Draft Final Report

Bicycle Boulevards Feasibility Study

Phase I Report - Primer

Prepared for City of Hamilton
by IBI Group
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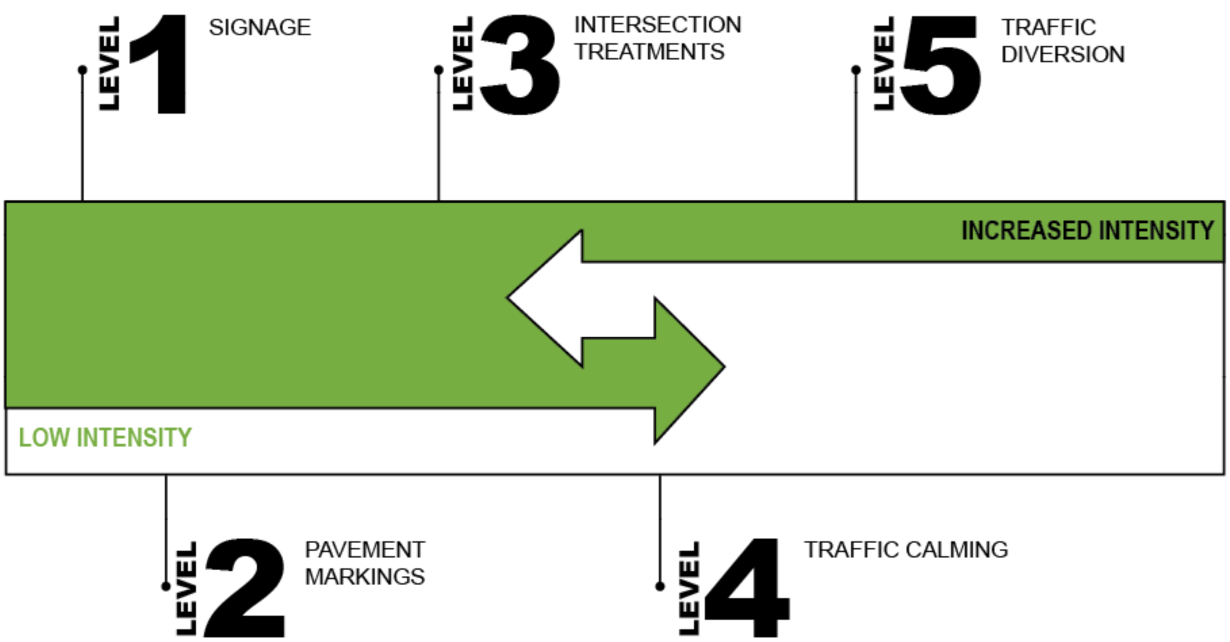
1 Introduction & Overview

1.1 Defining Bicycle Boulevards

Bicycle Boulevards, also known as *Bicycle Priority Streets, Slow Streets, Bicycle Greenways* or *Neighbourhood Greenways*, are slow-speed, low-volume streets where cyclists are prioritized through the application of various traffic control devices.

Various traffic control devices implemented along bicycle boulevards are shown (in increasing order of intensity) in Exhibit 1.1. Examples of bicycle boulevard implementations are shown in Exhibit 1.2.

Exhibit 1.1: Various Traffic Control Measures along Bicycle Boulevards



Source: IBI Group

Exhibit 1.2: Examples of Bicycle Boulevard Implementations

Images Source: NACTO

1.2 Vision

Bicycle boulevards can play an important role in the overall cycling network. When properly planned and designed, the operating conditions along a bicycle boulevard make them attractive routes for a wide variety of cyclists and can supplement and connect spine routes. The proposed vision for the City of Hamilton's network of bicycle boulevards is:

"As part of the overall cycling network, a system of bicycle boulevards across the City of Hamilton provides high-quality, comfortable and safe connections for cyclists of all ages and abilities through residential areas, contributing to Complete-Livable-Better neighbourhood streets."

2 Background & Work to Date

2.1 Bicycle Boulevards in City Plans

Bicycle boulevards have been recognized in a number of City plans and projects to date, laying the groundwork for this study.

A brief summary of information and references to bicycle boulevards in various planning and policy documents is provided in Exhibit 2.1.

Exhibit 2.1: Summary of Policy Directions for Bicycle Boulevards in Hamilton

Document	References & Guidance
City of Hamilton Transportation Master Plan and Cycling Master Plan Update (2018)	✚ Bicycle boulevards are identified as a suitable facility design for local neighbourhood streets. ✚ Implementation of bicycle boulevard devices are recommended on several street segments as spot modifications in coordinated works.
Centennial Neighbourhoods Transportation Master Plan (2017)	✚ Neighbourhood greenways are identified as a preferred solution to calm traffic and improve walking and cycling connections in the Centennial Neighbourhoods.
North End Traffic Management Plan (2008)	✚ Bike lanes on a portion of Bay Street from Burlington to Guise Streets, on Leander Drive and Guise Street from the westerly end to Dock Service Road, and on Ferguson Avenue from Strachan to Burlington Streets were proposed as part of the NETMP. ✚ Subsequent field review, design and consultation resulted in the bike lanes not being favourable for these streets, and “bicycle greenways” were proposed as an alternative. This report described what bicycle greenways are, how they are implemented, and specific strategies for bicycle greenways in Hamilton and the North End.
Kirkendall Neighbourhood Traffic Management Plan (2006)	✚ Low-intensity bicycle boulevard treatments such as on-street bicycle network signage and a Neighbourhood Speed Watch Programs are recommended in the Kirkendall neighbourhood.

2.2 Traffic Calming Practices & Policies

Traffic calming is an integral component of a bicycle boulevard, as control speeds and volumes of motor vehicles direct impact the performance of a bicycle boulevard. In July 2020, the City of Hamilton approved a Traffic Calming Management Policy that provides guidance on the process and structure by which traffic calming measures will be implemented in the City. It applies to retrofit locations on existing roadways with identified operational and/or safety needs, but it does not apply to major capital projects.

