considered for installation in advance of the speed hump/table.

If a speed hump/table is being installed on a one-way street, Speed Hump warning signs should be installed on both sides of the road facing oncoming traffic. White triangular pavement markings that are approximately 0.6 m wide and spaced 1.5 m apart should be painted directly on the approach end of speed humps/tables.

Other Considerations

- **Local Vehicle Access:** Traffic may be diverted to parallel streets without traffic calming measures.
- **Emergency Services:** It may have an effect on emergency service response times.
- **Active Transportation:** Consideration should be given to maintain the speed hump/table across the width of an adjacent bicycle lane or a physical separation (i.e. median, delineator posts) could be provided to 'protect' the bicycle lane from motorists trying to avoid the vertical deflection.
- **Parking:** May require removal of on-street parking at the location of the speed hump/table.
- **Maintenance:** Can create constraints and challenges for snow plowing and snow removal – plow operators must use caution to avoid damaging speed hump/table surface. Speed humps can also damage plow trucks themselves, increasing truck maintenance costs.
- **Implementation Cost:** Low to Medium

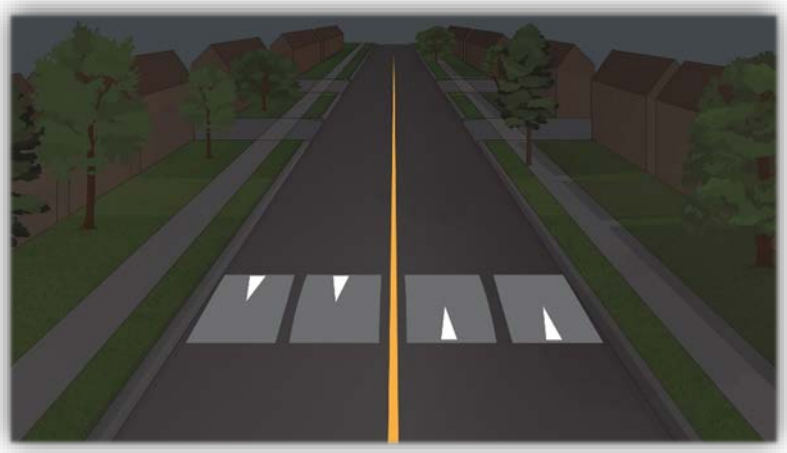
[15] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

Type II: Speed Cushions

Description

Speed cushions are a narrower version of a speed hump and are installed in the middle of each travel lane. They are designed to slow passenger vehicles while allowing vehicles with larger wheelbases (i.e. emergency vehicles and buses) to pass unimpeded. Speed cushions should be considered rather than speed humps on emergency response and transit routes. Speed cushions may be preferable on collector roads.

Applicability



- **Road Type:** Local and Collector Roads
- **Environment:** Urban
- **ADT:** All traffic volumes
- **Cross-Section:** N/A
- **Grade:** ≤ 8%
- **Locations to Avoid:**
  - Small turning radius curves and other areas with limited sight distance
  - Intersections
  - Driveways
  - Traffic signals (locate at least 75 m distance from traffic signals so that the speed cushion is not within the decision or braking zones).

Potential Benefits

- **Speed Reduction:** Vehicular speed reduction between 25 and 32 km/h has been observed at the top of speed cushions, however, the speed reduction declines with the distance to the measure by approximately 1 to 1.5 km/h every 30 m before and after the area of influence of the measure (approx. 60 m). Effectively reduces speed up to 8 km/h.
- **Volume Reduction:** Volume reduction of approximately 30% can be achieved. Amount of traffic diversion is dependent on the number of measures along the roadway. Traffic may be diverted to parallel streets without traffic calming measures.

Geometric Design Considerations[16]

It is typical to install one speed cushion per travel lane. The optimal width for speed cushions is 1.8 m, which is 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

[16] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

m, which is narrow enough such that motorists cannot maneuver to avoid the cushions but wide enough for cyclists and the tires of emergency vehicles to pass. If there are only two cushions 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.

Signing and Pavement Marking Design Considerations

A Speed Hump warning sign (Wa-74) facing oncoming traffic should be installed directly adjacent to the speed cushion to alert drivers of the vertical deflection. If sign or speed cushion visibility is obscured, Speed Hump warning signs with distance tabs may be considered for installation in advance of the speed cushion.

If a speed cushion is being installed on a one-way street, Speed Hump warning signs should be installed on both sides of the road facing oncoming traffic. White triangular pavement markings that are approximately 0.4 m wide and spaced 0.6 m apart should be painted directly on the approach end of speed cushions (assuming an optimal speed cushion width of 1.8 m).

Other Considerations

- **Local Vehicle Access:** Traffic may be diverted to parallel streets without traffic calming measures.
- **Emergency Services:** Speed cushions may affect smaller emergency vehicles (i.e. ambulance).
- **Active Transportation:** Consideration should be given to provide a physical separation (i.e. median, delineator posts) to ‘protect’ the bicycle lane from motorists trying to avoid the vertical deflection.
- **Parking:** May require removal of on-street parking at the location of the speed cushion.
- **Maintenance:** Can create constraints and challenges for snow plowing and snow removal; plow operators must use caution to avoid damaging speed cushion surface.
- **Implementation Cost:** Low to Medium

Type II (Engineered-based) Measures: Intersection Treatments

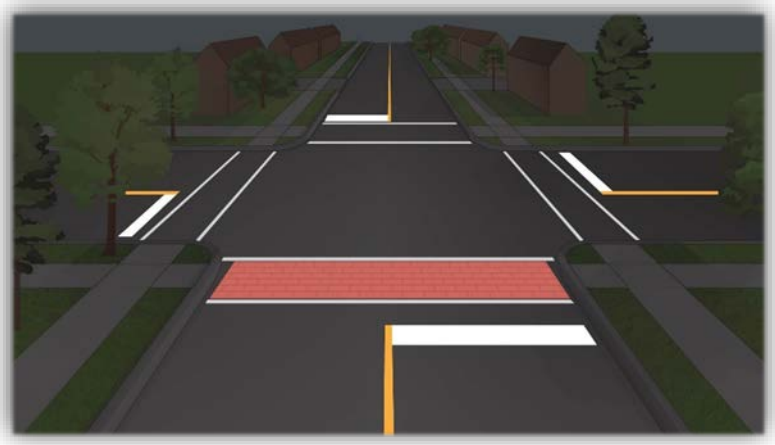
Textured Crosswalk

Description

Textured crosswalks may have a different colour and/or surface texture than the roadway to highlight the pedestrian crossing area. Marking products may include traditional pavement marking paint or more durable applications such as thermoplastic or cold plastic. The conspicuity of the colour and texture reduces over time as they wear out, but the use of more durable applications can retain good visibility for relatively long periods of time, reducing maintenance costs.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban
- **ADT:** All traffic volumes (with consideration of buses and heavy vehicles on truck routes)
- **Cross-Section:** N/A
- **Grade:** ≤ 8%
- **Locations to Avoid:** N/A



Potential Benefits

- **Speed Reduction:** Degree of speed reduction is dependent on the use of other traffic calming measures along the roadway (minimal demonstrated effect if used alone).

Design Considerations[17]

The crosswalk must be at least 2.5 m wide, but widths of 3 m to 4 m are considered typical in urban areas with higher levels of pedestrian activity. If the measure is installed at a controlled crossing, 0.1 m to 0.2 m wide parallel standard crosswalk lines are required to delineate the outside edges of the crosswalk. Additionally, if zebra crosswalk markings are used, the typical configuration consists of block markings that are 0.6 m wide and spaced at 0.6 m.

Other Considerations

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access.
- **Emergency Services:** No significant impact on emergency service response times.

[17] Ontario Traffic Manual Book 15 – Pedestrian Crossing Treatments, Ministry of Transportation of Ontario, June 2016.

