Capital Regional District Pedestrian and Cycling Master Plan Design Guidelines

The Capital Regional District (CRD) has been working to implement on- and off-street projects to encourage walking and cycling, improve safety and accessibility, and enhance the quality of the walkway and bikeway networks so that these activities become integral parts of daily life.

With increased congestion of its major traffic corridors, compact urban form, relatively flat topography, mild year-round climate, and a popular tourist destination, the Region and its member municipalities have for some time embraced non-motorized transportation options. A successful off-street trail network has already been established and rapid-transit options that will link with improved walking and bikeway networks are being considered. As growth continues, even greater emphasis will be placed on expanding the region's walkway and bikeway networks. Further, many trips in the CRD cross jurisdictional boundaries and it is imperative that member municipalities apply consistent design standards to walkway and bikeway network elements.

To this end, the purpose of the CRD Pedestrian and Cycling Master Plan (PCMP) Design Guidelines is to provide a consistent and comprehensive reference for the implementation of walkway and bikeway networks throughout the Region containing the highest quality standards of pedestrian and bicycle safety, comfort, and convenience.

These guidelines provide an exhaustive selection of design options for bicycle and trail treatments based on current National and Provincial bikeway and trail design guidelines, including the Transportation Association of Canada's (TAC) *Geometric Design Guide for Canadian Roads*, *Bikeway Traffic Control Guidelines for Canada*, and *Guidelines for the Design and Application of Bicycle Pavement Markings, as well as* the Ministry of Transportation and Infrastructure's (BC MOT) *Manual of Standard Traffic Signs & Pavement Markings.*

In addition, guidelines from other Provinces and the United States, including the Association of State Highway and Transportation Officials (AASHTO) *Guide for the Development of Bicycle Facilities* were also used. The CRD PCMP Design Guidelines use these documents as a baseline for minimum conditions and draw upon creative solutions applied in other Provinces, in the United States, and internationally. Some of the design solutions included in this guide are pilot projects at this stage, and should undergo additional engineering review before being applied in the CRD.

The following are key principles for these pedestrian and cycling guidelines:

- **The walking and cycling environments should be safe.** Sidewalks, multi-use trails, crossings, and cycling routes should be designed and built to be free of hazards and to minimize conflicts with external factors such as noise, vehicular traffic and protruding architectural elements.
- **The pedestrian and cycling network should be accessible.** Sidewalks, multi-use trails, and crosswalks should ensure the mobility of all users by accommodating the needs of people regardless of age or ability. Cyclists have a range of skill levels and facilities should be designed for the use of experienced cyclists at a minimum, with a goal of providing for inexperienced / recreational bicyclists (especially children and seniors) to the greatest extent possible. In areas where specific needs have been identified (for example, near schools) the needs of appropriate types of cyclists should be

accommodated. With a large senior population, providing walking and cycling options is particularly important within the CRD.

- **The pedestrian and cycling network should connect to places people want to go.** The pedestrian and cycling network should provide continuous direct routes and convenient connections between destinations, including homes, schools, shopping areas, public services, recreational opportunities and transit.
- **The walking and cycling environment should be clear and easy to use.** Sidewalks, multi-use trails, and crossings should be designed so people, including those with or without mobility, sensory, and cognitive disability impairments, can easily find a direct route to a destination and delays are minimized. All roads in the CRD are legal for the use of bicyclists. This means that most streets are bicycle facilities, and should be designed, marked and maintained accordingly.
- **The walking and cycling environment should provide good places.** Good design should integrate with, and support the development of, complementary uses, and should encourage preservation and construction of art, landscaping and other items which add value to public ways. These components might include open spaces such as plazas, courtyards, and squares and amenities including street furniture, banners, art, plantings and special paving, which, along with historical elements and cultural references, should promote a sense of place. Public activities should be encouraged and commercial activities such as dining, vending and advertising may be permitted when they do not interfere with safety and accessibility. A complete network of on-street bicycling facilities should connect seamlessly to the existing and proposed multi-use trails to complete recreational and commuting routes around the CRD.
- **Cycling and pedestrian improvements should be economical.** Bicycle and pedestrian improvements should be designed to achieve the maximum benefit for their cost, including initial cost and maintenance cost as well as reduced reliance on more expensive modes of transportation. Where possible, improvements in the right-of-way should stimulate, reinforce and connect with adjacent private improvements.
- **Design guidelines are intended to be flexible and can be applied with professional judgment by designers.** Specific National and Provincial guidelines are identified in this document, as well as design treatments that may exceed these guidelines. It is recognized that statutory and regulatory guidance may change. For this reason, among others, the guidance and recommendations in this document are meant to complement the other resources considered during the design process. In addition, land use and other planning initiatives impact walkability and bikeability, and should complement the techniques outlined in this document.

Guidelines / Best Practices

The following is a list of references and sources utilized to develop design guidelines for the CRD PCMP. Many of these documents are available to the public online and are a wealth of information.

National Guidelines

- Transportation Association of Canada. (2009). *Bikeway Traffic Control Guidelines for Canada* (Draft). Ottawa, Canada. http://www.tac-atc.ca/
- Transportation Association of Canada. (2007). *Guidelines for the Design and Application of Bikeway Pavement Markings*. Ottawa, Canada. http://www.tac-atc.ca/

- Transportation Association of Canada. (1999). *Geometric Design Guide for Canadian Roads*. Ottawa, Canada. http://www.tac-atc.ca/
- Transportation Association of Canada. (1998). *Bikeway Traffic Control Guidelines for Canada*. Ottawa, Canada. http://www.tac-atc.ca/
- Transportation Association of Canada, (1998). *Canadian Guide to Traffic Calming*. Ottawa, Canada. http://www.tac-atc.ca/
- Transportation Association of Canada, (1998). *Pedestrian Crossing Control Manual*. Ottawa, Canada. http://www.tac-atc.ca/
- Standards Council of Canada. (2010). Accessible design for the built environment.

Provincial Guidelines

- BC Parks. (No date). *Trail Design and Construction Standards Manual.* http://www.trailstobuild.com/Articles/BC%20Trail%20Standards/contents.htm
- British Columbia Ministry of Transportation and Highways. (2007). BC Supplement *to TAC Geometric Design Guide*. Victoria, BC. http://www.gov.bc.ca/tran/
- British Columbia Ministry of Transportation and Highways. (2000). *Manual of Standard Traffic Signs & Pavement Markings*. Victoria, BC. http://www.gov.bc.ca/tran/
- British Columbia Ministry of Transportation and Highways. (1996). *Pedestrian Crossing Control Manual for British Columbia.* Victoria, BC. http://www.th.gov.bc.ca/publications/eng_publications/Ped_X_Manual/1358-CH2-all.pdf
- British Columbia Office of Housing and Construction Standards. (2007). *Building Access Handbook*. http://www.housing.gov.bc.ca/building/docs/building_access_handbook_2007.pdf
- British Columbia Recreation and Parks Association (BCRPA) and Ministry of Transportation & Infrastructure (BC MOT). (2010). *Bicycle Facilities Design Course.*

Local Guidelines

- Capital Regional District Parks. (2003). *Everyone's parks and trails: a universal access plan for CRD Parks.* http://www.crd.bc.ca/parks/documents/access_plan.pdf
- City of Victoria. (2008). *City of Victoria Pedestrian Master Plan* http://www.victoria.ca/cityhall/eng_pdstrn.shtml
- District of Colwood, CSA Standards for Accessible Design
- District of Langford. (No Date). *District of Langford Bicycle Plan.* http://district.langford.bc.ca/documents/bylaws/Bicycle_Plan.pdf
- Juan de Fuca Parks & Recreation Commission. (No Date). *Juan de Fuca Electoral Area Community Parks Strategic Plan.* www.crd.bc.ca/jdf/parks/documents/JdFCommunityParksStrategicPlan_RevisedOct2010_Final.pdf
- Saanich Parks & Recreation. (2007). *Saanich Parks & Recreation Trail Guidelines.*

U.S. Federal Guidelines

- American Association of State Highway and Transportation Officials. (2001). *AASHTO Policy on Geometric Design of Streets and Highways*. Washington, DC. www.transportation.org
- American Association of State Highway and Transportation Officials. (1999). *AASHTO Guide for the Development of Bicycle Facilities*. Washington, DC. www.transportation.org

- Federal Highway Administration. (2009). *Manual on Uniform Traffic Control Devices (MUTCD).* Washington, DC. http://mutcd.fhwa.dot.gov
- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines (PROWAG).* Washington, D.C. http://www.access-board.gov/PROWAC/alterations/guide.htm
- United States Access Board. (2002). *Accessibility Guidelines for Buildings and Facilities.* Washington, D.C. http://www.access-board.gov/adaag/html/adaag.htm

Best Practice Documents

- Alta Planning + Design and the Initiative for Bicycle & Pedestrian Innovation (IBPI). (2009). *Fundamentals of Bicycle Boulevard Planning & Design.* http://www.ibpi.usp.pdx.edu/media/BicycleBoulevardGuidebook.pdf
- Alta Planning + Design. (2009). Cycle Tracks: Lessons Learned. http://www.altaplanning.com/App_Content/files/pres_stud_docs/Cycle%20Track%20lessons%20learned.pdf
- Association of Pedestrian and Bicycle Professionals (APBP). (2010). *Bicycle Parking Design Guidelines, 2nd Edition.*
- Canadian Institute of Transportation Engineers. (2006). *A Technical Review of Pedestrian Signals in Canada.* http://www.cite7.org/resources/documents/Pedestrian%20Signals.pdf
- Canadian Institute of Planners. (2004). *Community Cycling Manual.* http://www.physicalactivitystrategy.ca/index.php/beat/links/.
- Canadian Institute of Transportation Engineers. (2004). *Promoting Sustainable Transportation Through Site Design: An ITE Proposed Recommended Practice.* http://www.cite7.org/resources/documents/ITERP-PromotingSustainableTransportationThroughSiteDesign.pdf.
- City of Kelowna. (2003). *Guidelines for Accessibility in Outdoor Spaces.*
- City of Chicago and the Pedestrian and Bicycle Information Center (PBIC). (2002). Bike *Lane Design Guide.* http://www.activelivingresources.org/assets/chicagosbikelanedesignguide.pdf
- City of Portland Bureau of Transportation. (2010). *Portland Bicycle Master Plan for 2030.* http://www.portlandonline.com/transportation/index.cfm?c=44597
- Federal Highway Administration. (2005). *Report HRT-04-100, Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations.* http://www.tfhrc.gov/safety/pubs/04100/
- Federal Highway Administration. (2001). *Designing Sidewalks and Trails for Access.* http://www.fhwa.dot.gov/environment/sidewalk2/contents.htm
- King, Michael, for the Pedestrian and Bicycle Information Center. (2002). *Bicycle Facility Selection: A Comparison of Approaches.* Highway Safety Research Center, University of North Carolina – Chapel Hill. http://www.bicyclinginfo.org/pdf/bikeguide.pdf
- Oregon Department of Transportation. (1995). *Oregon Bicycle and Pedestrian Plan.* http://www.oregon.gov/ODOT/HWY/BIKEPED/planproc.shtml
- Rosales, Jennifer. (2006). *Road Diet Handbook: Setting Trends for Livable Streets.*
- Transportation Association of Canada (TAC). (2008). *Coloured Bicycle Lanes Simulator Testing.* Ottawa, Canada. http://www.tac-atc.ca/
- Urban Systems and Alta Planning + Design for the City of Victoria. (2010). *Bicycle Parking Strategy.*
- Urban Systems and Alta Planning + Design. (2009). *TransLink Regional Cycling Network Background Study – Chapter 3: Facility Design.* http://www.translink.ca/en/Cycling.aspx

- Vélo Québec. (2003). *Technical Handbook of Bikeway Design*.

The Bicycle as a Design Vehicle

Similar to motor vehicles, bicyclists and their bicycles come in a variety of sizes and configurations. This variation can take the form of the variety in types of vehicle (such as a conventional bicycle, a recumbent bicycle, or a tricycle), or the behavioural characteristics and comfort level of the cyclist riding the vehicle. Any bicycle facility undergoing design should consider what types of design vehicles will be using the facility and design with that set of critical dimensions in mind.

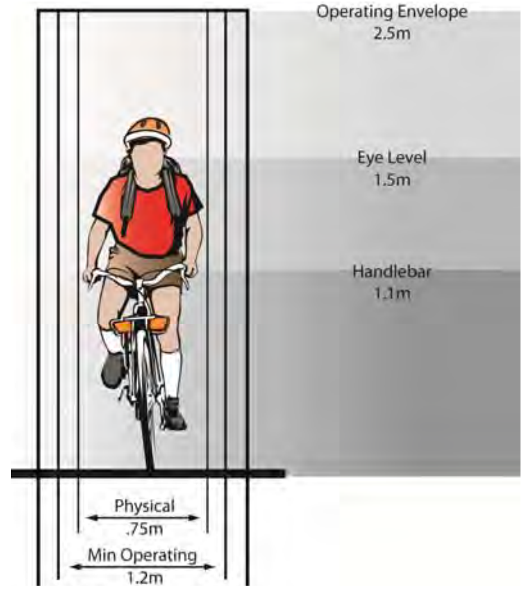


Figure 1. Standard Bicycle Rider Dimensions

Physical Dimensions

The operating space and physical dimensions of a typical adult bicyclist are shown in Figure 1. Clear space is required for the bicyclist to be able to operate; this is why the minimum operating width is greater than the physical dimensions of the bicyclist. Although 1.2 metres is the minimum, 1.5 metres or more is preferred.

Outside of the design dimensions of a typical bicycle, there are many commonly used pedal driven cycles and accessories that should be considered when planning and designing bicycle facilities. The most common types of bicycles, including tandem bicycles, recumbent bicycles, and trailer accessories, are depicted in Figure 2.

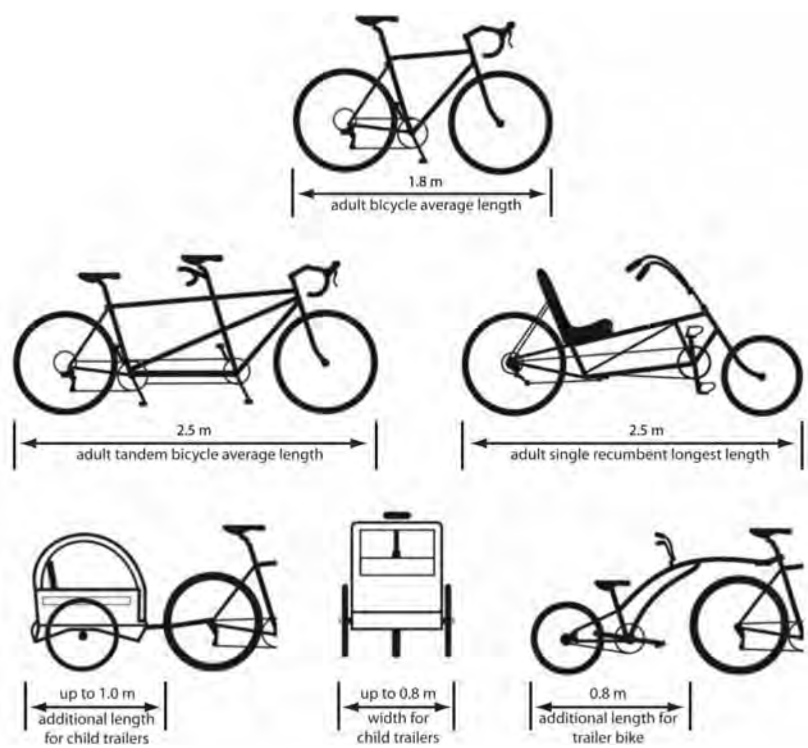


Figure 2.Various Bicycle Dimensions

Table 1 summarizes the typical dimensions for most commonly encountered bicycle design vehicles.

Table 1. Bicycle as Design Vehicle – Typical Dimensions

Bicycle Type	Feature	Typical Dimensions
Upright Adult Bicyclist	Physical width	0.8 m
	Operating width (Minimum)	1.2 m
	Operating width (Preferred)	1.5 m
	Physical length	1.8 m
	Physical height of handlebars	1.1 m
	Operating height	2.5 m
	Eye height	1.5 m
	Vertical clearance to obstructions (tunnel height, lighting, etc.).	3.0 m
	Approximate center of gravity	0.8 to 1.0 m
Recumbent Bicyclist	Physical length	2.1 m
	Eye height	1.2 m
Tandem Bicyclist	Physical length	2.4 m
Bicyclist with child trailer	Physical length	0.9 m
	Physical width	0.8 m
Hand Bicyclist	Eye height	0.8 m
Inline Skater	Operating width (sweep width)	1.5 m

Design Speed

The speed that various types of bicyclists can be expected to maintain under various conditions can also have influence over the design of facilities such as multi-use trails. Table 2 provides typical speeds of various types of bicyclists for a variety of conditions.

Table 2. Bicycle as Design Vehicle – Design Speed Expectations

Bicycle Type	Feature	Typical Speed
Upright Adult Bicyclist	Paved level surfacing	24 km/h
	Crossing Intersections	16 km/h
	Downhill	48 km/h
	Uphill	8-19 km/h
Recumbent Bicyclist	Paved level surfacing	29 km/h

Types of Cyclists

The skill level of the cyclist also provides a dramatic variance on expected speeds and expected behaviour. There are several systems of classification currently in use within the bicycle planning and engineering professions. These classifications can be helpful in understanding the characteristics and infrastructure preferences of different cyclists. However, it should be noted that these classifications may change in type or proportion over time as infrastructure and culture evolve. Often an instructional course can change a less confident cyclist to one that can comfortably and safely share the roadway with vehicular traffic. Bicycle infrastructure should be planned and designed to accommodate as many user types as possible with separate or parallel facilities considered to provide a comfortable experience for the greatest number of cyclists.

A classification system that is currently in use in Oregon and Washington and is also under consideration for the Draft 2009 AASHTO *Guide for the Development of Bicycle Facilities* provides the following bicycle user types:

- **Strong and Fearless** (Very low percentage of population) – Characterized by bicyclists that will typically ride anywhere regardless of roadway conditions or weather. These bicyclists can ride faster than other user types, prefer direct routes and will typically choose roadway connections -- even if shared with vehicles -- over separate bicycle facilities such as multi-use trails.
- **Enthused and Confident** (5-10% of population) -This user group encompasses the 'intermediate' cyclists who are mostly comfortable riding on all types of bicycle facilities but will usually prefer low traffic streets or multi-use trails when available. These cyclists may deviate from a more direct route in favour of a preferred facility type. This group includes all kinds of cyclists including commuters, recreationalists, racers, and utilitarian cyclists.
- **Interested but Concerned** (approximately 60% of population) – This user type makes up the bulk of the cycling population and represents cyclists who typically only ride a bicycle on low traffic streets or multi-use trails under favourable conditions and weather. These cyclists perceive significant barriers towards increased use of cycling with regards to traffic and safety. These cyclists may become "Enthused & Confident" with encouragement, education and experience.
- **No Way, No How** (approximately 30% of population) – Persons in this category are not cyclists, and perceive severe safety issues with riding in traffic. Some people in this group may eventually give cycling a second look and may progress to the user types above. A significant portion of these people will never ride a bicycle under any circumstances.

Pedestrian Priority Area Guidelines

This section provides a summary of how the design principles presented in these design guidelines can be linked with the identified 'Pedestrian Priority Areas' identified in the PCMP to offer guidance and best practices for pedestrian treatments throughout the region. Design treatments that are appropriate to different levels of anticipated pedestrian use are identified in this memorandum.

Areas that are more likely to receive high pedestrian use were defined as potential regional pedestrian priority areas. The following features were considered in the development of regional pedestrian priority areas.

- Regional growth centres
- Village centres
- Future rapid transit stations
- Regional, Provincial and Federal parks
- Bus stops
- Regional trails (Lochside, Galloping Goose and existing/future E&N alignment)
- Primary, secondary and post secondary schools)
- Civic destinations including justice and government buildings, libraries, museums, recreation centres, and community centres
- Transit exchanges

Treatments for High Pedestrian Use Areas

Pedestrian facilities should be designed to comfortably accommodate pedestrians where high numbers of pedestrians are anticipated, such as in urban and village centres, near bus stops or schools. Universal design and accessibility should be a priority in these locations.

In pedestrian priority areas, the sidewalk and amenity zones should:

- Provide an unobstructed, continuous and safe circulation system that serves the same destinations as are served by the road system.
- Provide convenient access to local land uses and transit.
- Provide a buffer for pedestrians and adjacent properties from the traffic and noise from the street.
- Provide visual interest and support community interaction through open space and other public activity space.
- Safely accommodate people of all ages and abilities.
- Support environmental goals through the integration of green infrastructure.

In addition, pedestrian and driver sight distances should be maintained near driveways, and curb cuts should be minimized in areas with pedestrian traffic. Intersections are particularly important along pedestrian priority areastreets, as higher traffic levels and pedestrian volumes increase the potential for conflicts between road users. Landscape buffers and/or low walls should separate sidewalks from parking and off-street passenger loading areas. Street trees in the buffer area can be used to make the pedestrian environment more comfortable. Scored or textured concrete should be used where appropriate to alert sight-impaired people of the sidewalk edge. Additional pedestrian treatments for mixed-use streets are shown in Table 3.

Table 3. Treatments for Pedestrian Priority Areas

Element	Usage
Corridor Treatments	
Sidewalks	Both sides of street along all routes. Minimum clear width 1.8m 2.3m preferred, furnishing zone 1.0m.
Boulevards	Recommended, particularly along major roads; 3.0m (arterial) or 2.0m (collector/local streets).
Intersection Treatments	
Marked crosswalks	Standard treatment at intersections.
Advance warnings	At marked crossings/pedestrian signals along higher-speed roads.
Raised median	At marked crossings/pedestrian signals along higher-speed roads.
In-street "yield to pedestrian" signs/flashers	At marked crossings along high pedestrian volume roads.
Curb extensions	At intersections with streets that have high motor vehicle speeds and/or volumes or poor visibility.
Median refuge islands	At intersections with streets that have high motor vehicle speeds and/or volumes.
Minimizing curb radii	Locations with high percentage of right-turning motor vehicle traffic and through-pedestrian traffic.
Parking control	At high-use locations, where on-street parking is allowed.
Advance stop bars	At high-use locations, where on-street parking is allowed.
Accessible curb ramps	At all intersections. Use with detectible warnings.
Bicycle/pedestrian traffic signals	At unsignalized locations where high numbers of pedestrians cross a major road, such as by a school or along a trail.
Pedestrian push-buttons	At all signalized intersections.
Countdown signal	At all signalized intersections.
Audible pedestrian signal	At major intersections or where vulnerable pedestrian groups (young or elderly) are likely to cross.
Leading pedestrian interval	At major intersections or where vulnerable pedestrian groups (young or elderly) are likely to cross.
Pedestrian Elements	
Pedestrian scale lighting	Along all routes.
Pedestrian amenities	Along commercial corridors.

Treatments for Moderate Pedestrian Use Area

Areas with fewer trip generators or attractors are anticipated to have less pedestrian traffic. However, people do walk in these areas, and walking trips are likely to include walking to transit, school, or because the pedestrian does not have other transportation options available. Table 4 provides a summary of pedestrian facility design recommended for moderate pedestrian use areas.

Table 4. Pedestrian Treatments for Moderate Pedestrian Use Areas

Element	Usage
Corridor Treatments	
Sidewalks	Both sides of street along all routes. Minimum clear width 1.8m 2.0m preferred, furnishing zone 1.0m.
Boulevards	Particularly along major roads; 3.0m (arterial) or 2.0m (collector/local streets).
Intersection Treatments	
Marked crosswalks	Standard treatment at intersections with moderate street crossings; major streets may require signalization.
Advance warnings	At marked crossings/pedestrian signals along higher-speed roads.
Raised median	At marked crossings/pedestrian signals along higher-speed roads.
Curb extensions	At intersections with streets that have high motor vehicle speeds and/or volumes or poor visibility.
Median refuge islands	At intersections with streets that have high vehicle speeds and/or volumes.
Minimizing curb radii	Locations with high percentage of right-turning motor vehicle traffic and through-pedestrian traffic.
Advance stop bars	Along four-lane streets, to reduce the potential for 'multiple threat' crashes.
Accessible curb ramps	Recommended for all intersections, particularly those near bus stops and along school routes. Use with detectible warnings.
Bicycle/pedestrian traffic signals	At unsignalized locations where high numbers of pedestrians cross a major road, such as by a school or along a trail.
Pedestrian push-buttons	At all signalized intersections.
Countdown signal	At all signalized intersections.
Audible pedestrian signal	At major intersections or where vulnerable pedestrian groups (young or elderly) are likely to cross.
Leading pedestrian interval	At major intersections or where vulnerable pedestrian groups (young or elderly) are likely to cross.
Pedestrian Elements	
Pedestrian scale lighting	Along all routes.
Pedestrian amenities	Along commercial corridors.

School Routes

Along school routes, increasing the visibility of pedestrians is crucial to safety for students. In addition, younger students may run into traffic or otherwise disobey traffic guides where they are not clear. Treatments specific to school routes should have high visibility-crosswalks with pedestrian push buttons at signals. These can include in-pavement flashers, signage, warning beacons, and other treatments. Street corners should have accessible curb ramps with detectible warnings.

Design Toolbox

Use of the Design Guidelines

These Design Guidelines are intended to provide a consistent and comprehensive reference for the implementation of walkway and bikeway networks throughout the Region containing the highest quality standards of pedestrian and bicycle safety, comfort, and convenience. These guidelines are build upon federal and provincial standards as well as regional and worldwide best practices. They provide guidance and identify considerations for treatments not specifically or comprehensively covered in federal design documents.

Throughout these guidelines, measurements are taken from the edge of the gutter pan, rather than the curb. The gutter pan can have a lip, which is dangerous for cyclists if it is located in the centre of the bicycle lane. In addition, the TAC and other standard planning documents recommend minimum widths exclusive of the gutter pan. Where possible, gutter pans should be 0.2 metres on bikeways to keep the facility clear of water.

While many treatments require additional lane width, minimum widths are provided to guide where treatments can be implemented. Additional width may be available after travel, turn, or parking lanes are reduced or removed (a "road diet"), which can improve safety and efficiency of the roadway.

1. On-Street Bicycle Facility Design Guidelines

A range of bicycle facilities can be applied in various contexts, providing varying levels of protection or separation from automobile traffic. This section summarizes the facility selection typology developed for the CRD through the Pedestrian and Cycling Master Plan (PCMP) process.

There are no 'hard and fast' rules for determining the most appropriate type of facility for a particular location; engineering judgement and planning skills are critical elements of this decision. However, consistent use of treatments and application of bikeway facilities allows users to anticipate whether they would feel comfortable riding on a particular facilitiy, and plan their trips accordingly.

1.1. User Type Classification

Bikeway class indicates what types of users might feel comfortable on a particular bikeway facility. The Cycling in Cities Program at the University of British Columbia found that the most significant factors influencing bicycle use are motor vehicle traffic volumes and speeds.[1] The study also found that most cyclists have a preference for facilities that are separated from motor vehicle traffic or that are located on local roads with low motor vehicle traffic speeds and volumes. Because off-street pathways are physically separated from the roadway, they are perceived as safe and attractive routes for cyclists who prefer to avoid motor vehicle traffic. A stated preference experiment in Edmonton found that for the typical cyclist, one minute cycling in mixed traffic is as onerous as 4.1 minutes on bike lanes.[2]

The PCMP identifies the following classes of facilities by user type:

- ***Class 1 facilities*** provide a high degree of separation between cyclists and motor vehicle traffic and which are comfortable for all users including recreational and inexperienced cyclists;
- ***Class 2 facilities***, which provide a moderate degree of separation from motor vehicle traffic and offer enhanced traffic calming treatments on local roadways; and
- ***Class 3 facilities*** generally include on-street facilities with limited physical separation from motor vehicle traffic but which may appeal to commuter cyclists due to their route connectivity.

[1] http://www.cher.ubc.ca/cyclingincities/survey.html
[2] Hunt and Abraham (2007).

1.2. Levels of Facility Separation

Standards for classifying bikeway types are provided in the Transportation Association of Canada (TAC) *Bikeway Traffic Control Guidelines for Canada* (2010 Draft), *Geometric Design Guide for Canadian Roads*, and *MUTCD-Canada*. The variety of existing facility classifications used in the CRD and member municipalities were synthesized into the categories:

- Multi-use trails are physically separated from motor vehicles and provide sufficient width and supporting facilities to be used by cyclists, pedestrians, and other non-motorized users.
- Separated on-street facilities offer physical or spatial separation within the roadway corridor. Facility types include cycle tracks and buffered bicycle lanes.
- Bicycle lanes/shoulders are the most common bicycle facility type, providing a separate travel lane for cyclists.
- Shared roadways are facilties where cyclists share a single lane of traffic with automobiles, either side-by-side or queueing.

The table below provides an overview of guidelines for these bicycle facilities, described in greater detail throughout this document.

Bicycle Facility Types and Sunmary Guidelines

Facility Type	Max.Posted Speed	Travel Lane Width	Bikeway Width	Signs	Markings
Separated On-Street					
Cycle track	N/A	N/A	2.1m; 0.6m buffer	IB-23 "Bike Route"	Bicycle symbol + reserved lane diamond
Buffered bike lane	100 km	N/A	1.5-1.8m	RB-90 "Reserved Bicycle Lane"	Bicycle symbol + reserved lane diamond
Bicycle Lane/Shoulser					
Bicycle lanes	100 km	N/A	1.8	RB-90 "Reserved Bicycle Lane"	Bicycle symbol + reserved lane diamond
Shoulder bikeways	freeways/ expressways	N/A	1.5	WC-47 "Share the Road" or IB-23 "Bike Route" optional	Bicycle symbol + reserved lane diamond optional
Shared Roadway					
Marked wide curb lanes	60 km/h	4.0m or greater	N/A	WC-47 "Share the Road;" IB-23 "Bike Route" optional	Shared lane markings
Shared lanes	N/A	less than 4.0m	N/A	IB-23 "Bike Route" optional	N/A
Neighbourhood bikeways	50 km/h	generally less than 4.0m	N/A	WC-XX "Single File;"** IB-23 "Bike Route" optional	Shared lane markings

* The maximum speeds cited in this table are TAC standards and may not provide facilities comfortable for most users.

** "Single File" sign used only where travel lane narrower than 4.0 metres.

1.3. Roadway Context

Context describes conditions on the roadway. Many roadway factors impact the experience of cycling; automobile speeds and volumes, presence of heavy vehicles, trucks, or transit vehicles, roadway width, visibility, adjacent land uses, and urban or rural context all contribute to the context of a bikeway. While all these factors are important, the major indicators of the context are automobile speed and volume. In addition, urban or rural context affects engineering treatments appropriate on a particular roadway. Roadway classification indicates many of these context issues and provides guidance for what types of bikeway facilities are appropriate.

The British Columbia Digital Road Atlas (DRA) database was used for classifying roadways. The classifications are defined in the table below. While this dataset is a useful first step in facility selection, in some cases actual road traffic speeds and/or volumes differ from the DRA. Additional engineering judgement should be applied when selecting bicycle facilities appropriate to a particular roadway.

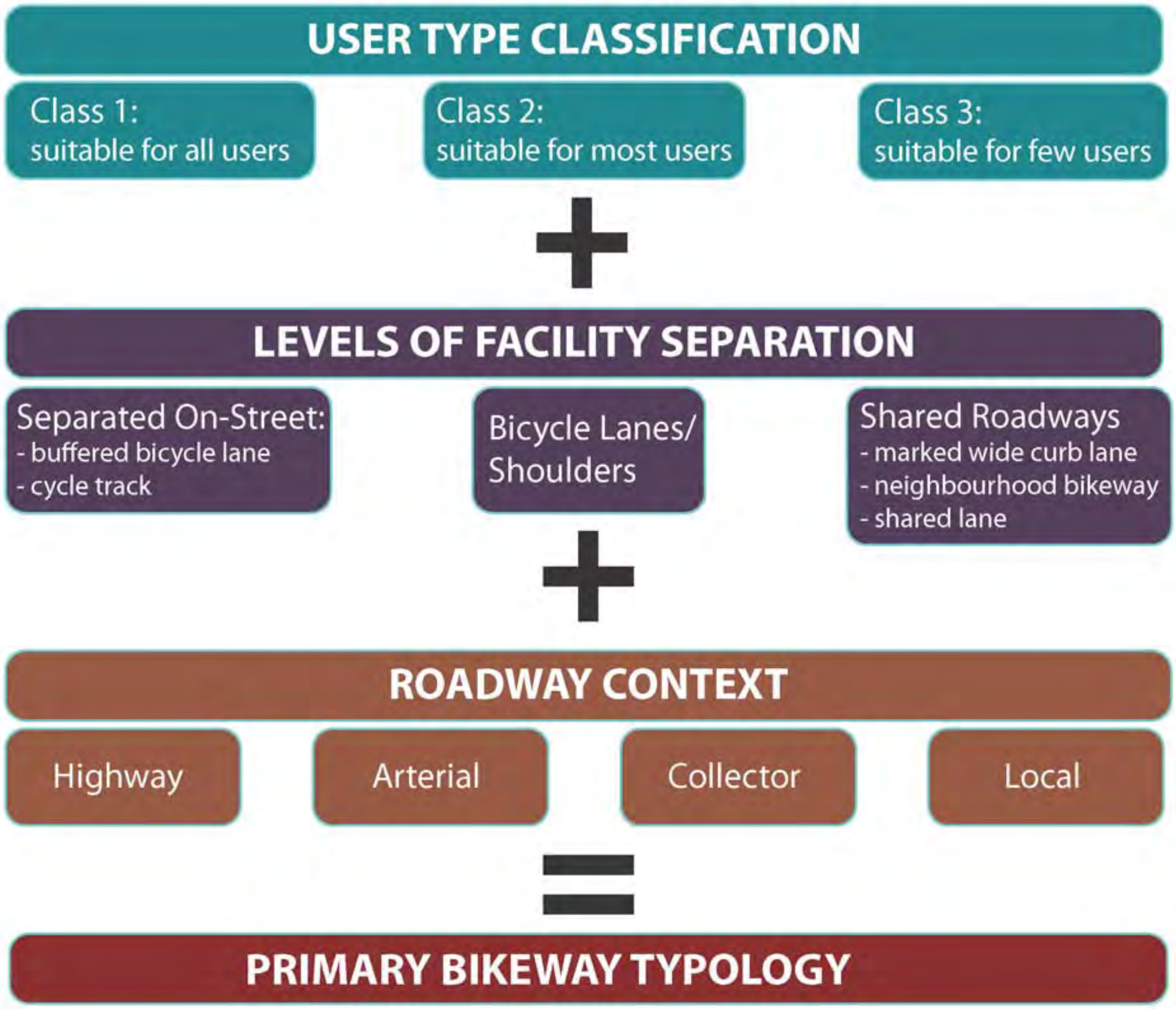
Definition of Roadway Classifications, B.C. Digital Road Atlas

Road Class	Definition	Posted Speeds*	Average ADT
Highway/Freeway	Controlled access, typically divided carriageway/ a primary or secondary provincial highway, may be single or multilane each way	50-90 km/h	5,400
Arterial	A thoroughfare with a generally large traffic capacity, generally multilane each way	30-70 km/h	3,200
Collector	A road to collect traffic from areas and/or to cross town with the general right of way, generally one lane each way	30-60 km/h	1,900
Local	local, residential roads	20-50 km/h	900

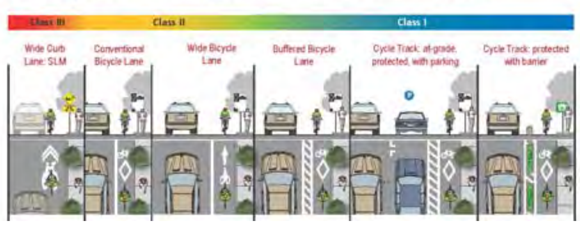
* Note: Speeds and ADT summarized from DRA GIS file, rather than a technical definition.

