Appendix A – Traffic calming measures effectiveness and decision tree

Figure 1 - *Effectiveness and Appropriate Contexts of Traffic Calming Measures*

(+) represents high effectiveness, a blue circle (O) moderate effectiveness, and a red minus sign (–) no effectiveness of a given traffic calming measure at accomplishing the objectives listed in each column. In the final three columns, an orange checkmark (✓) denotes that a particular measure is appropriate for the corresponding roadway classification while a red x (×) indicates that the particular measure is not appropriate in that context.

	EFFECTIVENESS			ROAD CLASSIFICATION		
Traffic Calming Measure	Reduce Speed	Reduce Volume	User Safety	Urban Local Road	Main Street	Minor Collector
Vertical Measures						
Speed Hump/Cushion/Table	+	+	O	✓	✓	✓
Raised Crossing	+	O	+	✓	✓	✓
Raised Intersection	+	–	+	✓	✓	×
Horizontal Measures						
Curb Extension	O	–	+	✓	✓	✓
Curb Radius Modification	+	–	+	✓	✓	✓
Chicane	+	O	O	✓	✓	×
Road Diet	+	–	+	✓	✓	✓
On-Street Parking	+	–	O	✓	✓	✓

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Traffic Calming Measure	EFFECTIVENESS			ROAD CLASSIFICATION		
	Reduce Speed	Reduce Volume	User Safety	Urban Local Road	Main Street	Minor Collector
Raised Median Island	+	−	+	✓	✓	✓
Traffic Circle	+	−	O	✓	✓	✗
Obstruction Measures						
Raised Median Through Intersection	−	O	O	✓	✓	✗
Diverter	O	+	O	✓	✓	✗
Directional Closure	O	+	O	✓	✓	✗
Full Closure	O	+	O	✓	✓	✗
Awareness Measure						
Textured Crosswalk	O	−	O	✓	✓	✓
Bicycle Boulevard	O	−	O	✓	✓	✓
Radar Speed Display Sign	+	−	O	✓	✓	✓

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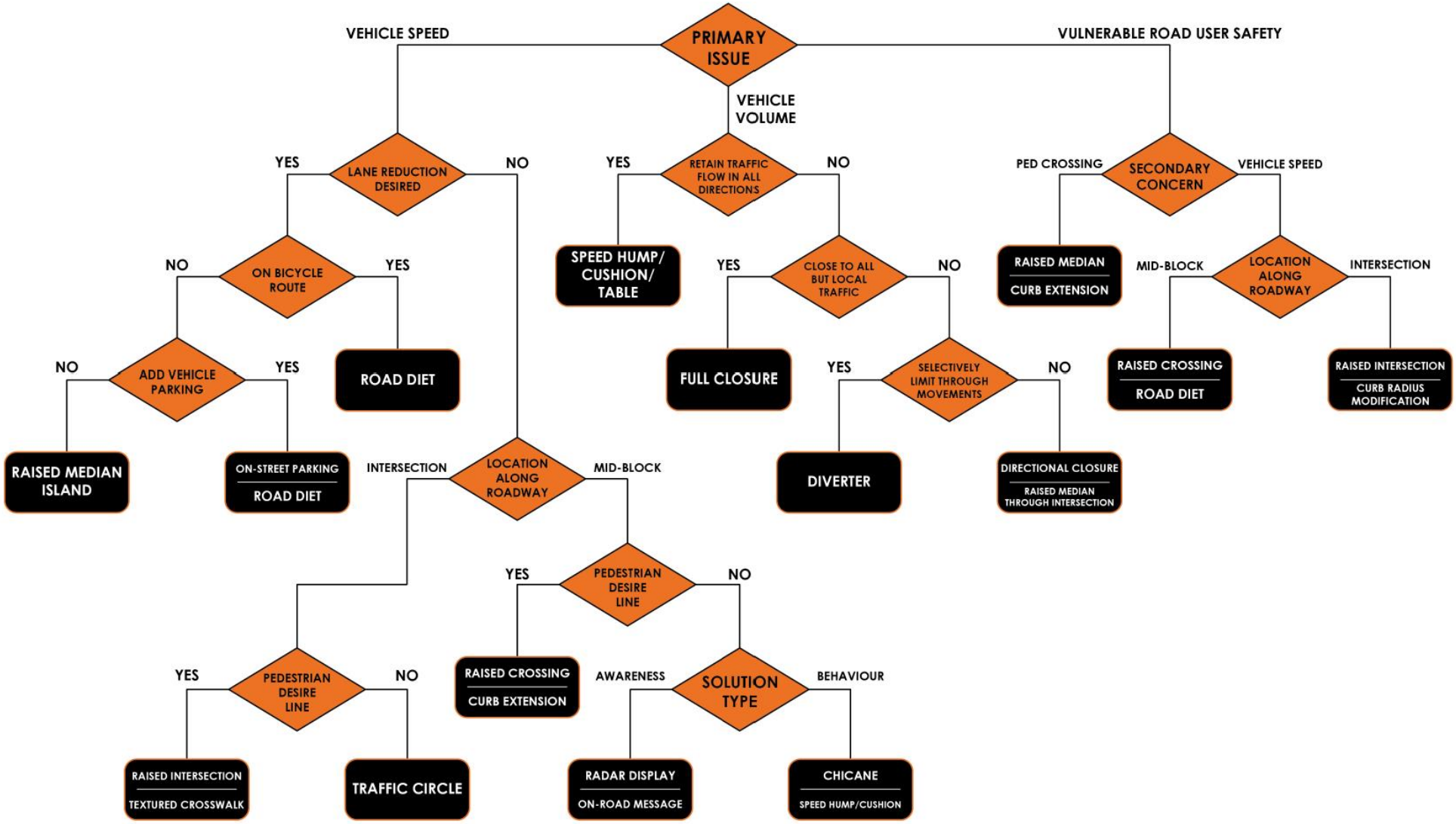
	EFFECTIVENESS			ROAD CLASSIFICATION		
Traffic Calming Measure	Reduce Speed	Reduce Volume	User Safety	Urban Local Road	Main Street	Minor Collector
On-Road Messaging	O	–	O	✓	✓	✓
Traffic Calmed Neighborhood/ Community Safety Zone Signs	O	–	O	✓	✓	✓