In addition to providing a standardized process for requesting, evaluating, and implementing potential traffic calming measures, this policy defines the types of treatments applicable in the City for different contexts. It separates potential traffic calming treatments into four categories:

- Passive traffic calming treatments:
  - Education
  - Community entrance sign
  - Targeted enforcement
  - On-street parking
  - Speed display
  - Road diet
- Physical vertical deflections:
  - Speed cushion
  - Raised intersection/crosswalk
  - Speed table
- Physical horizontal deflections:
  - Curb extension
  - Curb radius reduction
  - Neighbourhood traffic circle
  - Centre median island
  - One-lane chicane
  - Lateral shift
  - Roundabout

- Physical obstructions:
  - Directional closure
  - Raised median through intersection
  - Right-in/right-out island

All of the above measures are applicable on local roads, which are the focus for bicycle boulevards (see Section 3.3). Where a transit route is present, however, the following measures are not acceptable:

- Curb radius reduction
- Neighbourhood traffic circle
- One-lane chicane
- Directional closure
- Right-in/right-out island

These policies are directly adapted into the bicycle boulevard toolbox described in Section 4.

2.3 Case Studies

To help define the types of corridors that are most appropriate for bicycle boulevards, case studies of several municipalities with an established network of these facilities were completed, including:

- Seattle, WA;
- Vancouver, BC;
- Montréal, QC; and
- Portland, OR.

Each of these municipalities has a history of implementing all ages and abilities (AAA) bicycle boulevards as part of their broader cycling networks. Therefore, they provide a template for defining characteristics of successful bicycle boulevards as well as the overall role bicycle boulevards within the ultimate cycling network. To supplement guidance and context from larger urban centres across North America, case studies of specific bike boulevard corridors in Thunder Bay, Peterborough, and Toronto were also completed.

Practices and policies related to bicycle boulevards from across these case studies are summarized below.

Performance Criteria:

Most cities adapt the following criteria for bicycle boulevards:

- **Volumes**: a volume around or less than 1000 cars per day to be considered as a target for a bicycle boulevard
- **Speeds:** posted speed limits of approximately 30 km/hr

Other common considerations include:

- Prioritizing cyclist and pedestrian safety by including sufficient crossings, reducing vehicle access, and enhancing the street environment (i.e., including lighting, landscaping, etc.)
- Streets should be relatively flat to ensure active transportation is viable for residents of different abilities (ideally <3%)

Role in Network:

Some common themes relating to the role of bicycle boulevards for each of the case studies include:

- Providing safer streets that prioritize cyclists and pedestrians
- Contributing to a network of AAA cycling facilities
- Connecting cyclists and pedestrians to key destinations and other corridors in the City's cycling network

Toolbox of Interventions:

The case study cities use many of the same tools for signage and pavement markings and traffic calming features. It should be noted that many of the jurisdictions utilize a combination of signage and pavement markings, traffic calming features, and other higher-order cycling infrastructure interventions (e.g. contraflow lanes, multi-use paths through parks) where required to create a comfortable bicycle boulevard.

Signage and Pavement Markings:

- Bicycle Wayfinding Signage
- Wayfinding and Other Pavement Markings
- Signage indicating reduced speed limits or crossing opportunities

Traffic Calming Features:

- Speed Bumps/Speed Humps/Speed Cushions

- Traffic Diverters
- Raised Crosswalks or Intersections
- Realigned / Modified Intersections
- Bicycle-Friendly Corner Bulb Outs and Curb Extensions
- Curb Radius Reductions
- Radar Speed Display Signs and Mini-Roundabouts

For a detailed review of each case study, refer to the standalone *Bicycle Boulevard Case Study Memo*.

3 Bicycle Boulevard Criteria for the City of Hamilton

3.1 Overview

This section defines a series of **core criteria** and **considerations** for screening and prioritizing potential bicycle boulevard corridors based on findings to-date, including the jurisdictional comparison and case studies. Defining the characteristics of a suitable bicycle boulevard specific to the local context is helpful for both screening a candidate network of bicycle boulevards across the city and determining what potential issues may need to be mitigated through bicycle boulevard design and implementation.

Parameters related to the following topics are presented in this section:

- **Role in Cycling Network & Connectivity:** What role does the corridor play in the cycling network considering the existing and proposed cycling network, adjacent routes, intersecting facilities and destinations, and overall continuity? How supportive are those elements of bicycle boulevard implementation?
- **Roadway Context:** How well does the roadway context support bicycle boulevard implementation considering key factors such as motor vehicle speeds, motor vehicle volumes, functional road classification, vehicle mix and adjacent land use?
- **Topographic Considerations:** Is the topography of the corridor supportive of all ages and abilities cyclists?

Some parameters, such as speeds and volumes, are key to the successful and safe implementation of a bicycle boulevard; others are important considerations that must be considered when studying and prioritizing corridors but may be flexible depending on local contexts. To reflect this distinction, parameters have been highlighted as either **“Core Criteria”** or **“Considerations”**.

3.2 Role in Cycling Network & Connectivity

For the purposes of reviewing and defining bicycle boulevard routes across the City, not every corridor will be considered.

The basic premise for this strategy is to **consider corridors already identified in the City's existing and proposed cycling network**. As the City's cycling master plan is routinely updated (typically every five years), this provides a mechanism to identify new bicycle boulevard candidates on a regular basis. However, **it is also important that the City continues to be responsive to emerging opportunities.** In keeping with the City's Complete, Livable, Better Streets approach, opportunities to implement bike boulevards should also be considered through routine accommodation (for example, planned road reconstruction of a local street), when circumstances permit.

If a corridor is identified as desirable from a network perspective, factors such as the intended role in the network, connectivity to other cycling facilities, and length all affect the suitability of a corridor for bicycle boulevard implementation.

Cycling Master Plan Route

The City of Hamilton Cycling Master Plan (CMP) is the primary planning and policy guidance for developing the cycling network. As noted above, corridors will typically be identified within the CMP network to be investigated as candidate bicycle boulevards.

Exceptions to this may be considered on a case-by-case basis and may include:

- Routes which undergo significant redevelopment or where a major destination is added (e.g. school or community centre) within the lifespan of the master plan;
- Routes which emerge as alternatives to a corridor previously identified in the Cycling Master Plan, should a feasibility review find major challenges with implementing the original route identified in the master plan; or
- Routes that area identified within the context of an area-specific study such as a secondary plan or neighbourhood transportation study, which may provide a finer-grained analysis than available in the CMP.

The CMP also provides some insight into potentially suitable candidates for bicycle boulevards, as it identifies the cycling network broken down by proposed facility class. Pending the review of key criteria such as road class and traffic volumes (see Section 3.3), corridors identified as shared on-street facilities such as signed routes or neighbourhood bikeways are likely the most appropriate for bicycle boulevard treatments.