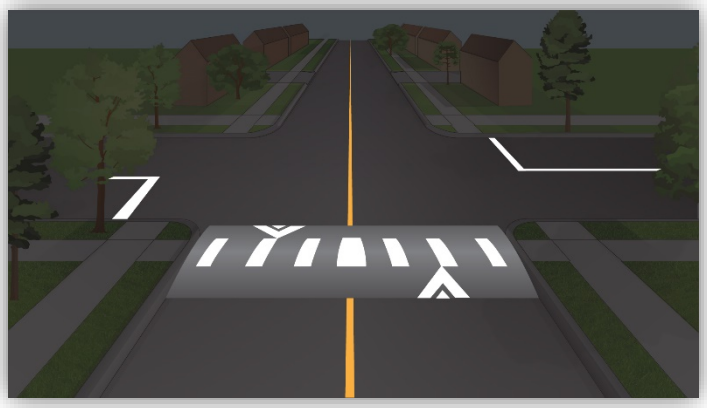
- **Active Transportation:**
  - Extension of sidewalk and textured surface treatment emphasizes pedestrian priority and may reduce pedestrian-vehicle conflicts
  - May result in a false sense of pedestrian security if not accompanied by pedestrian right-of-way legislation
  - Textured surfaces may create traction and/or stability issues for persons with mobility challenges
- **Parking:** Removal of on-street parking is not required.
- **Maintenance:**
  - Ongoing road maintenance is required to repair uneven transition between surfaces because asphalt and textured pavement settles differently
  - Textured surfaces may increase street sweeping time if the texturing involves deep grooves, and excess dust/debris may remain in the grooves
  - Less effective during the winter season due to snow/ice cover.
- **Streetscaping:**
  - May create extra traffic noise from vehicle wheels travelling over the textured surface (i.e. if texturing is rough or pronounced)
  - Textured treatment enhances the appearance of a street, especially when combined with other landscaping techniques.
- **Implementation Cost:** Low to Medium

Type II: Raised Crosswalks

Description

A raised crosswalk is a marked pedestrian crosswalk at an intersection or mid-block location constructed at a higher elevation than the adjacent roadway. Raised crosswalks may help reduce vehicle speeds and improve pedestrian visibility, thereby reducing pedestrian-vehicle conflicts.

Raised crosswalks are similar to speed humps, except they are typically wider and have a flat top. The elevation and width of the raised crosswalk matches the sidewalk approaches on either side of the roadway. These measures are suitable for all types of crosswalks (unsignalized, midblock, and intersection).



Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban and Rural
- **ADT:** All traffic volumes
- **Cross-Section:** N/A
- **Grade:** ≤ 8%
- **Locations to Avoid:**
  - Designated emergency access routes
  - Small turning radius curves and other areas with limited sight distance
  - Driveways
  - Transit routes where articulated buses are used due to potential decoupling
  - Bus stops

Potential Benefits

- **Speed Reduction:** Degree of speed reduction is dependent on the use of other traffic calming measures along the roadway (minimal demonstrated effect if used alone).

Geometric Design Considerations[18]

A raised crosswalk is typically 6.5 m wide, 80 mm high, has a minimum crosswalk width of 2.5 m, and has a curb-face height of 15 mm at the location of the measure. However, to achieve a curb-face height of 15 mm, sidewalk reconstruction adjacent to the curb may be required. The transition zone between each end of the raised crosswalk and the flat top of the crosswalk must be a minimum of 1.5 m long, but it is desirable to be at least 2.0 m. The maximum slope of this transition zone on both ends of the raised crosswalk is 6%. The vertical transition that is

[18] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

required at each end of a raised crosswalk should be keyed into the existing pavement to minimize any damage to, and by, snow plowing equipment.

Catch basins are required on the uphill side of a raised crosswalk.

Signing and Pavement Marking Design Considerations[19]
A Speed Hump warning sign (Wa-74) facing oncoming traffic should be installed directly adjacent to the raised crosswalk to alert drivers of the vertical deflection. If the visibility of the sign or raised crosswalk is obscured, Speed Hump warning signs with distance tabs may be considered for installation in advance of the raised crosswalk.

Pedestrian Crossover signs (Ra-4) must be installed on both sides of the roadway facing traffic if the raised crosswalk is being installed at a location without traffic signal control or Stop control.

If a raised crosswalk is being installed on a one-way street, Speed Hump warning signs should be installed on both sides of the road facing oncoming traffic. White triangular pavement markings that are approximately 0.6 m wide and spaced 1.5 m apart should be painted directly on the approach end of raised crosswalks.

Other Considerations

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access.
- **Emergency Services:** Raised crosswalks may have an effect on emergency service response times.
- **Active Transportation:** Pedestrian crossing area is better defined, and vehicles are forced to slow down through the pedestrian conflict zone, which may reduce pedestrian-vehicle conflicts.
- **Parking:** Removal of on-street parking is not required.
- **Transit:** It is recommended not to place these measures along routes where articulated buses are operating. It is also recommended to consider the design and proximity of raised crosswalks relative to proximity of bus stops.
- **Maintenance:**
    - Snow clearing time may be increased
    - Consideration of existing drainage elements such as catch basins, concrete channels, gutters, inlets, and trench drains
- **Streetscaping:**
    - Aesthetic benefits if raised crosswalk incorporates pavement treatments such as coloured and/or textured pavement
- **Implementation Cost:** Low to Medium

[19] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

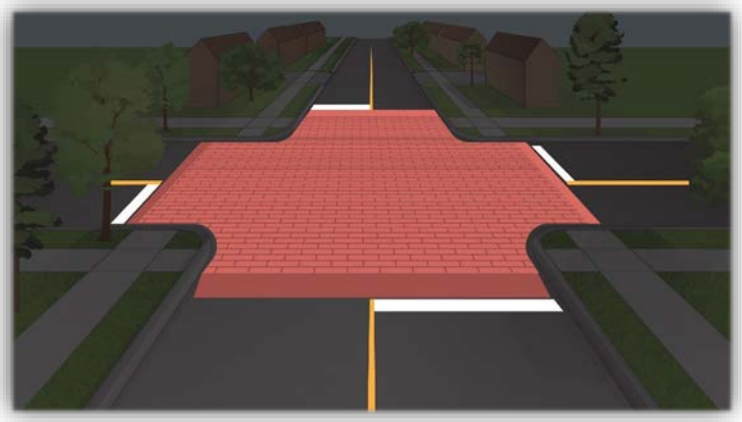
Type II: Intersection Treatments – Raised Intersection

Description

Raised intersections have a flat, elevated area between all approaching roadways of an intersection, similar to raised crosswalks and speed tables. However, the reduction in vehicle speeds is minor compared to raised crosswalks, speed humps, and speed tables due to the relatively large distance between access and egress ramps. Raised intersections alert drivers of pedestrians crossing through intersections.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban and Rural
- **ADT:** All traffic volumes
- **Cross-Section:** 2 lanes (one each direction) but can be used on one-way streets
- **Grade:** ≤ 8%
- **Locations to Avoid:** Designated emergency access routes.



Potential Benefits

- **Speed Reduction:** Speed reduction of up to 10 km/h can be achieved.
- **Volume Reduction:** Amount of traffic diversion is dependent on the number of measures along the roadway.
    - Traffic may be diverted to parallel streets without traffic calming measures.

Geometric Design Considerations[20]

A raised intersection is typically 80 mm high, has a minimum crosswalk width of 2.5 m, and has a curb-face height of 15 mm at the location of the measure. However, to achieve a curb-face height of 15 mm, sidewalk reconstruction adjacent to the curb may be required. The transition zone between each edge of the raised intersection and the flat top of the crosswalk is typically 2.0 m long. The sloping surfaces connecting adjacent sidewalks to those across the raised intersection should have a tactile finish and a slope no greater than 6%. The vertical transition that is required at each edge of a raised intersection should be keyed into the existing pavement to minimize any damage to, and by, snow plowing equipment.

[20] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

A minimum pavement slope of 1% should be provided within the raised intersection to facilitate surface drainage.

Signing and Pavement Marking Design Considerations[21]

A Speed Hump warning sign (Wa-74) facing oncoming traffic should be installed directly adjacent to the raised intersection to alert drivers of the vertical deflection. If sign or raised intersection visibility is obscured, Speed Hump warning signs with distance tabs may be considered for installation in advance of the raised crosswalk.

White triangular pavement markings that are approximately 0.6 m wide and spaced 1.5 m apart should be painted directly on the approach end of raised intersections.