1.4. Facility Typology

These elements are combined to provide a typology for bicycle facility selection, as illustrated below.



Bikeway Facilities on Arterials with Curb and Gutter



The following continua show the range of bicycle facilities that are can be used on by roads by classification. The PCMP recommends that all bicycle routes along designated regional bikeway corridors be brought to a Class I standard, that is, all regional bikeways should be appropriate for all users.

Engineering judgment, traffic studies, previous municipal planning efforts, community input and local context should be used to refine facility recommendations for a particular street. In some corridors, it may be desirable to construct facilities to a higher level of development than those recommended in this Plan to enhance user safety and comfort. For example, in areas where a paved shoulder is the recommended facility type, there may be an opportunity to build a separated multi-use trail, providing greater separation from the roadway. In other cases, the recommended level of separation is not warranted by motor vehicle speeds and volumes, and a lesser treatment may be acceptable.

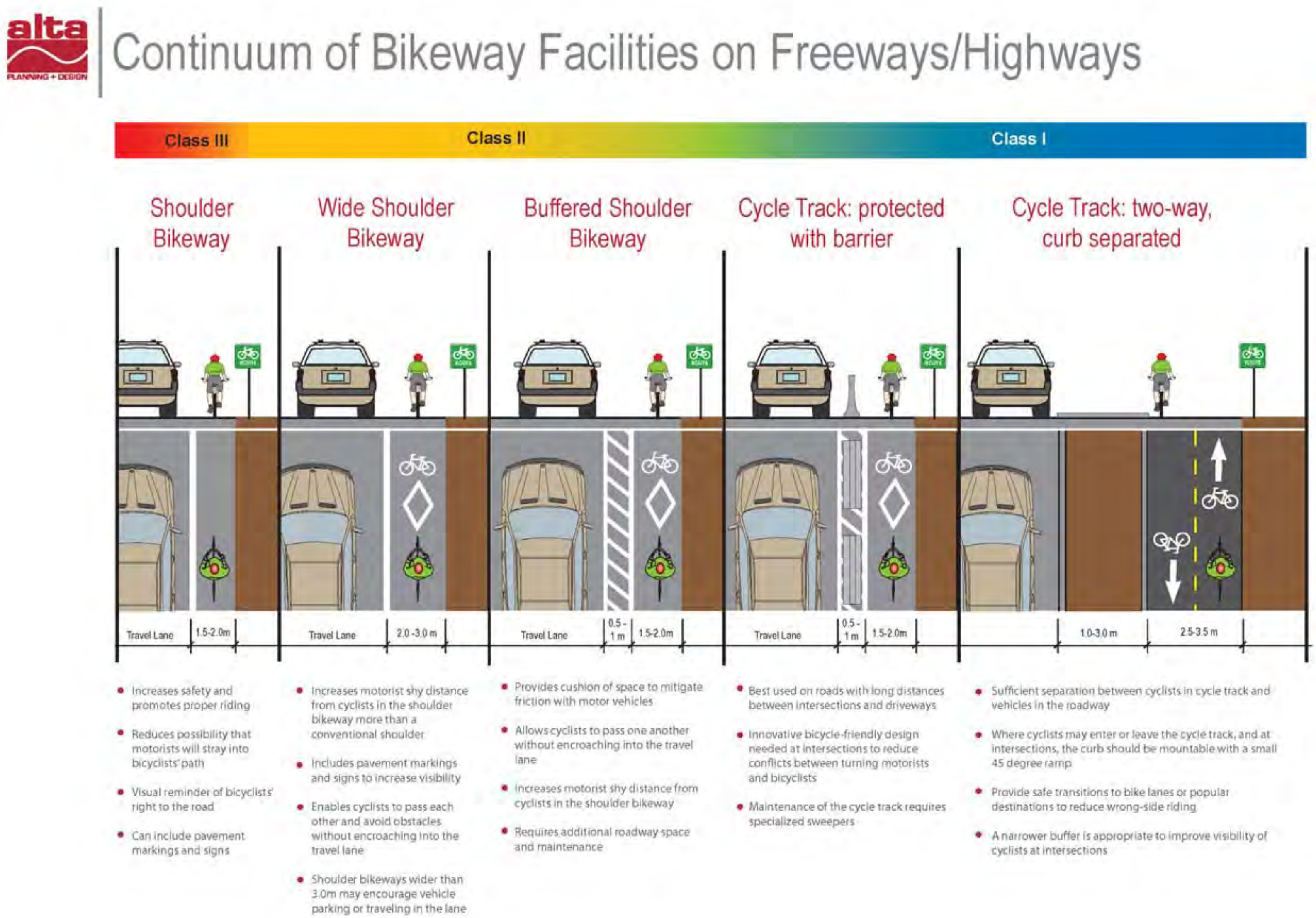


Figure 3. Continuum of Bikeway Facilities on Freeways/Highways

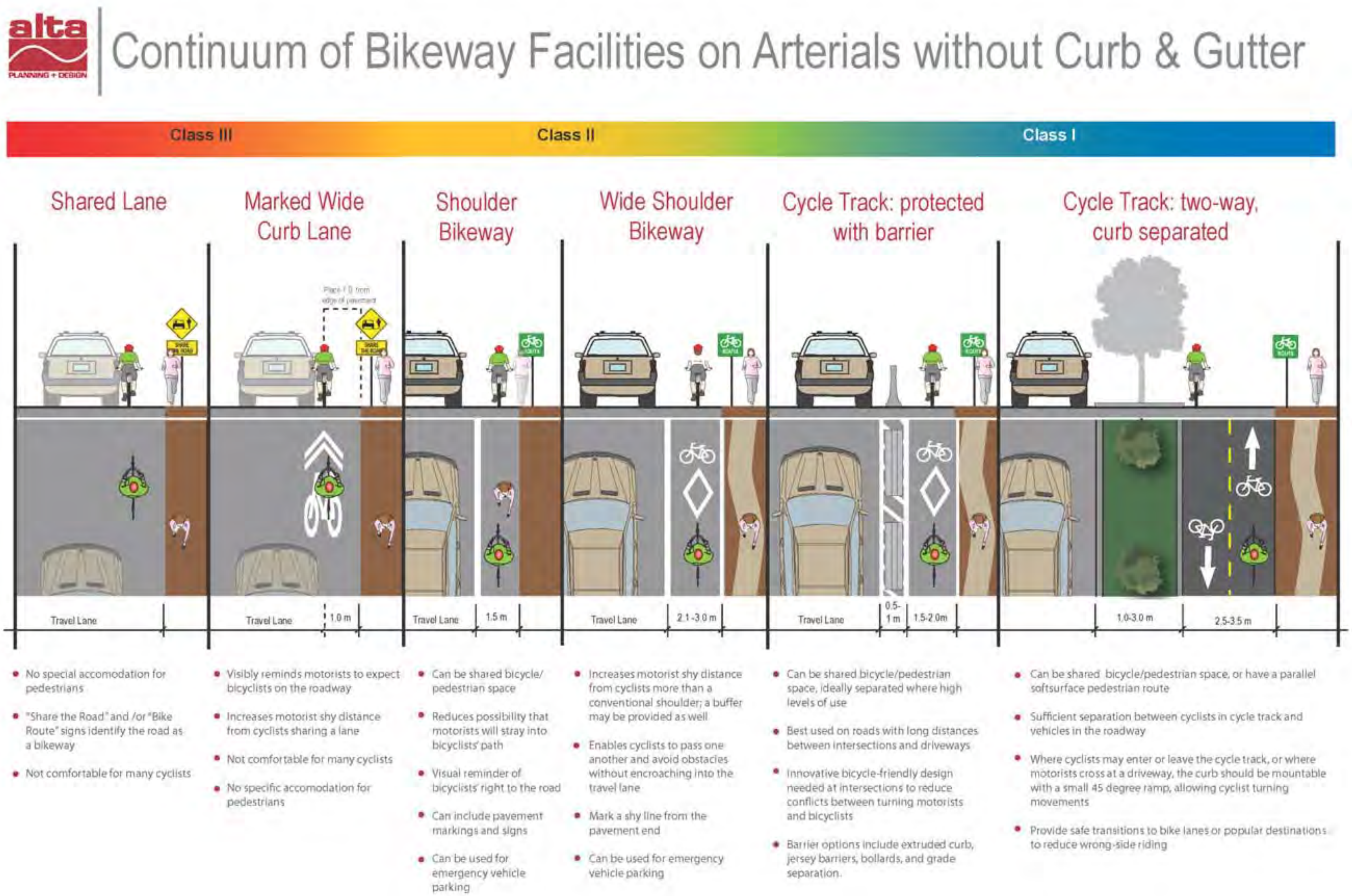


Figure 4. Continuum of Bikeway Facilities on Arterials without Curb & Gutter

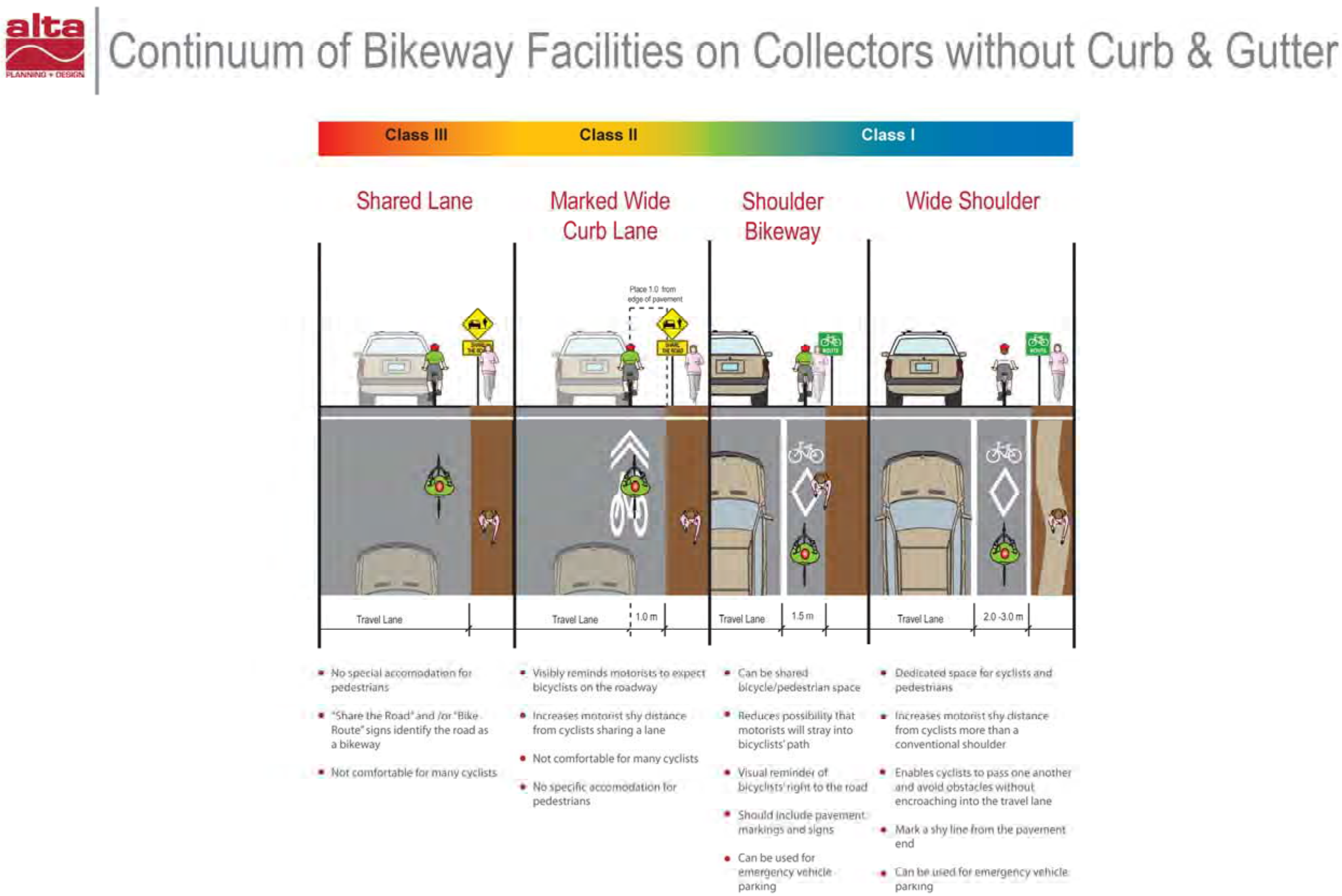


Figure 5. Continuum of Bikeway Facilities on Collectors with Curb & Gutter

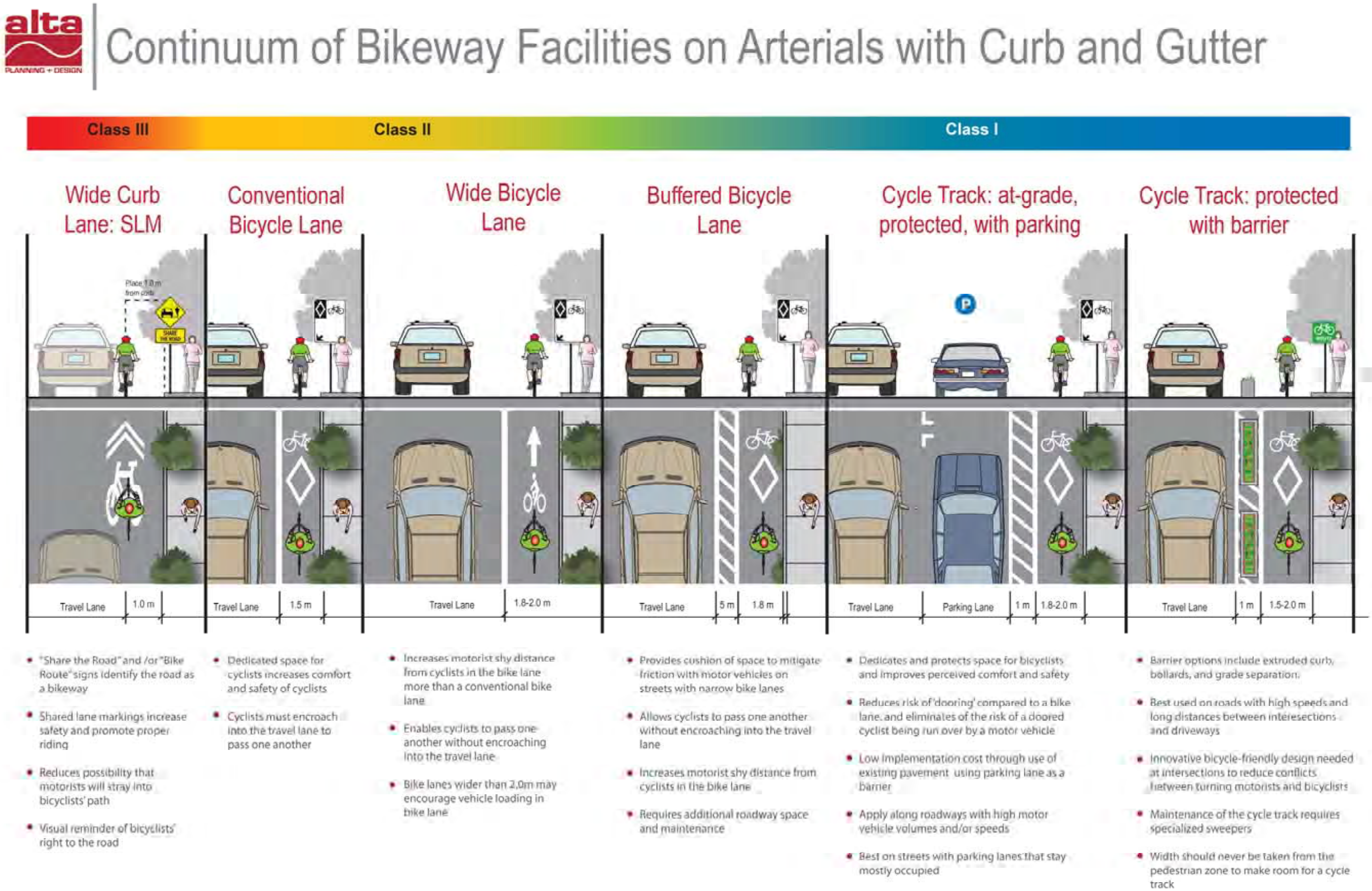


Figure 6. Continuum of Bikeway Facilities on Urban Arterials

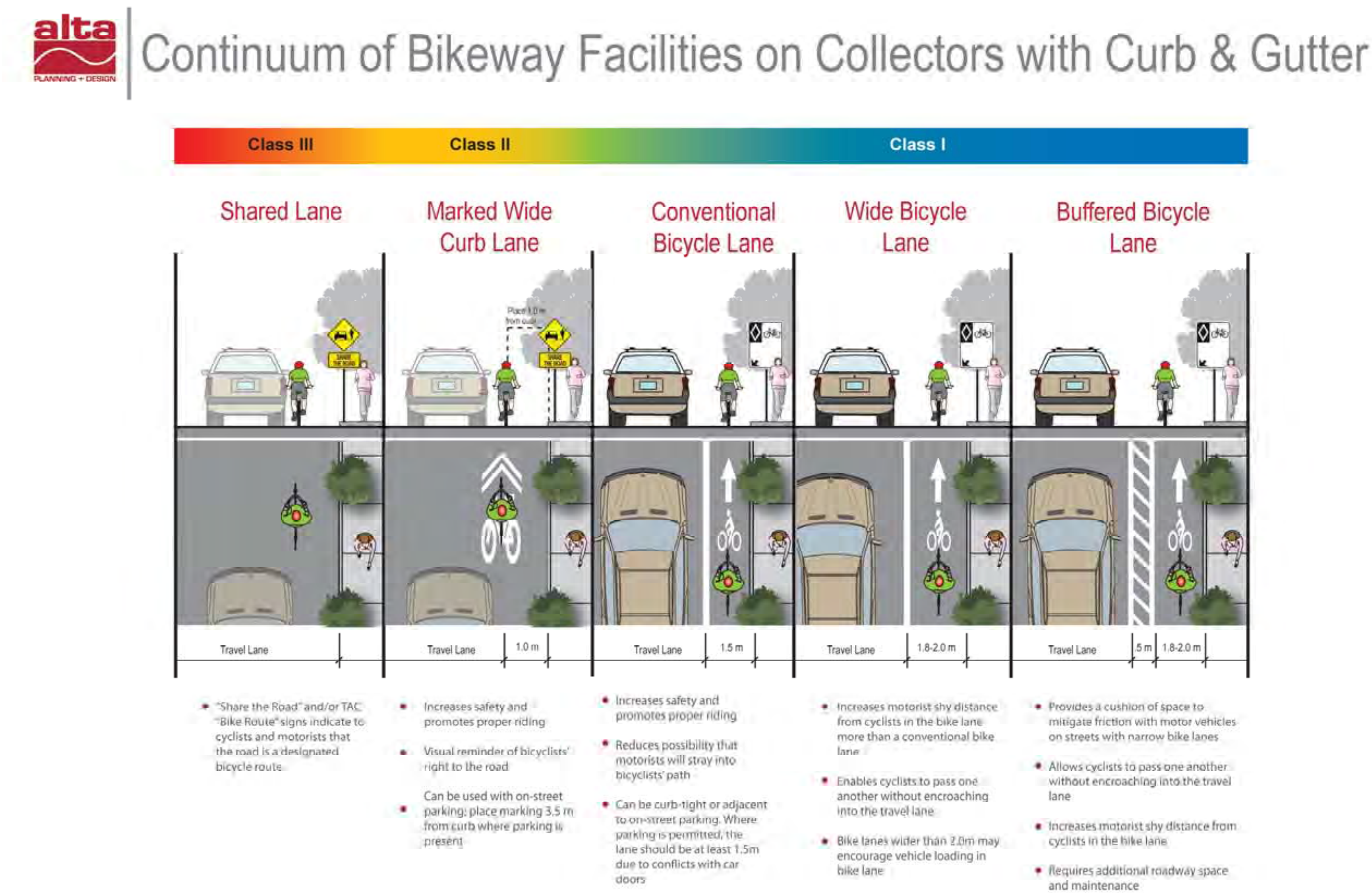


Figure 7. Continuum of Bikeway Facilities on Urban Collectors

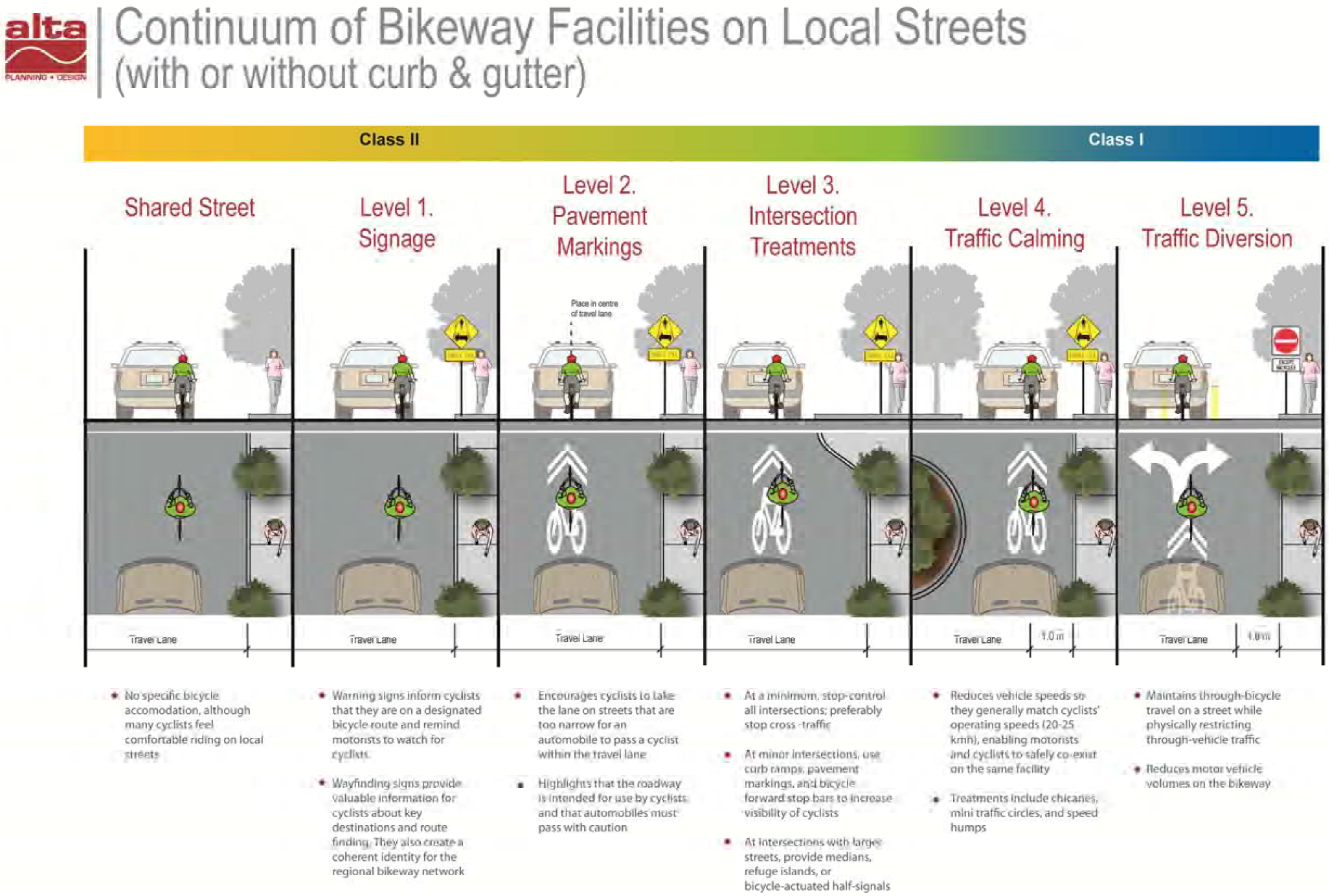


Figure 8. Continuum of Bikeway Facilities on Local Streets

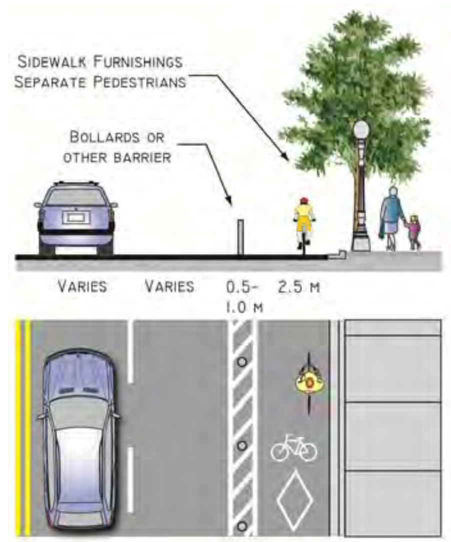
1.5. Physically or Spatially Separated within the Roadway

Streets with significant speed or volume of motor vehicle traffic are uncomfortable for all but the most confident and experienced cyclists. In order to attract the 'interested but concerned' group, physically and/or spatially separated bikeway facilities provide a trail-like experience along a roadway, where most destinations are located. Depending on the road context, facilities may be fully-separated cycle tracks, or they can be bike lanes that provide an additional buffer to enhance the user experience.

1.5.1. Cycle Tracks

Design Summary

- 2.5 m minimum width to allow passing.
- 0.6 -1.0 m buffer zone width.
- Requires additional treatments to improve visibility at intersections.
- Place along streets with long blocks and few driveways or mid-block access points for vehicles. Cycle tracks on one-way streets have fewer potential conflicts than on two-way streets.



Recommended cycle track design without parking.

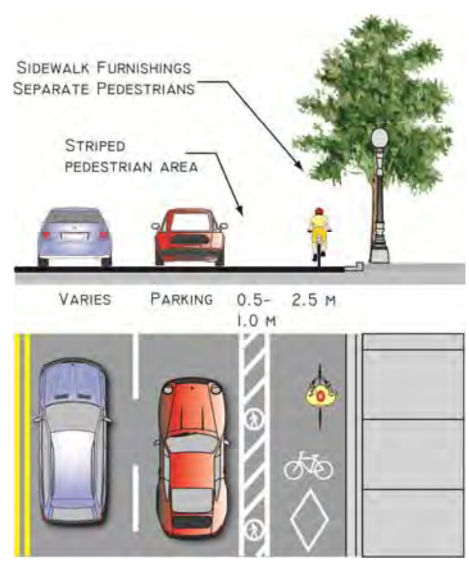
Discussion

Cycle tracks provide space that is intended to be exclusively or primarily for bicycles, and are separated from motor vehicle travel lanes, parking lanes and sidewalks. Cycle tracks can be either one-way or two-way, on one or both sides of a street, and are separated from vehicles and pedestrians by pavement markings or coloring, bollards, curbs/medians or a combination of these elements.

Cycle tracks provide increased comfort for bicyclists, greater clarity about expected behaviour, and fewer conflicts between bicycles and parked cars as cyclists ride inside the parking lane.

Danish research has shown that cycle tracks can increase bicycle ridership 18-20%, compared with the 5-7% increase associated with bicycle lanes. However, disadvantages of cycle tracks include:

- Increased vulnerability at intersections.
- Regular street sweeping and ploughing trucks cannot maintain the cycle track; requires smaller sweepers.
- Conflicts with pedestrians and bus passengers can occur, particularly on cycle tracks adjacent to the sidewalk or that are between the sidewalk and a transit stop.
- Decreased flexibility for incident management.



Recommended cycle track design with on-street parking.

Guidance

- Cycle tracks have been implemented in several European cities, as well as in Vancouver, Montreal, New York City, and several other cities.
- Alta Planning + Design. (2009). *Cycle Tracks: Lessons Learned*.
- CROW *Design Manual for Bicycle Traffic*.
- Vélo Québec. (2003). *Technical Handbook of Bikeway Design*.

1.5.1.1. Cycle Track Separation

Design Summary

- A buffer is not required of a cycle track wider than 2.0 metres, but is recommended where possible.
- Separation from motor vehicle traffic options outlined below.
- Separation from pedestrian space options includes: pavement markings or other minimal buffer.

Discussion

<u>Physical Barrier</u>

Physical barriers include bollards, a planter strip, an extruded curb, bicycle parking, motor vehicle parking, or several of these elements. A shy distance of 60 cm is recommended, and gaps should be provided at regular intervals.

<u>Parking Placement</u>

Where on-street parking exists, the cycle track should be placed between the parking and the sidewalk. The cycle track should be placed with a 0.6 m buffer between parking and the sidewalk to minimize the hazard of 'dooring' cyclists. Drainage inlets should be provided adjacent to the sidewalk curb to facilitate run-off.

<u>Buffer Area</u>

Cycle tracks can be at street-level, provided that there is a physical separation of at least 33 cm. The curb creates the separated space, as well as preventing passengers from opening doors into the cycle track and discouraging pedestrians from walking on the facility.

<u>Mountable Curb</u>

Cycle tracks can be grade-separated from the roadway. The cycle track should be 50 to 75 mm above street-level using a hard curb, and the sidewalk should be an additional 50 to 75 mm above that. Where cyclists may enter or leave the cycle track, or where motorists cross at a driveway, the curb should be mountable with a small ramp, allowing cyclist turning movements.

<u>Pavement Markings and Signage</u>

In addition or as an alternative to other separation, the cycle track should have signage, pavement markings and/or coloration or texture, to indicate that the facility is provided for bicycle use. Pavement markings in addition to bollards, can add to the physical separation of the facility.

Guidance

- CROW *Design Manual for Bicycle Traffic.*
- Alta Planning + Design. *Cycle Tracks: Lessons Learned.*

Cycle track with a parking buffer, Copenhagen.

Cycle track with curb separation, Montreal QC.

Mountable curb, Carrall Street, Vancouver BC.

Cycle track with bollard separation, New York City.

1.5.1.2. Cycle Track Intersection Treatments at Driveways and Minor Street Crossings

Design Summary

Recommendations for increasing bicyclist visibility at driveways and minor street crossings:

- Maintain height level of cycle track, requiring automobiles to cross over.
- Remove parking 5.0 m prior to the intersection.
- Use coloured pavement markings and/or shared lane markings through the conflict area.
- Place warning signage to identify the crossing (see page 42).

Cycle tracks should be continued through driveway crossings, improving visibility.

Discussion

At driveways and crossings of minor streets, the majority of traffic will continue through intersections, while a small number of automobiles will cross the cycle track. At these locations, cyclist visibility is important, as a buffer of parked cars or vegetation can reduce the visibility of a cyclist traveling in the cycle track. Cyclists should not be expected to stop at these minor intersections if the major street does not stop, and markings and signage should be used to indicate that drivers should watch for cyclists.

Access management should be used to reduce the number of crossings of driveways on a cycle track.

Coloured pavement informs bicyclists and drivers of a potential conflict area.

Guidance

- CROW *Design Manual for Bicycle Traffic.*
- Alta Planning + Design. (2009). *Cycle Tracks: Lessons Learned.*

Bicycle markings at a driveway crossing

1.5.1.3. Cycle Track Intersection Treatments at Major Street Crossings

Design Summary

- Stripe stop line 5.0 m back from the intersection.
- Remove parking 5.0 m prior to the intersection.
- Drop cycle track to bicycle lane 5.0 m back from intersection.
- Use bike box treatments to move cyclists in front of traffic (see page 40).
- Use coloured pavement markings and/or shared lane markings through the conflict area.
- If the speed of the main street is 70 km/h or less, the cycle track should turn inwards prior to crossing a side street to improve visibility of cyclists to right-turning motorists.
- If the speed is greater than 70 km/h, the cycle track should bend away from the main road at intersections, so that vehicles leaving the main road can stack up on the cross street, between the cycle track and the main road. Signage should also warn motorists of the crossing.

Discussion

Protected phases at signals or 'scramble signals' separate automobile turning movements from conflicting thru-bicycle movements. Bicycle signal heads ensure that all users know which signals to follow. Demand-only bicycle signals can require user actuation and reduce vehicle delay by preventing an empty signal phase from regularly occurring.

Advanced signal phases can be set to provide cycle track users an advance green phase. This places cyclists in front of traffic and allows them to make their turning movements without merging into traffic.

An advanced warning allows bicyclists to prepare to move forward through the intersection. This warning can be accomplished through a pre-green interval, a yellow warning display two seconds before the green, or a bicycle countdown signal.

Guidance

- CROW *Design Manual for Bicycle Traffic*.
- Alta Planning + Design. (2009). *Cycle Tracks: Lessons Learned*.

Cycle track dropping to bicycle lane before an intersection.

Crossings should separate space for bicyclists and pedestrians.

At this unsignalized right turn, the cycle track has dropped to a bicycle lane with blue coloration and pavement markings through the conflict area. A "Yield to Cyclists" Sign would further improve this intersection.

Bike box positions cyclists to make a left turn from a cycle track in Portland, OR.

1.5.1.4. Cycle Track Left Turn Movements

Design Summary

- Left turn opportunities for cyclists can be provided in the following ways:
  - o Copenhagen lefts are a two-stage crossing, which include a turning and waiting area at the far side of the first intersection.
  - o Box lefts are pockets where bicyclists can move to the right hand side of the cycle track and wait for a crossing signal. This treatment can result in the cyclist being on the wrong side of the street, in a standard four-way intersection.
  - o Scramble signals.

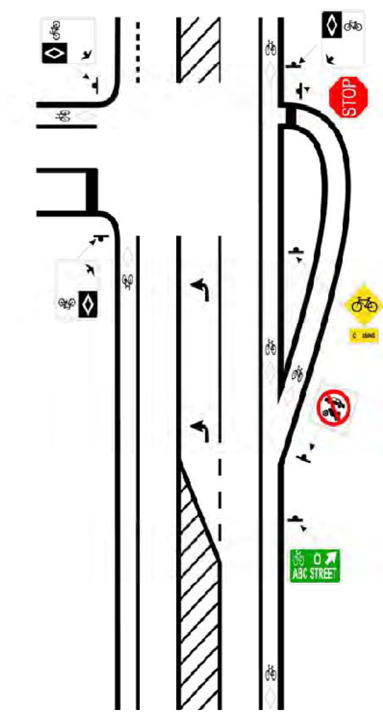
Left-turn from a cycle track on the right via bicycle-signal phase in Winterthur, Switzerland.

Discussion

Bicyclists are often not allowed to make left-turn movements from the cycle track can be physically barred from moving into the roadway by the cycle track barrier.

The "Copenhagen Left" (also known as the "Melbourne Left," the "jug-handle turn," and the "two-stage left") is a way of enabling a safe left-turn movement by bicyclists in a cycle track. Bicyclists approaching an intersection can make a right into the intersecting street from the cycle track, to position themselves in front of cars. Bicyclists can go straight across the road they were on during next signal phase. All movements in this process are guided by separate traffic signals – motorists are not allowed to make right turns on red signals. In addition, motorists have an exclusive left-turn phase, in order to make their movements distinct from the bicyclists'.

"Box left" turn in Troisdorf, Germany.



Jug handle treatment, TAC Bikeway Traffic Control Guidelines for Canada (2010 DRAFT)

Guidance

- CROW *Design Manual for Bicycle Traffic.*
- Alta Planning + Design. (2009). *Cycle Tracks: Lessons Learned.*

1.5.1.5. Two-Way Cycle Tracks

Design Summary

- 3.5 m minimum to allow head-on passing, 4.5 m recommended (New York City).
- Striped centre line to separate traffic.
- Pavement markings should indicate direction.

Two-way cycle track with dividing line.