Figure 2 - Traffic Calming Measures Decision Tree



Appendix B – Approved calming measures

Curb Extension

A horizontal extension of a curb into the roadway, resulting in a shorter pedestrian crossing distance. Also referred to as a bump out, curb extensions are most commonly installed at intersections, but may be used at mid-block crossings. Curb extensions are useful in defining and protecting parking lanes.

MEASURE

Horizontal

PRIMARY PURPOSE

Speed Reduction

ACCOMPANYING SIGNAGE

COST PER MEASURE

MATERIAL COST PER MEASURE

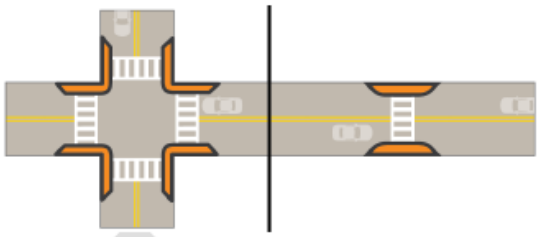
$52,700-$79,050
Excavation, milling, asphalt, concrete sidewalk/curb, tactile indicators, sod, topsoil. Total expenditures greater due to costs of labour, signage, potential relocation of catch basins, potential bollards

ADVANTAGES

- Increase pedestrian visibility
- Opportunity for landscaping

DISADVANTAGES

- May not be compatible with bike lanes
- May require removal of on-street parking spaces



DESIGN

- Bump outs should not narrow any lanes to an unsafe width. One-half metre should remain between the curb and the first travel or bicycle lane.
- Corner or midblock bump outs with crosswalks should be as wide as the crosswalk and extend to the stop bar.
- At corners with turn restrictions, use a bump out to encourage compliance.
- Consider bus turning requirements when proposing bump outs along streets that accommodate transit vehicles.

OPERATIONS AND MAINTENANCE

- Installation of bump outs can be temporary, using bollards and planters.
- Green infrastructure applications associated with bump outs require maintenance plans.
- Special snow removal equipment should not be necessary if bump outs are designed with adequate turn radii.

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Curb Radius Modification

A redesign and reconstruction of an intersection corner to create a smaller effective turning radius. Smaller curb radii result in slower turning speeds and greater pedestrian safety and comfort.