Other Considerations

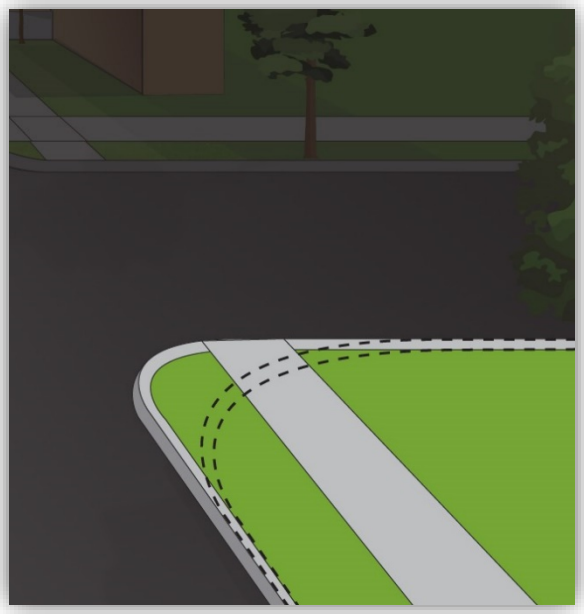
- **Local Vehicle Access:** Traffic may be diverted to parallel streets without traffic calming measures.
- **Emergency Services:** Raised intersections may have an effect on emergency service response times.
- **Active Transportation:** Pedestrian crossing area is better defined, and vehicles are forced to slow down through the pedestrian conflict zone, which may reduce pedestrian-vehicle conflicts.
- **Parking:** Removal of on-street parking is not required.
- **Maintenance:**
    - Snow clearing time may be increased
    - Attention needed to avoid need for relocation of drainage elements such as catch basins, concrete channels, gutters, inlets, and trench drains.
- **Streetscaping:**
    - Aesthetic benefits if raised intersection incorporates pavement treatments such as coloured and/or textured pavement
- **Implementation Cost:** Medium to High

[21] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

Type II: Intersection Treatments – Curb Radius Reduction

Description

A curb radius reduction is a reconstruction of an intersection corner with a smaller radius, generally between 3 and 5 m. A smaller corner radius requires vehicles to slow their speed to make a right turn but may make right turns difficult for larger vehicles. In addition, they reduce the distance pedestrians must walk from curb to curb in a crosswalk. A curb radius reduction can be implemented as a measure on local roads using pinned curbs.



Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban and Rural
- **ADT:** Use with caution on major roads > 10,000 vehicles per day
- **Cross-Section:** N/A
- **Grade:** ≤ 8%
- **Locations to Avoid:**
    - Intersections with designated truck routes and/or high volumes of large vehicles making turning movements.
    - Primary emergency vehicle routes.

Potential Benefits

- **Speed Reduction:** Speed reduction for right-turning vehicles.

Geometric Design Considerations[22]

A curb radius reduction should aim to introduce the smallest radius required to accommodate a passenger vehicle, which typically ranges from 3.0 m to 5.0 m. Afterwards, it is important to check any potential implications of this radius on the operation of larger vehicles. The width of a roadway at the location of a curb radius reduction is recommended to be a minimum of 6.0 m.

Signing and Pavement Marking Design Considerations[22]

If a curb radius reduction is used as an independent traffic calming measure, no additional signing or pavement markings are required. However, if combined with curb extensions, the installation of Object Markers (Wa-33) may be considered if the visibility of curb extensions is obscured. Object Markers should be installed in areas with heavy snowfall at the leading edge of each curb extension and at locations where there may be any concern regarding the sudden

[22] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

introduction of a curb extension into the roadway. Consideration can also be given to providing bollards with reflective striping as an alternative to Object Markers in some municipalities.

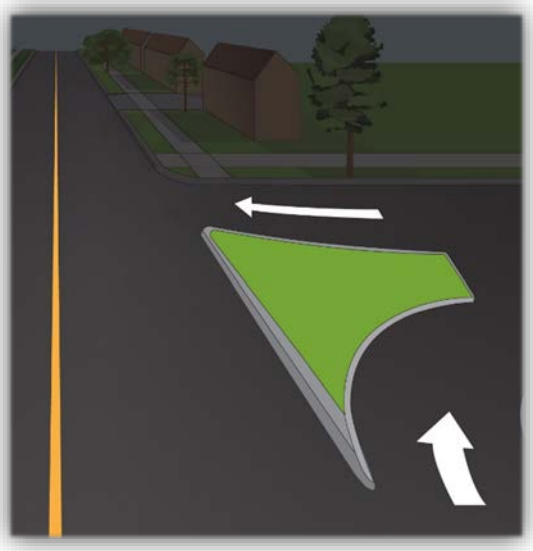
Other Considerations

- **Local Vehicle Access:**
  - Implementation of this type of traffic calming measure does not affect local traffic access
  - Large vehicles such as long trucks and busses may need to cross into adjacent (potentially oncoming) travel lanes to complete turns at intersections with radius reduction
- **Emergency Services:** Curb radius reductions may have an effect on emergency service response times if insufficient road width is available for turning radius needs.
- **Transit:** Implementation should consider transit routes (volume of buses and movements at the intersection). Consultation is recommended for areas of implementation along transit routes.
- **Active Transportation:**
  - Reduces pedestrian crossing distance / improves visibility of oncoming traffic, which may reduce pedestrian-vehicle conflicts
  - Large vehicles which may need to mount the curb when turning may conflict with pedestrians. This is dependent on selecting the design vehicle for the radius alignment. Consideration should be given to the design of appropriate pedestrian refuge and crossing areas.
- **Parking:** Removal of on-street parking is not required
- **Maintenance:**
  - Can create constraints for snow plowing and snow removal. Consultation is recommended for areas of implementation.
  - Requires consideration for presence of drainage elements such as catch basins, concrete channels, gutters, inlets, and trench drains.
- **Implementation Cost:** Low to Medium

Type II: Intersection Treatments – Right-In/Right-Out Islands, Intersection Channelization, and Raised Medians through Intersections

Description

Right-In/Right-Out Islands, Intersection Channelization, and Raised Medians through Intersection are vertical barriers obstructing and/or restricting specific vehicular movements at intersections, while preserving all or most of the original roadway configuration.



Applicability

- **Road Type:** Local Roads
- **Environment:** Urban
- **ADT:** All traffic volumes
- **Cross-Section:** N/A
- **Grade:** N/A
- **Locations to Avoid:**
    - Transit routes
    - Designated emergency routes (applicable for intersection channelization only)

Potential Benefits

- **Speed Reduction:** Minimal demonstrated effect on speed reduction if the treatment is implemented by itself.
- **Volume Reduction:** Expected reduction of traffic volumes is proportional to the directional movement to be prohibited.

Geometric Design Considerations: Right In/Right Out Islands[23]

The intersection radii should be chosen such that a divisional island large enough to effectively discourage through and left-turn movements can be implemented. A minimum island size of 6.0 m^2 to 10 m^2 is required for pedestrian refuge. It is also important to carefully select a curb radius between the two street edges that maximizes the island length along the unobstructed street, further discouraging through traffic on the obstructed street. Consideration is also required for the creation of right turn 'channelizations' and the alignment of vehicles relative to potential crossings of pedestrians and cyclists to ensure that channelizations do not create instances where vehicles increase speed making their movements at the corner. The location of depressed curbs and signs should consider the movement of larger/design vehicles.

Geometric Design Considerations: Intersection Channelization[24]

[23] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.
[24] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

The right-turn radius into the protected street segment should be chosen such that a divisional island large enough to effectively discourage left-turn and through movements can be implemented. A minimum island size of 6.0 m^2 to 10 m^2 is required for pedestrian refuge. Consideration is also required for the creation of right turn 'channelizations' and the alignment of vehicles relative to potential crossings of pedestrians and cyclists to ensure that channelizations do not create instances where vehicles increase speed making their movements at the corner.

The width of the turning lane should be designed to accommodate only those vehicles that need to use the street segment on a regular basis. Implications of infrequent access by larger vehicles should be reviewed as well. The use of depressed curbs could help assist with both of these considerations.

The effectiveness of channelization in discouraging motorists from making an illegal turn is improved if an island size of 10 m^2 or greater is used.

Geometric Design Considerations: Raised Medians through Intersection[25]
The median island should be wide enough to provide pedestrian refuge (i.e. 6.0 m^2 to 10 m^2). Additionally, the sidewalk crossings of the raised median through intersection should include a depressed section to facilitate pedestrian crossings. This depressed section should be narrow enough to deter general use, but still be able to accommodate emergency access if needed. Separate openings with a minimum 1.5 m width may also be considered for cyclists.