Discussion

A two-way cycle track is desirable when more destinations are on one side of a street (therefore preventing additional crossings), if the facility connects to a path or other bicycle facility on one side of the street, or if there is not enough room for a cycle track on both sides of the road. A two-way cycle track is desirable when there are more destinations on one side of a street or if the cycle track will connect to a multi-use trail or bicycle facility on one side of the street.

Bidirectional cycle tracks are acceptable in the following situations:

- On a street with few intersections or without access on one side (e.g., along a waterway or rail line).
- On a one-way street with fewer than one intersection every 30 metres.
- On two-way streets where left-hand turns are prohibited, and with a limited number of intersections and driveway entrances.

Parking should be banned along the street to ensure adequate stopping sight distances for motorists crossing the trail.

Directional markings on cycle track.

Two-way cycle tracks have many similar design characteristics as one-way tracks; they are physically divided from cars and pedestrians, and require similar amenities at driveway and side-street crossings.

Pavement markings indicate travel direction at a minor roadway crossing on this cycle track in Paris, France.

Two-way cycle tracks require a higher level of control at intersections, to allow for a variety of turning movements. These movements should be guided by a separated signal for bicycles and for motor vehicles. Transitions onto bidirectional cycle tracks should be simple and easy to use, to deter bicyclists from continuing to ride against the flow of traffic.

In addition, bicyclists riding against roadway traffic in two-way cycle tracks may surprise pedestrians and drivers at intersections.

The City of Vancouver recently implemented a two-way cycle track on Dunsmuir Street.

Guidance

- Vélo Québec. (2003). *Technical Handbook of Bikeway Design*.
- CROW *Design Manual for Bicycle Traffic.*
- Alta Planning + Design. (2009). *Cycle Tracks: Lessons Learned.*

1.5.2. Buffered Bicycle Lane

Design Summary

- Buffer width: 50-75 cm (CROW Guide)
- Bicycle lane width: 1.5-1.8 m.
- Green paint can be used just after intersections to increase visibility and highlight that the space is intended for bicycle use.

Discussion

Bicycle lanes on high-volume or high-speed roadways can be dangerous or uncomfortable for cyclists, as automobiles pass or are parked too close to bicyclists. Buffered bicycle lanes are designed to increase the space between the bicycle lanes and the travel lane or parked cars.

This treatment is appropriate on bicycle lanes with high automobile traffic volumes and speed, bicycle lanes adjacent to parked cars, and bicycle lanes with a high volume of truck or oversized vehicle traffic. Frequency of right turns by motor vehicles at major intersections should determine whether continuous or truncated buffer striping should be used approaching the intersection.

Advantages of buffered bicycle lanes:

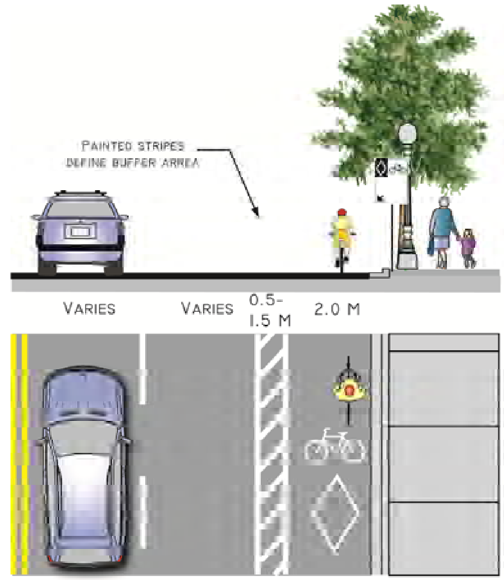
- Provides cushion of space to mitigate friction with motor vehicles on streets with narrow bicycle lanes.
- Provides space for cyclists to pass one another without encroaching into the travel lane.
- Provides space for cyclists to avoid potential obstacles in the bicycle lanes, including drainage inlets, manholes, trash cans or debris.
- Parking side buffer provides cyclists with space to avoid the 'door zone' of parked cars.
- Provides motorists greater shy distances from cyclists in the bicycle lane.

Disadvantages / potential hazards

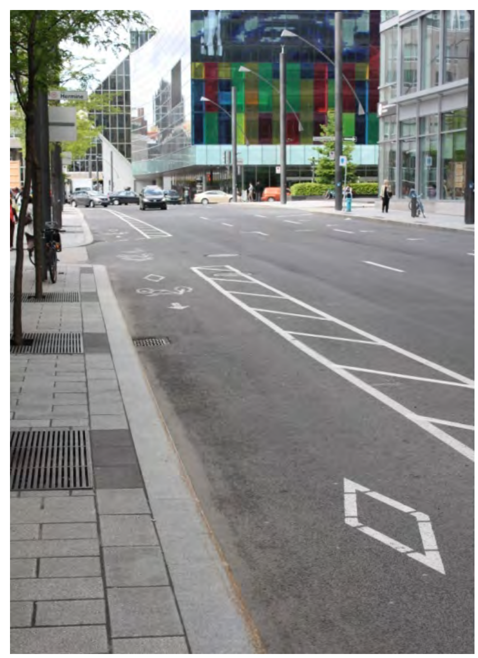
- Requires additional roadway space.
- Requires additional maintenance for the buffer striping.
- Frequency of parking turnover should be considered prior to installing buffered bicycle lanes.

Guidance

- City of Portland, OR. (2010). *Bicycle Master Plan* for *2030* Bikeway Design Best Practices.
- Buffered bicycle lanes are currently also used in Brussels & Bruges, Belgium, Budapest, Hungary, London, UK, Seattle, WA, San Francisco, CA, and New York, NY.



Recommended buffered bicycle lane design.



Montréal uses buffered bicycle lanes to protect cyclists from fast-moving traffic.

1.6. Separated On-Street Bikeways

Streets with relatively high vehicular speeds and volumes warrant dedicated space for cyclists on the roadway. Shoulder bikeways are used on streets without curb and gutter, where pedestrians may share the shoulder space with bicyclists. More urban streets with curbs and gutters use bicycle lanes as separated space for cyclists, and usually provide sidewalks for pedestrians.

1.6.1. Shoulder Bikeways

Design Summary

- Paved shoulders should generally be a minimum of 1.5 m wide (continuous), although 1.2 m can be accepted as an interim standard, particularly if an alternate pedestrian route is provided.
- For roads with higher traffic volumes and speeds, the shoulder bikeway width should be increased to:
  - o 2.0 m for a posted speed ≥ 70 km/h and Summer Average Daily Traffic (SADT) > 5,000 vpd.
  - o 2.5 m for a posted speed ≥ 80 km/h and SADT > 10,000 vpd.
  - o 3.0 m for freeways and expressways.
- Can include pavement markings and 'Bike Route" or Share the Road" signage (recommended).
- Shoulder bikeways should be paved and free of obstructions, such as telephone poles or drainage grates. Parking in the shoulder should be prohibited.
- If rumble strips are used to prevent motor vehicle drive-off accidents, these should be located on the far left of the shoulder, within 150mm of the white fog line, and should be a maximum of 300mm wide. The remainder of the shoulder should be a minimum of 1.5 m wide.
- Where space exists, mark a shy line from the edge of the pavement.

Recommended shoulder bikeway design.

Discussion

Shoulder bikeways are paved roadways with striped shoulders wide enough for bicycle travel. Shoulder bikeways are typically used by experienced commuter and long-distance recreational riders, rather than inexperienced riders who often find the high traffic volumes and speeds uncomfortable. Shoulder bikeways often, but not always, include signage alerting motorists to expect bicycle travel along the roadway.

The TAC defines 'paved shoulders' as, "The portion of the road adjacent to the travel lanes, not normally used by motor vehicles, but paved as a separate bicycle lane, bicycle route, or shared use lane. The use of this type of bikeway is dependent on the volume of traffic and the vehicle mix." Pavement markings or signs can encourage bicyclists and pedestrians to share this space without conflicts.

Shoulder bikeways can be indicated by pavement markings, and generally include signage.

Guidance

- Rural application - BC MOTI supplement to TAC.
- Constrained urban application – AASHTO.
- The *City of Langford Bicycle Plan* recommends a minimum of 3.7 m wide travel lanes adjacent to shoulder bikeways.
- The TAC *Geometric Design Guide for Canadian Roads* Chapter 3: Bicycles discusses shoulder bikeways in sections 3.4.3.2. and 3.4.6.2.

1.6.2. Bicycle Lanes

Design Summary

- Recommended width: 1.8 m (measured from end of gutter plan, if present). TAC guidelines recommended a minimum of 1.5m, with a minimum of 1.2m in constrained locations.
- Bicycle lane widths should be increased depending on the speed and composition of traffic as follows:
    - o If motor vehicle traffic volumes exceed 6,000 AADT, or if trucks exceed 10% of motor vehicle traffic volumes: 2.0 m (TAC standard).
    - o On roads with posted speeds of 70 km/h or more, bicycle lanes should be 1.8 m wide but not exceed 2.0 m, as this enables two-way bicycle travel and encourages motorists to pass or park in the lane.
    - o If roadway speed is 100 km/h or greater: 2.5 m (on rural, highway, or expressway conditions for which a shoulder bikeway may be more appropriate; TAC standard)).
    - o Wide bicycle lanes are appropriate in areas with high bicycle use; widths of 1.8 to 2.4 m allow bicyclists to pass each other without leaving the bicycle lane, increasing the capacity of the lane. However, buffered bicycle lanes are recommended, to reduce driving, parking, or wrong-way riding in the lane.
- Bicycle lane lines are solid white with a width of 100 mm.
- Where motor vehicles are permitted to move into or cross the bicycle lane to perform a turning movement, broken line segments should be used.
- Reserved bicycle lane signs should be provided either directly above or adjacent to the bicycle lane after each intersection and spaced at least every 200 m.

Markings should be placed ever 75 m or as conditions dictate, and 10 m downstream from an intersection or crosswalk.

Bicycle lanes should provide adequate space so that bicyclists are not riding in the 'door zone.'

Discussion

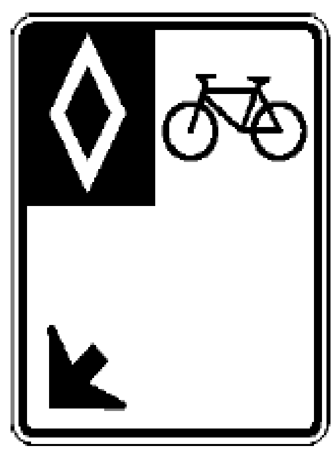
Designated exclusively for bicycle travel, bicycle lanes are separated from vehicle travel lanes and striped with a bicycle symbol and diamond symbol. Bicycle lanes are most appropriate on urban arterial and collector streets where higher traffic volumes and speeds warrant greater separation.

Bicycle lanes can increase safety and improve road user etiquette by:

- Defining road space for bicyclists and motorists, reducing the possibility that motorists will stray into the cyclists' trail.
- Discouraging bicyclists from riding on the sidewalk.
- Reminding motorists that cyclists have a right to the road.

In an urban setting, it is crucial to ensure that bicycle lanes and adjacent parking lanes have sufficient width, so that cyclists have enough room to avoid a suddenly-opened vehicle door.

The TAC provides additional guidelines for transitions between bicycle lanes and other facility types, and for treatments with traffic calming.



TAC sign RB-91 is used to indicate bicycle lanes.

Guidance

- TAC *Geometric Design Guide for Canadian Roads* and *Bikeway Traffic Control Guidelines for Canada.*
- AASHTO Guide for the Development of Bicycle Facilities.

1.6.2.1. Bicycle Lane Adjacent to On-Street Parallel Parking

Design Summary

- Combined width of the bicycle/parking lane should be at least 4m; 2.5 m for the parking lane and 1.5 m for bicycles, which provides clearance to avoid opened car doors.
- 1.8 m recommended when parking stalls are marked.
- 1.2 m minimum in constrained locations.
- 1.5 m acceptable if parking not marked (drivers tend to park closer to the curb where parking is unmarked).
- 2.0 m maximum (greater widths may encourage vehicle loading in bicycle lane).

Discussion

Bicycle lanes adjacent to on-street parallel parking are common but can be dangerous for bicyclists if not properly designed. Crashes caused by a suddenly-opened vehicle door are a common hazard for bicyclists using this type of facility.

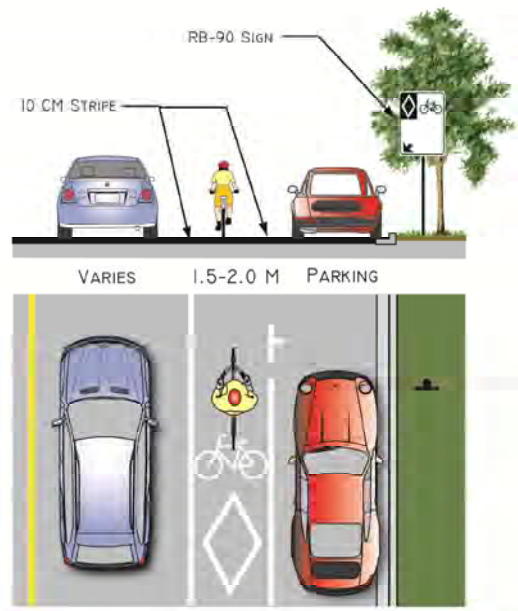
On the other hand, very wide bicycle lanes may encourage the cyclist to ride farther to the right (door zone) to maximize distance from passing traffic. Wide bicycle lanes may also cause confusion with unloading vehicles in busy areas where parking is full.

Some treatments to encourage bicyclists to ride away from the 'door zone' include:

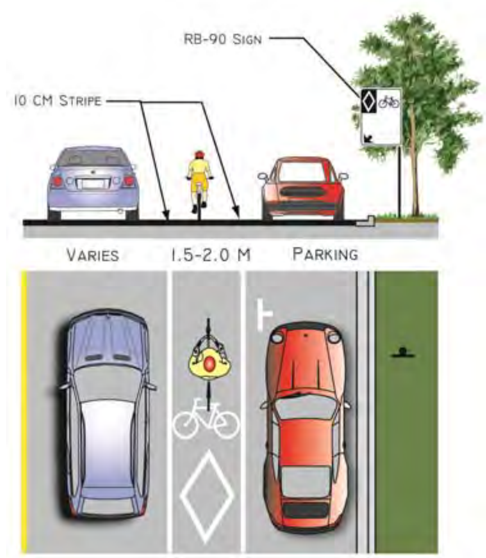
- Installing parking "T's" and smaller bicycle lane stencils placed to the left (see graphic at top).
- Using diagonal stripes to encourage cyclists to ride on the left side of the bicycle lane (shown bottom; this treatment is not standard and should be studied before use).
- Provide a buffer zone (preferred design). Bicyclists traveling in the center of the bicycle lane will be less likely to encounter open car doors. Motorists have space to stand outside the bicycle lane when loading and unloading.

Guidance

- TAC Geometric *Design Guide for Canadian Roads* and *Bikeway Traffic Control Guidelines for Canada.*
- AASHTO *Guide for the Development of Bicycle Facilities.*



Standard bicycle lane design.



Desired bicycle lane design with parking buffer.

1.6.2.2. Bicycle Lane Adjacent to On-Street Diagonal Parking

Design Summary

- Bicycle lane width: 1.5 m minimum.
- White 10 cm stripe separates bicycle lane from parking bays.
- Parking bays are sufficiently long to accommodate most vehicles (vehicles do not block bicycle lane).

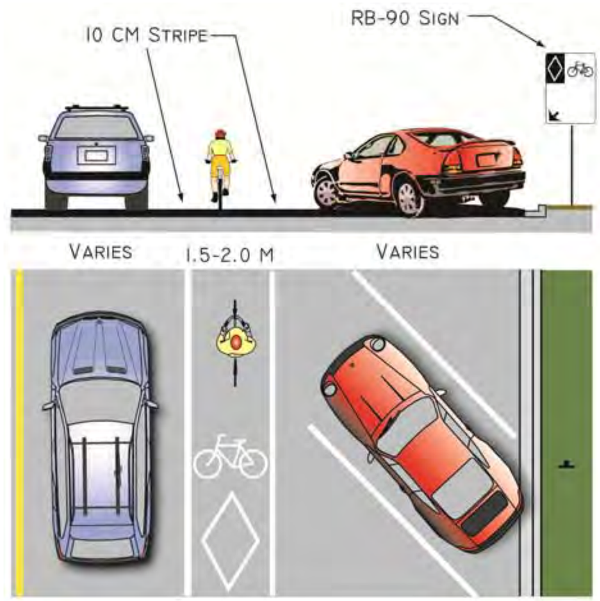
Discussion

In areas with high parking demand such as urban commercial areas, diagonal parking can be used to increase parking supply. Conventional "head-in" diagonal parking is not recommended in conjunction with high levels of bicycle traffic or with the provision of bicycle lanes as drivers backing out of conventional diagonal parking spaces have poor visibility of approaching bicyclists.

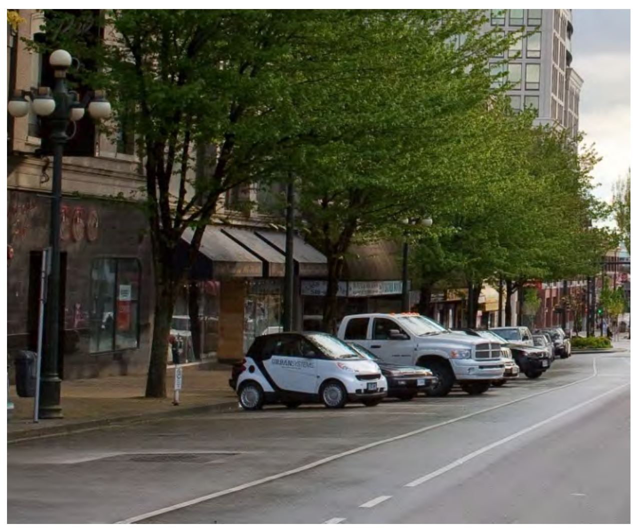
The use of 'back-in diagonal parking' or 'reverse angled parking' is recommended over front-in diagonal parking. This design addresses issues with diagonal parking and bicycle travel by improving sight distance between drivers and bicyclists and has other benefits to vehicles including: loading and unloading of the trunk occurs at the curb rather than in the street, passengers (including children) are directed by open doors towards the curb, no door conflict with bicyclists. While there may be a learning curve for some drivers, using back-in diagonal parking is typically an easier manoeuvre than conventional parallel parking.

Guidance

- This treatment is currently slated for inclusion in the update of the AASHTO *Guide for the Development of Bicycle Facilities.*



Recommended bicycle lane adjacent to on-street diagonal parking design.



'Back-in' diagonal parking is safer for cyclists than 'head-in' diagonal parking due to drivers' visibility as they exit the parking spot (New Westminster).

1.6.2.3. Bicycle Lane Without On-Street Parking

Design Summary

- Bicycle lane width:
  - 1.5 m minimum, 1.2 in constrained areas.
  - 1.8 m recommended where right-of-way allows.
  - 2.5 m maximum adjacent to high speed arterials (70 kph+).

Discussion

Where on-street parking is not present adjacent to a bicycle lane, cyclists can ride close to the curb and gutter without shying away from the doors of parked cars. Streets with high vehicle speeds and volumes are more likely to prohibit on-street parking, and additional widths should be considered to allow cyclists in the bicycle lane to increase separation between passing vehicles and cyclists.

Appropriate signing and stencilling is important with wide bicycle lanes to ensure motorists do not mistake the lane for a vehicle lane or parking lane.

Recommend bicycle lane without on-street parking design.

Guidance

- TAC *Geometric Design Guide for Canadian Roads.*
- AASHTO *Guide for the Development of Bicycle Facilities.*

1.6.2.4. Shared Bicycle/Bus Lane

Design Summary

- Provide a standard width bicycle lane (minimum 1.5 m) where possible.
- Paint bicycle symbol or shared lane marking symbol to the left side of the bus lane, to allow bicyclist to pass a bus that has turned in at a stop.

Discussion

The shared bus/bicycle lane should be used where width is available for a bus lane, but not a bus and bicycle lane. The dedicated lane attempts to reduce conflicts between bicyclists, buses, and automobiles. Various cities have experimented with different designs and there is currently no evidence of one design being more effective than the others.

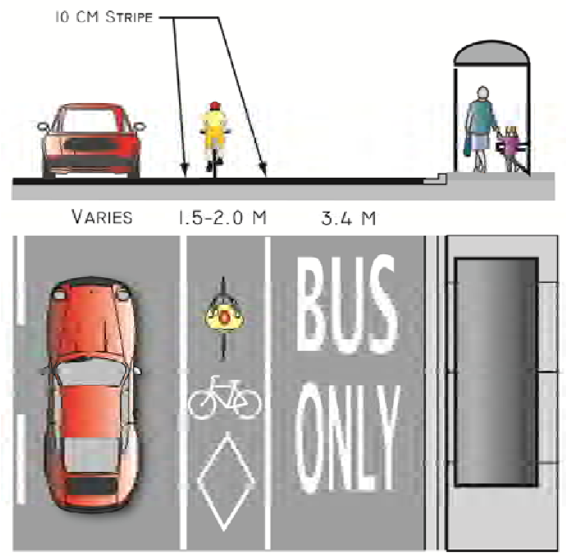
Shared bicycle /bus lanes can be appropriate in the following applications:

- On auto-congested streets, moderate or long bus headways.
- Moderate bus headways during peak hour.
- No reasonable alternative route.

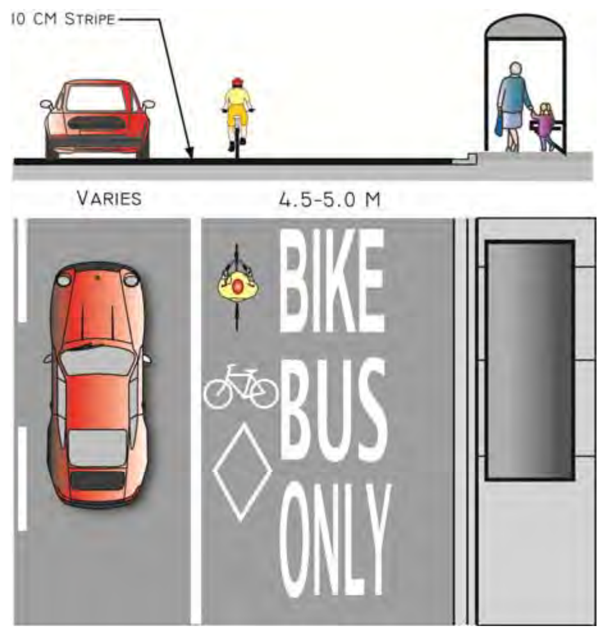
The TAC provides standards for breaking the inner line of the bicycle lane at bus stops where a bus crosses the bicycle line. This treatment is beneficial to indicate to bus drivers and cyclists that the area is a conflict zone. However, the treatment also assumes a continuous bicycle lane (see above right). Where the bicycle and bus lane are shared, shared lane markings are recommended over other treatments (such as a dotted bicycle lane line or coloured pavement markings) because the shared markings provide sufficient information as well as due to the expense of upkeeping paint where busses cross over.

Guidance

- Transportation Research Board. (2006). *TCRP Integration of Bicycles and Transit* http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_62.pdf



Preferred design: separated bicycle lane and bus lane. Where the bus pull-out crosses the bicycle lane (rather than a continuous bus-only lane as pictured), a dashed line should be used on the inside of the bicycle lane.



Minimum design: shared bicycle/bus lane.

1.6.2.5. Uphill Bike Lane Treatments

Design Summary

- Bicycle lane: 1.5 to 1.8 m wide (1.8 m preferred to provide extra manoeuvring room on steep grades).
- Can be combined with shared lane markings in the downhill direction, where downhill cyclists can match prevailing traffic speeds.

Discussion

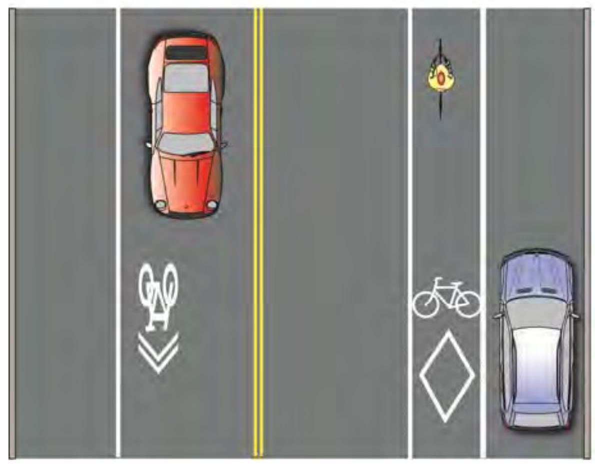
The right-of-way or curb-to-curb width on some streets may only provide enough space to stripe a bike lane on one side without removing travel lanes and on-street parking. Under these conditions, bicycle lane striping could be added to the uphill side of the street only.

Bicyclists ascending hills tend to lose momentum, especially on longer street segments with continuous uphill grades. This speed reduction creates greater speed differentials between bicyclists and motorists, creating uncomfortable and potentially unsafe riding conditions. Separating vehicle and bicycle traffic, uphill bike lanes (also known as "climbing lanes") enable motorists to safely pass slower-speed bicyclists, thereby improving conditions for both travel modes.

This measure often includes delineating on-street parking (if provided), slightly narrowing travel lanes, and/or shifting the centerline if necessary.

Guidance

- Uphill bike lanes are currently used in Portland, Oregon, Seattle, Washington, Madison, Wisconsin, and other cities.
- This treatment is likely to be included in the updated AASHTO *Guide for the Development of Bicycle Facilities*.



Recommended design for uphill bike lane with on-street parking.

Cyclists traveling downhill can match automobile speeds and do not require additional separation, unlike cyclists riding uphill.

1.6.2.6. Bike Lane on Left Side of One-Way Street

Design Summary

- 1.5m minimum.
- 2.0m maximum (may encourage vehicle loading in bike lane)
- See guidance for bike lanes adjacent to on-street parallel parking.

Discussion

Bicycle lanes on the left side of a one-way street are generally discouraged, but they can be useful in locations that have:

- Significant left-turning cyclist movement.
- Heavy transit use on the right side of the street (either in a dedicated lane or with traffic).
- High volumes of right turn movements by vehicles.

Advantages of a left side bike lane on a one-way street include:

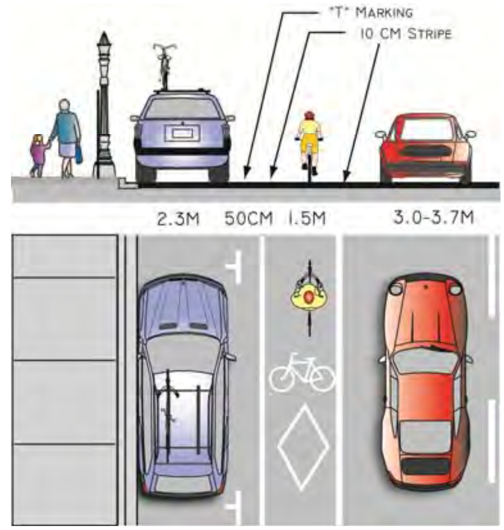
- Less risk of dooring – If on street parking is present, the passenger door is exposed to the bike lane rather than the driver's door.
- Increased driver visibility – with the bike lane on the left, bicyclists are seen in the motorist's driver's side mirror, which has a smaller blind spot than the passenger side mirror.
- Fewer bus and truck conflicts – Most bus stops and loading zones are on the right side of the street. Left-side bike lanes reduce the number of conflicts caused by buses or trucks blocking or merging through a bike lane.
- Fewer left turn conflicts – One-Way streets typically experience fewer left turn movements than right turns.

Disadvantages / potential hazards

- Conflicts between cyclists and motorists making left turns may potentially increase; provide a left turn pocket with the bike lane oriented to the right.
- Drivers are not used to looking for bicycles on the left hand side of their vehicles.
- Bike lanes on the left side of the street may experience higher levels of 'wrong way riding' by bicyclists.
- Bicyclists may not be accustomed to looking over their right shoulders to monitor traffic, helmet and handlebar mounted mirrors are also useless.
- Where adjacent to parallel parking, left side bike lanes result in poorer visibility to motorists leaving parking spaces.

Guidance

- AASHTO *Guide for the Development of Bicycle Facilities*.
- Expanded coverage will be included in the updated AASHTO *Guide for the Development of Bicycle Facilities*.



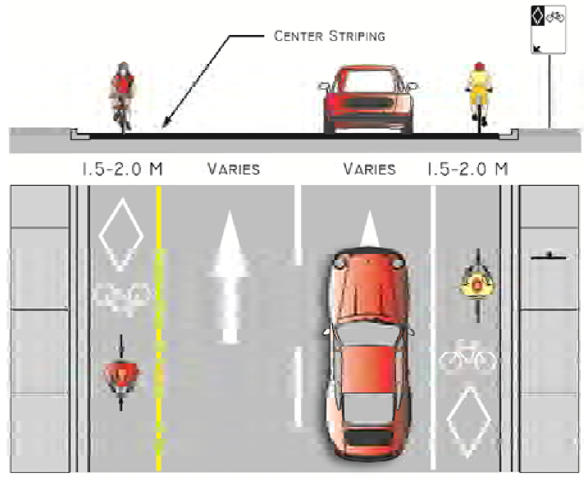
Recommended design.

Left-side bike lanes can be provided where bicyclists tend to make left-hand turns.

1.6.2.7. Contraflow Bicycle Lane

Design Summary

- The contraflow lane should be 1.5 to 2.0 m and marked with a solid yellow line and appropriate signage.
- Bicycle lane markings should be clearly visible to ensure that contraflow lane is exclusively for bicycles.
- Green colouration should be considered on the bicycle lane.
- Additional intersection treatments are necessary to improve awareness of cyclists traveling against the normal flow of traffic. Treatments include signs (see right) and a separated signal phase.



Recommended contraflow bicycle lane design.

Discussion

Contraflow bicycle lanes provide bi-directional bicycle access along a roadway that is one-way for automobile traffic. They are used to make a short connection where other treatments are not possible or would be indirect. This treatment can provide direct access and connectivity for bicyclists, avoiding detours and reducing travel distances for cyclists.

Advantages of contraflow bicycle lanes:

- Provides direct access and connectivity for bicycles traveling in both directions.
- Influences motorist choice of routes without limiting bicycle traffic.
- Cyclists do not have to make detours as a result of one-way traffic.

Disadvantages / potential hazards

- Parking should not be provided on the far side of the contraflow bicycle lane.
- Space requirements may require reallocation of roadway space from parking or travel lanes.
- The lane could be illegally used by motorists for loading or parking.
- Public outreach should be conducted prior to implementation of this treatment.

This contraflow bicycle lane in Denver, Colorado provides a key connection between bikeways.

The "Contraflow Bicycle Lane Crossing Sign" (WC-XX) is recommended in the Draft 2010 TAC Bikeway Traffic Control Guidelines for use at a street crossing a bi-directional or contraflow bicycle lane.

Guidance

- TAC *Bikeway Traffic Control Guidelines.*
- This treatment is a federally-recognized design standard in the United States.
- Contraflow bicycle lanes are currently used in Olympia and Seattle, WA; Madison, WI, Cambridge, MA; San Francisco, CA; and Portland, OR.

1.6.2.8. Bike Box

Design Summary

- Reduce conflicts between right-turning motorists and cyclists continuing straight through the intersection.
- Bike Box Dimensions:
  - Minimum depth: 2.75 m.
  - Recommended depth: 4.0 metres deep to allow for bicycle positioning.
- Appropriate signage as recommended by the MUTCD-CA applies. Signage should be present to prohibit 'right turn on red' and to indicate where the motorist must stop.
- Right turns on red should be prohibited.

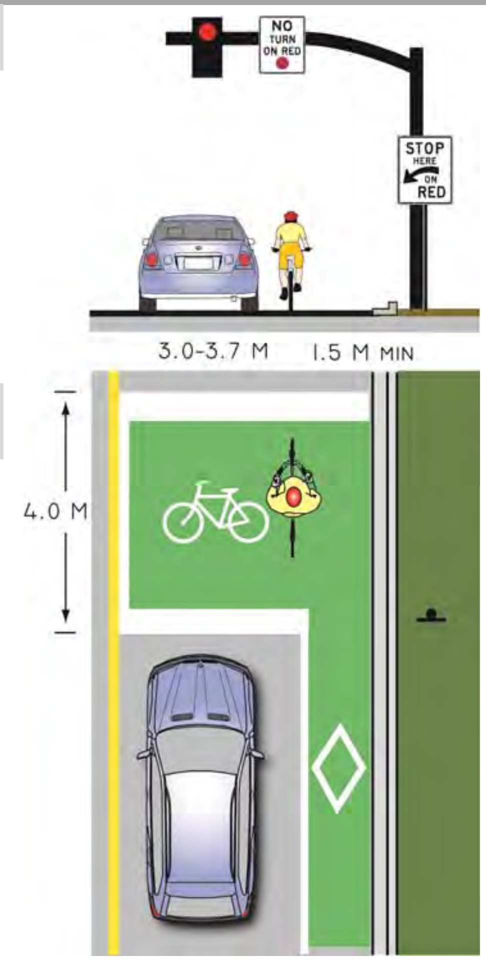
Discussion

A bike box is a right angle extension of a bicycle lane at the head of a signalized intersection. The bike box allows bicyclists to move to the front of the traffic queue on a red light and proceed first when that signal turns green. Motor vehicles must stop behind the white stop line at the rear of the bike box. Bike boxes are used to reduce conflicts between right-turning motorists and cyclists continuing straight through the intersection.

Bike boxes can be combined with dashed lines through the intersection for green light situations to remind right-turning motorists to be aware of bicyclists traveling straight, similar to the coloured bicycle lane treatment described earlier. Bike boxes can be installed with striping only or with coloured treatments to increase visibility. Use of colouration substantially increases costs of maintenance over uncoloured (striping, bicycle symbol, and text only) treatments.

Note that TAC does not recommend a colour to be used, although green is mandated as the standard colour in the United States by the Federal Highway Administration. Blue, green, and red coloured bike lanes are currently used in the CRD at this time. Green is the recommended colour, as red is considered a warning colour and blue is used to mark areas for individuals with disabilities. In addition, green is becoming the standard colour for bicycle lane treatments, and the region would benefit from consistency to aid visitors' interpretation of traffic symbols.

Bike boxes should be used at locations that have a large volume of cyclists, and are often utilized in central areas where traffic is usually moving slowly. On roadways with one travel lane in each direction, the box also facilitates cyclist left turning movements.



Recommended bike box design.

Bike boxes have been installed at several intersections in Portland, OR where right-turning motorists conflict with through bicyclists.

Guidance

- Hunter, W.W. (2000). *Evaluation of Innovative Bike-Box Application in Eugene, Oregon.*
- City of Portland, OR. (2010). *Bicycle Master Plan* for *2030* Bikeway Design Best Practices.

1.6.2.9. Shared Bicycle/Right Turn Lane

Design Summary

- Minimum widths:
  - o Shared turn lane – minimum 3.7 m.
  - o Bicycle lane pocket – minimum 1.2 metres; 1.5 metres preferred.

Case studies cited by the Pedestrian and Bicycle Information Center indicate that this treatment works best on streets with lower posted speeds (50 kph or less) and with lower traffic volumes (10,000 ADT or less).

The TAC *Coloured Bike Lanes Simulator Testing Report* makes the following recommendations:

- Where conflicts are not a major concern, white dashed markings are adequate.
- Shared lane marking is preferred for raising awareness of the bicycle lane through the conflict area.
- Dashed blue is preferable to solid blue.

Discussion

This treatment is recommended at intersections lacking sufficient space to accommodate a standard bicycle lane and right turn lane. The shared bicycle/right turn lane places a standard-width bicycle lane on the left side of a dedicated right turn lane. A dashed strip delineates the space for bicyclists and motorists within the shared lane. This treatment includes signage advising motorists and bicyclists of proper positing within the lane.