Core Criteria: Corridor is identified as shared and signed route in the Cycling Master Plan, or the project is identified through another community planning process or capital project.

Role in Network

There are some contexts in which a bicycle boulevard plays a particularly important function in the overall cycling network. Bicycle boulevard implementation should be strongly considered and prioritized if the potential candidate corridor:

- Runs parallel to a nearby high-stress collector or arterial route that may be uncomfortable for some cyclists, therefore creating an alternative “spine” bikeway facility through the neighbourhood;
- Provides an all ages and abilities (AAA) bikeway between two other AAA cycling facilities where no alternative connections exist nearby; or
- Serves one or more major destinations where AAA facilities are needed, such as school sites and recreational facilities.

Consideration: Corridor fulfilling a certain function within the cycling network, such as connecting other AAA facilities, serving major destinations where AAA facilities are needed, and providing alternatives to high-stress roads, should take priority for implementation of bicycle boulevards.

Parallel & Connecting Cycling Facilities

Due to the quiet, residential nature of most bicycle boulevards, few cyclists will be using the facility to access a destination on the corridor itself. Instead, most riders will need to connect to other cycling facilities to complete their trip. It is therefore critical that the candidate bicycle boulevard provides access to other low-stress cycling facilities such as cycle tracks, buffered bike lanes, and off-street paths. Bicycle boulevards act as a supplement to, rather than a substitute for, the conventional cycling network.

Balancing the need for connectivity with a desire to avoid duplicating infrastructure, many cities aim for a fine-grained low-stress network of facilities at 400-800 m intervals. A more fine-grained network may be justified in areas of high cycling potential (i.e. Downtown Hamilton).

Consideration: Corridor is located 400-800 m from the nearest parallel low-stress cycling facility.

Continuity

Candidate routes for bicycle boulevards are most attractive when they follow a long, direct, and relatively continuous desire line for bicycle travel along low-traffic streets. As the length of a typical urban cycling trip is approximately 3-8 km, a suitable bicycle boulevard candidate should be at least 3 km long to serve a significant portion of desired trips; however, a successful bicycle boulevard may be shorter as long as it traverses the city, community, or major centre it is intended to serve from end-to-end.

As bicycle boulevards are most suitable along local roads (refer to Section 3.3), which are often discontinuous or not in a grid pattern, it may be necessary to combine several streets to form one continuous route that achieves the desired length. It is important to note that cyclists are typically only willing to deviate from the most direct route for 2-3 short blocks at a time (or about 300 m) to access a continuous bicycle route or navigate around a major barrier. If a larger deviation is required, a candidate route should only be considered if there is potential to create a bicycle/pedestrian-only shortcut, such as a path through a park or between two cul-de-sacs.

Consideration: Bicycle boulevards should typically provide a continuous corridor with minimal diversion. Preferred length is 3 km with minimal deviations.

3.3 Roadway Context

This section discusses key performance criteria for identifying and evaluating bicycle boulevards related to the physical and operating characteristics of the roadway, including speeds, volumes, road classification, transit and emergency vehicle routes, and land use context.

Corridor Speeds

As maintaining a low-stress cycling environment is critical to the success of bicycle boulevards in attracting a wider spectrum of the population, streets with posted or operating speeds above 40 km/h are not suitable for bicycle boulevards. For the purposes of identifying potential candidate bicycle boulevards, however, streets with posted/operating speeds of up to 50 km/h may be considered provided that there is reasonable opportunity to reduce speeds to 30-40 km/h.

Core Criteria: Posted/operating speed ≤ 50 km/h

Vehicular Volumes

Similar to speed, high traffic volumes along a corridor create a more stressful environment for cyclists and are not compatible with shared cycling facilities like bicycle boulevards. Volumes of less than 1,000 cars per day are preferred operating conditions, while 1,500 vehicles per day represent the absolute maximum volumes that can be tolerated; however, candidate streets with current volumes of up to 3,000 vehicles per day could be reasonably expected to meet these volumes with the careful implementation of traffic diversion measures.

Core Criteria: Volume ≤ 3,000 vehicles per day.

Road Classification

Bicycle boulevards are intended to present opportunities to cycle along a quiet, safe roadway rather than serving as primary thoroughfares for motor vehicles. According to the Urban Hamilton Official Plan, only roads classified as “Local” are designed to carry low volumes of traffic, and they are the only roads that allow for the implementation of both horizontal and vertical traffic calming measures. For this reason, only local roads should generally be considered suitable candidates for bicycle boulevards. To accommodate a broken grid system, such as in Hamilton, short segments (typically up to two blocks) along a collector road may be acceptable provided that the segment meets the speed and volume criteria listed above; however, there may be limited opportunities to manage speeds and volumes on collector roads.

In addition to the functional road classification, the street typology as defined within the Complete-Livable-Better Streets (CLBS) Policy and Framework may be considered. The ‘Neighbourhood Street’ typology best reflects the desired operating environment for a bicycle boulevard.

Core Criteria: Road classification = ‘Local’.

Consideration: CLBS typology = ‘Neighbourhood Street’

Transit and Emergency Vehicle Routes

In general, it is not recommended that bicycle boulevards be implemented on major transit or emergency vehicle routes. Many traffic calming measures needed for effective bicycle boulevard implementation can negatively impact transit operations, and the frequent presence of buses with boarding or alighting passengers may increase cycling stress. In certain contexts, however, a candidate street that serves one or more local transit routes can be considered for a bicycle boulevard.

Some example circumstances in which a bicycle boulevard may be considered along a transit route are as follows:

- The transit route runs along the candidate for a very short portion of the bicycle boulevard (e.g. less than 10% of its total length);
- The transit service provided along the corridor is relatively low-frequency (e.g. 30-minute headways);
- There is no suitable alternative candidate in close proximity; or
- Some combination of the above factors.

In all cases, transit operators should be consulted to ensure that any routes running along the candidate boulevard would not be negatively affected.

Similarly, bicycle boulevards can be compatible with emergency vehicle routes in some cases, as several speed and volume management treatments can be applied with minimal impacts on emergency vehicles.

Consideration: Corridors that serve transit or emergency vehicle routes should be considered with caution to minimize negative impacts on transit service or emergency response.