MEASURE

Horizontal

PRIMARY PURPOSE

Speed Reduction

MATERIAL COST PER MEASURE

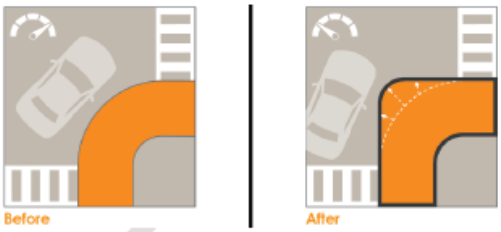
$12,300-$18,450
Excavation, milling, asphalt, concrete sidewalk/curb, sod, topsoil. Total expenditures greater due to costs of labour, potential relocation of catch basins, pavement repair

ADVANTAGES

- Slow right-turning vehicles
- Reduce crossing distance for pedestrian
- An expanded pedestrian area allowing for better pedestrian ramp alignment

DISADVANTAGES

- Where streets intersect at acute angles, tight turn radii may preclude use by certain vehicle types.



DESIGN

- Street designers should use the smallest practical actual corner radius that preserves an effective curb radius appropriate to the design vehicle and the overall objectives of the street.
- Control vehicles that rarely use the street, such as fire trucks, may encroach into oncoming lanes if and when required to slowly navigate a turn.
- Smaller radii should be the default where there is an expectation of high levels of use by persons with disabilities.

OPERATIONS AND MAINTENANCE

- Implementation of modified curb radii may be temporary, using rubber parking bumpers and flexible delineator posts. Winter removal may be considered.
- Special snow removal equipment should not be necessary if radii are designed adequately for the current fleet.

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Chicane

Two or more offset curb extensions that are designed to narrow a two-lane roadway to a one-lane roadway for a short distance, considerably slowing traffic speeds. Depending on the level of implementation, Chicanes may significantly increase the amount of public space along a street.

MEASURE

Horizontal

PRIMARY PURPOSE

Speed Reduction

ACCOMPANYING SIGNAGE

MATERIAL COST PER FULL PAIR

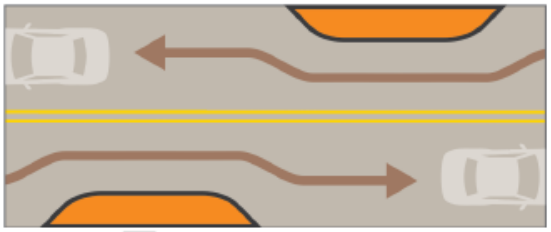
$39,800-$59,700
Excavations, milling, asphalt, concrete sidewalk/curb, sod, topsoil. Total expenditures greater due to costs of labour, signage, potential relocation of catch basins

ADVANTAGES

- Also discourages cut-through traffic.
- Increased public space creates landscaping opportunities.

DISADVANTAGES

- Not recommended on bike routes
- Suggested for roads with moderate traffic volumes. Chicanes have proven to be ineffective on low volume roads and other safety concerns are created when installed on high volume roads.



DESIGN

- Shifts in chicane alignment should be at least one lane in width with deflection angles of at least 45 degrees, with sufficient narrowing of the roadway center to prevent drivers from following a straight path.
- Additional signage may be warranted to alert drivers to the effective bends in the travel lanes.

OPERATIONS AND MAINTENANCE

- Monitor the impact of traffic calming treatments at the network or neighborhood level prior to and after installation.
- Horizontal control measures that allow for and result in added landscaping will require additional maintenance.
- Designs should consider snow removal operations. Visual cues should alert snow plow operators of the change in the roadway.

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Road Diet

A reconfiguration of the roadway, typically limited to striping, that typically removes and narrows vehicular travel lanes to accommodate bicycle lanes, two-way left turn lanes, and on-street parking.

MEASURE

Horizontal

PRIMARY PURPOSE

Speed Reduction

ACCOMPANYING SIGNAGE

MATERIAL UNIT COST

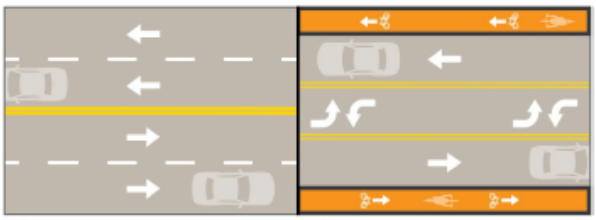
$200-$300 per painted square metre
Material expenditures vary according to length of roadway and lane allocation. Will include associated costs of traffic engineering

ADVANTAGES

- Provides opportunity to provide bicycle lanes, two-way left turn lanes, on-street parking, or other streetscape improvements.
- Discourages speeding while improving sight distances for left-turning vehicles.
- Minimal effect on the vehicular capacity of the roadway.
- General reduction in left-turning crashes.