The raised median is recommended to have a minimum 1.5 m raised portion and provide at least a 3.5 m single lane width on each side of the median beyond the intersection. However, turning vehicle requirements will determine the actual lane width adjacent to the median. The median is also recommended to extend 5.0 m to 7.0 m beyond the outer edge of the crosswalk, depending on driveway locations, to discourage shortcutting.

Signing and Pavement Marking Design Considerations: Right In/Right Out Islands[26]
On the protected intersection approach, a Right Turn Only sign (Rb-42) is required in advance of the intersection and on the right-in/right-out island. On the end of the island facing this same approach, a Keep Right sign (Rb-25) and an Object Marker (Wa-33L) are also required. An Object Marker (Wa-33) is also required on the end of the island facing traffic turning right onto the protected street.

A Do Not Enter sign (Rb-19) is required on the island facing the prohibited through movement. A No Left Turn sign (Rb-12) should be installed on the cross-street on the far side of the intersection and at the end of the island. Both signs should be facing the traffic that is prohibited to turn left.

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[25] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.
[26] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

On the intersection approach facing the island (i.e. intersection leg opposite to the protected approach), a Left or Right Turn Only sign (Rb-45) is required to inform drivers that they must turn onto the cross street.

Pavement marking arrows may be used to supplement the Rb-42 and Rb-45 signs. Additional signage may be required for pedestrian and/or cyclist crossings.

Signing and Pavement Marking Design Considerations: Intersection Channelization[27]
A Do Not Enter sign (Rb-19) is required on the island facing the prohibited through movement and a Left or Right Turn Only sign (Rb-45) should be installed as well on this approach to inform drivers that they must turn onto the cross street.

A No Left Turn sign (Rb-12) should be installed on the cross-street on the far side of the intersection and at the end of the island. Both signs should be facing the traffic that is prohibited to turn left.

A Keep Right sign (Rb-25) and Object Marker (Wa-33L) should be installed on the end of the island that is in the centre of the protected street. An Object Marker (Wa-33) is also required on the corner of this island facing traffic turning right from the collector street.

Pavement markings may be added to supplement the Eb-45 sign. Additional signage may be required for pedestrian and/or cyclist crossings.

Signing and Pavement Marking Design Considerations: Raised Medians through Intersection[28]
The two ends of the raised median should have Keep Right signs (Rb-25) and Object Markers (Wa-33L) installed. Depending on driver behaviour, No U-Turns signs (Rb-16) may also be required and should be installed back-to-back to the Keep Right signs (Rb-25). At the centre of the protected cross-street, installation of either a Right Turn Only sign (Rb-42) or a One-Way Sign (Rb-21) is required on the median facing both approaches.

Pavement markings on both approaches to the raised median are illustrated in the MUTCDC.

Other Considerations

- **Local Vehicle Access:** Vehicular traffic will be rerouted to adjacent locations, with the consequence of increased trip length for some residents.
- **Emergency Services:** Consultation with emergency services should be conducted in advance of implementation of these measures.
- **Active Transportation:** The alignment of vehicle movements being directed to make right turn movements needs to be considered with the potential for pedestrian and/or cyclist facilities crossing at a channelization to ensure that the channelization does not

[27] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.
[28] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

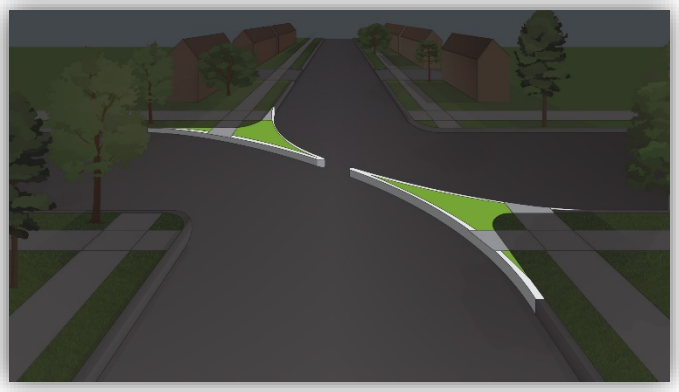
contribute to faster vehicle movements around the turn or introduce sightline challenges for visibility of any off-road facility crossings.

- **Parking:** Removal of on-street parking is not required.
- **Maintenance:** Winter maintenance and garbage collection routes may be subject to change based on the location of the measure.
- **Streetscaping:** Potential opportunities for streetscaping as part of the measure, but sightlines need to be considered for any proposed landscaping elements.
- **Implementation Cost:** Medium

Type II: Intersection Treatments – Vehicular Directional Closures and Diverters

Description

A directional closure is vertical barrier obstructing and/or prohibiting one direction of traffic. Usually located at the intersection of a local road with collector or arterial streets, the purpose of this measure is to eliminate an identified (or potential) infiltration of traffic along a specific corridor. A diverter differs from a directional closure in its position through the entire length of an intersection.



Applicability

- **Road Type:** Local Roads
- **Environment:** Urban
- **ADT:** < 1500 vehicles per day
- **Cross-Section:** Most effective on 2 lane roadways (one each direction)
- **Grade:** N/A
- **Locations to Avoid:**
    - Local street intersections with other local streets because this will shift any traffic volume issues to other local streets instead of the arterial system (applicable for directional closures only)
    - Designated emergency routes (applicable for diverters only)

Potential Benefits

- **Volume Reduction:** Expected reduction of traffic volumes is proportional to the directional movement to be prohibited.

Geometric Design Considerations: Vehicular Directional Closures[29]

The width of directional closure islands must be such that they effectively obstruct (prohibit) one direction of traffic and extend to approximately the centreline of a roadway. The length of these islands typically ranges from 5.0 m to 7.0 m but vary based on local conditions.

Gaps bordered by rolled curbs are commonly provided adjacent to the closures to accommodate cyclists through the intersection. These gaps are approximately 1.5 m in width to provide enough space for cyclists to maneuver but not enough space for motor vehicles.

Geometric Design Considerations: Diverters[30]

The alignment of the diverter must provide an adequate turning path for all vehicles. Parking should be prohibited within the limits of the diversion to allow for the minimum diversion width

[29] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.
[30] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

that maximizes the possible landscape area between the two diversions within the original intersection. The minimum width of the central diverter island should be 1.5 m and the maximum width of an adjacent roadway to a diverter is 7.5 m.

Bicycle channels bordered by rolled curbs are typically provided through the diverter at a width of 1.5 m to accommodate the movement of cyclists. If bicycle channels are provided, these should have bollards or planters installed immediately adjacent to the edge of each channel (typically installed at 1.5 m spacing) to deter usage by general traffic. Additionally, if a sidewalk is placed along the diverter, this requirement for landscaping and/or bollards applies as well. It is important to ensure that any plantings placed on the diverter should not obscure the visibility of motorists and cyclists. Provision of both features will require a central diverter island width greater than the minimum width of 1.5 m stated previously.

To accommodate emergency vehicles at diverters, break-away or lockable bollards or lockable gates can be considered.

Signing and Pavement Marking Design Considerations: Vehicular Directional Closures[31]
If the closure is “exit-only”, Left or Right Turn Only signs (Rb-45) and Do Not Enter signs (Rb-19) are required to inform approaching traffic of the closure. If bicycle access is to be permitted, a ‘Bicycles Excepted’ tab sign (Rb-17t) is required. One-Way signs (Rb-21) must also be installed to notify cross-street traffic that turns into the closed street are prohibited. An Object Marker (Wa-33L) must also be installed on the end of the island facing exiting traffic.

If the closure is “entrance-only”, a No Exit sign (Wa-31) informing motorists that existing is not possible and a Checkerboard sign (Wa-8) indicating that the road terminates are required.

Pavement markings may be added to supplement the Rb-45 sign(s).

Signing and Pavement Marking Design Considerations: Diverters[32]
Sharp Curve signs (Wa-2) should be installed in both directions approaching the diverter to warn motorists of the turning requirement. Additionally, Parking Prohibited signs (Rb-51) are also required within the vicinity of the diversions.

There are no pavement markings specific to this measure.