Advantages:

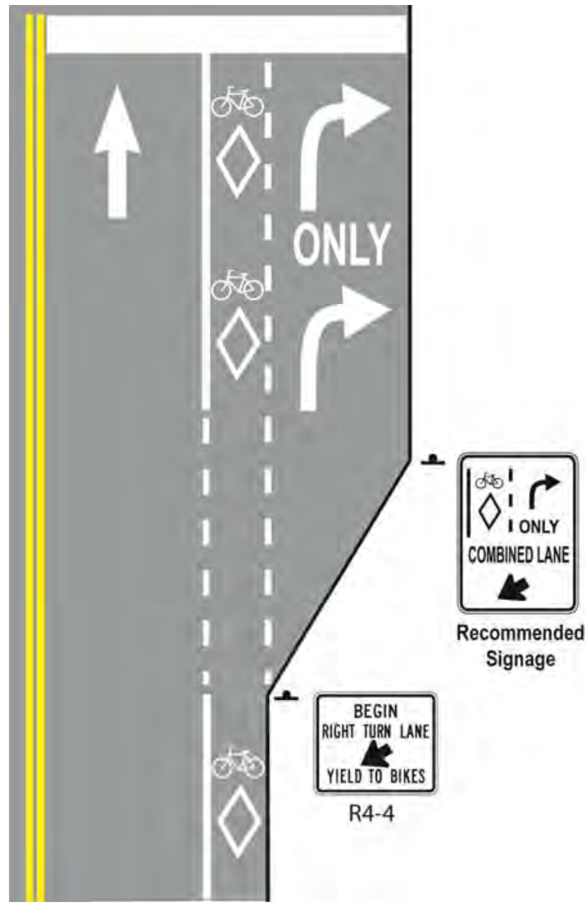
- Aids in correct positioning of cyclists at intersections with a dedicated right turn lane without adequate space for a dedicated bicycle lane.
- Encourages motorists to yield to bicyclists when using the right turn lane.
- Reduces motor vehicle speed within the right turn lane.

Disadvantages/potential hazards:

- May not be appropriate for high-speed arterials or intersections with long right turn lanes.
- May not be appropriate for intersections with large percentages of right-turning heavy vehicles.

Guidance

- TAC *Coloured Bike Lanes Simulator Testing Report.*
- Likely to be included in the updated AASHTO *Guide for the Development of Bicycle Facilities.*
- This treatment has been previously implemented in the Cities of San Francisco, CA and Eugene, OR.



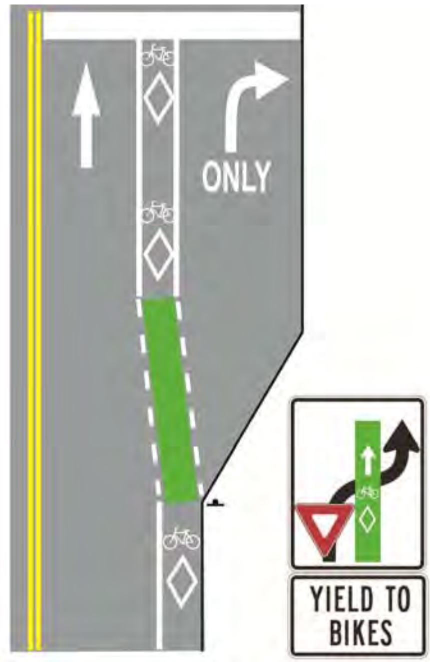
Recommended shared bike/right turn lane design. Shared lane markings can also be used to emphasize that the roadway is shared.

Shared bike-right turn lanes require warning signage as well as pavement markings to facilitate automobiles and cyclists sharing the lane.

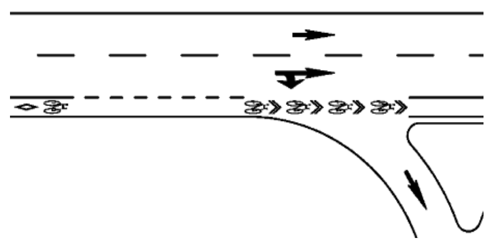
1.6.2.10. Coloured Bicycle Lanes at Conflict Areas

Design Summary

- Where a bicycle lane must merge through a vehicular travel lane with high traffic speeds and volumes, including on- or off-ramps and where the bicycle lane crosses the prevailing travel lane, provide enhanced visibility of the bicycle lane. Engineering judgement should be applied in the application of this treatment.
- Bicycle lane pocket – 1.2-1.5 metres preferred.
- Use coloured pavement through entire merge area.
- Dashed lines can be used to indicate that automobiles are crossing the bicycle lane.
- Signage reminds drivers to yield to cyclists in the bicycle lane.
- The *TAC Coloured Bike Lanes Simulator Testing Report* recommends:
  - o Where conflicts are not a major concern, white dashed markings are adequate.
  - o Shared lane marking are the preferred option for raising awareness of the bicycle lane through the conflict area.



Recommended coloured bicycle lane design.


Example of shared lane markings carried through a conflict area (Source: TAC Coloured Bike Lanes Simulator Testing Report)


Portland, OR has implemented coloured lanes where cyclists transition off a bridge.

Discussion

Some cities are using coloured bicycle lanes to guide cyclists through major vehicle/bicycle conflict points. These conflict areas are locations where motorists and cyclists must cross each other's path (e.g., at intersections or merge areas). Coloured bicycle lanes typically extend through the entire bicycle/vehicle conflict zone (e.g., through the entire intersection, or through the transition zone where motorists cross a bicycle lane to enter a dedicated right turn lane.

Double right turn lanes or an inside through/right combination lane should be avoided along bicycle routes, because merging across two lanes is challenging and can be dangerous for cyclists. Existing double-turn lanes along bicycle routes should be studied for potential conversion to single-turn lanes.

The colors commonly used in bicycle lanes are blue, green, and red. Several cities initially used blue; however, this color is associated with amenities for handicapped drivers or pedestrians. All three colours have been used in the CRD to date.

Advantages of coloured bicycle lanes at conflict points include:

- Draws attention to conflict areas.
- Increases motorist yielding behaviour.
- Emphasizes expectation of bicyclists on the road.

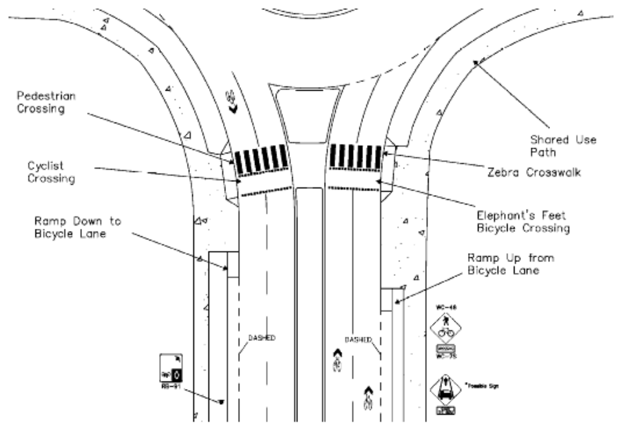
Guidance

- TAC Coloured Bike Lanes Simulator Testing Report.
- Portland Office of Transportation (1999). *Portland's Blue Bike Lanes: Improved Safety through Enhanced Visibility.* http://www.portlandonline.com/transportation/index.cfm?a=58842&c=34772
- AASHTO *Guide for the Development of Bicycle Facilities.*

1.6.2.11. Bicycle Lanes at Roundabouts

Design Summary

- Reduce the speed differential between circulating motorists and bicyclists (40 km/h maximum circulating design speed).
- Design approaches/exits to the lowest speeds possible, to reduce the severity of potential collisions with pedestrians.
- Encourage bicyclists navigating the roundabout like motor vehicles to "take the lane."
- Maximize yielding rate of motorists to pedestrians and bicyclists at crosswalks.
- Provide separated facilities for bicyclists who prefer not to navigate the roundabout on the roadway.
- Indicate to drivers and bicyclists the correct way for them to circulate through the roundabout through appropriately- designed signage, pavement markings and geometric design elements.
- Indicate to drivers, bicyclists and pedestrians the right-of-way rules through appropriately -designed signage, pavement markings and geometric design elements.



Recommended bicycle bypass at roundabout design.
Source: TAC Guidelines for the Design and Application of Bikeway Pavement Markings

Discussion

Research indicates that while single-lane roundabouts may benefit bicyclists and pedestrians by slowing traffic, multi-lane roundabouts may significantly increase safety problems for these users. Multi-lane roundabouts pose the following challenges to bicyclists riding in a bicycle lane:

- Bicyclists must take the lane before they enter the roundabout to avoid becoming caught in a "right hook," a situation in which a motorist turns right, across the path of a bicyclist traveling straight. Entry leg speeds must be slow enough for bicyclists to be able to take the lane safely.
- Theoretically, once motor vehicle volumes reach a certain magnitude, there are no gaps in traffic large enough to accommodate a bicyclist.
- Bicyclists must be able to correctly judge the speed of circulating motorists to find a gap that is large enough for them to safely enter the roundabout. This task is particularly difficult if the circulating motorists are traveling at a much higher speed than the bicyclists. In addition, if circulating speeds in a roundabout are much higher than 30 kph, drivers behind a bicyclist may become impatient, and may pass the bicyclist and turn in front of him, creating more risks for the bicyclist.
- As a circulating bicyclist approaches an entry lane, a driver waiting to enter must notice the bicyclist, properly judge the bicyclist's speed, and yield to him/her if necessary. In a location where there are few bicyclists, motorists may not even register that there is a bicyclist approaching. If a bicyclist is hugging the curb, s/he may be outside the motorist's cone of vision.

Guidance

- TAC *Guidelines for the Design and Application of Bikeway Pavement Markings.*
- UC Berkeley Traffic Safety Center for Caltrans. (2009). *Identifying Factors that Determine Bicyclist and Pedestrian-Involved Collision Rates and Bicyclist and Pedestrian Demand at Multi-Lane Roundabouts.*

1.6.2.12. Retrofitting Existing Streets with Bicycle Lanes

Most major streets in the CRD are characterized by conditions (e.g., high vehicle speeds and/or volumes) for which dedicated bicycle lanes are appropriate to accommodate safe and comfortable riding. Although opportunities to add bicycle lanes through roadway widening may exist in some locations, most major streets pose physical and other constraints requiring street retrofit measures within existing curb-to-curb widths. As a result, many of the recommended measures effectively reallocate existing street width through striping modifications to accommodate dedicated bicycle lanes. While largely intended for major streets, these measures may be appropriate on lower-order streets where bicycle lanes would best accommodate cyclists.

Roadway Widening

Design Summary

- See guidance for bicycle lanes, Section 1.6.2.1 to 1.6.2.6.

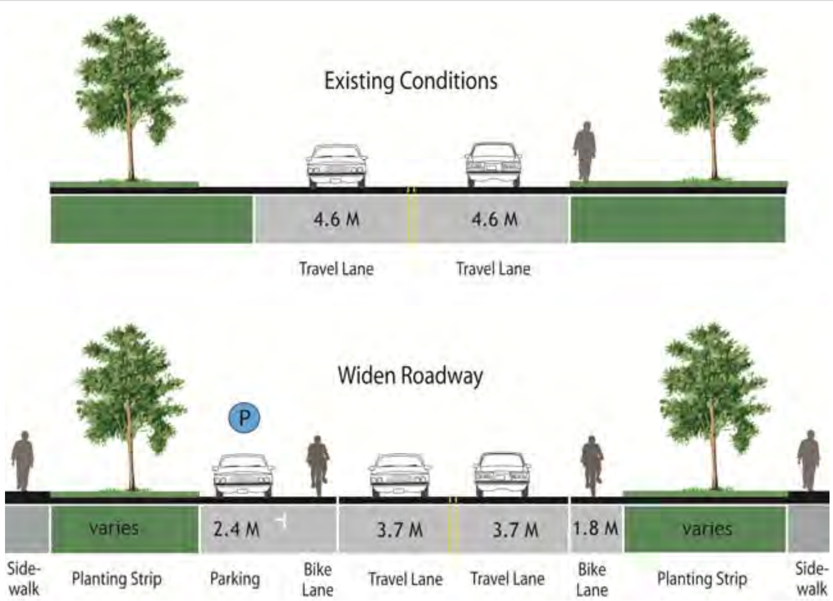
Discussion

Bicycle lanes could be accommodated on several streets with excess right-of-way through shoulder widening. Although street widening incurs higher expenses compared with re-striping projects, bicycle lanes could be added to streets currently lacking curbs, gutters and sidewalks without the high costs of major infrastructure reconstruction.

As a long-term measure, the CRD should find opportunities to add bicycle lanes to other major streets where they are needed. Opportunities include adding bicycle lanes as streets and bridges are widened for additional auto capacity or as property development necessitates street reconstruction.

Roadway widening is preferred on roads lacking curbs, gutters and sidewalks.

Guidance



Example of roadway widening to accommodate bicycle lanes and sidewalks.

1.6.2.12. Retrofitting Existing Streets with Bicycle Lanes

Lane Narrowing (Road Diet 1)

Design Summary

- Vehicle lane widths: before: 3.7 to 4.6 m; after: 3.0 to 3.7 m.
- See guidance for bicycle lanes, Section 1.6.2.1 to 1.6.2.6.

Discussion

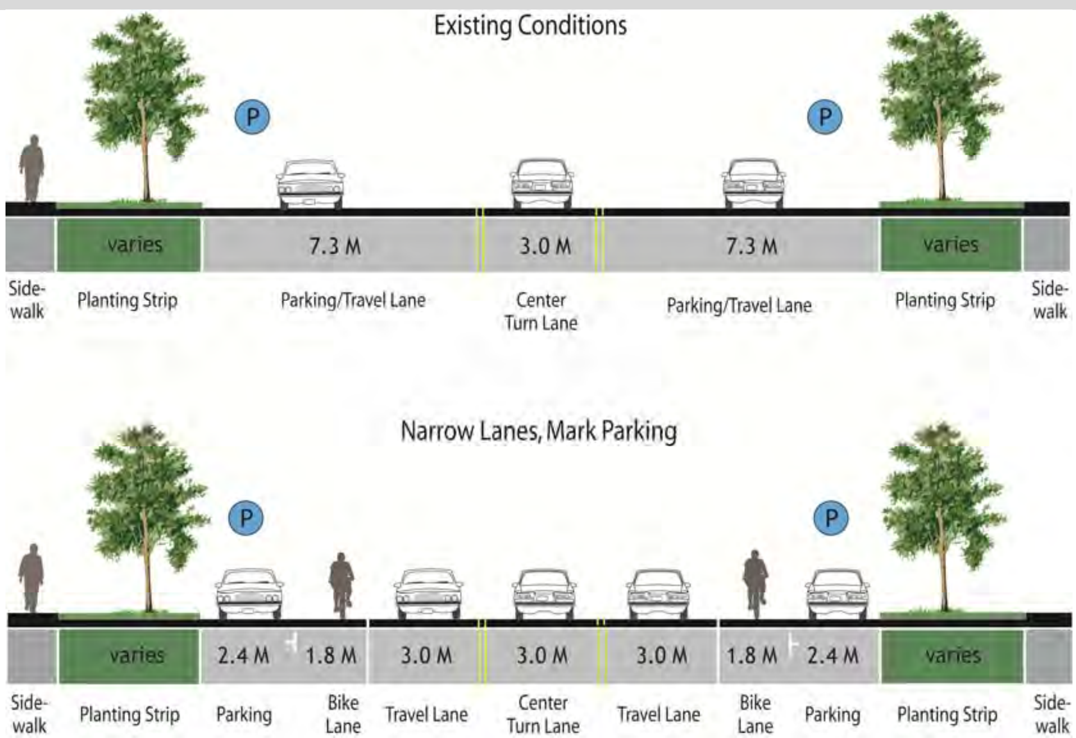
Also called a 'road diet', lane narrowing utilizes roadway space that exceeds minimum standards to create the needed space to provide bicycle lanes. Many roadways in the CRD have existing lanes that are wider than those prescribed in local and national roadway design standards, or which are not marked.

TAC guidelines for collector and arterial road widths are 3.5-3.7 m. However, many cities have narrowed roads to 3.0 m, including Vancouver and Victoria. In other applications, lane narrowing to less than 3.5 m should be considered in light of any other safety and operational considerations.

Special consideration should be given to the amount of heavy vehicle traffic and horizontal curvature before the decision is made to narrow travel lanes. Center turn lanes can also be narrowed in some situations to free up pavement space for bicycle lanes.

This street in Portland, Oregon previously had 4.0 m lanes, which were narrowed to accommodate bicycle lanes without removing a lane.

Guidance



Example of vehicle travel lane narrowing to accommodate bicycle lanes.

1.6.2.12. Retrofitting Existing Streets with Bicycle Lanes

Lane Reconfiguration (Road Diet 2)

Design Summary

- See guidance for bicycle lanes, Section 1.6.2.1 to 1.6.2.6.

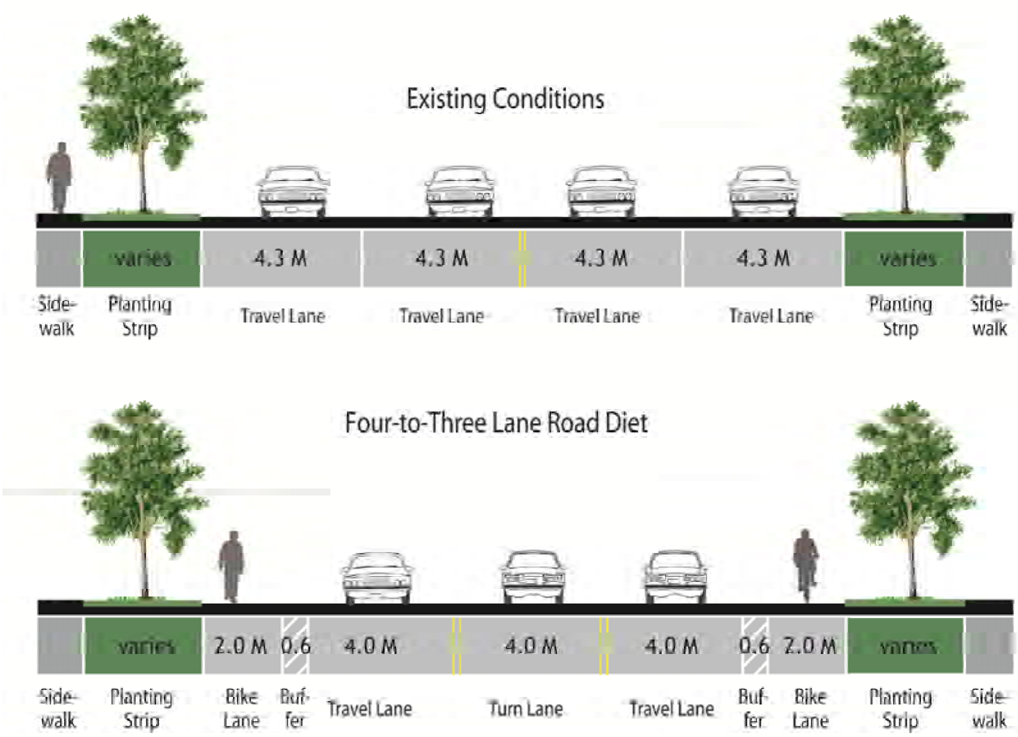
Discussion

The removal of a single travel lane will generally provide sufficient space for bicycle lanes on both sides of a street. Streets with excess vehicle capacity provide opportunities for bicycle lane retrofit projects. Depending on a street's existing configuration, traffic operations, user needs, and safety concerns, various lane reduction configurations exist. For instance, a four-lane street (with two travel lanes in each direction) could be modified to include one travel lane in each direction, a center turn lane, and bicycle lanes. Prior to implementing this measure, a traffic analysis should identify impacts.

This treatment is expected to be included in the update to the AASHTO *Guide for the Development of Bicycle Facilities*.

This road was re-striped to convert four vehicle travel lanes into three travel lanes with bicycle lanes.

Guidance



Example of vehicle travel lane reconfiguration to accommodate bicycle lanes.

1.6.2.12. Retrofitting Existing Streets with Bicycle Lanes

Parking Reduction (Road Diet 3)

Design Summary

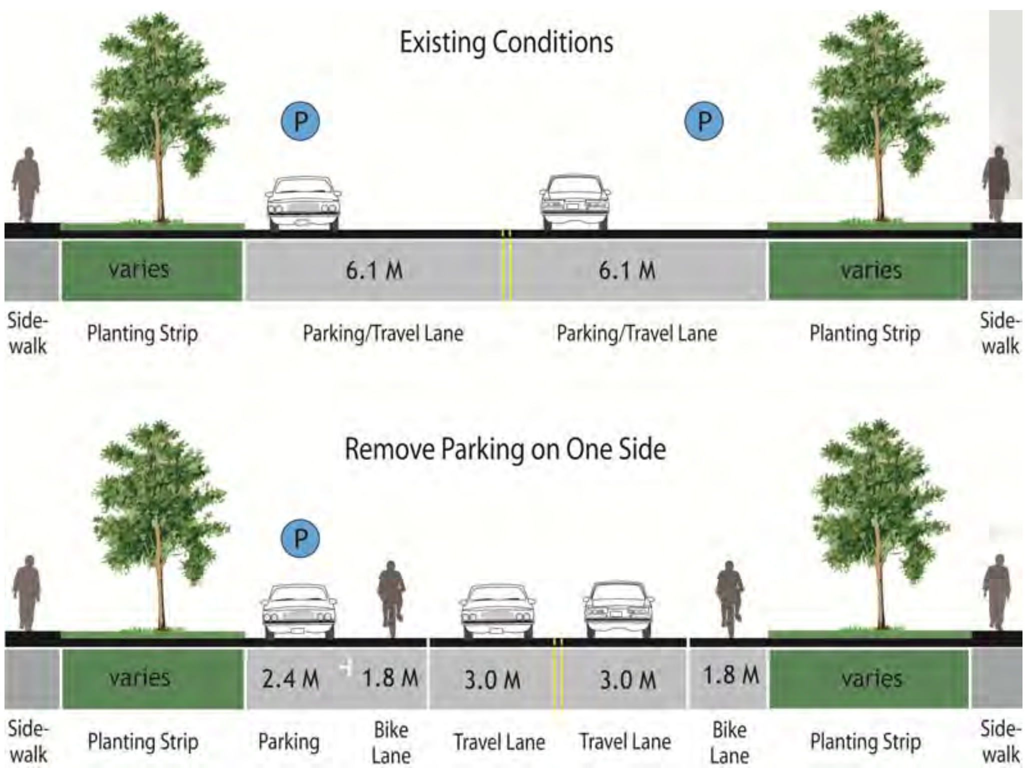
See guidance for bicycle lanes, Section 1.6.2.1 to 1.6.2.6.

Discussion

Bicycle lanes could replace one or more on-street parking lanes on streets where excess parking exists and/or the importance of bicycle lanes outweighs parking needs. For instance, parking may be needed on only one side of a street (as shown below and at right). Eliminating or reducing on-street parking also improves sight distance for cyclists in bicycle lanes and for motorists on approaching side streets and driveways. Prior to reallocating on-street parking for other uses, a parking study should be performed to gauge demand and to evaluate impacts to people with disabilities.

Some streets may not require parking on both sides

Guidance



Example of parking removal to accommodate bicycle lanes.

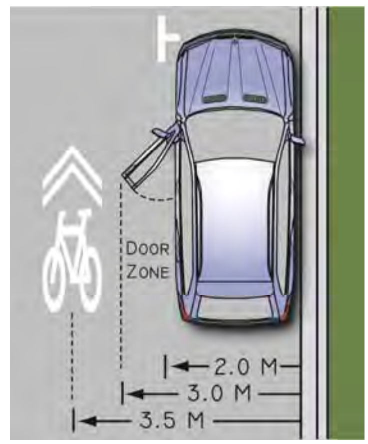
1.7. Shared Roadways

On shared roadways, cyclists physically share a travel lane with motor vehicles... The TAC defines two types of 'Shared Use Lanes:' one that is wider than a normal travel lane, where space for bicycles and motor vehicles are not separated by longitudinal pavement markings and users operate side by side. The other consists of a normal width travel lane, where motor vehicles and bicycles are expected to operate in single file.

1.7.1. Marked Wide Curb Lanes

Design Summary

- Side-by-side 'shared use lane' application should not be used on streets with posted speeds greater than 60 km/h and lane widths narrower than 4.0m. Where the travel lane less than 4.0 m and posted speed is 50 km/h or less, place stencils in the centre of the travel lane (see shared lane and neighbourhood bikeway treatments).
- The width of the door zone is generally assumed to be 0.75 m from the edge of the parking lane.
- Recommended placement:
  - 3.5 m minimum from face of curb (or shoulder edge) on streets with on-street parking.
  - At least 1.0 m from face of curb (or shoulder edge) on streets without on-street parking.
  - Place immediately after an intersection, 10 m before the end of the block, and spaced at intervals no greater than 75 m.
- Shared the road signage should be provided with this treatment.

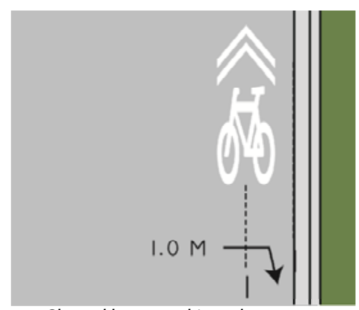


Shared lane marking placement guidance for streets with on-street parking.

Discussion

Wide curb lanes are marked with shared lane markings (also known as "sharrows"), which are high-visibility pavement markings that help position bicyclists within the travel lane. These markings are often used on streets where dedicated bicycle lanes are desirable but are not possible due to physical or other constraints.

Shared lane markings are placed strategically in the travel lane to alert motorists of bicycle traffic, while also encouraging cyclists to ride at an appropriate distance from the "door zone" of adjacent parked cars. Placed in a linear pattern along a corridor, shared lane markings also encourage cyclists to ride in a straight line so their movements are predictable to motorists. These pavement markings have been successfully used in many communities throughout North America. Shared lane markings made of thermoplastic tend to last longer than painted ones.



Shared lane marking placement guidance for streets without on-street parking.

Guidance

- TAC *Guidelines for the Design and Application of Bikeway Pavement Markings.*
- AASHTO *Guide for the Development of Bicycle Facilities.*
- The guidance provided in this sheet addresses the 'side-by-side application of shared lane makings, rather than on a queuing street.
- The following page shows a selection of treatments where shared lane markings are used along bikeway facilities.

TAC signs WC-47 and WC-47S should be used in shared lanes.

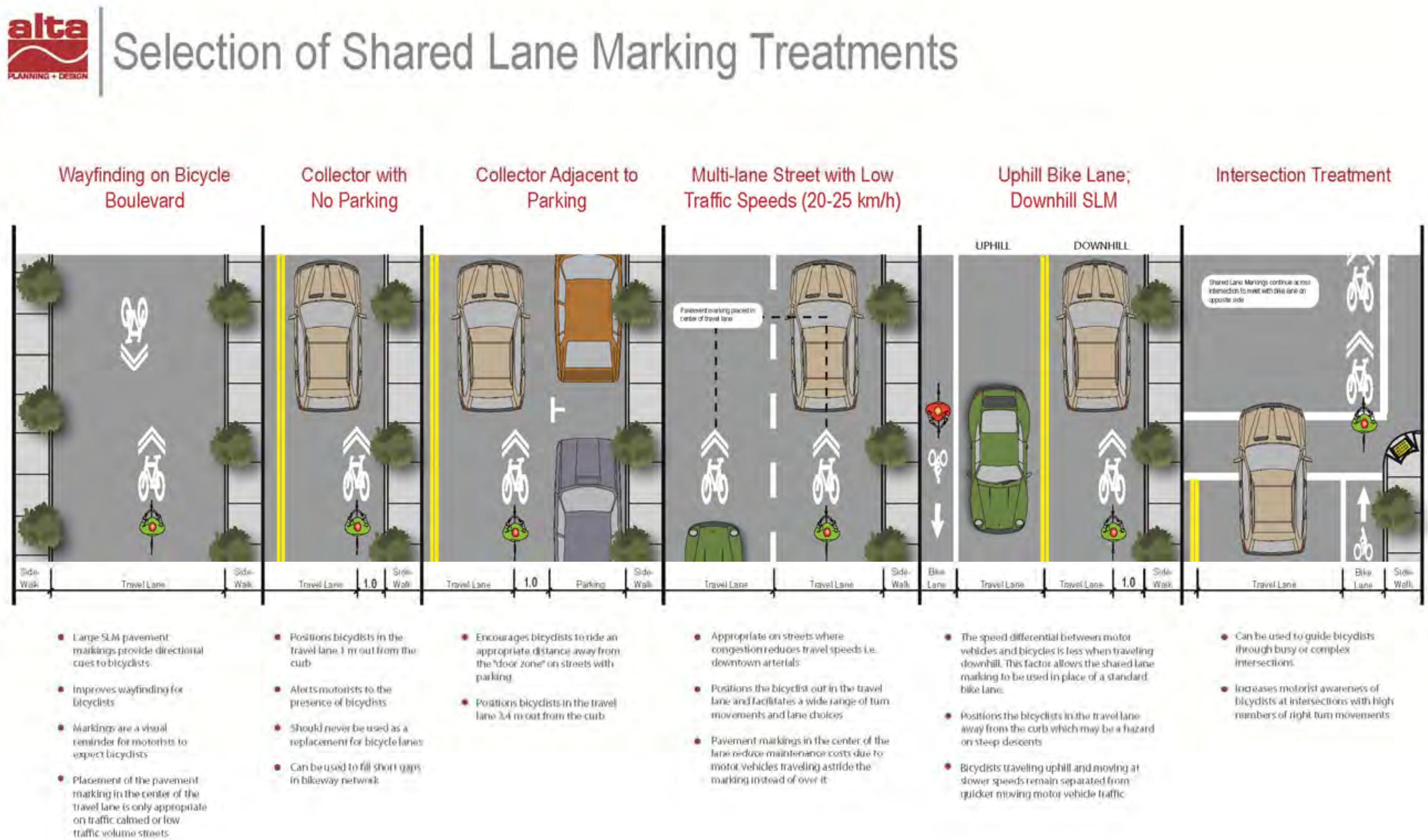


Figure 9. Overvire of Shared Lane Marking Treatments

1.7.2. Shared Lane

Design Summary

- Travel lane minimum width: 2.8 m for low volume streets (less than 3,000 vpd) with little or no truck or bus traffic (City of Victoria standard).
- Minimum width for unmarked parking/travel lane: 5.3 m.
- Indicated by "Bike Route" signage (TAC sign IB-23); can include pavement markings, wayfinding, or 'Share the Road" signage.
- On roads with higher speeds and/or volume, shared lane markings may be appropriate (see Section 1.4).

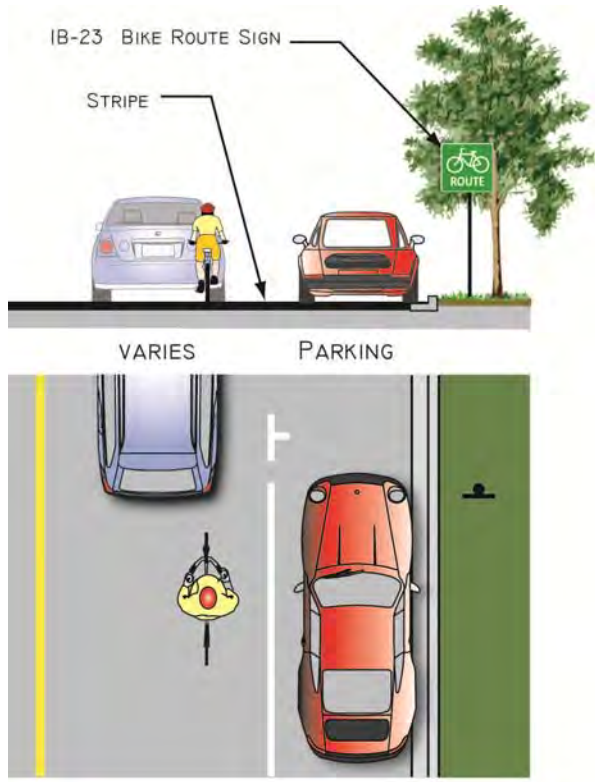
Discussion

A treatment appropriate for more experienced riders, particularly commuters, designated 'shared routes' are bikeways where cyclists and motorists physically share a standard travel lane, often with insufficient space for the automobile to pass a cyclist without merging into the opposite lane.

Shared routes are typically applied on collector or arterial roads which provide key connections to trails, schools, parks, or other important destinations where no other facilities are provided. The TAC *Geometric Design Guide for Canadian Roads* notes that, "As motor vehicle traffic volumes and speeds, and truck traffic, increase, the width of the travel lane should be widened in order to permit motorists and cyclists to pass without changing lanes."

Shared routes are designated exclusively by signage, i.e. there are no specific road markings associated with them.

Shared routes are applied on urban roadways with or without on-street parking. This type of bike route can also be developed on rural roadways without curb and gutter.



Shared route/shared roadway design.

Shared lanes use "Bike Route" signs to designate bikeways on local streets.

Guidance

- TAC *Geometric Design Guide for Canadian Roads* Chapter 3: Bicycles; Section 3.4.3.1. Widths are discussed in section 3.4.6.2.

1.7.3. Neighbourhood Bikeways

Design Summary

- Roadway width varies depending on roadway configuration.
- Use "Bike Route" signs.
- Shared lane markings may be applied per the previous section.
- Intersection treatments, traffic calming, and traffic diversions can be utilized to improve the cycling environment, as recommended in the following pages.

Neighbourhood bikeways are low-speed streets that provide a comfortable and pleasant experience for cyclists.

Discussion

Neighbourhood bikeways (also referred to as "bicycle boulevards" or "local street bikeways") are low-volume streets where motorists and bicyclists share the same space. Treatments for neighbourhood bikeways include five "application levels" based on their level of physical intensity, with Level 1 representing the least physically-intensive treatments that could be implemented at relatively low cost. Identifying appropriate application levels for individual corridors provides a starting point for selecting appropriate site-specific improvements.

Traffic calming and other treatments along the corridor reduce vehicle speeds so that motorists and bicyclists generally travel at the same speed, creating a safer and more-comfortable environment for all users. Neighbourhood bikeways incorporate treatments to facilitate safe and convenient crossings where the route crosses a major street. They work best in well-connected street grids where riders can follow reasonably direct and logical routes and when higher-order parallel streets exist to serve through vehicle traffic. When constructing neighbourhood bikeways, the CRD should consider repaving if the street is potholed.

Neighbourhood bikeways incorporate wayfinding signage to guide cyclists.