Land Use

Residential streets are preferred candidates for bicycle boulevards, as they are typically quieter and more comfortable for cyclists of all ages and abilities. With this principle in mind, a candidate bicycle boulevard should be primarily located within Neighbourhood land use contexts as designated in the Urban Hamilton Official Plan. Candidate streets with other land uses can be considered provided speed and volume constraints are met. For example, a bicycle boulevard that provides connections to major streets or destinations may include some commercial, mixed-use, or institutional land uses near intersections. There may also be opportunities for bicycle boulevards outside of the urban boundary, although higher speeds and longer distances between key destinations often prevent bicycle boulevards from being viable along rural roads; for these reasons, candidates that primarily serve Rural Settlement Areas are most likely to be appropriate outside the urban boundary.

Consideration: Designated Neighbourhoods are preferred, but some overlap with other land uses may be acceptable in certain contexts.

3.4 Topographic Considerations

To ensure that active transportation is viable, accessible, and comfortable for cyclists of different abilities, candidate bicycle boulevards should be relatively flat. Ideally, suitable candidates would have slopes no steeper than 3% along the entire length of the boulevard; however; short segments (less than 500 m) of steeper slopes may be accepted. Cyclists tend to be willing to take a less direct route to avoid steep grades, so short diversions may be acceptable in some cases depending on the steepness of the hill.

It is important to note that, depending on local geographies, there may not be a feasible route that does not involve climbing a steep slope (i.e. the escarpment). In these cases, alternative options for cyclists who are unable to or uncomfortable with climbing the slope should be considered. For example, the City of Hamilton currently provides a Mountain Climber program that allows cyclists to take an HSR bus up or down the escarpment for free.

Core Criteria: Slopes < 3% along the length of the corridor. Steeper segments accepted if < 500 m in length or if no feasible alternatives exist.

3.5 Summary of Screening Criteria and Considerations

Based on the preceding overview, a corridor can be considered a feasible candidate for bicycle boulevard implementation if the following **core criteria** are met:

- Corridor is identified in the Cycling Master Plan or through some other plan, community planning process, or capital project;
- Posted/operating speed is 50 km/h or lower;
- Observed traffic volumes are less than 3,000 vehicles per day;
- Road classification is “Local”; and
- Slopes are less than 3% along the length of the corridor (steeper segments accepted if shorter than 500 m in length or if no feasible alternatives exist).

The following **considerations** should also be factored into the assessment of a preferred candidate for bicycle boulevard implementation:

- Corridor is located 400-800 m from the nearest parallel AAA cycling facility;
- Corridor length is ideally at least 3 km with minimal deviations;

- Corridors that serve transit or emergency vehicle routes should be considered with caution to minimize negative impacts on transit service or emergency response;
- Corridors with “Neighbourhood Street” typologies within the CLBS Policy and Framework are preferred;
- Corridors serving designated Neighbourhood land uses are preferred, but some overlap with other land uses may be acceptable in certain contexts; and
- Certain key roles within the cycling network, such as connecting other AAA facilities and providing alternatives to challenging high-volume roads, should take priority for bicycle boulevards.

3.6 Post-Implementation Performance Criteria for Bicycle Boulevards

While the criteria above can be used to screen and prioritize potential bicycle boulevard corridors, further **performance criteria are needed to define targets for bicycle boulevards once improvements are in place and monitoring has begu**n. Corridor-specific targets should be refined based on firsthand experience over time, but these provide a universal starting point for evaluation.

Once a bicycle boulevard has been implemented, its performance should be evaluated against the following **targets**:

- Posted and operating speeds are < 30-40 km/h; and
- Traffic volumes are up to 1,500 vehicles per day, with less than 1,000 per day preferred.

These target post-implementation performance criteria should be used to define the specific measures to be implemented as part of the design of a bicycle boulevard on a block-by-block basis:

- Where existing speeds exceed 50km/hr, the design should include traffic calming elements designed to help reduce operating speeds; and
- Where existing volumes exceed 1000-1500 vehicles per day, the design should incorporate traffic diversion elements designed to help reduce through traffic along the corridor.

More information on the speed and volume management tools that can be applied is provided in the toolbox in Section 4.

4 Toolbox for Bicycle Boulevards

4.1 Overview

Once a corridor has been identified for implementation of a bicycle boulevard, a preliminary screening of potential improvements will be completed. To assist with the planning and subsequent design phases, a toolbox has been prepared to define the possible interventions that may be considered along bicycle boulevards.

These toolbox items can generally be grouped into the following three categories:

- Bicycle Signage, Pavement Markings & Wayfinding;
- Traffic Management Elements consisting of:
  - Speed Management Elements
  - Volume Management Elements; and
- Low Impact Development (LID) / Corridor Greening Treatments.

Bicycle signage, pavement markings and wayfinding will be consistent features across all bicycle boulevards. However, it is important that traffic management elements are implemented and considered along bicycle boulevards to achieve stated operational performance criteria. When completing the initial corridor review, a segment-by-segment review should be considered to identify project-specific needs. As discussed in Section 3.6, traffic management tools should be carefully applied to achieve the design performance criteria:

- Where existing speeds exceed 50km/hr, the design should include traffic calming elements designed to help reduce operating speeds; and
- Where existing volumes exceed 1000-1500 vehicles per day, the design should incorporate traffic diversion elements designed to help reduce through traffic along the corridor.

LID & corridor greening should be routinely considered along bicycle boulevards, as project scope and budget allows. These elements positively contribute to overall community support for bicycle boulevards and are encouraged wherever feasible.

4.2 Bicycle Signage, Pavement Markings & Wayfinding

Signs and pavement markings are important elements when creating a bicycle boulevard. These elements indicate that the roadway is a shared facility between bicycles and motor traffic and are designed to offer priority to cyclists within the shared space. Signs and pavement markings alone are not sufficient in creating a safe and effective bicycle boulevard, but instead, act as reinforcement for other traffic calming elements implemented on the roadway.

Wayfinding signage and pavement markings offer many benefits to bicycle boulevards: they differentiate bicycle boulevards from other local streets, raise awareness of designated routes, and provide information about suggested network routing. These elements can also help users remain on the designated bicycle boulevard route and encourage cyclists to properly position themselves in the roadway.

The toolbox in this section will focus on the following key elements of a bicycle boulevard:

- Wayfinding signage; and
- Wayfinding directional markings.

Other related elements of bicycle boulevards that can be considered for implementation include associated regular signage for contraflow bike lane sections, “bicycles excepted to no entries movements”, and streetscape pavement markings that help differentiate bicycle boulevards from other local roads.