Other Considerations

- **Local Vehicle Access:** Vehicular traffic will be rerouted to adjacent locations with the consequence of increased trip length for some residents.
- **Emergency Services:** Consultation with emergency services must be conducted in advance of implementation of the measure.
- **Active Transportation:** No significant impact on active transportation.

[31] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.
[32] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

- **Parking:** Removal of on-street parking is not required.
- **Maintenance:** Winter maintenance and garbage collection routes may be subject to change based on the location of the measure.
- **Streetscaping:** Potential opportunities for streetscaping as part of the measure, but sightlines need to be considered for any proposed landscaping.
- **Implementation Cost:** Medium

Type II (Engineered-based) Measures: Other Cross-sectional Treatments

Lane Narrowing

Description

Lane narrowing is the reduction of lane width using painted lines that may be supplemented with bollards, raised curbs, or other physical delineations to make the lane feel narrower to motorists. The additional roadway space can be used to add bike lanes, widen sidewalks, or widen the median. The purpose of the narrowed lanes is to reduce vehicle speeds by making drivers feel less comfortable driving at higher speeds. Lane narrowing is less effective if implemented with pavement markings only.

Applicability

- **Road Type:** Local, Collector, and Arterial Roads
- **Environment:** Urban
- **ADT:** All traffic volumes
- **Cross-Section:** 2 & 4 lane roadways
- **Grade:** ≤ 8%
- **Locations to Avoid:**
    - Large vehicle accesses (i.e. delivery vehicles)
    - Transit routes.

Potential Benefits

- **Speed Reduction:** Due to the narrowing effect of this measure, speed reduction of up to 10 km/h can be achieved. Physical lane narrowing tends to provide better results compared to the use of just pavement markings, which are less effective.

Design Considerations:[33]

Travel lanes can be narrowed up to a minimum width of 3.0 m.

Other Considerations

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access.
- **Emergency Services:** Consideration for larger vehicles along narrow roads.
- **Active Transportation:**

[33] Chiu, M., Clayton, C., Millen, G. et al. 2017. Geometric Design Guide for Canadian Roads: Chapter 6 - Pedestrian Integrated Design. Ottawa, ON: Transportation Association of Canada.

  - If lanes are physically narrowed and the space is not allocated to other modes, the crossing distance at pedestrian crossings is reduced and may lower pedestrian-vehicle conflicts
  - Due to the lane narrowing, cyclists may feel squeezed closer to vehicles if dedicated cycling facilities are not provided
  - Opportunities for re-balancing road width to provide more space for dedicated cycling facilities
  - Drivers must exert extra caution when passing a cyclist along the roadway.
- Lane narrowing may be considered along arterial roads in specific conditions.
- **Parking:** May require removal of on-street parking at the location of the measure.
- **Maintenance:**
  - Pavement markings require regular maintenance and may be less effective during the winter season due to snow/ice cover.
  - Can create constraints and challenges for snow plowing, snow removal, and snow storage; plow operators must use caution to avoid damaging the physical traffic calming measures (i.e. bollards) if they are not removed during the winter season.
- **Implementation Cost:** Medium to High

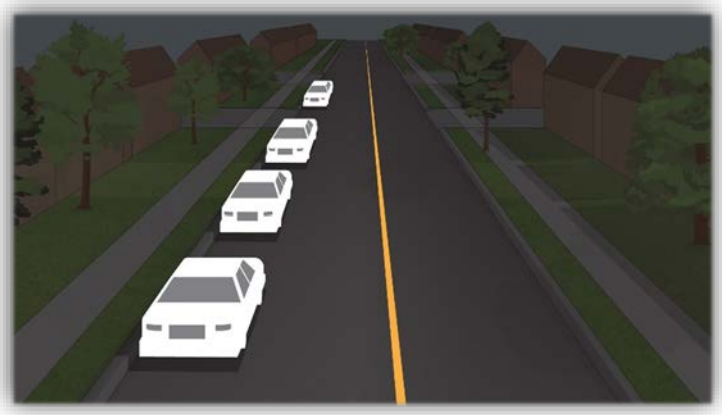
Type II: On-Street Parking

Description

On-street parking reduces the effective roadway width by allowing vehicles to park along the curb lane. On-street parking is recommended for local and collector roads with a maximum roadway width of 10 m (assuming a typical parking stall width of 2 m). Vehicle speeds may not be reduced on wider roadways because motorists are less likely to feel constrained by the parked vehicles. Angle parking is not used for this purpose due to the increased potential for conflicts.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban
- **ADT:** All traffic volumes (use with caution on roads > 10,000 vehicles per day)
- Cross-Section:
    - Minimum 8.0 m and maximum 10.0 m roadway width recommended for parking on one or both sides of the roadway, respectively
    - Minimum 6.0 m remaining roadway width recommended for through traffic in instances where parking alternates from one-side of the roadway to the other.
- **Grade:** ≤ 8%
- **Locations to Avoid:**
    - Driveways
    - Areas with limited sight distance
    - Bus Zones
    - Designated School Zones
    - Unfenced Playgrounds



Potential Benefits

- **Speed Reduction:** Can slow traffic by narrowing the effective roadway space.
- **Volume Reduction:** Possible reduction in short-cutting traffic or through traffic.

Geometric Design Considerations[34]

The maximum width for a parking stall is 2.5 m, but a width of 2.0 m is typically used. For a parking scenario where parking alternates from one side of the roadway to the other, a 6.0 m two-lane road width typically applies. For single lane traffic, the lane width can be reduced to 3.5 m.

[34] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

For a parking scenario where parking on both sides of the roadway is permitted, a maximum recommended roadway width of 10 m applies. If parking is to be on one side of the roadway only, a minimum recommended roadway width of 8.0 m applies.

The location of on-street parking stalls must consider site constraints such as driveways and fire hydrants. Additionally, due to the variable size of vehicles utilizing the on-street parking stalls and the risks associated with parking-related maneuvers, on-street parking should not be used as a form of curb extension at, or near, intersections.

Signing and Pavement Marking Design Considerations[35]
Parking Prohibited signs (Rb-51) should be used to restrict parking in areas of minimum pavement width and adjacent to intersections. There are no pavement markings specific to this measure.

Other Considerations

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access.
- **Emergency Services:** Consideration of larger vehicles along narrow roads.
- **Active Transportation:**
    - Parked vehicles provide a buffer between vehicular traffic and pedestrians on sidewalks
    - On-street parking may reduce mutual visibility for pedestrians crossing the roadway
    - Implementation and alignment of on-street parking areas require coordination with any on-street cycling facilities, particularly where on-street cycling facilities may transition or connect at intersections.
- **Enforcement:** Additional enforcement may be required if parking prohibitions are in place.
- **Parking:** Parked vehicles may obstruct driveways or reduce visibility for motorists entering the roadway from driveways, which could increase the potential for rear-end or sideswipe collisions.
- **Maintenance:**
    - Can create constraints and challenges for roadway maintenance operations because parked vehicles may obstruct street sweeping, catch basin cleaning, and snow removal (unless parking prohibitions are implemented for these operations)
    - Narrower roadway widths may be impacted where the right-of-way is used for snow storage.
- **Implementation Cost:** Low to Medium

[35] Solomon, H., Malone, B., Garcia, J. et al. 2017. Canadian Guide to Traffic Calming, Second Edition. Ottawa, ON: Transportation Association of Canada.

Type II (Engineered-based) Measures: Specialized Implementations

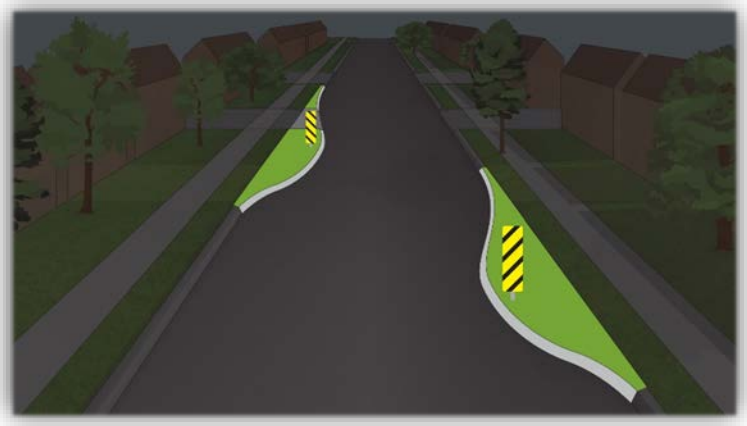
Chicanes

Description

Chicanes are curb extensions that alternate from one side of the road to the other. In general, a series of three or more curb extensions are used to force vehicles to slow down and travel in an S-shaped path through the chicane. A one-lane chicane narrows a two-lane roadway into the width of one-lane, requiring one vehicle to yield if two vehicles arrive at the same time in opposite directions. They are most effective on local roads with regular traffic in both directions to minimize opportunities for motorists to drive down the center unimpeded.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban
- **ADT:**
  - Minimum 750 vehicles per day or 100 vehicles per hour during peak hour
  - For roads with bicycle routes: < 1000 vehicles per day
- **Cross-Section:** Max. 2 lane roadway (one each direction)
- **Grade:** ≤ 8%
- **Locations to Avoid:**
  - Transit routes
  - Designated emergency access routes.