DISADVANTAGES

- Potential for increase in right-turning vehicle/cyclist conflict.



DESIGN

- The centre turn lane target width is 3.3 metres. Minimum width is 3.0 metres.
- Painted, textured, or raised medians may be incorporated between intersections to provide improved pedestrian crossings, incorporate landscape elements, and reduce travel speeds.
- Bump outs may be added to protect newly designated parking lanes, but care must be taken not to impede any new bicycle lanes created through space reallocation.

OPERATIONS AND MAINTENANCE

- A major street redesign requires reconsideration of signal placement and alignment, signal timing, intersection capacity, and turning movement dynamics at major intersections.
- Post-reconfiguration traffic operations monitoring is required to determine project impact.

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On-Street Parking

Restricts the roadway width by allowing automobiles to park along the roadway. When implemented diagonally, the position of the parking spaces are designed to change the perception and function of a street while allowing easier maneuvering and more stalls than parallel parking.

MEASURE

Horizontal

PRIMARY PURPOSE

Speed Reduction

ACCOMPANYING SIGNAGE

MATERIAL UNIT COST

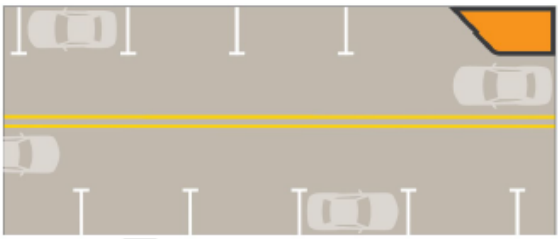
$200-$300 per painted square metre
Material expenditures vary according to length of parking area

ADVANTAGES

- Forces drivers to be more aware of nearby street activity
- Reduces effective pedestrian crossing distance
- Possible reduction in through traffic

DISADVANTAGES

- Perpendicular and angled parking not appropriate on narrower streets or streets with bicycle facilities



DESIGN

- Typically, on-street parking is curbside parking parallel to the curb. Perpendicular or angled parking are also acceptable configurations.
- Parking spaces may be marked with T and L pavement markings at their outside edge or defined with a solid white line.
- Parallel curbside parking spaces should be at least 2.8 metres wide by 6.5 metres long.

OPERATIONS AND MAINTENANCE

- General parking restrictions may be defined depending on roadway and community context.
- Parking lanes require the same snow clearing, sweeping, and other maintenance as travel lanes. Management through temporary restrictions may be required.

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Raised Median Island

An curb-lined structure running parallel to, and installed in the center of, a roadway to divide lanes of traffic and further restrict the width of remaining available roadway.

MEASURE

Horizontal

PRIMARY PURPOSE

Speed Reduction

ACCOMPANYING SIGNAGE

MATERIAL COST PER MEASURE

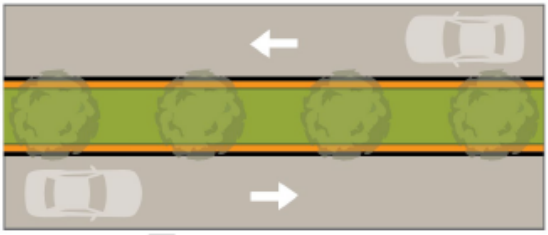
$435-$652.50 per linear metre
Earth excavation, cutting/milling, concrete curb, sod, topsoil. Total expenditures greater due to costs of labour, signage, landscaping, potential removal and repair of pavement

ADVANTAGES

- Reduce pedestrian-vehicle conflict by limiting turning movements
- Safer pedestrian crossing by providing refuge that lessens exposure by dividing crossing distance into two more manageable distances

DISADVANTAGES

- Potential driveway access restriction
- Potential loss of on-street vehicle parking
- Larger right-of-way required



DESIGN

- Striped or painted medians may precede more permanent improvements, providing an opportunity to test travel behavior before making a significant capital investment.
- Raised median design may include landscaping and stormwater control.
- Medians protecting turning lanes or pedestrian refuge areas should be at least 3.0 metres wide. All others should be a minimum of 2.0 metres wide.
- Medians should allow adequate width in adjacent travel lanes as well as turn radii that accommodate service vehicles.