Guidance

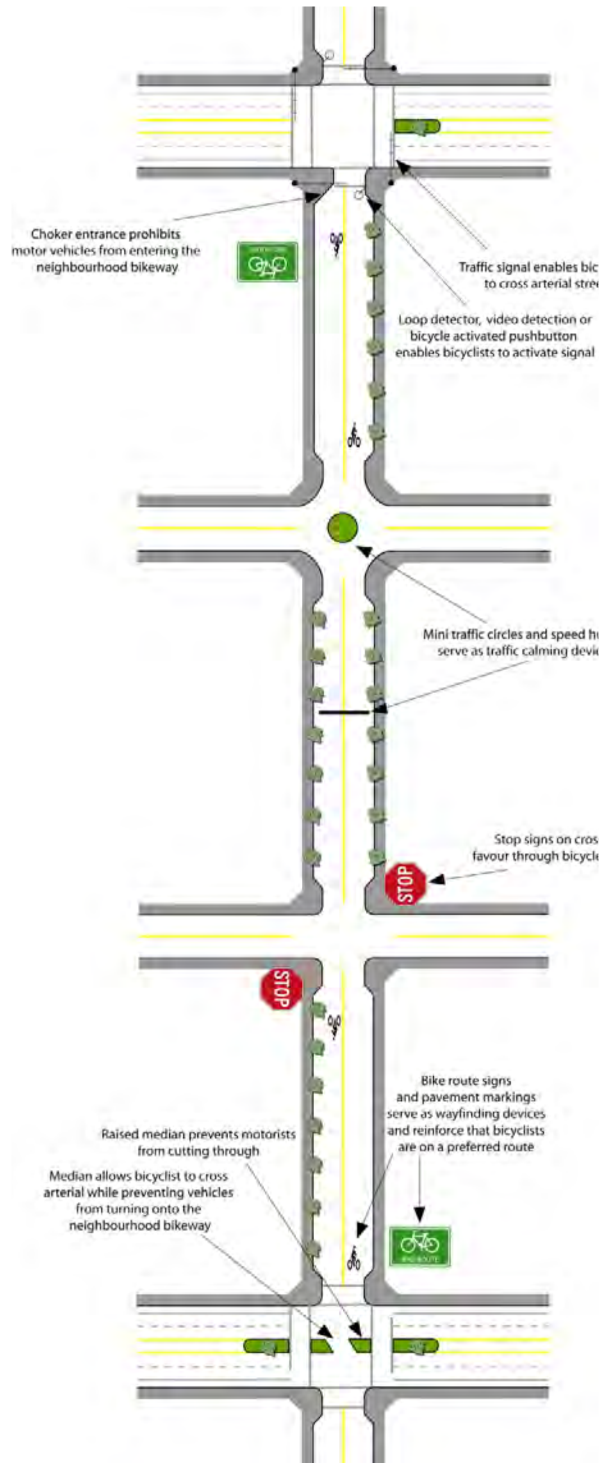
- Neighbourhood bikeways have been implemented in Berkeley, Emeryville, Palo Alto, San Luis Obispo, and Pasadena, CA; Portland and Eugene, OR; Vancouver, BC; Tucson, AZ; Minneapolis, MN; Ocean City, MD; and Syracuse, NY.
- Alta Planning + Design and IBPI. *Bicycle Boulevard Planning and Design Handbook.* www.ibpi.usp.pdx.edu/guidebook.php
- City of Berkeley. (2000). *Bicycle Boulevard Design Tools and Guidelines*. http://www.ci.berkeley.ca.us/contentdisplay.aspx?id=6652
- AASHTO *Guide for the Development of Bicycle Facilities.*

1.7.3. Neighbourhood Bikeways

Additional Guidance

Neighbourhood bikeways serve a variety of purposes:

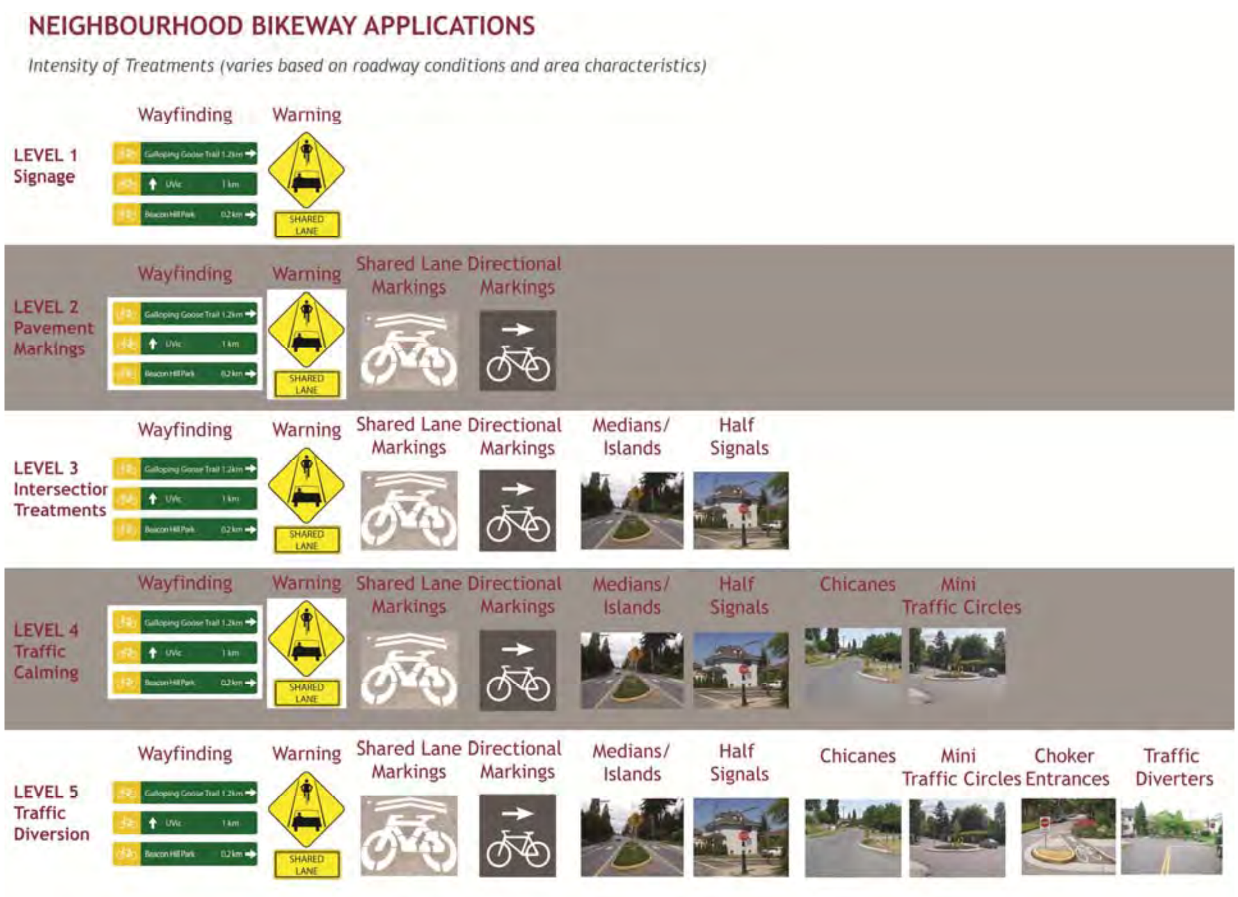
- Parallel major streets lacking dedicated bicycle facilities: Higher-order streets such as arterials and major collectors typically include major bicyclist destinations (e.g., commercial and employment areas, and other activity centers). However, these corridors often lack bicycle lanes or other dedicated facilities thereby creating an uncomfortable, unattractive and potentially unsafe riding environment. Neighbourhood bikeways serve as alternate parallel facilities allowing cyclists to avoid major streets for longer trip segments.
- Parallel major streets with bicycle facilities that are uncomfortable for some users: Some users may not feel comfortable using bicycle lanes on major streets for various reasons, including high traffic volumes and vehicle speeds, conflicts with motorists entering and leaving driveways, and/or conflicts with buses occupying the bicycle lane while loading and unloading passengers. Children and less-experienced riders might find these environments especially challenging. Utilizing lower-order streets, neighbourhood bikeways provide alternate route choices for bicyclists uncomfortable using the major street network. It should be noted however that bicycle lanes on major streets provide important access to key land uses, and the major street network often provides the most direct routes between major destinations. For these reasons, neighbourhood bikeways should complement a bicycle lane network and not serve as a substitute.
- Ease of implementation on most local streets: neighbourhood bikeways incorporate cost-effective and less physically-intrusive treatments than bicycle lanes and cycle tracks. Most streets could be provided relatively inexpensive treatments like new signage, pavement markings, striping and signal improvements to facilitate bicyclists' mobility and safety. Other potential treatments include curb extensions, medians, and other features that can be implemented at reasonable cost and are compatible with emergency vehicle accessibility.
- Benefits beyond an improved bicycling environment: Residents living on neighbourhood bikeways benefit from reduced vehicle speeds and through traffic, creating a safer and more-attractive environment. Pedestrians and other users can also benefit from bikeway treatments (e.g., by improving the crossing environment where neighbourhood bikeways meet major streets).



Sample neighbourhood bikeway treatments.

1.7.3. Neighbourhood Bikeways

Neighbourhood Bikeway Application Levels



It should be noted that corridors targeted for higher-level applications would also receive relevant lower-level treatments. For instance, a street targeted for Level 3 applications should also include Level 1 and 2 applications as necessary. It should also be noted that some applications may be appropriate on some streets while inappropriate on others. In other words, it may not be appropriate or necessary to implement all "Level 2" applications on a Level 2 street. Furthermore, several treatments could fall within multiple categories as they achieve multiple goals. To identify and develop specific treatments for each neighbourhood bikeway, the CRD's member municipalities should involve the bicycling community and neighbourhood groups. Further analysis and engineering work may also be necessary to determine the feasibility of some applications.

The CRD should strive to implement neighbourhood bikeways of Level 3 or higher, with additional traffic calming or diversion as needed.

1.7.3.1. Level 1: Neighbourhood Bikeway Signing

Design Summary

- Signage is a cost-effective yet highly-visible treatment that can improve the riding environment on a bicycle boulevard.
- The CRD should adopt consistent signage and paint markings throughout the region.
- Where the travel lane less than 4.0 m and the posted speed limit is 50 km/h or less, use "Shared Use Lane Single File" sign.

Wayfinding signs like this sign from Vancouver, B.C. help bicyclists stay on designated bicycle routes.

Discussion

<u>Wayfinding Signs</u>

Wayfinding signs are typically placed at key locations leading to and along neighbourhood bikeways, including where multiple routes intersect and at key bicyclist "decision points." Wayfinding signs displaying destinations, distances and "riding time" can dispel common misperceptions about time and distance while increasing users' comfort and accessibility to the boulevard network.

Wayfinding signs also visually cue motorists that they are driving along a bicycle route and should correspondingly use caution. Note that too many signs tend to clutter the right-of-way, and it is recommended that these signs be posted at a level most visible to bicyclists and pedestrians, rather than per vehicle signage standards.

<u>Warning signs</u>

Warning signs advising motorists to "share the road" and "watch for bicyclists" as well as those warning cyclists about pedestrian crossings may also improve conditions on shared streets. These signs are especially useful near major bicycle trip generators such as schools, parks and other activity centers. Warning signs should also be placed on major streets approaching neighbourhood bikeways to alert motorists of bicyclist crossings.

The shared use single lane single file sign is recommended in the TAC Traffic Control Guidelines (2010 DRAFT)

Guidance

- Alta Planning + Design and IBPI. *Bicycle Boulevard Planning and Design Handbook.*
- City of Berkeley. (2000). *Bicycle Boulevard Design Tools and Guidelines.*
- AASHTO *Guide for the Development of Bicycle Facilities.*
- TAC *Traffic Control Guidelines for Canada* (2010 DRAFT).

1.7.3.2. Level 2: Neighbourhood Bikeway Pavement Markings

Design Summary

- Pavement markings identify the roadway as a neighbourhood bikeway for cyclists and drivers, and provide wayfinding and traffic guidance.
- Where the travel lane less than 4.0 m and the posted speed limit is 50 km/h or less, place stencils s in the centre of the travel lane to allow single file bicycle and motor vehicle operations.

Discussion

<u>Directional Pavement Markings</u>

Directional pavement markings (also known as "breadcrumbs") lead cyclists along a neighbourhood bikeway and reinforce the notion that they are on a designated route. Markings can take a variety of forms, such as small bicycle symbols placed every 200-250 m along a linear corridor. When a neighbourhood bikeway follows several streets (with multiple turns at intersections), additional markings accompanied by directional arrows are provided to guide cyclists through turns and other complex routing areas. Directional pavement markings also visually cue motorists that they are traveling along a bicycle route and should exercise caution.

Shared lane markings are often used on streets where dedicated bicycle lanes are desirable but not possible due to physical or other constraints. Such markings delineate specifically where bicyclists should operate within a shared vehicle/bicycle travel lane. See shared lane marking guidelines (Section 1.7.1) for additional information on this treatment.

<u>On-Street Parking Delineation</u>

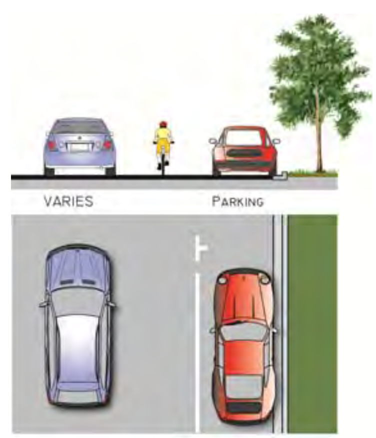
Delineating on-street parking spaces with paint or other materials clearly indicates where a vehicle should be parked, and can discourage motorists from parking their vehicles too far into the adjacent travel lane. This helps cyclists by maintaining a wide enough space to safely share a travel lane with moving vehicles while minimizing the need to swerve farther into the travel lane to manoeuvre around parked cars. Delineated parking spaces also promote efficient use of on-street parking by maximizing the number of spaces in high-demand areas.

<u>Centreline Striping Removal</u>

Automobiles have an easier time passing cyclists on roads without centerline stripes for the majority of the block length. If vehicles cannot easily pass each other using the full width of the street, it is likely that there is too much traffic for the subject street to be a successful neighbourhood bikeway. In addition, not striping the centerline reduces maintenance costs. This treatment may increase speeds, and additional treatments such as traffic circles should be used in conjunction with this treatment.

Neighbourhood bikeway directional marker used in Vancouver, B.C.

Shared lane markings also provide directional support for bicyclists.



Example of on-street parking delineation.

Guidance

- Alta Planning + Design and IBPI. *Bicycle Boulevard Planning and Design Handbook.*
- City of Berkeley. (2000). *Bicycle Boulevard Design Tools and Guidelines.*
- AASHTO *Guide for the Development of Bicycle Facilities.*
- TAC *Traffic Control Guidelines for Canada* (2010 DRAFT).

1.7.3.3. Level 3: Neighbourhood Bikeways at Minor Unsignalized Intersections

Design Summary

- To encourage use of the bikeways and improve cyclists' safety, reduce bicycle travel time by eliminating unnecessary stops and improving intersection crossings by improving visibility.

Discussion

Stop Sign on Cross-Street

Uncontrolled intersections are dangerous for bicyclists because cross-traffic may not be watching for cyclists. At a minimum, all intersections along a designated bikeway should be stop controlled.

Where stop signs are facing every other block, turning signs along the bikeway to stop the cross streets should be considered to maximize through-bicycle connectivity and momentum. This treatment should be combined with traffic-calming such as traffic circles to prevent excessive vehicle speeds on the neighbourhood bikeway.

Curb Bulb-outs and High-Visibility Crosswalks

This treatment is appropriate near activity centers with large amounts of pedestrian activity such as schools or commercial areas. The bulb-outs should only extend across the parking lane and should not obstruct bicyclists' path of travel or the travel lane.

Curb bulb-outs and high-visibility crosswalks both calm traffic and also increase the visibility of pedestrians waiting to cross the street, although they may impact on-street parking.

Bicycle Forward Stop Bar

A second stop bar for cyclists placed closer to the centerline of the cross street than the drivers' stop bar increases the visibility of cyclists waiting to cross a street. This treatment is typically used with other crossing treatments (i.e. curb extension) to encourage cyclists to take full advantage of crossing design. They are appropriate at unsignalized crossings where fewer than 25 percent of motorists make a right turn movement.

Stop signs effectively minimize conflicts along neighbourhood bikeways.

Curb bulb-outs can be a good location for pedestrian amenities, including street trees.

Bicycle forward stop bars encourage cyclists to wait where they are more visible.

Guidance

- Alta Planning + Design and IBPI. *Bicycle Boulevard Planning and Design Handbook.*
- City of Berkeley. (2000). *Bicycle Boulevard Design Tools and Guidelines.*
- AASHTO *Guide for the Development of Bicycle Facilities.*
- TAC *Traffic Control Guidelines for Canada* (2010 DRAFT).

1.7.3.4. Neighbourhood Bikeways at Offset Intersections

Design Summary

- Provide turning lanes or pockets at offset intersection, providing cyclists with a refuge to make a two-step turn.
- Bike turn pockets – 1.2 m wide, with a total of 3.4m required for both turn pockets and center striping.

Example of a bicycle left-turn pocket.

Discussion

Offset intersection can be challenging for cyclists, who need to transition onto the busier cross-street in order to continue along the boulevard.

Bicycle Left-Turn Lane

Similar to medians/refuge islands, bicycle left-turn lanes allow the crossing to be completed in two phases. A bicyclist on the boulevard could execute a right-hand turn onto the cross-street, and then wait in a delineated left-turn lane (if necessary to wait for a gap in oncoming traffic). The bike turn pockets should be at least 1.2m wide, with a total of 3.4m for both turn pockets and center striping.

This bike-only left-turn pocket guides cyclists along a popular bike route.

Bicycle Left Turn Pocket

A bike-only left-turn pocket permits bicyclists to make left turns while restricting vehicle left turns. If the intersection is signal-controlled, a left arrow signal may be appropriate, depending on bicycle and vehicle volumes. Signs should be provided prohibiting motorists from turning. Ideally, the left turn pocket should be protected by a raised curb, but the pocket may also be defined by striping if necessary. Because of the restriction on vehicle left-turning movements, this treatment also acts as traffic diversion.

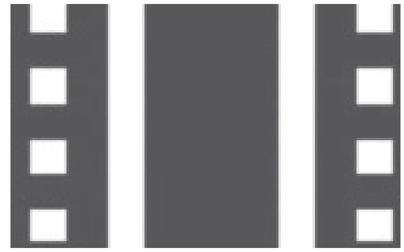
Guidance

- Alta Planning + Design and IBPI. *Bicycle Boulevard Planning and Design Handbook.* www.ibpi.usp.pdx.edu/guidebook.php
- AASHTO Guide for the Development of Bicycle Facilities.
- TAC Traffic Control Guidelines for Canada (2010 DRAFT).

1.7.3.5. Level 3: Neighbourhood Bikeways at Major Unsignalized Intersections

Design Summary

- Increase crossing opportunities by providing more crossing gaps.
- Bicycle signals may be appropriate for use where high levels of bicycle traffic on a minor street cross a major street. Instructional and regulatory signage should be included with installation of a bicycle signal.



Elephants' feet indicate separated bicycle and pedestrian space at crossings.

Discussion

Crossbikes/Elephant's Feet Markings

Shared pedestrian/cyclist crossings are identified by both standard crosswalk markings and 'elephant's feet' markings, with the crossbike markings on each side of the standard crosswalk. Separate crossbikes are provided adjacent to the standard crosswalk marking or independently. Cyclists must yield to pedestrians. Crosswalks/bikes should not be installed unless warranted, based on TAC standards and engineering judgement.

Paint markings such as pedestrian and bicycle stencils or colour treatment, as well as "Cyclists May Use Crosswalk" signs can accompany crossbikes to indicate to all users that cyclists may use the crossing. Unless such a sign is present or if the use of crosswalks by cyclists is permitted by a municipal bylaw, it remains illegal for cyclists to ride in a crosswalk.

Use of elephant's feet markings in Vancouver, B.C.

Medians/Refuge Islands

At uncontrolled intersections of neighbourhood bikeways and major streets, a bicycle crossing island can be provided to allow cyclists to cross one direction of traffic at a time when gaps in traffic allow. The bicycle crossing island should be at least 2.4 m wide (measured perpendicular to the centerline of the major road) to be used as the bike refuge area.

Narrower medians can accommodate bikes if the holding area is at an acute angle to the major roadway, which allows stopped cyclists to face oncoming motorists. Railings can also be provided so bicyclists do not have to put their feet down, thus making it quicker to start again. Crossing islands can be placed in the middle of the intersection, thus prohibiting left and thru vehicle movements.

Medians on bicycle boulevards should provide space for a bicyclist to wait.

Bicycle- and Pedestrian-Actuated Signals

Where cyclists have few crossable gaps and where vehicles on the major street do not stop for pedestrians and cyclists waiting to cross, "half signals" could be installed to improve the crossing environment. Bicycle signals can be actuated with bicycle sensitive loop detectors, video detection, or push buttons. The City of Vancouver uses the pedestrian signal warrant to determine the need for signals along bikeways, although the City's policy is to signalize all arterial crossings on neighbourhood bikeways. Additional information can be found on page 77.

Half-signals for bicyclists should be clearly marked to minimize confusion.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.
- TAC Traffic Control Guidelines for Canada (2010 DRAFT).

1.7.3.6. Level 4: Neighbourhood Bikeway Traffic Calming

Design Summary

- Traffic calming treatments reduce vehicle speeds to the point where they generally match cyclists' operating speeds, enabling motorists and cyclists to safely co-exist on the same facility.
- Use engineering judgement in determining proper use and appropriateness of traffic calming treatments.

Discussion

Chicanes

Chicanes are a series of raised or delineated curb extensions on alternating sides of a street forming an S-shaped curb, which reduce vehicle speeds through narrowed travel lanes. Chicanes can also be achieved by establishing on-street parking on alternate sides of the street. These treatments are most effective on streets with narrower cross-sections.

Mini Traffic Circles

Mini traffic circles are raised or delineated islands placed at intersections, reducing vehicle speeds through tighter turning radii and narrowed vehicle travel lanes (see right). These devices can effectively slow vehicle traffic while facilitating all turning movements at an intersection. Mini traffic circles can also include a paved apron to accommodate the turning radii of larger vehicles like fire trucks or school buses.

Speed Humps

Speed humps are rounded raised areas of the pavement requiring approaching motor vehicles to reduce speed. These devices also discourage through vehicle travel on a street when a parallel route exists. Speed humps should not be used on emergency vehicle routes, which do not tend to be good candidates for neighbourhood bikeway treatments.

Speed humps should never be constructed so steep that they may cause a bicyclist to lose control of the bicycle or be distracted from traffic. In some cases, a gap could be provided, whereby a bicyclist could continue on the level roadway surface, while vehicles would slow down to cross the barrier.

Chicanes require all vehicles to slow down.

Traffic circles provide an opportunity for landscaping, but visibility should be maintained.

Speed humps are a common traffic calming treatment.

Guidance

- Alta Planning + Design and IBPI. *Bicycle Boulevard Planning and Design Handbook.* www.ibpi.usp.pdx.edu/guidebook.php
- City of Berkeley. (2000). Bicycle Boulevard Design Tools and Guidelines.
- AASHTO Guide for the Development of Bicycle Facilities.

1.7.3.7. Level 5: Neighbourhood Bikeway Traffic Diversion

Design Summary

- Traffic diversion treatments maintain thru-bicycle travel on a street while physically restricting thru vehicle traffic.
- Traffic diversion is most effective when higher-order streets can sufficiently accommodate the diverted traffic associated with these treatments.

Discussion

Choker Entrances

Choker entrances are intersection curb extensions or raised islands allowing full bicycle passage while restricting vehicle access to and from a neighbourhood bikeway. When they approach a choker entrance at a cross-street, motorists on the neighbourhood bikeway must turn onto the cross-street while cyclists may continue forward. These devices can be designed to permit some vehicle turning movements from a cross-street onto the neighbourhood bikeway while restricting other movements.

Right In/Right Out Islands

Right-in right-out channelization is used to control left-turn movements into and out of road approaches. These islands prevent automobile thru-movement on the neighbourhood bikeway, while restricting left turns onto the bikeway.

Traffic Diverters

Traffic diverters are raised features directing vehicle traffic off the neighbourhood bikeway while permitting thru travel. Traffic diverters provide traffic calming and safety benefits by reducing vehicle volumes on the neighbourhood bikeway. However, they may have narrow travel lanes, reduce on-street parking and limit local access.

Guidance

- Alta Planning + Design and IBPI. Bicycle Boulevard Planning and Design Handbook.
- City of Berkeley. (2000). Bicycle Boulevard Design Tools and Guidelines.
- AASHTO Guide for the Development of Bicycle Facilities.
- Oregon Department of Transportation. (1998). *Right-In Right-Out Channelization.* http://www.oregon.gov/ODOT/HWY/ACCESSMGT/docs/RtInRtOut.pdf?ga=t

Choker entrances prevent vehicular traffic from turning from a main street onto a traffic-calmed neighbourhood bikeway.

Right in/right out islands prohibit thru-vehicle traffic on a neighbourhood bikeway.

Traffic diverters prevent access to both directions of motor vehicle traffic.

2. On-Street Pedestrian Facilities

Sidewalks, multi-use trails, and roadway shoulders are typically recognized as pedestrian facilities. Pedestrian travel is accommodated and enhanced by intersection treatments such as crosswalks, curb ramps, as well as boulevards and other amenities.

2.1. Accessibility Guidelines

Design Summary

Universal design' is designed to make places and routes accessible to all people, whether they have a disability or not. Universal design extends to curb ramps, walking and roadway surfaces, push-buttons for signal activation, signage standards, and many other elements of the pedestrian and bicycle environment. Universal design principles are beneficial to all users of the transportation network; curb ramps are essential for pushing strollers or grocery carts, and highly-visible signage can be read by pedestrians of all ages.

Discussion

The Center for Universal Design at North Carolina State University lays out the following universal design principles:

- **Equitable use**: the design is useful and marketable to people with diverse abilities.
  - Provide the same means of use for all users: identical whenever possible; equivalent when not.
  - Avoid segregating or stigmatizing any users.
  - Provisions for privacy, security, and safety should be equally available to all users.
  - Make the design appealing to all users.
- **Flexibility in use**: The design accommodates a wide range of individual preferences and abilities.
  - Provide choice in methods of use.
  - Accommodate right- or left-handed access and use.
  - Facilitate the user's accuracy and precision.
  - Provide adaptability to the user's pace.
- **Simple and intuitive**: Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
  - Eliminate unnecessary complexity.
  - Be consistent with user expectations and intuition.
  - Accommodate a wide range of literacy and language skills.
  - Arrange information consistent with its importance.
  - Provide effective prompting and feedback during and after task completion.
- **Perceptible information**: The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
  - Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.
  - Provide adequate contrast between essential information and its surroundings.
  - Maximize "legibility" of essential information.
  - Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).
  - Provide compatibility with a variety of techniques or devices used by people with sensory limitations.
- **Tolerance for error**: The design minimizes hazards and the adverse consequences of accidental or unintended actions.
  - Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements

2.1. Accessibility Guidelines

eliminated, isolated, or shielded.
- o Provide warnings of hazards and errors.
- o Provide fail safe features.
- o Discourage unconscious action in tasks that require vigilance.
- **Low physical effort**: The design can be used efficiently and comfortably and with a minimum of fatigue.
  - o Allow user to maintain a neutral body position.
  - o Use reasonable operating forces.
  - o Minimize repetitive actions.
  - o Minimize sustained physical effort
- **Size and space for approach and use**: Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.
  - o Provide a clear line of sight to important elements for any seated or standing user.
  - o Make reach to all components comfortable for any seated or standing user.
  - o Accommodate variations in hand and grip size.
  - o Provide adequate space for the use of assistive devices or personal assistance.[3]

Guidance

- BC Parks. (No date). *Trail Design and Construction Standards Manual*. www.trailstobuild.com/Articles/BC%20Trail%20Standards/contents.htm
- British Columbia Office of Housing and Construction Standards. (2007). *Building Access Handbook*. http://www.housing.gov.bc.ca/building/docs/building_access_handbook_2007.pdf
- Capital Regional District Parks. (2003). *Everyone's parks and trails: a universal access plan for CRD Parks.* http://www.crd.bc.ca/parks/documents/access_plan.pdf
- City of Victoria. (2008). *City of Victoria Pedestrian Master Plan* http://www.victoria.ca/cityhall/eng_pdstrn.shtml
- Saanich Parks & Recreation. (2007). *Saanich Parks & Recreation Trail Guidelines.*
- *BC Transit Accessibility*
- *Access to Transit* – Saanich Design Guidelines
- Association of Municipal Managers, Clerks & Treasurers of Ontario. (2010 Draft). *Ontario Accessibility Toolkit.* http://www.accessiblemunicipalities.ca/home.asp?itemid=13949
- City of Ottawa (2009 Draft). *Ottawa Pedestrian Plan.* www.ottawa.ca/residents/onthemove/walking/pedestrian/pedestrian_plan_en.html
- Federal Highway Administration. (2001). *Designing Sidewalks and Trails for Access.* http://www.fhwa.dot.gov/environment/sidewalk2/contents.htm
- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines (PROWAG).* Washington, D.C. http://www.access-board.gov/PROWAC/alterations/guide.htm
- United States Access Board. (2002). *Accessibility Guidelines for Buildings and Facilities*. Washington, D.C. http://www.access-board.gov/adaag/html/adaag.htm

Best practices review of accessibility plans and policies are based on the United States *Americans with Disabilities Act* (ADA), as well as the *BC Parks Trail Design and Construction Standards Manual*, the *BC Building Access Handbook*, and the CRD's, *Everyone's parks and trails: a universal access plan for CRD Parks* (2003). Although there is no Canada-wide equivalent to the ADA, it should be noted that in 2005 the Province of Ontario passed the Accessibility for Ontarians with Disabilities Act (AODA) to develop, implement and enforce mandatory accessibility standards. The first standard to come into effect is the Accessibility Standards for Customer Service; other standards currently under development include the built environment (buildings and other structures) and transportation, among others.[4]

[3] University of North Carolina, Center for Universal Design. *Universal Design Principles*. http://www.design.ncsu.edu/cud/about_ud/udprincipleshtmlformat.html#top
[4] Draft AODA guidelines are available at: http://www.accessiblemunicipalities.ca/home.asp?itemid=13949

2.1. Accessibility Guidelines

2.2. Sidewalks

Design Summary

Attributes of well-designed sidewalks include the following:

- **Accessibility**: A network of sidewalks shall be accessible to all users.
- **Adequate width:** Two people should be able to walk side-by-side and pass a third comfortably, and different walking speeds should be possible. In areas of intense pedestrian use, sidewalks should accommodate the high volume of walkers.
- **Safety:** Design features of the sidewalk should allow pedestrians to have a sense of security and predictability. Sidewalk users should not feel they are at risk due to the presence of adjacent traffic.
- **Continuity:** Walking routes should be obvious and should not require pedestrians to travel out of their way unnecessarily.
- **Landscaping:** Plantings and street trees within the boulevard should contribute to the overall psychological and visual comfort of sidewalk users, and be designed in a manner that contributes to the safety of people.
- **Social space:** There should be places for standing, visiting, and sitting. The sidewalk area should be a place where adults and children can safely participate in public life.
- **Quality of place:** Sidewalks should contribute to the character of neighbourhoods and business districts.

A well-designed sidewalk provides plenty of pedestrian space.

Discussion

Sidewalks are the most fundamental element of the walking network, as they provide an area for pedestrian travel that is separated from vehicle traffic. Sidewalks are typically constructed out of concrete and are separated from the roadway by a curb or gutter and sometimes a landscaped boulevard. Sidewalks are a common application in urban and suburban environments.

Installing new sidewalks can be costly, particularly if drainage improvements such as undergrounding of roadside culverts and installation of curb/gutter are part of the design. However, fixing short gaps in an existing sidewalk network is important to maximize system continuity, and can be a relatively low-cost fix.

Guidance

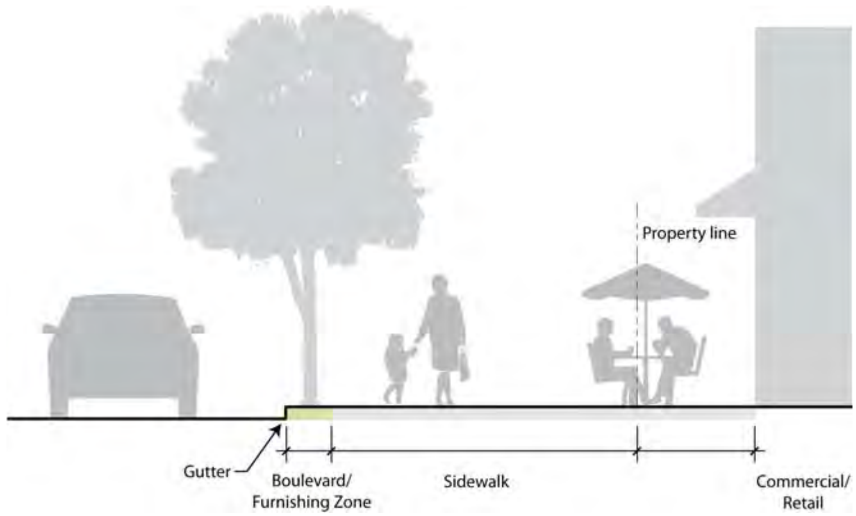
- Standards Council of Canada. (2010). Accessible design for the built environment.
- United States Access Board. (2002). Accessibility Guidelines for Buildings and Facilities.
- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines* (PROWAG).

2.2.1. Zones in the Sidewalk Corridor

Design Summary

The sidewalk corridor is typically located within the public right-of-way between the curb or roadway edge and the property line. The sidewalk corridor contains four distinct zones, which have different purposes.

Recommended and minimum widths are provided following.



Zones in the sidewalk network.

Discussion

<u>The Gutter Zone</u>

Curbs prevent water in the street gutters from entering the pedestrian space, discourage vehicles from driving over the sidewalk, and make it easy to sweep the streets. In addition, the gutter helps define the pedestrian environment within the streetscape, although other designs can be effective for this purpose. At the corner, the curb is an important tactile element for pedestrians who are finding their way with the use of a cane.

<u>The Boulevard/Furnishing Zone</u>

The boulevard buffers pedestrians from the adjacent roadway, and is also the area where elements such as street trees, signal poles, utility poles, street lights, controller boxes, hydrants, signs, parking meters, driveway aprons, grates, hatch covers, and street furniture are properly located. This is the area where people alight from parked cars.

<u>The Sidewalk Zone</u>

The sidewalk is the area intended for pedestrian travel. This zone should be entirely free of permanent and temporary objects.

Guidance

- TAC *Geometric Design Guide for Canadian Roads*, Chapter 2.2: Cross Section Elements, section 2.2.6.1: Sidewalks, Boulevards, and Border Areas.

2.2.2. Sidewalk Widths

Design Summary

- Sidewalk clear width is exclusive of the curb and obstructions. Recommended widths:
  - o Enable two pedestrians (including wheelchair users) to walk side-by-side, or to pass each other comfortably (0.9 metres for each pedestrian)
  - o Allow two pedestrians to pass a third pedestrian without leaving the sidewalk
- Sidewalk width should be increased by a minimum of 0.5 m where sidewalks are directly against the curb, allowing for street hardware, opening car doors, and to provide additional separation from moving traffic
- In areas near hospitals and nursing homes, minimum sidewalk widths should increase by 0.5 metres to accommodate persons in wheelchairs.
- In commercial areas, clear widths of 2.5 metres or more are common to allow for higher pedestrian volumes and storefront window shopping.
- Additional clearance (60 cm) is also recommended for lateral clearance where sidewalks abut retaining walls, fences or similar structures.
- Proposed guidelines apply to new development and depend on available street width, motor vehicle volumes, surrounding land uses, and pedestrian activity levels. Standardizing sidewalk guidelines for different areas of the CRD, dependent on the above listed factors, ensure a minimum level of quality for all sidewalks.

Recommended sidewalk widths (Victoria Pedestrian Plan).

	Furnishing Zone / Boulevard	Sidewalk Zone	Frontage Zone*
Pedestrian districts, arterials	1.2 m	2.5 m †	750 mm
Local streets in pedestrian districts	1.2 m	1.9 m	450 mm
Local service walkways	1.2 m	1.9 m	150 mm
Local service walkways in less dense residential zones	1.2 m	1.5 m	150 mm

* The minimum width of grass boulevards is 1.5 metres.