Potential Benefits

- **Speed Reduction:**
  - Can slow traffic by encouraging a driver to moderate vehicle speed through a series of horizontal deflections
  - Speed reduction between 5 and 15 km/h can be achieved
  - May reduce collision rates up to 40%
- **Volume Reduction:** Amount of traffic diversion is dependent on the number of measures along the roadway (can be significant)

Geometric Design Considerations[36]

A two-lane chicane requires a pavement width of at least 12.0 m and a one-lane chicane with requires a pavement width of at least 7.0 m. The size of chicane islands will vary with the street

[36] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

width and the spacing of chicane segments is dependent on-site considerations (i.e. location of driveways).

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.

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, this is subject to site specific design based on crossfall, grades, expected storm intensity, etc.

Signing and Pavement Marking Design Considerations[36]
Each island in a chicane typically has an Object Marker (Wa-33) at its apex so that drivers are aware of their presence and can comfortably negotiate around the island without striking them. Consideration can also be given to providing bollards with reflective striping as an alternative to Object Markers in some municipalities.

Stopping Prohibited signs (Rb-55) are required for all chicanes because parking and stopping is 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 required.

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.

Other Considerations

- **Local Vehicle Access:** Traffic may be diverted to parallel streets or alternative routes without traffic calming measures
- **Emergency Services:**
    - Chicanes may have an effect on emergency service response times
    - A sufficient roadway width should be maintained to facilitate the movement of fire apparatus and other large vehicles.
- **Active Transportation:** Dedicated cycling facilities may be affected. Consideration may be given to directing cycling facilities off-road through these areas.
- **Enforcement:** Additional enforcement is not typically required, however, implementation of this type of traffic calming measure may incite sharp cornering, braking and acceleration, and other aggressive driving behaviour.
- **Parking:** Requires removal of on-street parking within the operational envelope of the chicane.
- **Maintenance:**

  - Can create constraints and challenges for snow plowing and snow removal; may require specialized vehicles
  - May require enhanced street-sweeping
  - Consideration for existing drainage elements such as catch basins, concrete channels, gutters, inlets, and trench drains.
  - Not anticipated to notably impact below-grade utilities, however presence of and adjustment to at grade valves and maintenance holes should be reviewed
  - May require careful consideration of the alignment and presence of at-grade utilities.
- **Streetscaping:**
  - May provide an opportunity for landscaping, however opportunities may be limited depending on the scope and size of the curb extensions
- **Implementation Cost:** Medium to High

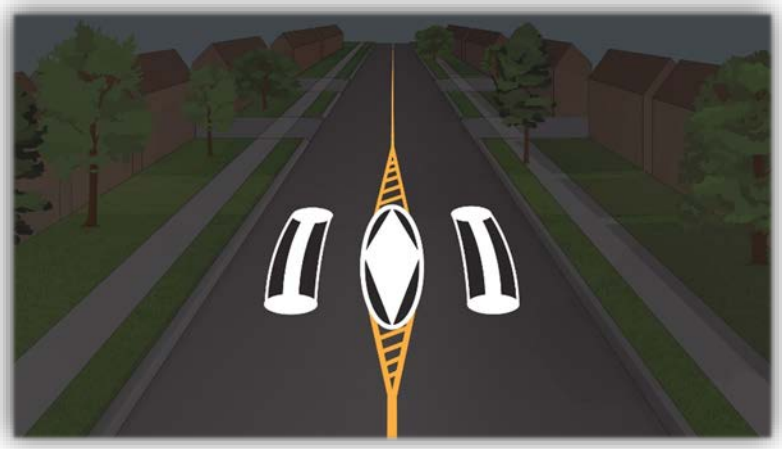
Type II: Speed Kidneys

Description

A speed kidney is an arrangement of three speed humps elongated with a curvilinear shape in the direction of traffic flow. The main speed humps of the speed kidney are placed in the travel lane, while a complimentary speed hump is placed between the lanes. Drivers that choose to travel in a straight path will experience discomfort as two or four wheels traverse the different parts of the speed kidney. Vehicles are required to take a curvilinear path to avoid vertical deflection.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban
- **ADT:** All traffic volumes
- **Cross-Section:** Only two-lane roadways (one each direction)
- **Grade:** ≤ 5%
- **Locations to Avoid:** Intersections and horizontal/vertical curves



Potential Benefits

- **Speed Reduction:** Speed reduction of up to 5 km/h can be achieved.
- **Volume Reduction:** Amount of traffic diversion is dependent on the number of measures along the roadway

Geometric Design Considerations[37]

On roads where a speed kidney is being considered, the lane width should be a minimum of 3.7 m to ensure that trucks, emergency vehicles, and buses are able to continue on a straight path by safely straddling the main speed hump. The radius of the central curve is dependent on the radius of the speed kidney, which is determined by the operating speed. If the street is not wide enough to accommodate a pair of speed kidneys, the curb (if one is present) or the edge line should be modified to a curve line that follows the curvature of the speed kidney.

Signing and Pavement Marking Design Considerations[37]

The speed kidney should be painted white with a Speed Hump warning sign (Wa-74) installed to alert drivers of the vertical deflection. Stopping Prohibited signs (Rb-55) are required for all speed kidneys because parking and stopping on both sides of the speed kidney to ensure that motorists can safely drive along the curved path.

[37] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

Other Considerations

- **Local Vehicle Access:** Traffic may be diverted to parallel streets without traffic calming measures.
- **Emergency Services:** It may have an effect on emergency service response times.
- **Active Transportation:** Since the speed kidney directs traffic towards the curb, specific warning signage should be used wherever speed kidneys are used on a roadway with dedicated cycling facilities or where significant volumes of cyclists are present.
- **Parking:** May require removal of on-street parking on outer sides of the roadway by the speed kidney.
- **Maintenance:** Can create constraints and challenges for snow plowing and snow removal; plow operators must use caution to avoid damaging the surface of the speed kidney.
- **Implementation Cost:** Medium

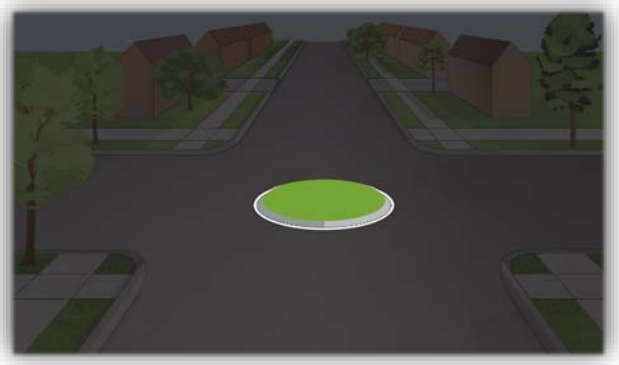
Type II: Mini-Roundabouts

Description

Mini roundabouts are raised islands located in the centre of an intersection that motorists navigate around in a counterclockwise direction. They also include median islands on all approaches to guide vehicles into the mini roundabout and may include a truck apron on the outer island circumference to enable the passage of transit and emergency vehicles.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban and Rural
- **ADT:** < 1500 vehicles per day (use with caution for low-volume collectors with 1500 to 5000 vehicles per day)
- **Cross-Section:** Max. 2 lane roadway (one each direction)
- **Grade:** ≤ 8%
- **Locations to Avoid:**
    - Local street intersections with other local streets where this may shift traffic volume issues to other local streets instead of the arterial system (directional closure only)
    - Designated emergency routes



Potential Benefits

- **Speed Reduction:**
    - Speed reduction can be maximized when mini-roundabouts are used in series.
    - Speed reductions for through movements of up to 14 km/h can be achieved.
- **Volume Reduction:**
    - Volume reduction of up to 20% can be achieved

Geometric Design Considerations[38]

A mini-roundabout should be designed as large as possible within the intersection's constraints where the right-of-way is wide enough to accommodate at least a 13 m inscribed circle diameter (ICD) roundabout. However, the ICD of a mini-roundabout should generally not exceed 30 m. The central island should be domed using a 5% to 6% cross slope with a maximum height of 125 mm.