OPERATIONS AND MAINTENANCE

- Medians should be designed with snow removal in mind and can be used for snow storage if necessary, though this may negatively impact planted materials and can block driver sight lines.
- Median construction should facilitate maintenance of plantings and vegetation.

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Traffic Circle

Also known as a mini roundabout, a traffic section is an intersection control type. It provides a raised island in the center of the intersection around which traffic circulates. It can be used at existing intersections to replace two-way stop control, all-way stop control, or a traffic signal.

MEASURE

Horizontal

PRIMARY PURPOSE

Speed Reduction

ACCOMPANYING SIGNAGE

MATERIAL COST PER MEASURE

$8,100-$12,150
Excavation, cutting/milling, concrete median, asphalt. Total expenditures greater due to costs of labour, signage, landscaping

ADVANTAGES

- Reduce vehicle-vehicle conflicts at intersections
- Opportunity for landscaping

DISADVANTAGES

- Restricts turning movements by large vehicles
- May increase Emergency Services response time

DESIGN

- The size and location of the central island should allow for all traffic movements typically accommodated by a four-way intersection.
- However, central island physical parameters should ensure vehicle path deflection to encourage proper circulation and reduced speeds.
- Where a bicycle boulevard turns at an intersection featuring a traffic circle, use bicycle-specific wayfinding signage and using pavement (shared-lane) markings to reiterate the bike route direction.

OPERATIONS AND MAINTENANCE

- Shrubs or trees in the traffic circle must be properly maintained to not compromise visibility.
- Like medians, traffic circles can store snow if necessary, but consideration should be given to preservation of plantings and sight obstructions.

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Raised Median Through Intersection

An elevated median installed through an intersection, blocking through traffic and left turning movements in certain directions, generally to and from local streets.

MEASURE

Obstruction

PRIMARY PURPOSE

Volume Reduction

ACCOMPANYING SIGNAGE

MATERIAL UNIT COST

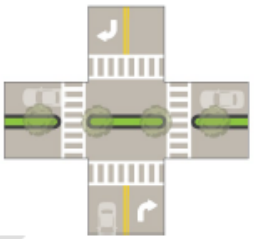
$490-$735 per linear metre
Earth excavation, milling, concrete curb, sod, topsoil. Total expenditures greater due to costs of labour, signage, landscaping, potential removal and repair of pavement

ADVANTAGES

- Obstruct short-cutting traffic along lower order road classifications
- Safer pedestrian crossing by providing refuge that lessens exposure by dividing crossing distance into two more manageable distances
- Maintain non-motorized access

DISADVANTAGES

- May increase traffic on adjacent streets
- May increase trip length for residents



DESIGN

- Raised medians through intersections provide opportunities for landscaping and two-stage pedestrian crossings.
- Medians protecting turning lanes or pedestrian refuge areas should be at least 3.0 metres wide. All others should be a minimum of 2.0 metres wide.
- The median should extend a sufficient distance beyond the intersection's edge to prevent attempts by drivers to circumvent the barrier. A smaller opening may be provided for bicycle cross-traffic.

OPERATIONS AND MAINTENANCE

- Post-installation impacts on adjacent lower order streets should be monitored.
- Medians should be designed with snow removal in mind and can be used for snow storage if necessary, though this may negatively impact planted materials and can block driver sight lines.
- Median construction should facilitate maintenance of plantings and vegetation.

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Diverter

Raised triangular islands at an intersection that prevent vehicles from turning a certain direction or driving through an intersection. May be oriented diagonally across an intersection to force left turns in two directions and right turns from other approaches.