* In constrained locations, the full sidewalk width should be provided, with a reduced-width planting strip/buffer.

† Short sidewalk segments can have narrower widths in physically-constrained areas.

Discussion

In some cases, it is possible to increase the dimensions of the sidewalk corridor, either through acquisition of right-of-way or public walkway easements, or by re-allocation of the overall right-of-way (such as by narrowing roadway travel lanes or reducing the number of lanes). As part of a roadway reconstruction project on a street with a narrow sidewalk corridor, project planners should first analyze the impact of reclaiming a portion of the existing right-of-way. If this proves impractical, the feasibility of acquiring additional right-of-way should be examined. Acquisition should be considered where its cost is reasonable in proportion to the overall project cost. In the case of infill development, the dedication of public right-of-way or the granting of a public walkway easement to widen the sidewalk corridor may be included as a requirement for obtaining a building permit or land use approval.

Guidance

- Standards Council of Canada. (2010). Accessible design for the built environment.
- City of Victoria. (2008). *City of Victoria Pedestrian Master Plan*
- United States Access Board. (2002). Accessibility Guidelines for Buildings and Facilities.
- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines* (PROWAG).

2.2.3. Sidewalk Surfaces

Design Summary

- Sidewalk surfaces should be smooth and continuous.

Discussion

The selection of sidewalk surface treatments should take into consideration that some patterns and joints may cause vibrations that are uncomfortable for wheelchair users.

It is also desirable that the sidewalk surface be stable, firm and slip resistant. Preferred materials include Portland Cement Concrete (PCC) and Asphalt Concrete (AC). PCC provides a smooth, long-lasting and durable finish that is easy to grade and repair. AC has a shorter life expectancy but may be more appropriate in less urbanized areas and in park settings, although it can be affected by root heave. Crushed aggregate may also be used as an all-weather walkway surface in park areas, but this material generally requires a higher level of maintenance to maintain accessibility.

The *Americans with Disabilities Act* allows a maximum two percent cross-slope on sidewalks and other walkways. Where sidewalks meet driveways, curb cuts or intersections, a 90 centimetre wide area should be maintained with a two percent cross-slope. Curb grades should be 1:12 (8.3%) maximum slope.

Additional sidewalk treatment options can be attractive and increase visibility of pedestrians. Brick is often used in downtown areas that have high pedestrian use, while pervious pavement can be used to minimize environmental and drainage impact.

Newly constructed sidewalks as well as reinstallations incorporated with another roadway project should follow these guidelines.

Guidance

- Alta Planning + Design. (2009). *What's Under Foot? Multi-use Trail Surfacing Options.* http://atfiles.org/files/pdf/AltaTrailSurface.pdf
- United States Access Board. (2002). Accessibility Guidelines for Buildings and Facilities.
- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines* (PROWAG).

Concrete is often used as a multi-use trail material, and also can be used for sidewalks.

Asphalt is a common sidewalk surfacing material.

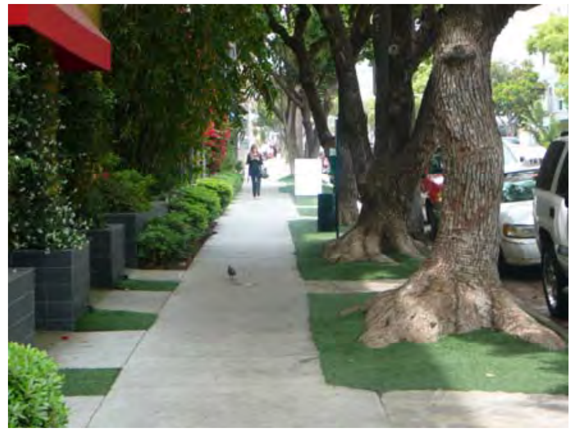
Brick can be an attractive and high-visibility surfacing.

Permeable pavement can be used where drainage is an issue or where tree/sidewalk issues exist.

2.2.4. Sidewalk Furnishing Zone/Boulevards

Design Summary

- Arterial streets - 3.0 m wide (TAC).
- Collector and local streets - 2.0 m wide (TAC).
- Incorporation of boulevards is particularly important on streets with posted speeds of 60 km/h or greater.
- In areas where space is limited and sidewalk widths need to be increased to accommodate high volumes of pedestrians – such as in commercial areas – boulevards may be narrower than the recommended dimension.
- Sidewalks on streets without boulevards should have a wider sidewalk; 1.5m is the recommended minimum for local streets without boulevards.



Boulevards with street trees create a comfortable pedestrian environment

Discussion

Although the boulevard strip within a road right-of-way is not considered a pedestrian facility, its presence significantly contributes to the enhancement of the pedestrian environment. In addition to providing a location for surface and underground utilities, street furniture, traffic signs and other control devices, boulevards – the area between the curb and the sidewalk – provide an important buffer zone between pedestrians and motor vehicle traffic along roadways. Boulevards are desirable for the following reasons:

- They provide increased safety for pedestrians and children at play by separating them from vehicular traffic.
- The probability of vehicle/ pedestrian collisions is reduced in the instance that a vehicle travels outside the roadway and up onto the curb.
- The boulevard provides an area in which to store street hardware such as utility poles, signs, transit shelters, fire hydrants, and newspaper boxes, thereby maintaining minimum clear distances for pedestrians on sidewalks.
- Landscaping can be added to the boulevard to enhance the walking environment for pedestrians.
- Where driveways intersect the sidewalk, the boulevard provides an adequate slope zone for driveway ramps between the curb and the sidewalk. Where sidewalks are provided right up to the curb, sloped driveways create an inconvenience and potential hazard for wheelchair users and elderly pedestrians.
- In situations where sidewalk widths are insufficient to allow a number of pedestrians or wheelchair users to pass, boulevards provide additional width to allow users to comfortably pass each other.
- An area is provided for the storage of snow ploughed off of the roadway and sidewalk.
- Pedestrians are less likely to be splashed by passing vehicles in wet weather.

As with sidewalks, recommend widths for boulevards vary with street classification and land use designation.

Guidance

- TAC Geometric Design Guide for Canadian Roads.
- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines* (PROWAG).

2.2.5. Addressing Sidewalk Obstructions

Design Summary

Obstructions to pedestrian travel in the sidewalk corridor typically include sign posts, utility and signal poles, mailboxes, fire hydrants and street furniture.

Discussion

Obstructions should be placed between the sidewalk and the roadway to create a buffer for increased pedestrian comfort. When sidewalks abut perpendicular or angle on-street parking, wheelstops should be placed in the parking area to prevent parked vehicles from overhanging in the sidewalk. When sidewalks abut hedges, fences, or buildings, an additional 0.6 metres of lateral clearance should be added to provide appropriate shy distance.

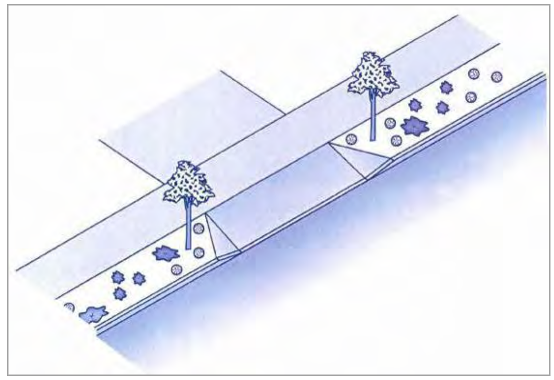
Driveways represent another sidewalk obstruction, especially for wheelchair users. The following techniques can be used to accommodate wheelchair users and other pedestrians at driveway crossings:

- Reducing the number of accesses reduces the need for special provisions. This strategy should be pursued first.
- Constructing wide sidewalks avoids excessively steep driveway slopes. The overall width must be sufficient to avoid an abrupt driveway slope.
- Planter strips allow sidewalks to remain level, with the driveway grade change occurring within the planter strip (top graphic at right).
- Where constraints preclude a planter strip, wrapping the sidewalk around the driveway has a similar effect (middle graphic at right). However, this method may have disadvantages for visually-impaired pedestrians who follow the curb line for guidance.

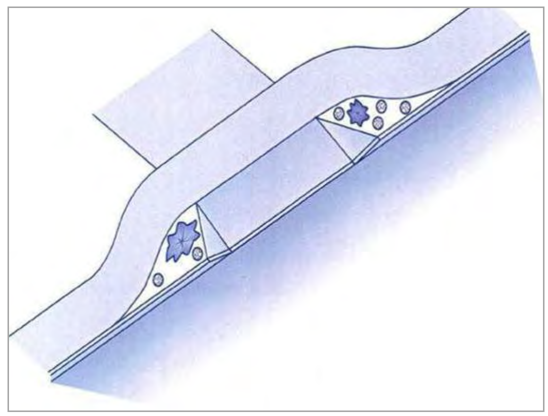
When constraints only allow curb-tight sidewalks, dipping the entire sidewalk at the driveway approaches keeps the cross-slope at a constant grade (bottom graphic at right). However, this may be uncomfortable for pedestrians and could create drainage problems behind the sidewalk.

Guidance

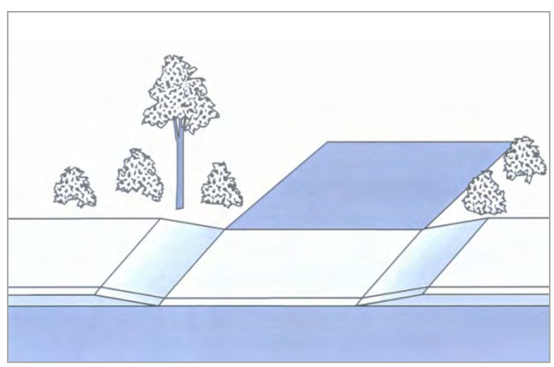
- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines* (PROWAG).



Driveway apron utilizing the planting strip (preferred).



Sidewalk wrapped around driveway.



Entire sidewalk dips at driveway (not recommended).

2.3. Accessible Bus Stops

Design Summary

- Transit stop areas should be 1.28 m wide x 2.4 m to 3.525 m length.

In areas where a sidewalk is the pedestrian right-of-way:

- Provide a concrete barrier curb 150 mm high, without indentation for a catch basin.
- Maintain 2.1 m by 1.98 m clear for the transit stop-waiting pad should be a clear minimum to accommodate wheelchair ramp deployment from the bus and to allow for wheelchair movement after clearing the ramp.
- Provide one or two paved connections from waiting pad to the sidewalk for a width of 1.5 m.
- If street furniture or other such objects are provided (i.e. newspaper box, overhead signage), maintain 1.5 m wide and 2.0 m overhead clear for the pedestrian path. Keep clear of the transit loading and unloading area.
- Benches within bus stop areas should not reduce the sidewalk width to less than 2 m. Do not place within 6 m of any fire hydrant.

Where no sidewalk exists, a concrete or asphalt pad on the shoulder is recommended. Design standards include:

- Elevate above the road 150 mm.
- Follow curb cut standards (max slope 8%, min width 800 mm.
- Provide a barrier to prevent wheelchair passengers from rolling off the pad, especially onto the roadway.

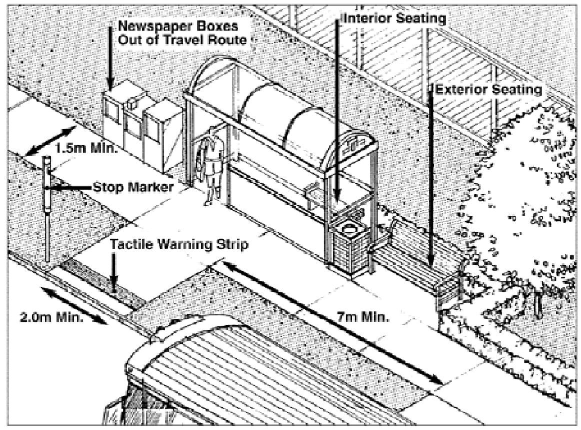
Discussion

Accessible bus stops ensure that all people can use the bus system. Where no sidewalk or pad exists, the 4:1 slope of the ramp is within acceptable guidelines; the bus driver should advise the passenger in the wheelchair or scooter that caution is required in boarding the bus.

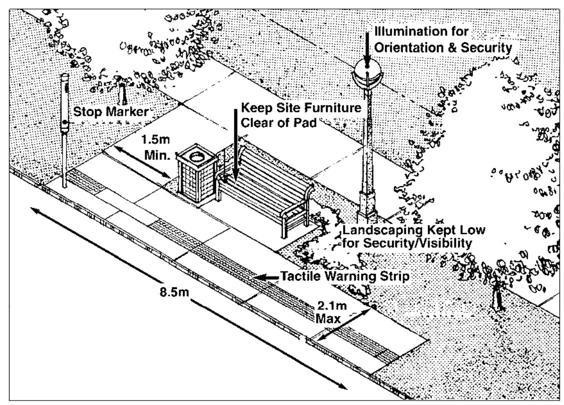
On routes where bi-directional service is provided (as opposed to a loop route), an accessible inbound stop should correspond to nearby accessible outbound stop. A stop should not be deemed fully accessible until this can be achieved.

Guidance

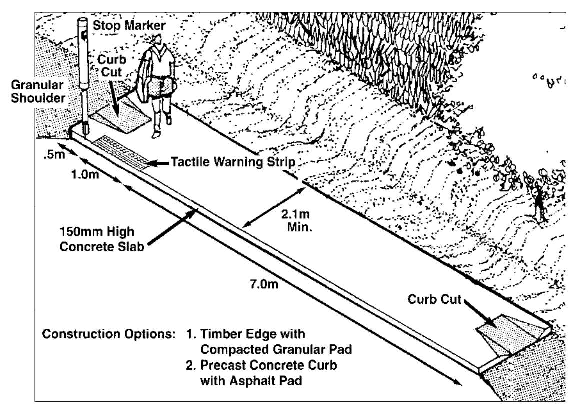
- BC Transit Municipal Systems Program, Design Guidelines for Accessible Bus Stops



Transit stop – suburban wide boulevard.



Transit stop – suburban pad.



Transit Stop – rural situation.

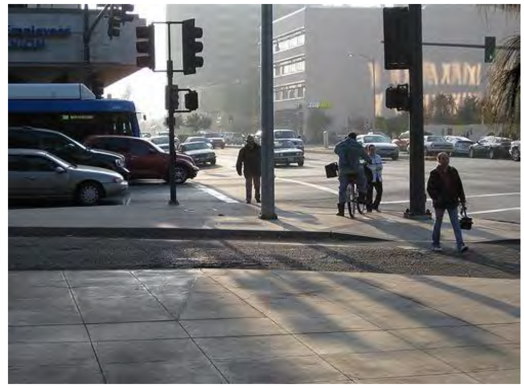
Source: BC Transit Municipal Systems Program, Design Guidelines for Accessible Bus Stops

3. General Intersection Design Guidelines

3.1. Crosswalks

Design summary

- Intersection frequency on mixed-use streets and other high pedestrian use areas:
  - o Generally not farther apart than 60 – 90 m where blocks are longer than 120 m.
  - o Generally not closer together than 45 m.
- Intersection frequency on residential or local streets based on adjacent uses. Do not prohibit for more than 120 m.
  - o Generally not closer together than 45 m.
- The TAC *Geometric Design Guide for Canadian Roads* and MoTI *Pedestrian Crossing Control Manual for British Columbia* provide guidance for the use of pedestrian crosswalks.



Intersections with many user types should provide good crossing opportunities and clearly delineate crossing patterns.

Discussion

In general, pedestrians are not inclined to travel very far out-of-direction to access a designated crosswalk, so providing sufficient crossings is critical for a safe pedestrian environment. Conversely, excessive numbers of marked crosswalks may result in poor driver compliance. Crosswalks can also be designed for increased visibility of pedestrians, and curb ramps and vehicle turning radii should also be considered for the pedestrian environment.

In areas of high pedestrian use, the convenience and travel time of pedestrians deserves special consideration when considering signal placement and timing. In these locations, pedestrian mobility and access may need to be weighted against the efficiency of vehicle progression.

Several types of crosswalks are commonly used, as shown in the table below.

Crosswalk Types and Uses

Crosswalk Type	Description	Use
Transverse crosswalk	Two parallel painted lines	intersections controlled by traffic signals or stop signs
Zebra crosswalks	longitudinal markings spaced about 60 cm apart	To increase visibility, typically at schools or at channelized right turn islands
Special crosswalk	pedestrians push a button to activate overhead flashing beacons	Where warranted by *Pedestrian Crossing Manual for British Columbia*, (1994) or the *Pedestrian Crossing Manual* (1998)

Guidance

- TAC *Geometric Design Guide for Canadian Roads, Pedestrian Crossing Manual*
- City of Victoria. (2008). *City of Victoria Pedestrian Master Plan*
- Ministry of Transportation. (1996). *Pedestrian Crossing Control Manual for British Columbia.*
- MUTCD-CA

3.2. High-Visibility Crosswalk Techniques

Design Summary

- Additional treatments can be used to increase visibility of the crosswalk at high-use locations and in locations with high use from school children, elderly pedestrians, or pedestrians with disabilities.

"Pedestrian Crosswalk Ahead" sign.

Discussion

Advance Warning Sign

A WC-2 black on yellow "Pedestrian Crosswalk Ahead" warning sign can be used where visibility of the crosswalk is limited. The recommended distance between the crosswalk and the sign is the safe stopping sight distance, which depends upon approach speed.

Raised Crosswalk

A raised crosswalk can eliminate grade changes from the pedestrian path and give pedestrians greater prominence as they cross the street. Raised crosswalks should be used only in limited cases where a special emphasis on pedestrians is desired such as at a mid-block crossing; review on case-by-case basis.

Additional guidelines include:

- Use detectable warnings at the curb edges to alert vision-impaired pedestrians that they are entering the roadway.
- Approaches to the raised crosswalk may be designed to be similar to speed humps, or may be designed so they do not have a slowing effect (such as on emergency response routes).
- Use post mounted pedestrian crosswalk signs placed on the median and on the right side of the roadway for each approach

Raised medians require drivers to slow down.

In-Street "Yield to Pedestrians" Signs and Flashers

In-street "Yield to Pedestrian" signs are flexible plastic 'paddle' signs installed in the center of a roadway to enhance a crosswalk at uncontrolled crossing locations. In-pavement flashers may be appropriate on undivided roadways in densely developed areas that do not offer median refuges for crossing pedestrians.

See MoTI *Pedestrian Crossing Control Manual for British Columbia* for addition information about 'Special Crosswalks', which use pedestrian-activated flashing beacons.

In-street yield to pedestrian signage.

Guidance

- Ministry of Transportation. (1996). *Pedestrian Crossing Control Manual for British Columbia*.
- TAC Geometric Design Guide for Canadian Roads.
- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines* (PROWAG).

3.3. Reducing Crossing Distance

Design Summary

- Pedestrian exposure to travel lanes should be minimized to the greatest extent possible.
- In general, 15 m is the longest uninterrupted crossing a pedestrian should encounter at an unsignalized crosswalk (four travel lanes).

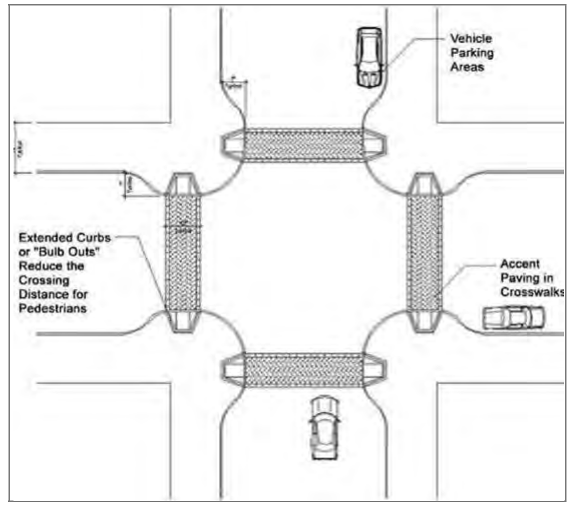
Discussion

Curb Extensions

Curb extensions minimize pedestrian exposure by shortening crossing distance and give pedestrians a better chance to see and be seen before committing to crossing. They can be used as bus stop locations to improve safety for transit riders. If there is no parking lane, the extensions may be a problem for bicycle travel and truck or bus turning movements. Curb extensions also decrease the length of the pedestrian phase at signalized intersections due to the smaller crossing distance.

Guidelines for use:

- Design to transition between the extended curb and the running curb in the shortest practicable distance.
- For efficient street sweeping, the minimum radius for the reverse curves of the transition is 3 m and the two radii should be balanced to be nearly equal.
- Curb extensions should stop 30 cm short of the parking zone for bicycle safety.

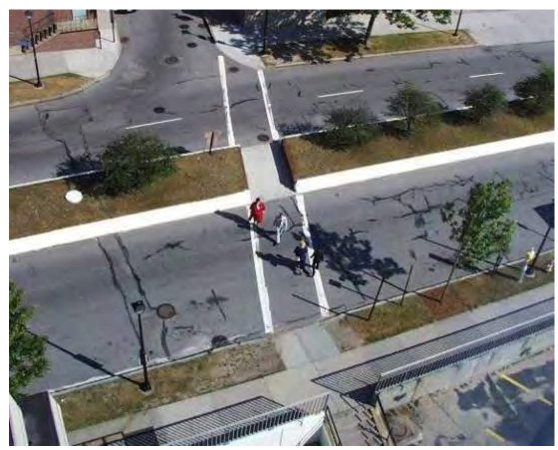


Curb extensions benefit both bicyclists and pedestrians by reducing crossing distances.

Median Refuge Island

Median refuge islands help improve safety by providing a crossing refuge, allowing pedestrians and cyclists to gauge safe crossing of "one direction" of traffic at a time, and slowing motor vehicle traffic.

This treatment is appropriate where the roadway to be crossed is greater than 15 metres wide or more than four travel lanes; can be used where distance is less to increase available safe gaps. Use at signalized or unsignalized crosswalks. The refuge island must be accessible, preferably with an at-grade passage through the island rather than ramps and landings.



Median refuge islands break up a crossing and allow pedestrians to cross one side of a street at a time

Refuge islands at intersections should have a median "nose" that gives protection to the crossing pedestrian (see photo). A median refuge island should be at least 1.8 metres wide between travel lanes and at least 1200 mm deep (SCC) with reflectors and paint tapering off to prevent vehicles from parking illegally too close to the crossing. Streets with speeds higher than 40 kph should use a double centerline marking, reflectors, and "KEEP RIGHT" signage.

If a refuge island is landscaped, the landscaping should not compromise the visibility of pedestrians crossing in the crosswalk. Tree species should be selected for small diameter trunks and tree branches should be no lower than 3.0 metres. Shrubs and ground plantings should be no higher than 45 centimetres.

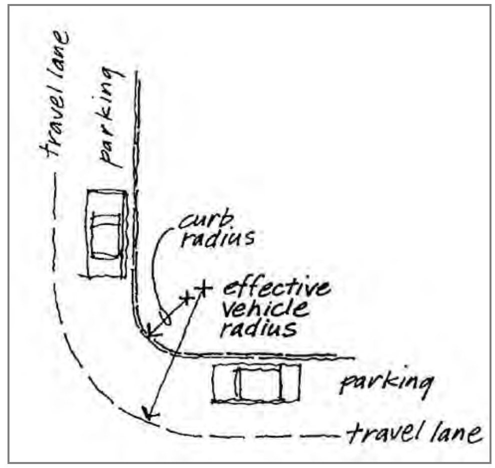
Guidance

- TAC Geometric Design Guide for Canadian Roads.
- Standards Council of Canada. (2010). Accessible design for the built environment.
- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines* (PROWAG).

3.4. Minimizing Curb Radii

Design Summary

- Consider the desired pedestrian area of the corner, traffic turning movements, the turning radius of the design vehicle, the geometry of the intersection, the street classifications, and whether there is parking or a bicycle lane (or both) between the travel lane and the curb.
- Use the smallest possible curb radius for the circumstances; Saanich typically uses 8 m, while Victoria uses 6 m. Narrowing curb radii should include consideration for buses, trucks, or emergency vehicles.



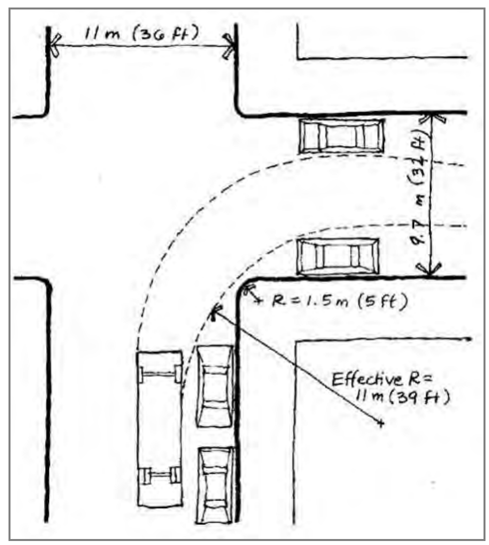
An "effective radius" is created by the presence of a parking lane or bicycle lane.

Discussion

In general, the smaller the curb radius, the better for pedestrians. In comparison to a large curb radius, a tight curb radius provides more pedestrian area at the corner, allows more flexibility in the placement of curb ramps, results in a shorter crosswalk, and requires vehicles to slow more as they turn the corner.

A small curb radius is also beneficial for street sweeping operations. The presence of a lane for parking or bicycles creates an "effective radius" that allows the designer to choose a radius for the curb that is smaller than the turning radius required by the design vehicle.

Designers sometimes consider that on-street parking will begin or end at the point of tangency or point of curvature of the corner radius. In practice, however, this point is not always evident in the field. Parking control should not be a factor in selecting curb radius.



Where there is an effective curb radius sufficient for turning vehicles, the actual curb radius may be as small as 1.5 metres.

Guidance

- TAC Geometric Design Guide for Canadian Roads.
- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines* (PROWAG).

3.5. Minimizing Conflict with Automobiles

Design Summary

- Separating pedestrians and motor vehicles at intersections improves safety and visibility.

Advance stop bars alert motorists of pedestrians.

Discussion

Parking Control

Parking control improves visibility in the vicinity of the crosswalk. Parking is prohibited within all intersections and crosswalks unless otherwise signed. At "T" and offset intersections, where the boundaries of the intersection may not be obvious, this prohibition should be made clear with signage.

Parking shall not be allowed within any type of intersection adjacent to schools, school crosswalks, and parks.

Installation of parking signage to allow and/or prohibit parking within any given intersection will occur at the time that the Parking Control section is undertaking work at the intersection.

Advance Stop Bars/Stop Lines

Advance stop bars increase pedestrian comfort and safety by stopping motor vehicles well in advance of marked crosswalks, allowing vehicle operators a better line of sight of pedestrians and giving inner lane motor vehicle traffic time to stop for pedestrians. Pedestrians feel more comfortable since motor vehicles are not stopped adjacent to the crosswalk. The multiple threats of motor vehicles are reduced, since vehicles in the inner travel lane have a clearer line of sight to pedestrians entering the sidewalk. Without an advance stop bar, the vehicle in the outer lane may stop for the pedestrian, but the vehicle in the inner lane proceeds, increasing the possibility of a vehicle-pedestrian conflict. Conversely, if the setback is too large, compliance may be poor.

Advanced stop bars should be used:

- On streets with at least two travel lanes in each direction.
- Prior to a marked crosswalk
- In one or both directions of motor vehicle travel
- Usually 1.0 metres in advance of the crosswalk; 4.0m (2.75m) minimum if used with a bike box application (MoTI).

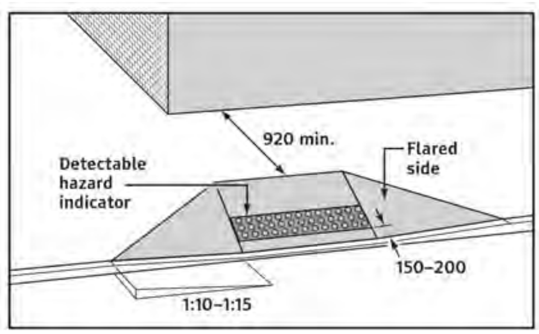
Guidance

- TAC Geometric Design Guide for Canadian Roads.
- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines* (PROWAG).
- Ministry of Transportation. (1996). *Pedestrian Crossing Control Manual for British Columbia*.

3.6. Accessible Curb Ramps

Design Summary

- Every ramp should have a landing at the top and at the bottom.
  - o Toplanding: at least 1.22 metres long and at least the same width as the ramp itself.
  - o Bottom landing into a crosswalk: at least1.22 metres long, completely contained within the crosswalk.
- Ramp slope between 1:15 (6.66%) and 1:10 (10%) with a cross slope of no more than 1:20 (5%), with 1:50 (2.0%) preferred (Standards Council of Canada standard).
- Minimum width of a ramp: 920 millimetres.



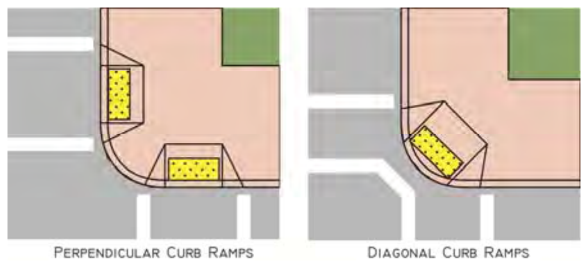
Curb ramp guidelines, Standards Council of Canada. (2010). Accessible design for the built environment.

Discussion

Curb ramps allow all users to make the transition from the street to the sidewalk. A sidewalk without a curb ramp can be useless to someone in a wheelchair, forcing them back to a driveway and out into the street for access.

The *Victoria Pedestrian Plan* states that, "The lack of provincial warrants or standards for pedestrian sidewalk ramps at intersections may have led to the variety of warrants and standards." Several municipalities surveyed for that Plan typically install two ramps due to safety, drainage, catch basin location, ice build-up, and costs.

If the ramp lands on a dropped landing within the sidewalk or corner area where someone in a wheelchair may have to change direction, the landing must be a minimum of 1.5 metres long and at least as wide as the ramp, although a width of 1.5 metres is preferred. The landing shall not slope more than 1:50 (2.0%) in any direction (including cross-slope). A single landing may serve as the top landing for one ramp and the bottom landing for another.



Types of common recommended curb ramps.

Example of an accessible perpendicular curb ramp.

Guidance

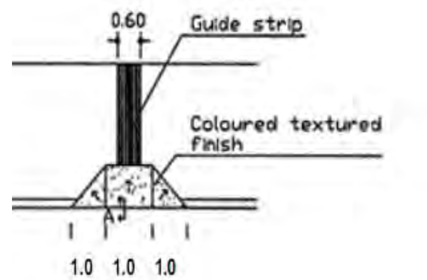
- Standards Council of Canada. (2010). *Accessible design for the built environment.*
- City of Victoria. (2008). *City of Victoria Pedestrian Master Plan*
- TAC *Geometric Design Guide for Canadian Roads*, Chapter 2.2: Cross Section Elements, section 2.2.6.1: Sidewalks, Boulevards, and Border Areas.

3.6.1. Raised Tactile Devices Used as Detectible Warnings

Design Summary

- Raised tactile devices (also known as truncated domes) alert people with visual impairments to changes in the pedestrian environment and should be used at:
  - The edge of depressed corners.
  - The border of raised crosswalks and intersections.
  - The base of curb ramps.
  - The border of medians.
  - The edge of transit platforms where railroad tracks cross the sidewalk.
- The Standards Council of Canada states, "The surface of a curb ramp shall
  - (a) be stable, firm, and slip-resistant;
  - (b) have a detectable hazard indicator that
    - (i) complies with Clause 4.1.2.2;
    - (ii) extends the full width of the ramp; and
    - (iii) has a length of 600 to 650 mm, starting at 150 to 200 mm from the curb; and
  - (c) have a level transition to adjacent surfaces.

A diagonal curb ramp with detectible warning.



Curb cut with guide strip, City of Kelowna Guidelines for Accessibility in Outdoor Spaces.

Discussion

A detectable warning at the bottom of a curb ramp identifies the transition between the sidewalk and the street for people with vision impairments. Contrast between the raised tactile device and the surrounding infrastructure is important so that the change is readily evident. These devices are most effective when adjacent to smooth pavement so the difference is easily detected. The devices must provide strong colour contrast so partially-sighted people can see them.

Parallel Grooves

The City of Kelowna *Guidelines for Accessibility in Outdoor Spaces* recommends that a series of parallel groove trowelled into the concrete walkway perpendicular to the road can also act as a tactile warning (fig. 3). Grooves should be 610 mm long, 2cm maximum depth, spaced 15 cm. from centre to centre, with a radius of 1 cm.

Raised Tactile Devices Used for Wayfinding

In addition to use at curbs, raised tactile devices can be used for wayfinding along a trail or across a road. This is particularly useful to visually impaired pedestrians in areas where the pedestrian environment is unpredictable. Complex intersections, roundabouts, wide intersections and open plazas are areas where raised tactile devices could be considered. No standards or guidelines for these devices have been adopted nationally. Raised devices with bar patterns can indicate the proper walking direction. Textured pavement that provides enough material and color contrast can be used to mark the outside of crosswalks, in addition to white paint or thermoplastic.

Guidance

- Standards Council of Canada. (2010). *Accessible design for the built environment*.
- City of Kelowna. (2003). *Guidelines for Accessibility in Outdoor Spaces).*
- TAC *Geometric Design Guide for Canadian Roads*.
- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines* (PROWAG).

3.7. Bicycle and Pedestrian Traffic Signals

Design Summary

- Bicycle and pedestrian half-signals use a flashing green light that turns to a full red light for motor vehicles when activated by pedestrians and cyclists with pushbuttons.
- Scramble signals provide a simultaneous "All Red" phase for motorists and a green phase for bicycle/pedestrian movements.

Pedestrian signal.

Discussion

In cases where there is less bicycle traffic, a demand-only pedestrian or bicycle signal can be used to reduce vehicle delay. This technique would prevent an empty signal phase from regularly occurring. For the demand-responsive signal, a push button or imbedded loop should be available to actuate the bicycle phase.

Pedestrian signals are recognized by their flashing green operation. They feature 'full' signal control for vehicles on the major street and stop sign control for vehicles on the minor street. Pedestrians are provided with signalized crosswalks in all directions.

The signal rests in flashing green for the major street until a pedestrian pushes the button to activate the crossing across the major street. For major street traffic, the signal changes to yellow, then red, at which time the WALK and FLASH DON'T WALK phases are displayed.

Scramble signals can be used at intersections with frequent vehicle/bicycle conflicts, and/or intersections experiencing high bicycle turning movements (especially left turns that force bicyclists to cross vehicle traffic). Scramble signals provide a simultaneous "All Red" phase for motorists and a green phase dedicated for bicycle/pedestrian movements (using special signal heads with accompanying signage). This phase enables non-motorized users to cross an intersection using their desired travel path (straight or diagonal).

Scramble signals allow cyclists to cross an intersection diagonally.

Guidance

- Scramble signals have been used successfully in urbanized areas and locations with high bicycle/pedestrian volumes. Cities currently using this application include Davis, California, Honolulu, Hawaii and Portland, Oregon.

3.8. Pedestrian Push-Buttons

Design Summary

- Pedestrian can be accommodated by an automatic pedestrian phase, or by using a push button (demand-actuated signal).
- The U.S. Access Board recommends buttons be large enough for people with visual impairments to see, min. 5 cm, and the force to activate the signals should be no more than 22.2 newtons.