Wayfinding Signage

Overview:

Bicycle wayfinding signage is used, often in conjunction with pavement markings such as wayfinding directional markings, to guide cyclists along preferred bike routes. Signage systems typically consist of decision signs (at junctions of two or more bikeways), turn signs (where bikeways turn from one street onto another), and confirmation signs (to make cyclists and motorists aware of the route).

Image Source: NACTO

Hamilton Examples:

- Modifications of standard bike route signage such as examples at Hunt & Dundurn, King & Breadalbane and Dundurn & Glenside;
- City has developed templates for integrated bicycle boulevard / street signs to replace standard street signs along bicycle boulevard routes

Expected Transportation Network Impacts:

- Cyclist Wayfinding & Priority: Wayfinding signage complements pavement markings to facilitate navigation, helping to provide continuity along a route, identifying intersecting cycling routes, and alerting drivers to the presence of cyclists along a route
- Operations & Maintenance: Minimal impacts (signage replacement as needed)

Application Guidance for Bicycle Boulevards:

- Approaching an intersection where a turn must be completed to stay on the bicycle boulevard, a decision sign should be applied on the intersection approach with a confirmation sign applied following the intersection
- Decision signs should be placed on the near-side of intersections with other bicycle routes or along a route to indicate a key destination nearby

Ease of Implementation

- Retrofit and permanent applications
- Simple to implement

Cost Range

- Anticipated cost range: $100 - $1000 per sign, depending on size and complexity

Wayfinding Directional Markings

Overview:

Shared lane markings are pavement markings used to indicate a shared environment for bicycles and motor vehicles, and are composed of a bicycle icon and chevrons. When used to provide guidance along a route, these markings include directionality and are referred to as **'Wayfinding Directional Markings'.**

Image Source: NACTO

Hamilton Examples:

- None currently in use;

Expected Transportation Network Impacts:

- Cyclist Wayfinding & Priority: Wayfinding directional pavement markings complement signage to facilitate navigation, helping to provide continuity along a route, identifying intersecting cycling routes, and alerting drivers to the presence of cyclists along a route
- Operations & Maintenance: Minimal impacts (refresh pavement markings as needed)

Application Guidance for Bicycle Boulevards:

- Approaching an intersection where a turn must be completed to stay on the bicycle boulevard, a decision sharrow should be applied on the intersection approach with a confirmation sharrow applied following the intersection;
- Wayfinding directional markings should be typically provided after each block and repeated midblock at a minimum spacing of **75 m**;
- Along a bicycle boulevard with wide lanes and full-time on-street parking, wayfinding directional markings should be placed **1.3 m from the edge of the parking lane**;
- Along a bicycle boulevard with wide lanes without on-street parking, wayfinding directional markings should be placed **1.0 m from the face of curb**; and
- On a narrow signed bicycle route (with or without on-street parking), wayfinding directional markings should be placed **in the centre of the travel lane**.

Ease of Implementation

- Retrofit and permanent applications
- Simple to implement

Cost Range

- Anticipated cost range: $300 - $1000 per sharrow (depending on materials)

4.3 Traffic Management Elements

Traffic management elements should be implemented on bicycle boulevards as necessary to achieve the desired motor vehicle operating speeds and target volumes. Reducing the motor vehicle operating speeds on bicycle boulevards can greatly improve cyclists' safety by reducing the frequency of overtaking events, enhancing the motorists' ability to see and react, and diminishing the severity of collisions should they occur. Other benefits of implementing traffic calming measures on bicycle boulevards include reinforcing bicycle priority and providing opportunities for landscaping to build a more attractive and comfortable community for all.

Traffic calming elements are generally categorized as either vertical measures, horizontal measures, or both. Vertical measures are comprised of slight elevations in the pavement to encourage motorists to reduce speeds, such as speed humps, and raised crossings/intersections. Horizontal measures involve a narrowing or curving of the roadway which cause motorists to slow down, such as curb extensions. The toolbox items in this section include:

- Speed humps/cushions;
- Raised crossings;
- Raised intersections;
- Mini-roundabouts;
- Realigned / modified intersections;
- Bicycle-friendly corner bulb-outs and curb extensions;
- Curb radius reductions;
- Radar speed display signs;
- Traffic diverter: directional closure;
- Traffic diverter: full closure;
- Traffic diverter: intersection channelization;
- Traffic diverter: raised median through intersection; and
- Right-in/right-out island.

Typical design concepts for new elements to the City's traffic calming toolbox are included in Appendix A.

Speed Humps/Cushions

Overview:

Raised areas of a roadway that cause vertical deflections of travelling vehicles. While speed humps cover the entire width of the road, speed cushions have gaps designed to allow larger vehicles to straddle the cushions and avoid or limit vertical deflections.

Image Sources: NACTO

Hamilton Examples:

- Eleanor Ave north of Dulgaren St
- Glenside Avenue
- Herkimer Street

Expected Transportation Network Impacts:

- Traffic Calming: Speed reduction; Discourages cut-through traffic, may contribute to reduce traffic volumes; May result in traffic diversion to parallel streets without traffic calming measures
- Cyclist & Pedestrian Priority: For both speed humps and cushions, designs can be modified to taper further from the gutter and create a flat surface for cyclists and mobility devices
- Operations & Maintenance: Impact to emergency vehicle response time and to transit (partially mitigated with speed cushions); Snow clearing times are increased

Guidance for Bicycle Boulevards:

- To be designed in accordance with the **City of Hamilton Standard Drawings for speed humps/cushions**
- Do not place within decision or braking zone of traffic signals

Ease of Implementation

- Temporary or permanent installations
- Relatively simple to implement; speed cushions more difficult to construct

Cost Range

- Low to medium
- Anticipated cost range: up to $5,000 per installation

Raised Crossings

Overview:

Marked pedestrian crossings at intersections or midblock locations that have been elevated flush with sidewalks.

Image Source: NACTO

Hamilton Examples:

- Creekside Drive, Dundas

Expected Transportation Network Impacts:

- Traffic Calming: Speed reduction to 85th percentile speed; Discourages cut-through traffic, may contribute to reduce traffic volumes; May result in traffic diversion to parallel streets without traffic calming measures
- Cyclist & Pedestrian Priority: The elevated crossing enhances pedestrian visibility thereby encouraging drivers & cyclists to yield to pedestrians
- Operations & Maintenance: Impact to emergency vehicle response time and to transit (potential design mitigation); Snow clearing times are increased

Guidance for Bicycle Boulevards:

- Should generally be used where there is existing traffic control for the crossing (i.e. stop-controlled, PXO, etc.)
- If no traffic controls are present, but there is a clear desire line for pedestrians across two or more approaches, then further consideration is needed (e.g. uncontrolled crossing)

Ease of Implementation

- Permanent applications only
- Complex to implement (e.g., geometric design and roadway drainage impacts)

Cost Range

- Medium to high depending on width of crossing and drainage impacts
- Anticipated cost range: $5,000-$50,000

Raised Intersection

Overview:

An intersection, including crosswalks, that has been elevated flush with sidewalks. Ramps on each approach lead up to the intersection. The intent is to slow traffic through vertical deflection, while providing improved ride comfort for vehicles with long wheel bases.