MEASURE

Obstruction

PRIMARY PURPOSE

Volume Reduction

ACCOMPANYING SIGNAGE

MATERIAL COST PER MEASURE

$14,200-$21,300
Excavation, cutting/milling, concrete median, asphalt. Total expenditures greater due to costs of labour, signage, landscaping

ADVANTAGES

- Obstruct short-cutting traffic along lower order road classifications

DISADVANTAGES

- May increase traffic on adjacent streets
- May increase trip length for some residents
- Impacts to emergency response access

DESIGN

- Can be used on one-way and two way streets but can only be implemented at intersections.
- Barriers may take the form of walls, gates, landscaped areas, or other obstructions.
- Openings for pedestrians and cyclists should be provided to preserve movement in all directions for non-motorized transportation modes.
- Approaches require signage corresponding to valid and invalid movements from all approaches.
- Should not be used on streets providing frequent access to emergency services.

OPERATIONS AND MAINTENANCE

- Post-installation impacts on the surrounding street network should be monitored to ensure that traffic is diverted to higher order, rather than other lower order streets.

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Directional Closure

A directional closure is a longer curb extension or vertical barrier extending to the roadway's midpoint that obstructs or prohibits one direction of traffic, creating a one way street for all but local traffic.

MEASURE

Obstruction

PRIMARY PURPOSE

Volume Reduction

ACCOMPANYING SIGNAGE

MATERIAL COST PER MEASURE

$7,000-$10,500
Excavation, cutting/milling, concrete median, asphalt. Total expenditures greater due to costs of labour, signage, landscaping

ADVANTAGES

- Obstruct short-cutting traffic along lower order road classifications

DISADVANTAGES

- May increase traffic on adjacent streets
- May increase trip length for some residents
- Impacts to emergency response access

DESIGN

- Can only be implemented at intersections.
- Barriers may take the form of walls, gates, landscaped areas, or other obstructions.
- Openings for pedestrians and cyclists should be provided to preserve movement in all directions for non-motorized transportation modes.
- Approaches require signage corresponding to valid and invalid movements from all approaches.
- Should not be used on streets providing frequent access to emergency services or on transit routes.

OPERATIONS AND MAINTENANCE

- Post-installation impacts on the surrounding street network should be monitored to ensure that traffic is diverted to higher order, rather than other lower order streets.

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Full Closure

Installation of a barrier across the entire width of a roadway, preventing drivers from passing through. Full closures can be designed and built to allow emergency vehicle access through the use of gates or breakaway/mountable materials.

MEASURE

Obstruction

PRIMARY PURPOSE

Volume Reduction

ACCOMPANYING SIGNAGE

COST PER MEASURE

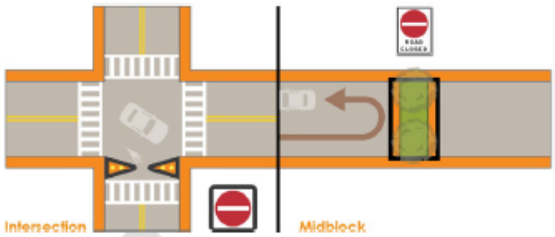
Highly varied based on roadway width, material choice, appropriate signage, and required labour

ADVANTAGES

- Reduce pedestrian-vehicle conflict
- Obstruct short-cutting traffic along lower order road classifications

DISADVANTAGES

- May increase traffic on adjacent streets
- May increase trip length for some residents
- Impacts to emergency response access



DESIGN

- May be implemented at intersections or mid-block locations.
- Barriers may take the form of walls, gates, landscaped areas, or other obstructions.
- Openings for pedestrians and cyclists should be provided to preserve movement in all directions for non-motorized transportation modes.
- In addition to site signage, full closures require pre-warning signage at the most proximate intersection in each direction.
- Should not be used on streets providing frequent access to emergency services or on transit routes.

OPERATIONS AND MAINTENANCE

- Post-installation impacts on the surrounding street network should be monitored to ensure that traffic is diverted to higher order, rather than other lower order streets.

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Textured Crosswalks

A textured or patterned surface placed along a pedestrian crosswalk to increase visibility and safety. Textured pavements reinforce the shared nature of crosswalk space between motorists and pedestrians.