The splitter islands used at mini-roundabouts can either be raised, traversable, or flush (painted) depending on various site conditions.

[38] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

Signing and Pavement Marking Design Considerations[39]

Yield signs (Ra-2) are recommended at all approaches. Chevron alignment signs (Wa-9) indicating a change in horizontal alignment are required.

The Manual of Uniform Traffic Control Devices for Canada provides additional details regarding mini-roundabout signing and pavement markings.

Parking Considerations[39]

Parking within the circulatory roadway of a mini-roundabout is typically prohibited because it may lead to unsafe and inefficient roundabout operations. It is recommended that parking should be prohibited at least 6 m from the crosswalk of an intersection and that curb extensions or bulb-outs be used to clearly indicate the limit of permitted parking.

Pedestrian Treatment Considerations[39]

Pedestrian crosswalks are recommended to be located 6 m upstream of the mini roundabout's entrance line to accommodate one passenger vehicle stopped between the crosswalk and the entrance line.

At locations where a traversable or raised splitter island is used, it is ideal for a walkway with a minimum width of 3 m to be provided that cuts through the splitter island instead of being ramped. Sidewalk ramps should be provided to connect to the sidewalks at each end of the crosswalk and a detectable warning surface should be applied to meet any accessibility requirements. If a minimum splitter island width of 1.8 m is available on an approach, a pedestrian refuge should be provided within the splitter island. However, if the available roadway width does not allow the provision of an adequate pedestrian refuge area, no detectable warnings should be used within the splitter island.

Bicycle Considerations[40]

Where bicycle lanes are provided on an approach, the entire bicycle lane need to be terminated at least 30 m upstream of the entrance line to warn motorists and cyclists of the need for cyclists to merge. An appropriate taper (recommended ratio of 7:1) should be provided on the approaches with bicycle lanes to narrow the total roadway width down to an appropriate width necessary to achieve the target motor vehicle speeds on the mini-roundabout approach.

Other Considerations

- **Local Vehicle Access:**
    - Traffic may be diverted to parallel streets without traffic calming measures.
    - Access may be restricted for longer trucks and school busses.
- **Emergency Services:** It may have an effect on emergency service response times.
- **Active Transportation:**

[39] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.
[40] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

  - Mini roundabouts may force vehicles into the crosswalk area, increasing potential for pedestrian-vehicle conflicts
  - Mini-roundabouts do not allow for on-road cycling facilities to be carried through (i.e. they need to be terminated and cyclists must proceed with motor vehicle traffic – single file), potential for conflicts if cyclists are curbside circulating through and motorists are trying to exit at one of the legs
  - Consideration should be given to providing safe crossing locations (i.e. crosswalks) and off-road cycling facilities for pedestrians and cyclists.
- **Parking:** Requires removal of on-street parking in vicinity of mini-roundabout.
- **Maintenance:** Can create constraints and challenges for snow plowing and snow removal; may increase snow plowing time, alter pre-established snow clearing routes, or require specialized vehicles
- **Implementation Cost:** High

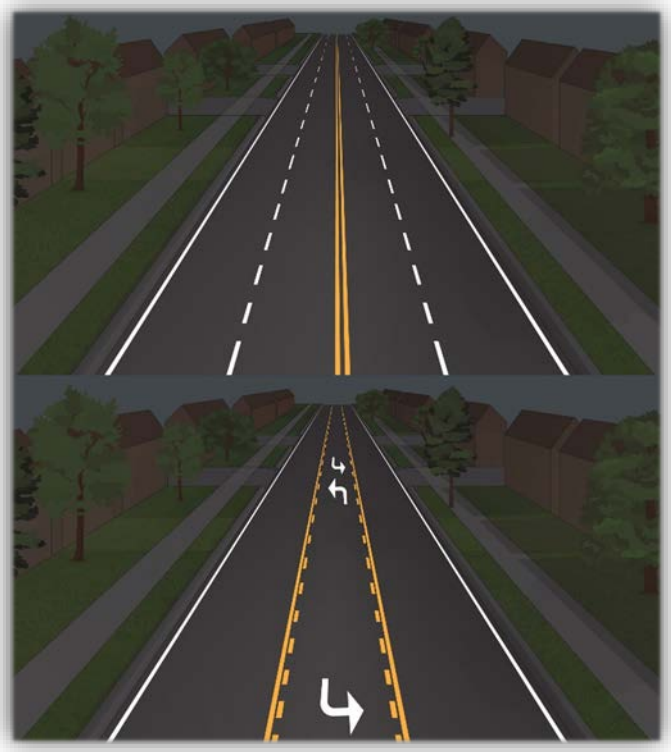
Type II: Lane Reductions

Description

A lane reduction involves the removal of one or more travel lanes. Traffic analysis may be conducted to review projected future vehicular volumes in considering the reduced roadway capacity, and potential for vehicle re-routing depending on the adjacent transportation network linkages. The most common application is reducing four lane roadways to three lanes, with one travel lane in each direction, and a two-way centre left-turn lane. Other configurations may include reducing a four lane roadway to a three lane cross-section with the potential to introduce transit priority lanes or elements, or a reversible lane which may be used to allow traffic flow in one direction during certain times of day and in the opposite direction during other times of day, which can be useful when both directions do not require additional capacity at the same time (e.g. if there is a predominant peak flow of travel in one direction in the morning and in the opposing direction in the evening). Lane reductions also introduce opportunities for shifting more right of way width to pedestrian and cycling facilities. The implementation needs to consider the cross-section of the right-of-way and intersections and connections to other roadway facilities.

Applicability

- **Road Type:** Collector and Arterial Roads
- **Environment:** Urban
- **ADT:** Moderate traffic volumes
- **Cross-Section:** Most appropriate for 4-lane collector roads
- **Grade:** ≤ 8%
- **Locations to Avoid:** N/A



Potential Benefits

- **Speed Reduction:**
  - Speed reduction of up to 12 km/h can be achieved.
  - It may reduce the number of collisions per kilometre (collision density) and collision rate (controlled for volume) by 25% and 18%, respectively.
- **Volume Reduction:**
  - Traffic may be diverted to parallel streets without traffic calming measures.

Design Considerations[41]

Intersection turn lanes and geometric alignment, traffic volumes, signing, pavement markings, transit routes and stops, numbers and proximity of driveways and access points, and pedestrian and cycling facilities all need to be carefully considered and managed in the planning and implementation process to create the optimal lane reduction. Typically, implementation requires full reconstruction of the right-of-way.

Full details and design specifications for lane reductions can be found in the Federal Highway Administration Road Diet Informational Guide.

Other Considerations

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access.
- **Emergency Services:** It may have an effect on emergency service response times; however, emergency vehicles can bypass congestion if there is space for vehicles to pull over the side of the road.
- **Active Transportation:**
    - Can improve pedestrian crossing ease and safety.
    - Can improve bicycle accessibility if travel lanes are converted to shoulders/bike facilities instead.
    - Effective for widening sidewalks, adding bicycle lanes, and creating more attractive streets for pedestrians and cyclists.
- Lane reductions may be considered along arterial roads in specific conditions.
- **Parking:** Addition of on-street parking can be implemented as part of a reconfigured cross-section.
- **Maintenance:** No significant impact on roadway maintenance operations.
- **Implementation Cost:** Medium

[41] Solomon, H., Malone, B., Garcia, J. et al. 2017. *Canadian Guide to Traffic Calming, Second Edition.* Ottawa, ON: Transportation Association of Canada.