Image Sources: IBI Group

Hamilton Examples:

- N/A

Expected Transportation Network Impacts:

- Traffic Calming: Speed reduction to 85th percentile speed; Discourages cut-through traffic, may contribute to reduce traffic volumes; May result in traffic diversion to parallel streets without traffic calming measures
- Cyclist & Pedestrian Priority: The elevated intersection enhances pedestrian visibility thereby encouraging drivers & cyclists to yield to pedestrians
- Operations & Maintenance: Impact to emergency vehicle response time and to transit (potential design mitigation); Snow clearing times are increased

Guidance for Bicycle Boulevards:

- For use where traffic controls are present for all approaches
- If no traffic controls are present, but there is a clear desire line for pedestrians across two or more approaches, then further consideration is needed

Ease of Implementation

- Permanent applications only
- Complex to implement (e.g., geometric design and roadway drainage impacts)

Cost Range

- Medium to high depending on width of the intersection and drainage requirements
- Anticipated cost range: $10,000-$50,000

Mini-Roundabout

Overview:

A roundabout consisting of a mountable or raised centre island and mountable/painted splitter islands. In some cases, the roundabout can be retrofit into an existing intersection with little modification of the existing curbs. Signage updates are required to change the right-of-way control.

Image Source: NACTO

Image Source: Ken Sides via FHWA

Hamilton Examples

- Royce Avenue & Margraret Avenue
- Federal Street & Blenheim Drive
- Federal Street & Chester Avenue

Expected Transportation Network Impacts:

- Traffic Calming: Speed reduction; Conflict point and collision rate reduction; May result in traffic diversion to parallel streets without traffic calming measures
- Operations & Maintenance: Impact to emergency vehicle response time and to transit (potential design mitigation); May need to remove on-street parking; Snow clearing times are increased

Guidance for Bicycle Boulevards:

- For use with one-lane approaches and posted speeds at 50km/h or less
- Not used where there are high volumes of large trucks or left turning buses

Ease of Implementation

- Temporary or permanent applications
- Complex to implement (permanent)
- Road user education recommended

Cost Range

- Medium to high
- Anticipated cost range: $10,000-$100,000, depending on materials

Realigned/Modified Intersections

Overview:

Creates a change in horizontal alignment through a T-intersection by use of a curb extension within the intersection. The curb extension creates a horizontal deflection through the intersection.

Image Source: Naperville Traffic Calming Toolkit

Image Source: Delaware DOT Traffic Calming Manual

Hamilton Examples

- Strachan Street & Catharine Street

Expected Transportation Network Impacts:

- Traffic Calming: Speed reduction; Discourages cut-through traffic
- Cyclist & Pedestrian Priority: Reduces crossing distances for pedestrians
- Operations & Maintenance: Drainage needs to be considered; May impact on-street parking

Guidance for Bicycle Boulevards:

- Use at stop-controlled T-intersections
- Local or collector roadways with one-lane approaches

Ease of Implementation

- Temporary or permanent implementation
- Somewhat challenging to implement

Cost Range

- Low to medium depending on drainage requirements
- Anticipated cost range: $2,000-$10,000

Bicycle-Friendly Corner Bulb-Outs and Curb Extensions

Overview:

Horizontal extensions of curbs into the roadway that result in narrower roadway sections while providing space for cyclists to ride over/through. “Ride-over” designs are flush with the adjacent sidewalk, while “ride-through” designs have a cycle track at-grade with the roadway and an adjacent median or barrier.

Image Source: City of Toronto

Image Source: Google Streetview

Hamilton Examples:

- N/A;

Expected Transportation Network Impacts:

- Traffic Calming: Speed reduction; Discourages cut-through traffic; large vehicles may need to cross into oncoming lane to negotiate turns
- Cyclist & Pedestrian Priority: Creates physical separation between cyclists, motor vehicles, and pedestrians; does not reduce crossing distance for pedestrians like conventional bulb-outs or extensions from cyclists, but does reduce crossing distance with conflicting motor vehicles
- Operations & Maintenance: Drainage needs to be considered; May need to remove on-street parking; “ride-over” designs may be preferred from a maintenance perspective but may not be preferred from an accessibility perspective

Application Guidance for Bicycle Boulevards:

- Use at intersections or midblock (typically at pedestrian crossing)
- Local or collector roadways with one-lane approaches

Ease of Implementation

- Temporary or permanent implementation
- Simple to implement on temporary basis for future study and upgrades

Cost Range

- Low to medium depending on drainage requirements
- Anticipated cost range: $1,000-$10,000

Curb Radius Reductions

Overview:

Curb radius reductions tighten intersection corners to achieve smaller turning radii for vehicles.

Source: Google Streeview

Hamilton Examples:

- Charlton Avenue & Locke Street
- Dundurn Street & Stanley Avenue
- Numerous throughout City

Expected Transportation Network Impacts:

- Traffic Calming: Speed reduction for right-turning vehicles; larger vehicles may need to encroach into adjacent travel lanes
- Cyclist & Pedestrian Priority: Reduces pedestrian crossing distances

Guidance for Bicycle Boulevards:

- For use at intersections between local, collector, and/or arterial roads
- Particularly appropriate where vehicles may be turning onto the bicycle boulevard from higher speed/volume streets or vice-versa

Ease of Implementation

- Temporary or permanent implementation
- Moderate complexity to implement permanently (e.g., geometric design and roadway drainage impacts)

Cost Range

- Medium to high depending on site conditions
- Anticipated cost range: $2,000-$25,000 per corner

Radar Speed Display Signs

Overview:

Radar technology and connected display board that are designed to show speeds of approaching vehicles or display other messages to oncoming motorists.