MEASURE

Awareness

PRIMARY PURPOSE

Safety

ACCOMPANYING SIGNAGE

MATERIAL UNIT COST

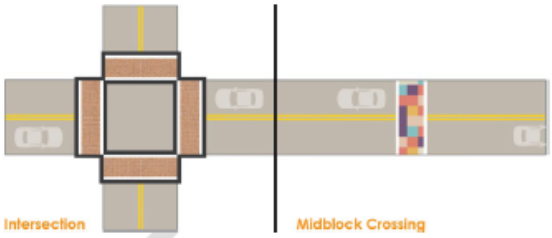
$200-$300 per patterned square metre
Material expenditures vary according to size of crosswalk, choice of paint/stamped concrete/brick

ADVANTAGES

- Alert drivers to a change in area context/character
- Positive aesthetic value

DISADVANTAGES

- Depending on the material used, textured crosswalk can make crossing more difficult for those with mobility aids and the visually impaired
- Materials may be costly and maintenance burden greater than painted crosswalks
- Less effective during winter when obscured by snow and ice



DESIGN

- While able to be implemented alone, texturing is often used to enhance other elements such as raised crosswalks.
- Color is typically added as a visual cue to increase effectiveness through earlier indication of the presence of a crosswalk.
- While not specifically defined, dimensions should be limited to the area required to provide adequate visual recognition.

OPERATIONS AND MAINTENANCE

- Textured crosswalk require more frequent maintenance action due to likelihood of uneven transitions between asphalt and other materials.
- Similar to painted crosswalks, stamped, patterned, or painted textured crosswalks require repainting at regular intervals to maintain appearance and effectiveness.

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Bicycle Boulevard

Installation of signage and pavement markings on streets with less vehicle traffic indicating that the roadways are shared facilities for bicycles and automobiles. Sometimes referred to as neighbourhood greenways, bicycle boulevards typically combine elements such as speed cushions, bulb-outs, diverters, signage, and pavement markings to create useful low-stress routes parallel to heavily trafficked corridors.

MEASURE

Awareness

PRIMARY PURPOSE

Safety

ACCOMPANYING SIGNAGE

COST CONSIDERATIONS

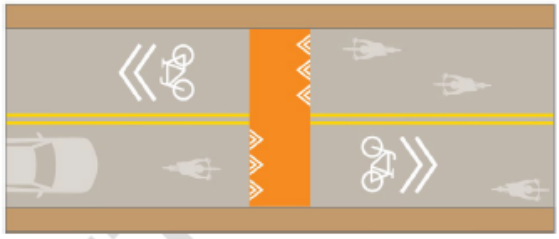
Implementations costs vary as a function of the number of installed vertical control elements, signage, pavement markings

ADVANTAGES

- Well programmed bicycle boulevards greatly expand an official lower stress cycling network
- Vehicular access is maintained
- Can also slow and limit cut-through traffic

DISADVANTAGES

- May greatly increase trip length for cyclists versus a comparable vehicular route depending on street grid connectivity



DESIGN

- Bicycle boulevards are most appropriate for streets already experiencing lower vehicular speeds and volumes.
- Clear signage and directional pavement markings enhance bicycle boulevard corridors that follow indirect routes.
- Bicycle boulevards create a major opportunity to integrate many forms of green infrastructure into speed and volume management.
- Traffic signals may be required to ensure safety of cyclists where bicycle boulevards cross high vehicular volume streets.

OPERATIONS AND MAINTENANCE

- Post-implementation traffic conditions should be monitored to ensure conditions meet desired targets.
- Designated bicycle boulevards should receive higher priority within street maintenance service plans.

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Radar Speed Display Sign

Radar-activated devices that display the speeds of approaching vehicles and may display an alert that a driver is violating the speed limit. The signs are designed to reduce speeds and promote cautious driving by creating a sense of the presence of official surveillance.

MEASURE

Awareness

PRIMARY PURPOSE

Speed Reduction

COST PER MEASURE

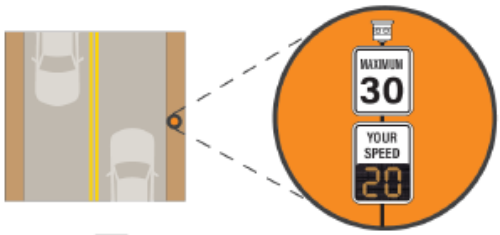
Highly varied based on vendor, style, power source, mounting pole, physical installation and potential electrical work

ADVANTAGES

- Minimal to no impact on transit/emergency vehicle operations
- Minimal to no impact on physical roadway features such as drainage
- Can be used at multiple locations
- Less expensive than direct enforcement
- Useful where physical measures are not feasible due to roadway constraints

DISADVANTAGES

- Initial capital cost
- Two units required to serve both directions of travel
- Requires ongoing maintenance
- Effectiveness may wane if overused and drivers perceive no likely true enforcement



DESIGN

- Devices may be portable or permanent.
- Signs may include displayed messages when a vehicle is in violation of the speed limit such as SLOW DOWN or REDUCE SPEED.
- Signs may be effective when posted in a transition zone to a lower speed area.