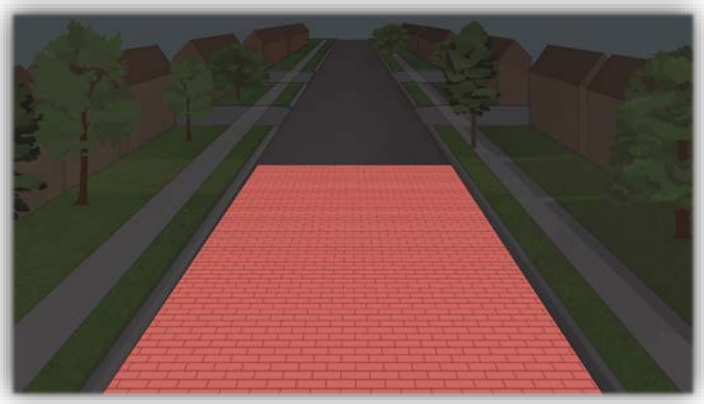
Type II: Textured Pavement

Description

Textured pavement is roadway pavement that incorporates a textured and/or patterned surface which contrasts other adjacent roadways in the surrounding area. The difference in texture is intended to alert drivers of the potential need to reduce speed.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban
- **ADT:** All traffic volumes (with consideration of busses and heavy vehicles on truck routes)
- **Cross-Section:** N/A
- **Grade:** ≤ 8%
- **Locations to Avoid:** N/A



Potential Benefits

- **Speed Reduction:** Amount of speed reduction is dependent on the number of measures along the roadway (minimal effect if used alone).

Other Considerations

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access.
- **Emergency Services:** No significant impact on emergency service response times.
- **Active Transportation:** The textured surface may be difficult for cyclists and pedestrians to traverse (i.e. if brick or unit pavers are used). Consideration should be given to the texture/pronouncement of the pattern, materials, and area of implementation.
- **Parking:** Removal of on-street parking is not required.
- **Maintenance:**
    - Certain materials (e.g. brick pavers) requires regular maintenance. There are alternatives to textured surfaces such as stamping asphalt or concrete that may achieve a texture without requiring the same level of maintenance.
    - Textured surfaces may increase street sweeping time if the texturing involves deep grooves and excess dust/debris may remain in the grooves.
    - Textured surfaces can be less effective during the winter season due to snow/ice cover.
- **Streetscaping:**
    - May create extra traffic noise from vehicle wheels travelling over the textured surface (i.e. if texturing is rough or pronounced).

  - Textured treatment can enhance the appearance of a street, especially when combined with other landscaping techniques.
- **Implementation Cost:** Medium to High

Community-based Initiatives

Lawn Signs Encouraging Slower Driving

Description

This community-based measure involves the placement of signs encouraging slower driving that are placed on residential lawns. The lawn signs are intended to encourage safe driving habits and to lower operating speeds of motor vehicles on neighbourhood streets.

Applicability

- **Road Type:** Local Roads
- **Environment:** Urban and Rural
- **ADT:** All traffic volumes
- **Cross-Section:** N/A
- **Grade:** N/A
- **Locations to Avoid:**
    - Within 3 m of a fire hydrant
    - In a drainage ditch
    - Within 0.6 m from the curb or edge of the road
    - Any location that may obstruct the road, median, traffic island, sidewalk, bicycle path, or multi-use trail
    - On a building, structure, post, pole, tree or bush

Potential Benefits

- **Speed Reduction:** Limited data available on the potential degree of speed reduction – minimal demonstrated effect if used alone.

Other Considerations

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access.
- **Enforcement:**
    - Implementation of informational signage is not enforceable as per the Highway Traffic Act, unless used in conjunction with other types of traffic calming measures (i.e. community safety zones)
    - Overuse of this measure may reduce effectiveness
    - Avoid the overuse of custom signs to highlight conditions where standard signs (OTM or MUTCDC) are already present
- **Implementation Cost:** Low

Community-based Initiatives: Pace Car Program

Description

The Pace Car Program is designed to promote safe roadways for all users. In Canada, the main concept of the program is to encourage drivers to sign a pledge and display a sign in their back car window that demonstrates their commitment to drive within the speed limit and show courtesy to all road users.

Applicability

- **Road Type:** Local and Collector Roads
- **Environment:** Urban and Rural
- **ADT:** All traffic volumes
- **Cross-Section:** N/A
- **Grade:** N/A
- **Locations to Avoid:** N/A

Potential Benefits

- **Speed Reduction:** Limited data available on the degree of speed reduction – minimal demonstrated effect if used alone.

Other Considerations

- **Local Vehicle Access:** Implementation of this type of traffic calming measure does not affect local traffic access.
- **Enforcement:** The Pace Car Program is not enforceable and may create tension with other motorists who are unfamiliar with the program. However, the purpose of the window decal is simply to display to other motorists that they are driving courteously and not above the speed limit, encouraging others to do the same.
- **Implementation Cost:** Low

Community-based Initiatives: Local-traffic Implementations

Description

Local-traffic implementations use heavy or anchored materials to encourage 'local traffic only' at a block-level for a pre-defined/temporary period. The degree of vehicular volume reduction of this implementation is largely dependent on the extent of compliance of motorists with the signage that suggests 'local traffic only'.

Applicability

- **Road Type:** Local Roads
- **Environment:** Urban
- **ADT:** All traffic volumes
- **Cross-Section:** N/A
- **Block Length**: 600 metres or less and two blocks or less
- **Grade:** N/A
- **Locations to Avoid:** Not recommended along Transit routes

Potential Benefits

- **Volume Reduction** (limited data available on the degree of volume reduction)

Other Considerations

- **Local Vehicle Access:** Ensure that local access in and out of homes is maintained during the temporary closure. Traffic may be diverted to parallel streets without traffic calming measures.
- **Emergency and Municipal Services**: Materials should be implemented to allow for the easy movement of essential emergency service vehicles as well as waste and road maintenance vehicles.
- **Maintenance:** Installations require inspection and maintenance to ensure that materials are placed, visible and remain effective.
- **Enforcement:** Materials should indicate to drivers that their travel path has been altered
- **Implementation Cost:** Low

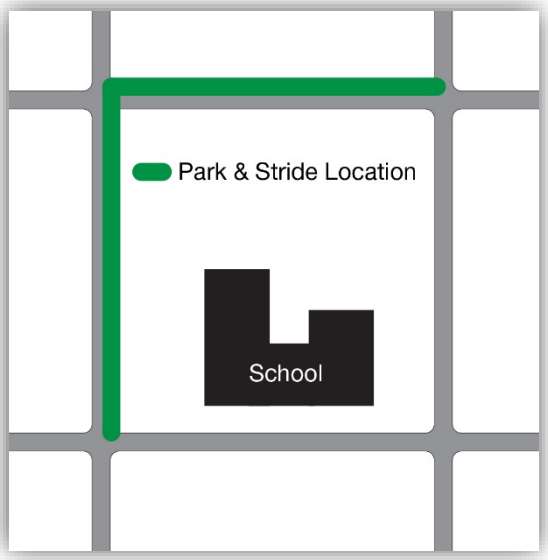
Community-based Initiatives: Park & Stride Program

Description

In partnership with interested schools, the Park & Stride program identifies suitable parking areas in a neighbourhood approximately 200-600 meters away from school entrances. This provides families who need to drive to school with an opportunity to incorporate active travel into their school commute by walking the last few minutes to school. It also improves safety by reducing the volume of vehicular traffic directly in front of schools. The associated messaging of the program highlights the benefits of active school travel, and the importance of driving safely in the neighbourhood and respecting existing parking regulations.

Applicability

- **Road Type:** Local Roads
- **Environment:** Urban
- **ADT:** All traffic volumes
- **Cross-Section:** N/A
- **Grade:** N/A
- **Locations to Avoid:** Avoid redirecting to parking areas that do not provide a direct connection to the school grounds (through pedestrian facilities and/or controlled crossings).



Potential Benefits

- **Volume Reduction:** Reduces vehicular volume in front of the school.

Other Considerations

- **Local Vehicle Access:** Ensure that messaging reinforces appropriate driving behaviour, such as not blocking driveway accesses.
- **Emergency Services:** N/A
- **Enforcement:** Park & Stride implementations should be done in coordination with Parking Services to ensure compliance with parking regulations.
- **Implementation Cost:** Low