Image Source: City of Hamilton

Hamilton Examples:

- Numerous throughout City

Expected Transportation Network Impacts:

- Traffic Calming: Encourages speed reduction when supported by other measures, though should not be used independently; increases public education and awareness
- Operations & Maintenance: Requires power source such as solar panel, battery, or direct grid connection; temporary/seasonal installations can be accommodated using mobile trailer units

Guidance for Bicycle Boulevards:

- For midblock use along local two-lane roads, particularly on segments with long distances between TCDs; Must be combined with other traffic calming elements
- Consider installing within initial bicycle boulevard installation and monitoring impacts of bicycle boulevard features
- Most applicable in school zones

Ease of Implementation

- Temporary or permanent installation
- Simple to implement

Cost Range

- Low to medium
- Anticipated cost range: $2,000-$5,000

Traffic Diverter: Directional Closure

Overview:

A barrier or vertical barrier that extends to the centreline of the roadway, obstructing one direction of traffic.

Hamilton Examples:

- James Street N & Burlington Street W

Expected Transportation Network Impacts:

- Traffic Calming: Eliminates cut-through traffic in one direction; Contributes to reducing traffic volumes; May result in traffic diversion to parallel streets without traffic calming measures
- Cyclist & Pedestrian Priority: No impact on cyclist or pedestrian access; The barrier shortens the crossing distance for pedestrians and increases visibility of pedestrians standing on the barrier.
- Operations & Maintenance: Minimal impacts to emergency and maintenance vehicle access (potential design mitigation); Snow clearing and street sweeping may be more complicated.

Guidance for Bicycle Boulevards:

- Gaps should be provided in the barrier for cyclist access in both directions.

Ease of Implementation

- Permanent or interim applications
- Moderate complexity to implement permanently (e.g., geometric design and roadway drainage impacts)

Cost Range

- Low for interim application
- Moderate to high depending on width of the intersection and drainage requirements
- Anticipated cost range: $2,000-$10,000

Traffic Diverter: Full Closure

Overview:

A barrier that extends the entire width of the roadway to prevent all motor traffic from entering the obstructed leg of the intersection. Gaps can be provided for cyclists and emergency/maintenance vehicles.

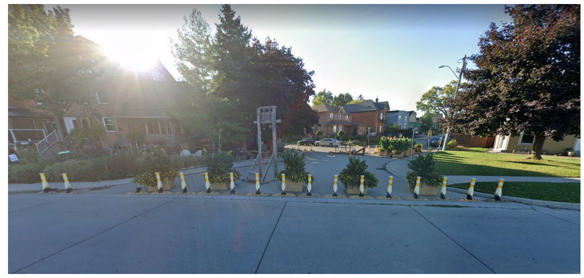


Image Source: Google Streetview

Hamilton Examples:

- Guise Street E & Hughson Street N
- Roxborough Avenue between Graham Avenue and Province Street
- Kenora Avenue & Village Drive

Expected Transportation Network Impacts:

- Traffic Calming: Eliminates all cut-through traffic, may contribute to reduced traffic volumes; May result in traffic diversion to parallel streets without traffic calming measures; Reduces conflict points.
- Cyclist & Pedestrian Priority: No impact on cyclist or pedestrian access, but motorists may be less likely to anticipate cyclists who enter the intersection through the barriers.
- Operations & Maintenance: Impacts to emergency and maintenance vehicle access (potential design mitigation); Snow clearing and street sweeping may be more complicated.

Guidance for Bicycle Boulevards:

- Appropriate at intersections or mid-block on local roads with 20% or more cut-through traffic.
- Gaps should be provided in the barrier for cyclist access.

Ease of Implementation

- Permanent or interim applications
- Moderate complexity to implement permanently (e.g., geometric design and roadway drainage impacts)

Cost Range

- Low to high depending on the complexity of closure and drainage requirements
- Anticipated cost range: $2,000-$10,000

Traffic Diverter: Intersection Channelization

Overview:

Raised islands or bollards are located in an intersection to physically direct traffic movements and obstruct specific traffic movements, for example, discouraging through and left turn movements.

Image Source: Google Maps

Image Source: IBI Group

Hamilton Examples:

- N/A

Expected Transportation Network Impacts:

- Traffic Calming: Reduces conflict points; May increase vehicle speeds depending on geometry and configuration; Traffic may be diverted to parallel routes with no traffic calming measures.
- Cyclist & Pedestrian Priority: The channelized islands reduce crossing distances and provide an area of refuge for pedestrians; Cyclists are permitted to may all movements at the intersection.
- Operations & Maintenance: Snow clearing and street sweeping times are increased; May impact garbage collection routes.

Guidance for Bicycle Boulevards:

- Appropriate for intersections between local streets with collector or arterial roads. Avoid intersections between two local streets as motorists are likely to circumvent channels in low-volume locations.

Ease of Implementation

- Temporary or permanent implementation
- Moderate complexity to implement permanently

Cost Range

- Low to medium depending on channel size and drainage requirements
- Anticipated cost range: $2,000-$10,000

Traffic Diverter: Raised Median through Intersection

Overview:

A series of raised concrete or asphalt islands located in the centre of a two-way roadway intersection which prevents left turns and through movements to and from the intersecting roadways. The purpose of the raised median is to obstruct short-cutting or through traffic.

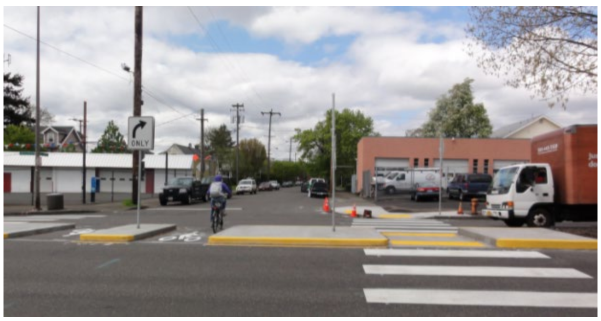


Image Source: Steven Vance / NACTO

Image Source: City of Edmonton

Hamilton Examples:

- N/A

Expected Transportation Network Impacts:

- Traffic Calming: Eliminates all cut-through traffic; Overall volume reduction of up to 35%; May result in traffic diversion to parallel streets without traffic calming measures.
- Cyclist & Pedestrian Priority: The median creates a refuge for pedestrians and cyclists and reduces crossing distance.
- Operations & Maintenance: May restrict residential and emergency vehicle access; Impacts on transit (potential design mitigation); Snow clearing times are increased; Street sweeping may be complicated; On-street parking may need to be removed.