OPERATIONS AND MAINTENANCE

- Speed display signs require a reliable power source. Many contemporary models are equipped with backup batteries or solar panels that should be inspected regularly.
- Rotation, relocation, or repair of damaged signs requires action on the part of public works.
- Continually ensure sign visibility is not blocked by vegetation or other obstacles.

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On-Road Messaging

Pavement markings communicate a higher sense of priority and the potential for a significant change in the roadway to drivers. Messages may emphasize the presence of traffic calming features.

MEASURE

Awareness

PRIMARY PURPOSE

Safety

COST PER MEASURE

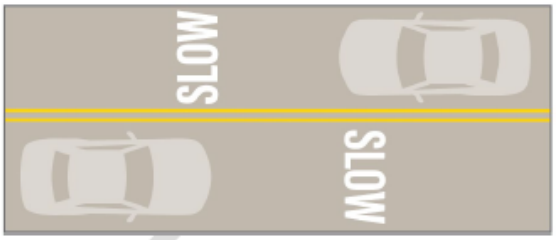
$200-$300 per painted square metre
Material expenditures vary according to number and size of messages

ADVANTAGES

- Minimal to no impact on transit/emergency vehicle operations
- Minimal to no impact on physical roadway features such as drainage

DISADVANTAGES

- Requires ongoing maintenance
- Less effective during winter
- May impact cyclists or motorcycles
- May increase roadway noise



DESIGN

- Often used in conjunction with gateways or other traffic calming measures.
- Typically placed in a transition zone or along a bicycle boulevard.
- Added colour may add to effectiveness
- Use skid-resistant surfacing and paints

OPERATIONS AND MAINTENANCE

- Similar to painted crosswalks, stamped, on-road messaging requires repainting at regular intervals to maintain appearance and effectiveness.

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Traffic Calmed Neighbourhood/ Community Safety Zone Signs

Signs indicating that the driver is either entering a neighborhood that has forms of traffic calming measures in place or a community safety zone where fines are doubled for traffic related incidents or violations. Both signs are intended to enhance driver awareness and encourage safe driving.

MEASURE

Awareness

PRIMARY PURPOSE

Speed Reduction

COST PER MEASURE

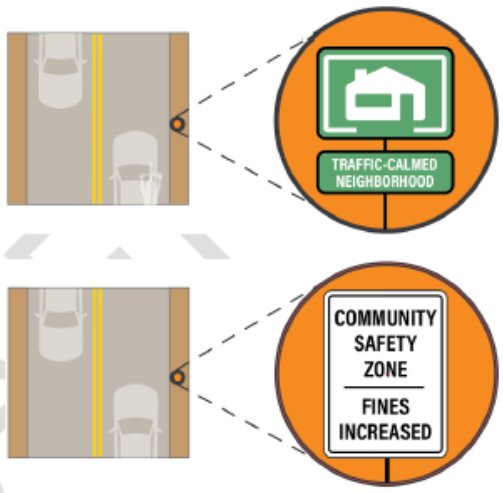
Varied based on vendor, size of signage, material type, sheeting type, mounting pole

ADVANTAGES

- Consequences of enforcement and increased fines increase effectiveness
- Minimal to no impact on transit/emergency vehicle operations
- Minimal to no impact on physical roadway features such as drainage

DISADVANTAGES

- Can lose effectiveness if deployment is not selective and appropriate
- Requires input and commitment from police for the enforcement needed to retain maximum effectiveness



DESIGN

- Establishment of zones and use of signs must be authorized by local by-laws.
- Community safety zones are typically implemented near public places such as schools, daycare facilities, senior homes, or hospitals.
- Signs must be posted at each limit of a community safety zone.

OPERATIONS AND MAINTENANCE

- Responsibility for replacement and/or repair of damaged signs and posts.
- Continually ensure sign visibility is not blocked by vegetation or other obstacles.

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