Discussion

Pedestrian push buttons detect pedestrians desiring to cross at an actuated or semi-actuated traffic signal, at intersections with low pedestrian volumes and at mid-block crossings. When push buttons are used, they should be:

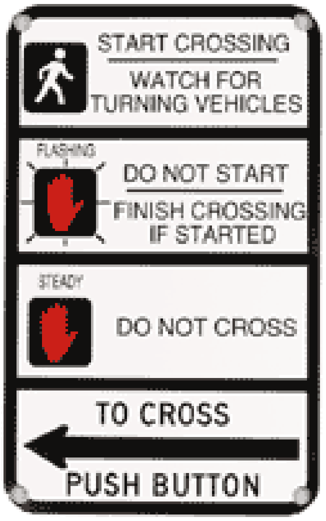
- Located so that someone in a wheelchair can reach the button from a level area of the sidewalk without deviating from the natural line of travel into the crosswalk.
- Marked with arrows to indicate which signal is affected.

Signalized crossings in areas of high pedestrian use may automatically provide a pedestrian crossing phase during every signal cycle, eliminating the need for push-buttons. However, there should be a demonstrated benefit for actuated signals before push buttons are installed, which could include:

- The main street carries thru-traffic or transit, such as an arterial, collector, or bus route.
- Traffic volumes on the side street are considerably lower than on the main street.
- The pedestrian signal phase is long (for example, on a wide street) and eliminating it when there is no demand would significantly improve the level of service of the main street.

Where push buttons must be installed in high pedestrian use areas, designers should consider using a regular pedestrian phase during off-peak hours. In addition, vibro-tactile buttons and voice recording can be used to improve actuation options.

Example standard pedestrian push button. (Polara Navigator)



Pedestrian push buttons can be accompanied by informational signage.

Guidance

- TAC Geometric Design Guide for Canadian Roads.
- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines* (PROWAG).

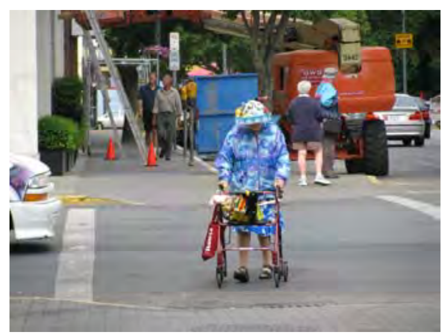
3.9. Accommodating Pedestrians at Signals

Design Summary

- Pedestrians benefit from information provided by signal head indications, countdown signals, and audible signals.
- Traffic signal timing should assume a pedestrian walking speed of 1.0 metres per second (or 0.9mps in an area with a larger population of children or seniors),, meaning that the length of a signal phase with parallel pedestrian movements should provide sufficient time for a pedestrian to safely cross the adjacent street.
- At crossings where older pedestrians or pedestrians with disabilities are expected, crossing speeds as low as 0.9 metres per second may be assumed.
- Special pedestrian phases can be used to provide greater visibility or more crossing time for pedestrians at certain intersections.

Pedestrian signal indication.

Speaker on pedestrian traffic signal.



Traffic signals should provide sufficient time for pedestrians of all ages and abilities to cross.

Discussion

Pedestrian Signal Indication ("Ped Head") and Countdowns

Pedestrian signal indicators use a symbol to indicate when to cross at a signalized crosswalk. All traffic signals should be equipped with pedestrian signal indications except where pedestrian crossing is prohibited by signage. Countdown pedestrian signals are particularly beneficial, as they indicate whether a pedestrian has time to cross the street before the signal phase ends.

Audible Pedestrian Traffic Signals

Audible pedestrian traffic signals provide crossing assistance to pedestrians with vision impairment at signalized intersections. To be considered for audible signals, the location must be suitable to the installation of audible signals (safety, noise level, and neighbourhood acceptance).

Audible signals should be activated by a pedestrian push-button with at least a one second-delay to activate the sound.

Pre-Timed Signal

Pre-timed signals use automatic "phasing" concurrent with parallel vehicle traffic, as opposed to actuated signals, where pedestrians push an activation button to trigger the walk signal.

Leading Pedestrian Interval (LPI)

At intersections where there are conflicts between turning vehicles and pedestrians, pedestrians are given a "walk" designation a few seconds before the associated green phase for the intersection.

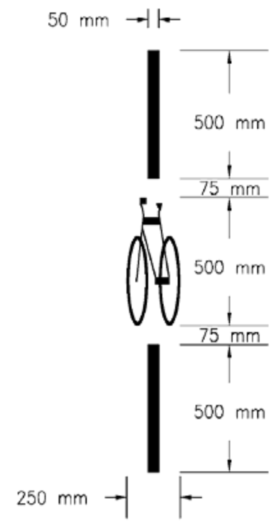
Guidance

- TAC Geometric Design Guide for Canadian Roads.
- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines* (PROWAG).

3.9.1. Accommodating Bicyclists at Intersections

Design Summary

At signalized intersections, cyclists should be able to trigger signals when cars are not present. Requiring cyclists to dismount to press a pedestrian button is inconvenient and requires the cyclist to merge in into traffic at an intersection. It is particularly important to provide bicycle actuation in a left-turn only lane where cyclists regularly make left turn movements.



Recommended design from TAC Bikeway Traffic Control Guidelines, Section 7.4.6.

Discussion

Loop Detectors

Bicycle-activated loop detectors are installed within the roadway to allow the presence of a bicycle to trigger a change in the traffic signal. This allows the cyclist to stay within the lane of travel and avoid manoeuvring to the side of the road to trigger a push button.

Most demand-actuated signals in the CRD currently use loop detectors, which can be attuned to be sensitive enough to detect any type of metal, including steel and aluminum. The amount of metal in a bicycle's chainrings and bottom bracket is sufficient to trigger a properly-calibrated loop detector.

Current and future loops that are sensitive enough to detect bicycles should have pavement markings to instruct cyclists how to trip them, as well as signage (see right).

Instructional Sign (TAC Bikeway Traffic Control Guidelines, Sign ID-20R).

Detection Cameras

Video detection cameras can also be used to determine when a vehicle is waiting for a signal. These systems use digital image processing to detect a change in the image at the location. Cameras can detect bicycles, although cyclists should wait in the center of the lane, where an automobile would usually wait, in order to be detected. Video camera system costs range from $20,000 to $25,000 per intersection.

Detection cameras are currently used for cyclists in the City of San Luis Obispo, CA, where the system has proven to detect pedestrians as well.

Push Buttons

Where numbers of cyclists are low, or where a bicycle route crosses a busy street with a half-signal, push buttons can be provided for cyclists to actuate the signal. Place 1.8 m in advance of the intersection at a height where cyclists do not have to dismount to activate the button.

Guidance

- Additional technical information is available at: www.humantransport.org/bicycledriving/library/signals/detection.htm
- ITE Guidance for Bicycle—Sensitive Detection and Counters: http://www.ite.org/councils/Bike-Report-Ch4.pdf

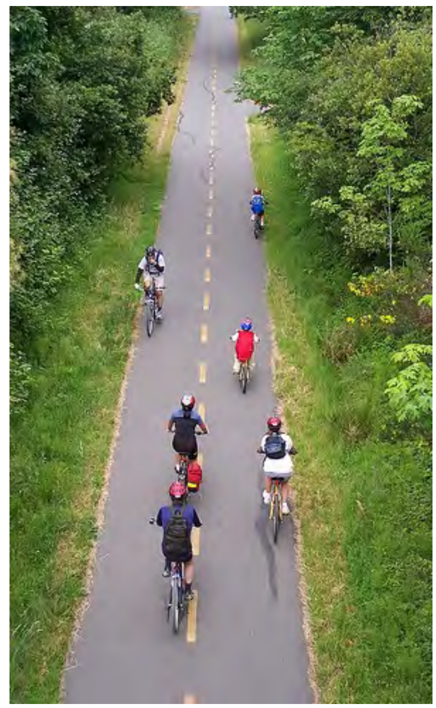
4. Multi-Use Trail Design Guidelines

Design Summary

Multi-use trails can provide a desirable facility particularly for novice riders, recreational trips, and cyclists of all skill levels preferring separation from traffic. Multi-use trails should generally provide new travel opportunities.

Discussion

Multi-use trails serve bicyclists and pedestrians and provide additional width over a standard sidewalk. Facilities may be constructed adjacent to roads, through parks, or along linear corridors such as active or abandoned railroad lines or waterways. Regardless of the type, trails constructed next to the road must have some type of vertical (e.g., curb or barrier) or horizontal (e.g., landscaped strip) buffer separating the trail area from adjacent vehicle travel lanes.



Multi-use trails (also referred to as "trails" and "shared-use paths") are often viewed as recreational facilities, but they are also important corridors for utilitarian trips. Source: John Luton

Elements that enhance multi-use trail design include:

- Providing frequent access points from the local road network; if access points are spaced too far apart, users will have to travel out of direction to enter or exit the trail, which will discourage use
- Placing directional signs to direct users to and from the trail
- Building to a standard high enough to allow heavy maintenance equipment to use the trail without causing it to deteriorate
- Limiting the number of at-grade crossings with streets or driveways
- Terminating the trail where it is easily accessible to and from the street system, preferably at a controlled intersection or at the beginning of a dead-end street. If poorly designed, the point where the trail joins the street system can put pedestrians and cyclists in a position where motor vehicle drivers do not expect them
- Identifying and addressing potential safety and security issues up front
- Whenever possible, and especially where heavy use can be expected, separate bicycle and pedestrian ways should be provided to reduce conflicts
- Providing accessible parking space(s)

Guidance

Multi-use trails should be constructed according to the TAC *Geometric Design Guide for Canadian Roads*. Where possible, multi-use trails should be designed according to ADA standards. Constructing trails may have limitations that make meeting ADA standards difficult and sometimes prohibitive. Prohibitive impacts include harm to significant cultural or natural resources, a significant change in the intended purpose of the trail, requirements of construction methods that are against federal, state or local regulations, or presence of terrain characteristics that prevent compliance.

4.1. Multi-Use Trail Hierarchy

Design Summary

Trail Type	Purpose	Intended Use	Width	Shoulder Width	Surfacing
Regional ▪ High-use ▪ Standard ▪ Soft Surface/ environ-mentally sensitive	Foster trail use over longer distances, usually passing through several municipalities.	Recreational and commuter cyclists, walkers, joggers/runners, in-line skaters, skateboarders, horse riders, and people using mobility aids.	4-6 metres	1.0 metres minimum	Asphalt or concrete or soft surface, in consideration for context and user types
Community	Barrier-free trails suitable for trail users with the widest range of physical capabilities, as well as for emergency access.	Recreational and commuter cyclists, walkers, joggers/runners, in-line skaters, skateboarders, horse riders, and people using mobility aids.	3-5 metres	1.0 metres minimum	Asphalt or compacted gravel (limited rural application)
Neighbourhood	Connect neighbourhoods and be the neighbourhood link to the Community Trails.	Walkers, joggers/runners, cyclists, people with mobility aids, horse riders and other trail users where terrain permits.	2-3 metres	1.0 metres minimum	Asphalt or compacted granular surface
Rustic Trails	Be used in natural areas having topographic or special environmental features.	Hikers, joggers/runners, horse riders. Some trails may have restrictions on users.	1-2 metres	0.5 metres minimum	Compacted grave, natural soil/rock
Specialty Trails	Be used in areas having topographic or special environmental features.	Walkers, joggers/runners, horse riders, mountain bikers. Some trails may have restrictions on users to protect the natural environment.	vary according to the trail purpose.	vary according to the trail purpose.	vary according to the trail purpose.

Discussion

A hierarchical trail system consists of a core system of regional trails that serve as the backbone of the trails network and which are supported by a complementary system of community trails and neighbourhood trails. This hierarchical system of trails provides community members high quality trail opportunities throughout the CRD and ensures consistency throughout the trail system. The above table provides suggested guidelines for different types of trails within individual municipalities. The PCMP Bicycle and Pedestrian Design Guidelines focus on design for trails that have been identified as regionally significant.

Guidance

- *Saanich Trail Design Guidelines*, 2007.

4.2. Multi-Use Trail Design

Design Summary

Width:

- 3.0 m is the minimum allowed for a two-way multi-use trail and is only recommended for low traffic situations.
- 4.0 m is the minimum desired standard in most situations.

Lateral Clearance:

- A 60 cm or greater shoulder on both sides.
- Vegetation should be cleared well beyond that distance, as landscaping is maintained twice per year.

Overhead Clearance:

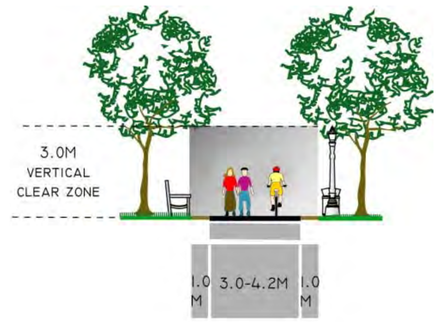
- Clearance to overhead obstructions should be 2.5 m minimum, with 3.6 m recommended.

Design Speed:

- TAC guidelines recommend that bicycle trails be designed for a speed that is at least as high as the preferred speed of the faster cyclists. The guidelines specify a minimum design speed of 30 km/h.
- When the downgrade exceeds 4%, or if strong tailwinds prevail, the design speed should be 50 km/h.
- On unpaved trails, use a lower design speed of 25 km/h.
- Speed bumps or other surface irregularities should never be used to slow bicycles.

Grade:

- Maximum uphill grades on hard-surfaced trails should not exceed 3% for sustained sections, 5% for sections of 30 metres of less, or 10% for sections 15 metres or less. A maximum 3% grade for aggregate surfaces helps to avoid instability for users and minimize erosion.



Recommended multi-use trail design.

The Galloping Goose is a regional trail that receives significant daily use.

Discussion

A hard surface should be used for multi-use trails. Concrete, while more expensive than asphalt, is the hardest of all trail surfaces and lasts the longest. However, joggers and runners prefer surfaces such as asphalt or decomposed granite due to its relative “softness”. While most asphalt is black, dyes (such as reddish pigments) can be added to increase the aesthetic value of the trail itself.

Guidance

These standards are described in additional detail in:

- U.S. Access Board, Public Rights-of-Way Accessibility Guidelines (PROWAG).
- FHWA. Designing Sidewalks and Trails for Access.
- BC Parks Trail Design and Construction Standards Manual.

4.2.1. High-Use Trail Design

Design Summary

- Trail capacity is based on expected use (e.g., destinations served and population adjacent to the trail), terrain, and types of users expected.
- Width:
  - o 6.0 m or greater - recommended for heavy use situations with high concentrations of multiple users.
  - o Where multi-use trails are expected to accommodate significant numbers of in-line skaters, a minimum width of 4.0 m is required, which reflects the width of the staking stride as well as a manoeuvring allowance.
- Accessibility standards apply.

Discussion

The CRD has several regional multi-use trails that receive high daily use. As cycling and walking increase in popularity, conflicts can arise between faster-moving bicyclists and slower bicyclists, as well as pedestrians and other users. The following recommendations mitigate these issues.

Provide a Separate Pedestrian Path

Surfacing suitable to each user group visually separates and clarifies where each group should be. When trail corridors are constrained, the two trail surfaces can be side by side with no separation. The pedestrian path should be offset where possible; otherwise, physical separation of a small hump or other crossable barrier should be provided.

The bicycle trail should be located on whichever side of the trail will result in the fewest number of anticipated pedestrian crossings. For example, the bike trail should not be placed adjacent to large numbers of destinations. Site analysis of each project is required to determine expected pedestrian behaviour.

Centerline Striping

On trails of standards widths, striping the centerline identifies which side of the trail users should be on.

Trail Etiquette Signage

Informing trail users of acceptable trail etiquette is a common issue when multiple user types are anticipated. The message must be clear and easy to understand.

Guidance

- *BC Parks Trail Design and Construction Standards Manual*.
- FHWA. Designing Sidewalks and Trails for Access.

The Galloping Goose trail provides a separated pedestrian path and divided bicycle trail through high-use areas.

Recommended design for a separated multi-use trail.

TAC sign RB-94 directs cyclists and pedestrians how to share a trail.

4.2.2. Soft Surface Trail Design

Design Summary

- Width: 30 to 90 cm
- Maintain vegetation s clear on both sides of the trail tread for a minimum of 30 cm.
- Avoid trail grades in excess of 12 percent to minimize erosion.
- Surfacing options:
  - Gravel and crusher fines provide a relatively stable footing that is less likely to collect rain water in the winter. Gravel is made from rounded rocks, while crusher fines (also called native pit-run fines) are made from angular rocks.
  - Bark chip/mulch is an inexpensive and easily-applied surface. However, it decays rapidly when exposed to moisture, sun, wind, and heat and should not be used in the floodway or where trail drainage would transport the material where it would cause water quality issues.
  - Native soil trails can be an inexpensive and context-sensitive pleasing natural trail surface. High clay content soils or soils in wet areas can become muddy and take a long time to dry out. A soil survey can be used to determine the potential for a native soil trail.

Rolling grade is the preferred design pattern for sustainable trails.

Crusher fines is similar to gravel and a common soft-surface trail material.

Bark chip trail.

Discussion

In locations where environmental sensitivity or the characteristics of the trail environment do not make a paved trail appropriate, many options exist for soft-surface trails. Soft surfaces such as gravel and dirt are less jarring on the joints than concrete.

Soft-surface trails accommodate walking and hiking in a variety of contexts and are generally defined by the presence of functional drainage, trail structures and bridges where required, but are generally an unmodified natural soil surface.

The Juan de Fuca Community Trail Design Guidelines state that trail widths vary from one to two meters and that, where possible trail surfaces should be packed earth or fine granular materials.

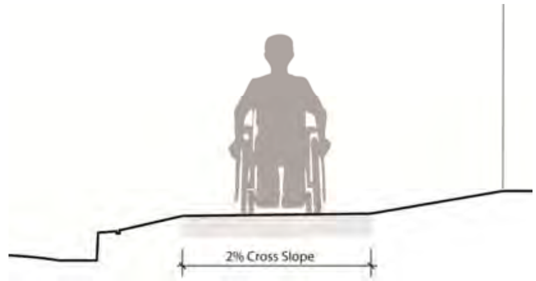
Guidance

- Juan de Fuca *Community Trail Design Guidelines*
- *BC Parks Trail Design and Construction Standards Manual*.

4.2.3. Trail Accessibility

Design Summary

- 0.9 m minimum clear width, where less than 1.5 m, passing space should be provided at least every 30 m.
- Tread obstacles should be no more than 5 cm high (maximum and up to 7.5 cm where running and cross slopes are 5% or less).
- Cross slope should not exceed 5%.
- Signs shall be provided indicating the length of the accessible trail segment.
- Curb ramps shall be provided at roadway crossings and curbs. Tactile warning strips and auditory crossing signals are recommended.



Accessible cross-slope requirement.

Multi-use trail surfacing materials affects which types of users can benefit from the facility.

Discussion

The Saanich Trail Guidelines promote the development of universally accessible trails, which "creates trails that are safer and more welcoming for many types of users."

Slopes typically should not exceed 5%. However certain conditions may require the use of steeper slopes, with no more than 30% of the total trail length exceeding a running slope of 8.33%. For those conditions exceeding a 5% slope, the recommendations are as follows:

- Up to an 8.33% slope for a 60 m max run.
- Up to a 10% slope for a 10 m maximum run
- Up to 12.5 % slope for 3 m maximum run.

Where rights-of-way are available, trails can be made more accessible by creating side paths that meander away from a roadway that exceeds a 5% slope.

The trail surface shall be firm and stable. The *Forest Service Accessibility Guidelines* defines a firm surface as a trail surface that is not noticeably distorted or compressed by the passage of a device that simulates a person who uses a wheelchair. Constructing trails outdoors may have limitations that make meeting universal accessibility standards difficult and sometimes prohibitive. Prohibitive impacts include harm to significant cultural or natural resources, a significant change in the intended purpose of the trail, requirements of construction methods that are against federal, state or local regulations, or presence of terrain characteristics that prevent compliance.

Guidance

- *American with Disabilities Act* (ADA) for accessible trails.
- Saanich Trail Guidelines Appendix B.
- BC Building Access Handbook.

4.2.4. Multi-Use Equestrian Trail Design

Design Summary

Width:

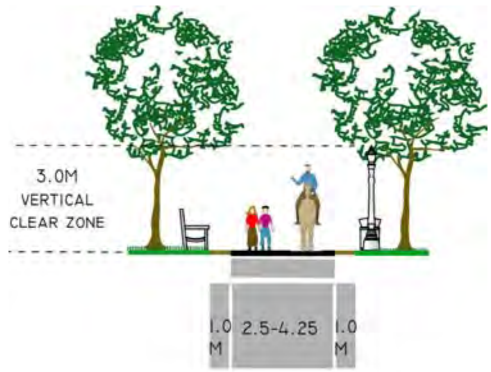
- 1.5 – 1.8 metres low (rural) development
- 2.5 – 4.5 metres in moderate to high development

Lateral Clearance:

- A 1 metre or greater shoulder on both sides.

Overhead Clearance:

- Clearance to overhead obstructions should be 3.0 metres minimum, with 3.7 metres recommended.



Recommended design for a multi-use trail that accommodates equestrians.

Discussion

Walkers, hikers, and cyclists often share trail corridors with equestrians. Pedestrians and riders are often compatible on the same tread as they both accept unpaved surfaces and move at relatively slow speeds. However, fast moving and quiet cyclists, approaching a horse from behind, are a valid concern for riders. In areas where conflicts seem likely, efforts are made to physically separate the different user groups.

For equestrian routes, trail tread or surface should be relatively stable. The trail surface should be solid, obstacle free and should stay in place. Appropriate trail surfaces include: compacted native soil and crusher fines. Hard surfaces, such as asphalt and concrete are not amenable to equestrians.

Trails that are comfortable for equestrians are ones that accommodate most trail users. While horses can easily negotiate grades up to 20% for short distances (up to 60 metres), steeper running grades result in faster water run-off and erosion problems. Following contours helps reduce erosion problems, minimize maintenance needs and increase comfort levels. A 2% cross slope or crowned tread and periodic grade reversals along running slopes will minimize standing surface water and will resolve most drainage issues on a multi-use trail. An exception is cut sections where uphill water must be collected in a ditch and directed to a catch basin, where the water can be directed under the trail in a drainage pipe of suitable dimensions. Additionally, on running grades steeper than 5%, add 15 to 30 centimetres of extra tread width as a safety margin where possible.

Example multi-use equestrian trail.

Guidance

- USDA/FHWA Equestrian Design Guidebook for Trails, Trailheads, and Campgrounds.

4.2.5. Trail Opportunities

Design Summary

- Trails can be constructed along abandoned or active rail corridors, as well as utility and waterway corridors.

Discussion

Rails-to-Trails

The CRD has an established network of off-street trails, many of which utilize abandoned railroad corridors. Commonly referred to as Rails-to-Trails, these projects convert vacated rail corridors into multi-use trails. Rail corridors offer several advantages, including relatively direct routes between major destinations, and following generally flat terrain. The CRD benefits from several existing rail-to-trail corridors as well as opportunities for future corridor development.

Rails-with-Trails

Rails-with-Trails projects typically consist of trails adjacent to active railroads. Offering the same benefits as rail-to-trail projects, these facilities utilize active rail corridors. It should be noted that some constraints could impact the feasibility of rail-with-trail projects. In some cases, space needs to be preserved for future planned freight, transit or commuter rail service. In other cases, limited right-of-way width, inadequate setbacks, concerns about trespassing, and numerous mid -block crossings may affect a project's feasibility.

Utility and Waterway Corridor Trails

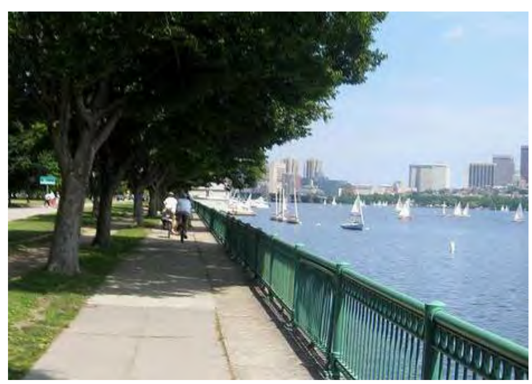
Utility and waterway corridors offer excellent trail development and bikeway gap closure opportunities. Utility corridors typically include powerline and sewer corridors, while waterway corridors include canals, drainage ditches, rivers, and beaches. These corridors offer excellent transportation and recreation opportunities for cyclists of all ages and skills.

Guidance

- *BC Parks Trail Design and Construction Standards Manual*.
- FHWA. (2002). *Rails-with-Trails: Lessons Learned.* http://www.fhwa.dot.gov/environment/rectrails/rwt/

Rails-to-Trails Corridor, Nanaimo BC.
Source: John Luton.

Rails-with-Trails Corridor, Kelowna BC.
Source: John Luton.

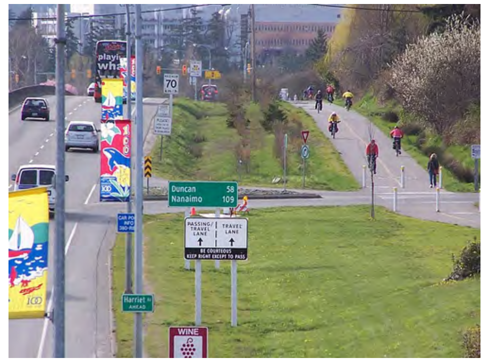


The Charles River Esplanade in Boston, MA.

4.2.6. Trails Along Roadways

Design Summary

- Where a smulti-use trail must be adjacent to a roadway, a 1.5 metre minimum buffer should separate the trail from the edge of the roadway, or a physical barrier of sufficient height should be installed.



The Galloping Goose regional trail is located within a road corridor, and provides adequate separation. Source: John Luton.

Discussion

Also known as "side paths," these facilities create a situation where a portion of the bicycle traffic rides against the normal flow of motor vehicle traffic and can result in wrong-way riding where cyclists enter or leave the trail. This can also result in an unsafe situation where motorists entering or crossing the roadway at intersections and driveways do not notice bicyclists coming from their right, as they are not expecting traffic coming from that direction. Stopped cross-street motor vehicle traffic or vehicles exiting side streets or driveways may frequently block trail crossings. Even bicyclists coming from the left may also go unnoticed, especially when sight distances are poor.

Concerns about multi-use trails directly adjacent to roadways (e.g., with minimal or no separation) are:

- Half of bicycle traffic may ride against the flow of vehicle traffic, contrary to the rules of the road.
- When the trail ends, cyclists riding against traffic tend to continue to travel on the wrong side of the street, as do cyclists who are accessing the trail. Wrong-way bicycle travel is a major cause of crashes.
- At intersections, motorists crossing the trail often do not notice bicyclists approaching from certain directions, especially where sight distances are poor.
- Bicyclists are required to stop or yield at cross-streets and driveways, unless otherwise posted.
- Stopped vehicles on a cross-street or driveway may block the trail.
- Because of the closeness of vehicle traffic to opposing bicycle traffic, barriers are often necessary to separate motorists from cyclists. These barriers serve as obstructions, complicate facility maintenance and waste available right-of-way.
- Trails directly adjacent to high-volume roadways diminish users' experience by placing them in an uncomfortable environment. This could lead to a trail's underutilization.

As bicyclists gain experience and realize some of the advantages of riding on the roadway, some riders stop using trails adjacent to roadways. Bicyclists may also tend to prefer the roadway as pedestrian traffic on the shared use trail increases due to its location next to an urban roadway. Multi-use trails may be considered along roadways under the following conditions:

- The trail will generally be separated from all motor vehicle traffic.
- Bicycle and pedestrian use is anticipated to be high.
- To provide continuity with an existing trail through a roadway corridor.
- The trail can be terminated onto streets or trails with good bicycle and pedestrian facilities.
- There is adequate access to local cross-streets and other facilities along the route.
- Any needed grade separation structures do not add substantial out-of-direction travel.
- The total cost of providing the proposed trail is proportionate to the need, compared to the cost of providing on-street facilities.

Guidance

- The AASHTO *Guide for the Development of Bicycle Facilities* generally recommends against the development of trails adjacent to roadways

4.2.7. Environmental Considerations

Design Summary

- Assess the impacts of trail use on wildlife species, while considering opportunities for wildlife viewing.
- Avoid critical (and potentially dangerous) wildlife habitat areas, for example foraging areas, nesting sites, calving grounds, wintering areas, or denning sites. Consider seasonal movements and requirements of wildlife species. For example, bears and many other large mammals follow a seasonal round depending on food or cover available at different elevations.
- Avoid critical habitat of rare or fragile plant species. If there are fragile plant communities next to the trail, define the trail edges by using logs or rocks.
- Avoid sensitive or fragile archaeological or historic sites.
- Design trail widths to accommodate the expected number of users.
- Widen trails at feature points, view sites or interpretive displays where use is expected to be more intense.
- In low-lying wet areas, raise the trail tread to cross standing water or wet organic soils. Avoid these wet areas during trail flagging to minimize costly construction techniques.
- Avoid trail routing that encourages users to take shortcuts where an easier route or interesting feature is visible. Use landforms or vegetation to block potential shortcut routes. Alter the shortcut route if it is superior to the original route.
- Close shortcuts by obstructing access using rocks, branches, fallen trees or new plantings. Provide signs, for example advising users not to stray off the trails.
- Use signs to explain why shortcuts should not be taken and request user cooperation.
- Minimize the use of switchbacks in trail construction because users often tend to shortcut in these sections.

Discussion

Environmental constraints should be considered before choosing construction materials. Often trails and boardwalks are constructed to minimize impacts to sensitive ecosystems such as wetlands. Material considerations in these areas should mitigate potential long-term impacts to the resource. Steps to consider taking include:

- **Identify and map water resources within 60 metres of the trail system.** Accurately locating wetlands, streams and riparian areas relative to the trail is an important element of the trail planning. The location of these potential "receiving resources" for trail drainage and associated sediments will affect decisions about placement of trail drainage structures, manoeuvring of maintenance equipment, season of work, interception and infiltration of trail drainage, and disposal of earth materials generated during maintenance activities.
- **Minimize crossings of streams and wetlands.** Minimize channel crossings and changes to natural drainage patterns.
- **Minimize trail drainage to streams and wetlands.** Minimize the hydrologic connectivity of trails with streams, wetlands and other water resources.
- **Keep heavy equipment off wet trails.** Avoid operating heavy equipment on trails when they are wet. Use alternate routes for heavy equipment when trails are wet. Provide crossing structures where needed. Where trails traverse wet areas, structures should be provided to avoid trail widening and damage at "go-around" spots. Crossing structures also help protect water quality, wetlands and riparian areas.
- **Establish vegetative buffers between trails**, streams and wetlands. Retain a buffer between trails and water resources by establishing riparian and streamside management zones (RSMZs), within which trail influences such as drainage, disturbance and trail width are minimized.

Guidance

- The BC Parks *Trail Design and Construction Standards Manual* makes recommendations for environmental protection in trail design.

4.3. Trail/Roadway Crossings

Design Summary

At-grade trail/roadway crossings generally will fit into one of four basic categories:

- Type 1: Marked/Unsignalized Unprotected crossings include trail crossings of residential, collector, and sometimes major arterial streets or railroad tracks.
- Type 1+: Marked/Enhanced – Unsignalized intersections can provide additional visibility with flashing beacons and other treatments
- Type 2: Route Users to Existing Signalized Intersection - Trails that emerge near existing intersections may be routed to these locations, provided that sufficient protection is provided at the existing intersection.
- Type 3: Signalized/Controlled - Trail crossings that require signals or other control measures due to traffic volumes, speeds, and trail usage.
- Type 4: Grade-separated crossings - Bridges or under-crossings provide the maximum level of safety but also generally are the most expensive and have right-of-way, maintenance, and other public safety considerations.

An offset crossing forces pedestrians to turn and face the traffic they are about to cross.

Discussion

While at-grade crossings create a potentially high level of conflict between trail users and motorists, well-designed crossings have not historically posed a safety problem for trail users. This is evidenced by the thousands of successful trails around North America with at-grade crossings. In most cases, at-grade trail crossings can be properly designed to a reasonable degree of safety and can meet existing traffic and safety standards.

Evaluation of trail crossings involves analysis of vehicular and anticipated trail user traffic patterns, including

- Vehicle speeds.
- Street width.
- Sight distance.
- Traffic volumes (average daily traffic and peak hour traffic).
- Trail user profile (age distribution, destinations served).

Crossing features for all roadways include warning signs both for vehicles and trail users.

Consideration must be given for adequate warning distance based on vehicle speeds and line of sight, with visibility of any signing absolutely critical. Catching the attention of motorists jaded to roadway signs may require additional alerting devices such as a flashing light, roadway striping or changes in pavement texture. Signing for trail users must include a standard trail (smaller) “STOP” or “YIELD” sign at all intersections and pavement marking, sometimes combined with other features such as bollards or a kink in the trail to slow bicyclists. This is particularly important in locations where bicycle speeds are high and/or visibility is poor, where additional traffic calming/visibility treatments should be considered on both the trail and the crossing roadway.

Guidance

- FHWA, Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations.
- TAC, Bikeway Traffic Control Guidelines, Section 7.3.3.

4.3. Trail/Roadway Crossings

Guidance (continued)

Summary of Trail/Roadway At-Grade Crossing Recommendations

	Motor Vehicle ADT ≤ 000			Motor Vehicle ADT > 9,000 to 12,000			Motor Vehicle AD > 12,000 to 15,000			Motor Vehicle ADT > 15,000		
	Speed Limit (kph)**											
Roadway Type	50	5	65	50	55	65	5	55	65	50	55	65
Lanes	1	1	1/1+	1	1	1/1+	1	1	1+/3	1	1/1+	1+/3
3 Lanes	1	1	1/1+	1	1/1+	1/1+	1/1+	1/1	1+/3	1/1+	1+/3	1+/3
Multi-Lane (4 +) w/ raised median***	1	1	1/1+	1	1/1+	1+/3	1/1+	1/1+	1+/3	1+/3	1+/3	1+/3
Multi-Lane (4 +) w/o raised median	1	1/1 +	1+/3	1/1+	1/1+	1+/3	1+/3	1+/3	1+/3	1+/3	1+/3	1+/3

***General Notes:** Crosswalks should not be installed at locations that could present an increased risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone **will not** make crossings safer, nor will they necessarily result in more vehicles stopping for pedestrians. Whether or not marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic-calming measures, curb extensions), as needed, to improve the safety of the crossing. **These are general recommendations; good engineering judgment should be used in individual cases for deciding which treatment to use.**

For each trail-roadway crossing, an engineering study is needed to determine the proper location. For each engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, etc. may be needed at other sites.

** Where the speed limit exceeds 65 km/h marked crosswalks alone should not be used at unsignalized locations.

*** The raised median or crossing island must be at least 1.5 metres wide and 2.8 metres long to adequately serve as a refuge area for pedestrians in accordance with TAC guidelines. A two-way center turn lane is not considered a median.

1= Type 1 Crossings. Zebra-style crosswalks with appropriate signage should be used.

1/1+ = With the higher volumes and speeds, enhanced treatments should be used, including marked zebra style crosswalks, median refuge, flashing beacons, and/or in-pavement flashers. Ensure there are sufficient gaps through signal timing, as well as sight distance.