Guidance for Bicycle Boulevards:

- Appropriate for intersections between local streets with collector or arterial roads. Avoid intersections between two local streets as motorists are likely to circumvent raised medians in low-volume locations.
- Traffic analysis is required to ensure adjacent streets can accommodate diverted traffic.

Ease of Implementation

- Temporary or permanent implementation
- Moderately complex to implement (e.g., geometric design and roadway drainage impacts)

Cost Range

- Low to moderate depending on width, materials, landscaping and drainage impact
- Anticipated cost range: $2,000-$10,000

Right-in/Right-out Island

Overview:

A raised triangular island on approach to an intersection that directs traffic to the right and obstructs left turn and through movements.

Image Source: Richard Drdul

Image Source: Andrew Bossi

Hamilton Examples:

- N/A

Expected Transportation Network Impacts:

- Traffic Calming: Typical volume reduction of 10-35%; May increase vehicle speeds depending on geometry and configuration; May result in traffic diversion to parallel streets without traffic calming measures; Reduces conflict points at intersection.
- Cyclist & Pedestrian Priority: The island reduces vehicle-pedestrian conflicts by reducing crossing distances and provide an area of refuge. Cyclists are permitted to make left turns and through movements.
- Operations & Maintenance: Impact to street sweeping; Snow clearing times are increased.

Guidance for Bicycle Boulevards:

- Appropriate on local and collector roads in urban areas.
- Consider opportunities to maintain all movements for cyclists while restricting vehicular movements

Ease of Implementation

- Temporary or permanent implementation
- Moderately complex to implement (e.g., geometric design and roadway drainage impacts)

Cost Range

- Low to medium depending on width of the island, materials and landscaping.
- Anticipated cost range: $5,000-$10,000

4.4 LIDs & Corridor Greening

Bicycle boulevards play an important role in improving the transportation system but they can also support public realm enhancements, improve livability and contribute to greener streets. The integration of cycling facilities with green infrastructure technologies, such as innovative stormwater management systems and street plantings, aims to address climate change and improve health outcomes.

Low-Impact Developments (LIDs) in the road right-of-way are a primary example of using green infrastructure in stormwater management systems. LIDs can direct drainage from hardscaped areas along the bicycle boulevard corridor to landscaped areas such as bioswales and bioretention cells or subsurface infiltration facilities, including soil cell systems for street trees. The resulting benefits of LIDs include reducing or eliminating pollutants in stormwater runoff from impervious surfaces, regulating surface flow by sequestering overland flow, and replicating a natural treatment system. Moreover, a key benefit of LIDs is the aesthetic quality they can bring to a streetscape.

The toolbox below introduces bioretention cells and bioswales as potential treatments. Other examples of green infrastructure that can be integrated with bicycle boulevards include permeable paving systems, self-watering planters and the strategic incorporation of streetscape plantings. Streetscape plantings, and boulevard trees, in particular, have a number of beneficial effects including improving air quality, optimizing the microclimate by increasing the urban canopy and reducing urban heat island effects, and enhancing the character of a neighbourhood.

Bioretention Cells

Overview:

Bioretention cells are a commonly adopted LID practice that use vegetated areas to temporarily store, treat and infiltrate stormwater runoff. Examples of bioretention forms include bioretention planters, bioretention curb extensions and boulevard bioretention units.

Regardless of type and configuration, planting strategies within bioretention areas should factor in considerations such as maintenance requirements, urban tolerance (salt, pollutants, etc.), and water saturation levels. Plant architecture should also be a consideration where the design should respond to the contextual aesthetics of the streetscape as well as situational requirements such as height restrictions within sight triangles.

Image Source: Portland Environmental Services

Image Source: Google Maps

Hamilton Examples:

- Bay Street North and Simcoe Street West LID Curb Extension

Regional Examples:

- King Street Revitalization, Rain Gardens, Kitchener, ON

Guidance for Bicycle Boulevards:

- Can be constructed in medians, cul-de-sac islands, and in curb extensions
- Use low plantings near intersections to maintain sight clearance.
- Planting and landscaping can be customized to match the aesthetics of the community and contribute positively to the surrounding properties.

Ease of Implementation

- Permanent applications only
- Complex to implement (e.g., geometric design and roadway drainage impacts)

Cost Range

- Medium to high depending on size of the curb extension or median, and drainage requirements
- Anticipated cost range: $10,000-$50,00

Bioswales

Overview:

Bioswales are shallow, depressed, vegetated areas with sloped sides. They are designed to capture, treat and infiltrate stormwater runoff as it moves downstream. Swales are less expensive to construct than planters but require more space for infiltration and conveyance and can handle only low-to-moderate runoff volumes.

A more complex method would be to incorporate designed infrastructure such as trench trains or catch basins as stormwater entry points to the systems. These are particularly critical if curbs or seat-walls are to be incorporated into the bioswale edge.

Image Source: Seattle Public Utilities

Image Source: IBI Group - King Street Revitalization, Kitchener, ON

Guidance for Bicycle Boulevards:

- Appropriate in lower density or lower traffic contexts given their large footprint. Commonly implemented on residential streets, medians, and unused right-of-way areas.
- In areas with significant on-street parking turnover, consider including a concrete strip at the back of the curb to provide a level area in the step-out zone for pedestrian comfort.

Ease of Implementation

- Permanent applications only
- Complex to implement (e.g., geometric design and roadway drainage impacts)

Cost Range

- Low to medium depending on width of the boulevard right-of-way and drainage requirements
- Anticipated cost range: $10,000-$50,000

5 Summary

Bicycle boulevards can play an important role in the overall cycling network by attracting a wide variety of cyclists and supplementing dedicated or separated cycling facilities throughout the city. This report provides a standard definition of bicycle boulevards to inform local implementation considering key performance criteria and considerations related to potential candidate routes and operating bicycle boulevards. It also identifies a toolbox of bicycle boulevards elements to be considered in Hamilton, with high-level concepts for each potential tool with contextual guidance on appropriate applications. These concepts can be used in the planning and design of bicycle boulevards across the City of Hamilton.

Appendix A: Toolbox Design Concepts

Raised Intersection

Traffic Circle

Realigned/Modified Intersection

Traffic Diverter: Directional Closure (Entrance Only)

Traffic Diverter: Directional Closure (Exit Only)

Traffic Diverter: Full Closure

Traffic Diverter: Intersection Channelization

Traffic Diverter: Diagonal Diverter

Traffic Diverter: Raised Median through Intersection

Right-in/Right-out Island