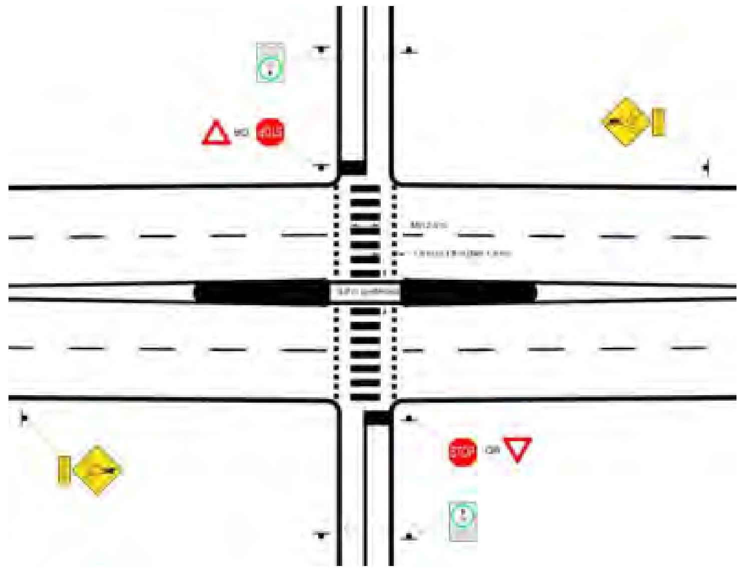
1+/3 = Carefully analyze signal warrants using a combination of Warrant 2 or 5 (depending on school presence) and Equivalent Adult Unit (EAU) factoring. Make sure to project trail usage based on future potential demand. Consider pedestrian half signals in lieu of full signals. For those intersections not meeting warrants or where engineering judgment or cost recommends against signalization, implement Type 1 enhanced crosswalk markings with marked ladder style crosswalks, median refuge, flashing beacons, and/or in-pavement flashers. Ensure there are sufficient gaps through signal timing, as well as sight distance.

This table is based on information contained in the U.S. Department of Transportation Federal Highway Administration Study, "Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations," February 2002.

4.3.1. Type 1: Marked/Unsignalized Crossings

Design Summary

- Consists of a crosswalk with 'elephants feet' pavement markings, signage, and often no other devices to slow or stop traffic.
- Maximum traffic volumes:
- ≤9,000-12,000 Average Daily Traffic (ADT) volumes
- Up to 15,000 ADT on two-lane roads, preferably with a median.
- Up to 12,000 ADT on four-lane roads with median.
- Maximum travel speed: 55 kph
- Minimum line of sight:
- 47 m (40 kph zone).
- 76 m (55 kph zone).
- 110 m (70 kph zone).
- Signing for trail users includes a standard "STOP" or "YIELD" sign and pavement marking, which can be combined bollards or a kink in the trail to slow bicyclists.



Type 1 Crossing with 'elephant's feet' pavement markings on both sides of the crosswalk.
Source: TAC, Bikeway Traffic Control Guidelines.

Discussion

Crossings of multi-lane higher-volume arterials over 15,000 ADT may be unsignalized with features such as a combination of some or all of the following: excellent sight distance, sufficient crossing gaps (more than 60 per hour), median refuges, and/or active warning devices like flashing beacons. These are referred to as "Type 1 Enhanced" (Type 1+). Such crossings would not be appropriate if a significant number of schoolchildren used the trail or for high levels of trail use.

On two-lane residential and collector roads below 15,000 ADT with average vehicle speeds of 55 kph or less, crosswalks and warning signs ("Path Xing") should be provided to warn motorists, and stop signs and slowing techniques (bollards/geometry) should be used on the trail approach. Curves in trails that orient the trail user toward oncoming traffic are helpful in slowing trail users and making them aware of oncoming vehicles. Care should be taken to keep vegetation and other obstacles out of the sight line for motorists and trail users. Engineering judgment should be used to determine the appropriate level of traffic control and design.

On roadways with low to moderate traffic volumes (<12,000 ADT), "YIELD" signs can be used on the trail, while the cross-traffic is forced to stop. This is particularly applicable where volumes on the trail are higher than volumes on the cross-street.

Guidance

- Federal Highway Administration (FHWA) Report, Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations.
- AASHTO Guide for the Development of Bicycle Facilities.
- TAC, Bikeway Traffic Control Guidelines, Section 7.3.3.

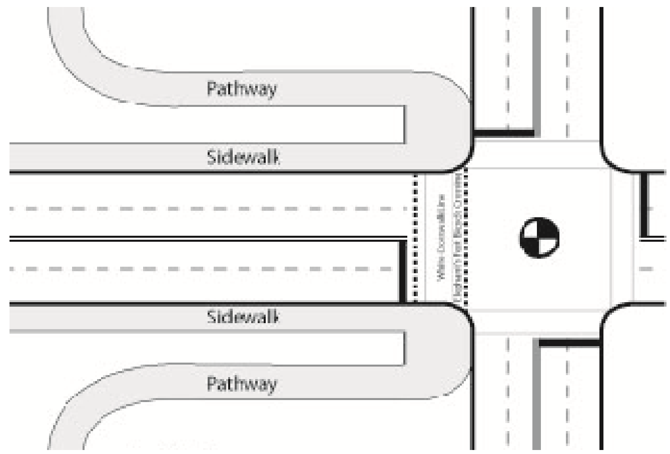
4.3.2. Type 2: Route Users to Existing Signalized Intersection

Design Summary

- A trail should cross at a signalized intersection if there is a signalized intersection within 75 m of the trail and the crossroad is crossing a major arterial with a high ADT.
- Reducing the speed of the conflicting motor vehicle traffic should be considered. Sinusoidal speed humps[5] are compatible with slow speed snow removal operations.

Discussion

Crossings within 75 m of an existing signalized intersection with pedestrian crosswalks are typically diverted to the signalized intersection for safety purposes. For this option to be effective, barriers and signing may be needed to direct multi-use trail users to the signalized crossings. In most cases, signal modifications would be made to add pedestrian detection and to comply with the United States ADA guidelines



Shared at-grade crossing of a major arterial at an intersection where trail is within 75 m of a roadway intersection.

Separated at-grade crossing of a major arterial at an intersection where trail is within 75 m of a roadway intersection.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.
- AASHTO Policy on the Geometric Design of Highways and Streets.
- FHWA-RD-87-038 Investigation of Exposure-Based Pedestrian Accident Areas: Crosswalks, Sidewalks, Local Streets, and Major Arterials.
- TAC, Bikeway Traffic Control Guidelines, Section 7.3.3.

[5] Humps with a sinusoidal profile are similar to round-top humps but have a shallower initial rise (similar to a sine wave). They were developed to provide a more comfortable ride for cyclists in traffic calmed areas.

4.3.3. Type 3: Signalized/Controlled Crossings

Design Summary

Approximately 75 metres from an existing signalized intersection and where 85th percentile travel speeds are approximately 65 km/h and above and/or ADT exceeds 15,000 motor vehicles.

Type 3 Crossing.

Discussion

New signalized crossings may be recommended for crossings that meet pedestrian, school, or modified warrants, are located more than 75 m from an existing signalized intersection and where 85th percentile travel speeds are 65 km/h and above and/or ADT exceeds 15,000 vehicles. Each crossing, regardless of traffic speed or volume, requires additional review by a registered engineer to identify sight lines, potential impacts on traffic progression, timing with adjacent signals, capacity, and safety.

Trail signals are normally activated by push buttons, but also may be triggered by motion detectors. The maximum delay for activation of the signal should be two minutes, with minimum crossing times determined by the width of the street. The signals may rest on flashing yellow or green for motorists when not activated, and should be supplemented by standard advanced warning signs. As described in the "Half Signalized Crossings" section earlier in this chapter, various types of pedestrian signals exist and can be used at Type 3 crossings.

Guidance

AASHTO Guide for the Development of Bicycle Facilities, Chapter 2.

- TAC, Bikeway Traffic Control Guidelines, Section 7.3.3.

4.3.4. Type 4: Grade Separated Undercrossing

Design Summary

- 4.2 m minimum width to allow for access by maintenance vehicles if necessary.
- 3.0 m minimum overhead height.
- The undercrossing should have a centerline stripe even if the rest of the trail does not have one.
- Lighting can be used in some locations to decrease personal safety concerns.

Discussion

Undercrossings should be considered when high volumes of bicycles and pedestrians are expected along a corridor and:

- Vehicle volumes/speeds are high.
- The roadway is wide.
- A signal is not feasible.
- Crossing is needed under another grade-separated facility such as a freeway or rail line.

Advantages of grade separated undercrossings include:

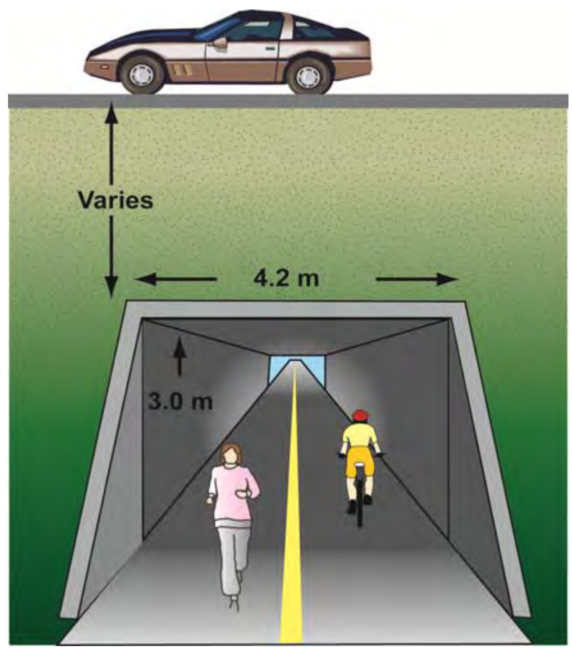
- Improves bicycle and pedestrian safety while reducing delay for all users.
- Eliminates barriers to bicyclists and pedestrians.
- Undercrossings require 3.0 m of overhead clearance from the trail surface. Undercrossings often require less ramping and elevation change for the user versus an overcrossing, particularly for railroad crossings.

Disadvantages or potential hazards include:

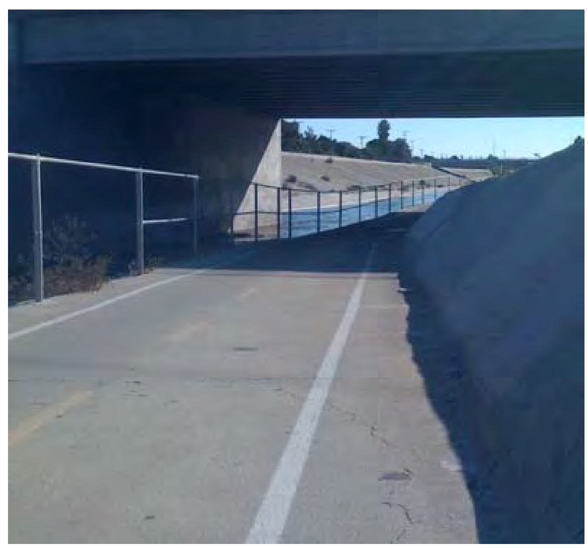
- If crossing is not convenient or does not serve a direct connection it may not be well utilized.
- Potential issues with vandalism, maintenance.
- Security may be an issue if sight lines through undercrossing and approaches are inadequate. Undercrossing width greater than 14 feet, lighting and /or skylights may be desirable for longer crossings to enhance users' sense of security.
- High cost.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.
- TAC, Bikeway Traffic Control Guidelines, Section 7.3.3.
- Ministry of Transportation. (1996). Pedestrian Crossing Control Manual for British Columbia.



Recommended undercrossing design.



Undercrossings provide key connections and allow trail users to avoid a potentially dangerous at-grade crossing of a major street.

4.3.5. Type 4: Grade Separated Overcrossing

Design Summary

- 3.0 m minimum width, 3.5 m preferred.
- If overcrossing has any scenic vistas, additional width should be provided to allow for stopped trail users.
- A separate 2 m pedestrian area may be provided in locations with high bicycle and pedestrian use.
- Minimum of 5.2 m of vertical clearance to the roadway below.
- 3.0 m headroom on overcrossing.
- Clearance below will vary depending on feature being crossed.
- The overcrossing should have a centerline stripe even if the rest of the trail does not have one.
- Ramp slopes should be accessible: 5% (1:20) grade with landings at 100 m intervals, or 8.33% (1:12) with landings every 10 m.

Overcrossings are frequently used over a major roadway.

Discussion

Overcrossings require a minimum of 5 m of vertical clearance to the roadway below versus a minimum elevation differential of around 3.5 m for an undercrossing. This results in potentially greater elevation differences and much longer ramps for bicycles and pedestrians to negotiate.

Overcrossings should be considered when high volumes of bicycles and pedestrians are expected along a corridor and:

- Vehicle volumes/speeds are high.
- The roadway is wide.
- A signal is not feasible.
- Crossing is needed over a grade-separated facility such as a freeway or rail line.

Advantages of grade separated overcrossings include:

- Improves bicycle and pedestrian safety while reducing delay for all users.
- Eliminates barriers to bicyclists and pedestrians.

Disadvantages and potential hazards include:

- If crossing is not convenient or does not serve a direct connection it may not be well utilized.
- Overcrossings require substantial clearance to the roadway below involving up to 120 m or greater of approach ramps at each end. Long ramps can sometimes be difficult for the disabled.
- Potential issues with vandalism, maintenance.
- High cost.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.
- TAC, Bikeway Traffic Control Guidelines, Section 7.3.3.
- Ministry of Transportation. (1996). Pedestrian Crossing Control Manual for British Columbia.

4.3.6. Pedestrian-Scale Lighting

Design Summary

- Depending on the location, average maintained horizontal illumination levels of 5 lux to 22 lux should be considered (AASHTO).
- Where special security problems exist, higher illumination levels may be considered.
- Light standards (poles) should meet the recommended horizontal and vertical clearances.

Discussion

Pedestrian-scale lighting improves safety and enables the facility to be used year-round, particularly on winter afternoons. Minimizing glare, not lighting the night sky, and protecting the light from vandalism are the three main issues neighbourhood trail lighting design should consider. Lights should not have a visible source, either to the trail users or to neighbouring residences, as they can blind users and pollute the night sky. In addition, globes, acorns and other light types that are not reflected or shielded on the top light the sky and should be avoided. Low level lighting, such as very short poles or bollards, are often problematic, due to their easy access for vandalism.

In some areas, street lighting is sufficient trail light for users, and in other locations homeowners may not want to publicize the trails in their neighbourhoods. If lights are desired, some neighbourhood-scale options are available. A few of these include:

- In-ground lighting – dim lights which indicate the extent of the trail.
- Bollards – low-level lighting, susceptible to vandalism.
- Solar lighting – best used in situations where running power to the trail would be costly or undesirable.

Pedestrian scale lighting can have screens to deter the glare from affecting neighbours. In addition, lights can be programmed to dim or turn off later in the night.

A guideline for a pedestrian way is illumination of between 5 and 10 meter-candles.

Recommended pedestrian-scale lighting.

Guidance

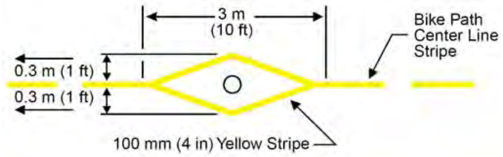
- AASHTO Guide for the Development of Bicycle Facilities.

4.3.7. Bollards

Design Summary

- A single bollard is recommended rather than two bollards, as the former directs users to separate by direction. If more than one bollard is used, an odd number reduces user conflicts.
- Place back from the intersection to allow cyclists to wait for a crossing opportunity past the bollard, but close enough to prevent parking on the trail,
- Where removable bollards are used, the top of the mount point should be flush with the trail's surface so as not to create a hazard or potentially be damaged by snow removal devices when the bollard is not in place. (Flexible bollards that do not leave an anchored mounting device on the trail or roadway surface when removed are not currently available.)
- Posts should be permanently reflectorized for night time visibility and painted a bright color for improved daytime visibility.
- Striping an envelope around the post is recommended.
- When more than one post is used, an odd number of posts at 1.5 m spacing is desirable. Wider spacing can allow entry by adult tricycles, wheelchair users and bicycles with trailers.

Bollards deter motorists from driving on the trail, but they can be dangerous for cyclists, particularly on a busy trail.



Recommended striping design.

Discussion

Bollards are posts that can be used to block vehicle access to the trail and that can provide information such as mile markings, wayfinding for key destinations, or small area maps.

Minimize the use of bollards to avoid creating obstacles for bicyclists. Flexible bollards and posts are designed to give way on impact with automobiles and can be used instead of steel or solid posts. These bollards are typically made of plastic that is bolted to the roadway and bend and return to their original position when hit. They are intended to deter access, but allow vehicles through in an emergency.

Bollards are typically installed using one of two methods: 1) The bollard is set into concrete footing in the ground; and 2) the bollard is attached to the surface with glue.

Where used, bollards should be high-visibility with reflective tape or paint, and should not be low enough to be unnoticed. Cyclists using the multi-use trail can bump into a bollard, particularly in low light conditions. Bollards should be placed in the middle of the trail, with sufficient space for trail users of all abilities, using a variety of mobility devices, to pass. They can create bottlenecks with trail users at intersections, and should be used with caution.

Route marker, Kamloops BC.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.
- TAC, Bikeway Traffic Control Guidelines, Section 7.3.3.

4.3.8. Fencing

Design Summary

- The *Langford Bicycle Plan* requires a minimum height of 1.4 m adjacent to a bikeway.
- Fencing provides access control, visual screening, channelling of trail users, and elimination of liability concerns.

Post and wire fence.

Discussion

Fencing is a means of assuring safety for both trail users and neighbouring residents by preventing unwanted access onto or off of the trail. However, fencing both sides of the trail right of way can result in a "tunnel" effect with the perception of being trapped, resulting in a detrimental effect on the trail user experience. The narrow width of many corridors in compounds this tunnel effect. Additionally, fencing could inhibit community surveillance of the trail. Solid fencing that does not allow any visual access to the trail should therefore be discouraged.

Fencing should not be a barrier to wildlife passage across the corridor. For example, a small six inch gap between the bottom of the fence and the ground can allow wildlife passage while not allowing trail users to trespass on private property.

Fencing that allows a balance between the need for privacy, while simultaneously allowing informal surveillance of the trail should be encouraged. If fencing is requested purely for privacy reasons, vegetative buffers should be considered.

Open boundaries can be used where users may be entering the trail.

Some factors to consider when deciding on fencing necessity and styles include:

- Cost: Fencing and other barriers, depending on the type of materials used and the length, can be costly, so options should be considered carefully.
- Security: Fencing between the trail and adjacent land uses can protect the privacy and security of the property owners. While crime and vandalism have not proven to be a common problem along most multi-use trails, fencing is still considered a prudent feature. The type, height, and responsibility of the fencing are dependent on local policies.
- Fencing height: The height and design of a fence influences whether lateral movement will be inhibited. Few fences are successful at preventing people from continuing to cross at historic illegal crossing locations. Fencing that cannot be climbed will typically be cut or otherwise vandalized. Heavy-duty fencing such as wrought iron or other styles of fencing that are difficult to climb are often more expensive.
- Noise and dust: Trail corridors adjacent to busy roadways, freeways or rail lines may be subject to noise, dust, and vibration, which may been seen as a nuisance to adjacent trail users. Methods of reducing this impact include the addition of vegetation or baffles to fencing barriers. This can increase the costs for a relatively low impact.

Guidance

- AASHTO *Guide for the Development of Bicycle Facilities*.

4.3.9. Landscaping

Design Summary

Safety and security concerns on a trail can be addressed through Crime Prevention Through Environmental Design (CPTED) guidelines. The four principles of CPTED are:

- Natural surveillance – maintaining sight lines and visibility to deter criminal; activities.
- Natural access control utilises fences, lighting, signage and landscape to clearly define where people and vehicles are expected to be.
- Territorial reinforcement – use physical designs such as pavement treatments, landscaping, and signage to develop a sense of proprietorship over the trail.
- Maintenance - if graffiti or vandalism occurs and is not repaired replaced right away, it can send the message that no one is watching or that no one cares.

Plantings adjacent to the trail can be attractive, but should be managed to maintain visibility and keep the trail clear.

Discussion

Whether natural or planted, vegetation can serve as both a visual and physical barrier between a roadway and a trail, can make the trail more attractive and can serve as shelter from the sun. The density and species of plants in a vegetative barrier determine how effective the barrier can be in deterring potential trespassers. A dense thicket can be, in some cases, just as effective as a fence (if not more so) in keeping trail users off restricted areas. Even tall grasses can discourage trail users from venturing across to these areas, although less effectively than trees and shrubs. Planted barriers typically take a few years before they become effective barriers. Separation of the trail may need to be augmented with other temporary barriers until planted trees and hedges have sufficiently matured.

All proposed trailside, trailhead and screen landscaping should consist of an approved native and drought-tolerant plant palette. A preliminary plant palette should be designed in conjunction with local botanical expertise, biological expertise, and landscape architectural consultation.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.
- International CPTED Association. http://www.cpted.net/
- National Crime Prevention Council. http://www.ncpc.org/training/training-topics/crime-prevention-through-environmental-design-cpted-

4.3.10. Trailheads

Design Summary

- Major trailheads should include automobile and bicycle parking, trail information (maps, user guidelines, wildlife information, etc.), garbage receptacles and restrooms.
- Minor trailheads can provide a subset of these amenities.

Discussion

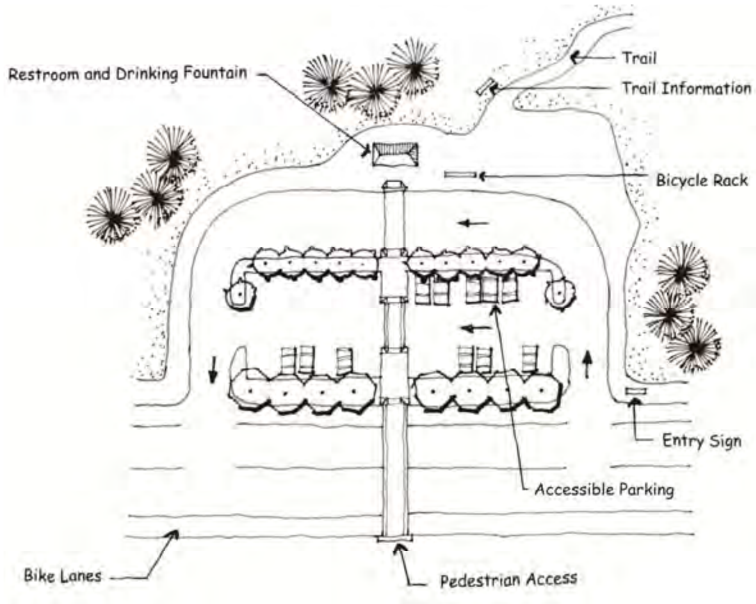
Good access to a trail system is a key element for its success. Trailheads (formalized parking areas) serve the local and regional population arriving to the trail system by car, transit, bicycle or other modes. Trailheads provide essential access to the multi-use trail system and include amenities like parking for vehicles and bicycles, restrooms (at major trailheads), and posted maps.

Trailheads with a small parking area should additionally include bicycle parking and accessible parking.

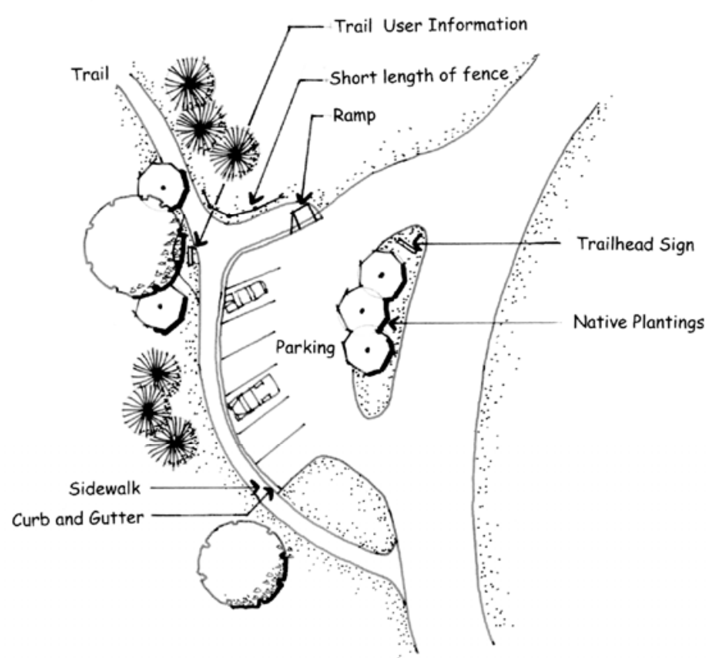
Neighbourhood access should be achieved from all local streets crossing the trail. No parking needs to be provided, and in some situations "No Parking" signs will be desirable to minimize impact on the neighbourhood.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.



Example major trailhead.



Example minor trailhead.

5. Wayfinding Standards and Guidelines

Design Summary

Types of signage include:

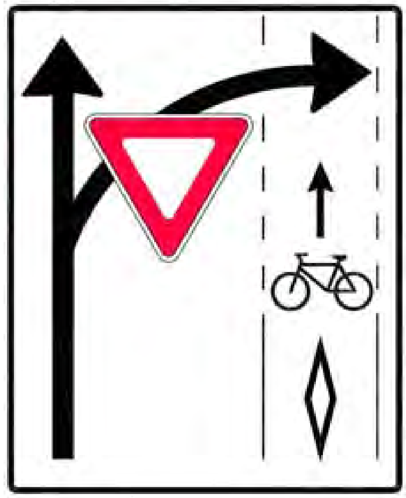
- **Regulatory signs** indicate to cyclists the traffic regulations which apply at a specific time or place on a bikeway.
- **Warning signs** indicate in advance conditions on or adjacent to a road or bikeway that will normally require caution and may require a reduction in vehicle speed.
- **Guide and information signs** indicate information for route selection, for locating off-road facilities, or for identifying geographical features or points of interest.

Discussion

The ability to navigate through a region is informed by landmarks, natural features, and other visual cues. Signs throughout the CRD can indicate to pedestrians and bicyclists their direction of travel, location of destinations, and travel time/distance to those destinations.

Guidance

- Manual on Uniform Traffic Control Devices-Canada (MUTCD-C)
- TAC Bikeway Traffic Control Guidelines for Canada.



The "Turning Vehicles Yield To Bicycles" sign will be included in the 2010 TAC Bikeway Traffic Control Guidelines for Canada (RA-XX).

The "Hill Sign for Bicycles" (WA-41) is an example of a warning sign.

The "Bike Route Marker Sign" (IB-23) is a guide that should be used along bicycle routes.

5.1.1. Multi-Use Trail Signage

Design Summary

- Signage style and imagery should be consistent throughout the trail to provide the trail user with a sense of continuity, orientation, and safety.
- Do not over sign the trail. Where possible, Incorporate signage into trailside vertical elements such as bollards.

Discussion

<u>Directional Signage</u>

Directional signage provides orientation to the trail user and emphasizes trail continuity. Street names should be called out at all trail intersections with roadways. Mileage markers should be based on the historic railroad mileposts, with mileage call outs at 400 metre increments. In addition to providing a distance reference, mileage markers are attractive to users who target exercise for set distances.

Directional signing may be useful for trail users and motorists alike. For motorists, a sign reading “Path Xing” along with a CRD emblem or logo helps both warn and promote use of the trail itself. The directional signing should impart a unique theme so trail users know which trail they are following and where it goes. The theme can be conveyed in a variety of ways: engraved stone, medallions, bollards, and mile markers.

Directional signage should identify key destinations along the trail route and include schools, parks, municipal centres, trails, and other points of interest.

<u>Trail Etiquette Signage</u>

Establishing goals and policies sets a common framework for understanding trail rules and regulations. Rights and responsibilities of trail usage should be stated at main trail access points. Once rules and regulations are established, the trail managing agency has a means of enforcement. Local ordinances may be adopted to help enforce trail policies. Penalties such as fines or community service may be imposed in response to non-compliance.

<u>Informational Kiosks</u>

Interpretive signage provides enrichment to the trail user experience, focuses attention on the unique attributes of the local community, and provides educational opportunities. Natural and cultural resources in trail corridors may provide opportunities for interpretation.

Directional signs are regularly used along the Galloping Goose and Lochside Trails.

Multi-use trail etiquette signage

Guidance

- TAC *Bikeway Traffic Control Guidelines for Canada*.

5.1.2. On-Street Wayfinding Signage

Design Summary

Wayfinding signage currently used in Saanich, Oak Bay and Victoria are well-liked for their visibility for cyclists, but are less visible to motorists and do not comply to TAC and MUTCD-C standards.

- Design:
  - Use TAC and MUTCD-C standards for signs along the roadway.
- Placement:
  - Place along the designated regional network as facilities are developed to Class I standards (comfortable for most users).
  - See table, next page.
  - Post at a level most visible to bicyclists and pedestrians, rather than per vehicle signage standards to reduce confusion.
  - Place further from the intersection when it is downhill, due to faster average travel speeds.
- Content: Destinations for on-street signage can include:
  - On-street bikeways
  - Commercial centres
  - Regional parks and trails
  - Public transit sites
  - Civic/community destinations
  - Local parks and trails
  - Hospitals
  - Schools
- Place the closest destination to each sign in the top slot. Destinations that are further away can be placed in slots two and three. This allows the nearest destination to 'fall off' the sign and subsequent destinations to move up the sign as the bicyclist approaches.
- Use pavement markings to help reinforce routes and directional signage. Markings, such as neighbourhood bikeway symbols (see page 55), may be used in addition to or in place of directional signs along bike routes. Pavement markings can help cyclists navigate difficult turns and provide route reinforcement.
- Seasonal bush and tree trimmings may be necessary to keep signs visible.

Discussion

Wayfinding signs help users find the best bicycle route to their destinations. They passively market the network by providing unique and consistent imagery throughout the region. Providing time and distance information can help address misperceptions about time and distance and encourages residents to try bicycling to local destinations. Bicycle wayfinding signs also visually cue motorists that they are driving along a bicycle route and should use caution.

Wayfinding signs should be placed along the designated regional network as facilities are brought to Class I standards. This requirement ensures that users can follow the signs and are not forced to ride on a difficult or dangerous bikeway to reach their destinations. Coordinate across municipal boundaries so users are not 'stranded.' Routing may change as facilities are upgraded to Class I.

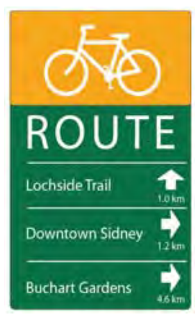
It is recommended that local bikeways use the same or similar signs to maintain consistency, although it is recognized that municipalities may desire branding the local bikeway system in a more individualized manner.

Recommended signs for the CRD incorporate the unique and familiar Saanich sign with a standard that is internationally recognized.

5.1.2. On-Street Wayfinding Signage

Discussion (continued)

Recommended guidelines for wayfinding signs along a bikeway network

Sign Type	Purpose	Information	Placement	Sample Designs
Confirmation signs	Indicate to cyclists that they are on a designated bikeway. Make motorists aware of the bicycle route.	Can include destinations and distance /time, no arrows. TAC "BIKE ROUTE" signs can be used.	Every 200 m on both sides of the street, unless another type of sign is used (i.e. skip this sign within 50 m of a turn or decision sign).	 
Turn signs	Indicates where a bikeway turns from one street onto another street. Can be used with pavement markings.	Includes destinations and arrows. TAC "BIKE ROUTE" signs and arrows can be used.	Near-side of intersection where bike route turns (e.g. where the street ceases to be a bicycle route or does not go through),	  
Decision signs	Marks the junction of two or more bikeways Informs cyclists the designated bike route to access key destinations.	Destinations, arrows, and distances.	Near-side of intersections in advance of a junction with another bicycle route. Along a route, to indicate a nearby destination.	

Guidance

- TAC *Bikeway Traffic Control Guidelines for Canada*.
- MUTCD-C
- Wick, Darrell. (No Date). Saanich "Bicycle and Pedestrian Mobility Committee" Bicycle Route Signs. City of Oakland. (2009). Design Guidelines for Bicycle Wayfinding Signage.
- City of Portland (2002). Bicycle Network Signing Project.

6. Trip Enhancement Facilities

6.1. Pedestrian Amenities

Design Summary

A variety of amenities can make a trail inviting to the user. Costs vary depending on the design and materials selected for each amenity. Amenities shall be designed and located so as not to impede accessibility.

Discussion

Benches

Providing benches at key rest areas and viewpoints encourages people of all ages to use the trail by ensuring that they have a place to rest along the way. Benches can be simple (e.g., wood slates) or more ornate (e.g., stone, wrought iron, concrete).

Benches and rest areas encourage trail use by seniors and families with children.

Restrooms

Restrooms benefit trail users, especially in more remote areas where other facilities do not exist. Restrooms can be sited at trailheads along the trail system and can be provided at standard intervals along the trail,

Water Fountains

Water fountains provide water for people (and pets, in some cases) and bicycle racks allow recreational users to safely park their bikes if they wish to stop along the way, particularly at parks and other desirable destinations.

Drinking fountain, Kamloops BC.

Bicycle Parking

Bicycle parking allows trail users to store their bicycles safely for a short time. Bicycle parking should be provided if a trail transitions to an unpaved pedestrian-only area.

Trash Receptacles

Litter receptacles should be placed at access points. Litter should be picked up once a week and after any special events held on the trail, except where specially designed trash cans have been installed. If maintenance funds are not available to meet trash removal needs, it is best to remove trash receptacles.

Signage

Informational kiosks with maps at trailheads and signage for other destinations can provide information trail users. They are beneficial for areas with high out-of- area visitation rates as well as the local citizens.

Art

Local artists can be commissioned to provide art for the trail system, making it uniquely distinct. Many trail art installations are functional as well as aesthetic, as they may provide places to sit and play on.

Art installations can provide a sense of place for the trail.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.

6.2. Short-Term Bicycle Parking

Short-term bicycle parking facilities include racks which permit the locking of the bicycle frame and at least one wheel to the rack and support the bicycle in a stable position without damage to wheels, frame or components.

6.2.1. Sidewalk Bicycle Racks

Design Summary

<u>Location</u>

- 15 m maximum distance from main building entrance.
- 0.6 m minimum from the curb face to avoid 'dooring.'
- Avoid fire zones, loading zones, bus zones, etc.
- Location should be highly visible from adjacent bicycle routes and pedestrian traffic.

<u>Additional Considerations</u>

- To allow ample pedestrian movement, a minimum clear distance of 1.8 metres should be provided between the bicycle rack and the property line. A clear distance of 1.5 m is the minimum standard.
- Where parking is clustered, provide a ramp from the street to the parking area from the approach. Do not place a ramp for exiting cyclists, encouraging them to walk their bicycles to the intersection before merging into traffic.

<u>Spacing between bicycle racks</u>

- If two bicycle racks are to be installed parallel to each other, a minimum of 0.7 m should be provided between the racks.
- If bicycle racks are to be installed in a parallel series, at least 1.8 m should be provided between the racks.

Stationnement de Montreal parking meter retrofit for bicycle parking.

Cluster or coathanger racks can accommodate more than two bikes.

Discussion

Bicycle racks should be located close to the entrances of key destinations such as shops or shopping centres. They are generally appropriate for commercial and retail areas, office buildings, healthcare and recreational facilities, and institutional developments such as libraries and universities.

On-sidewalk racks should be placed adjacent to the curb in the utility strip, where other street furniture, utility poles, and trees are located. Racks should be oriented so that bicycles are positioned parallel to the curb, where neither the rack nor the bicycle in it impedes pedestrian traffic. Where a clear right-of-way for pedestrians cannot be maintained by installing the rack on the sidewalk, place bicycle racks in curb extensions or on-street (see next page). A certain number of bicycle racks should be weather protected. This may be achieved by simply locating the racks under awnings.

Custom racks using creative designs can double as public artwork or advertising space for local businesses. The "post and ring" style rack is an attractive alternative to the standard inverted-U, which requires only a single mounting point and can be customized to have the City's name or emblem stamped into the rings. These racks can also be easily retrofitted onto existing street posts, such as parking meter posts. While custom racks can add a decorative element and provide consistency with an existing neighbourhood theme, the rack function should not be overlooked; all racks should adhere to the basic functional requirements for bicycle parking as described above.

6.2. Short-Term Bicycle Parking

6.2.2. On-Street Corrals

Design Summary

- See guidelines for sidewalk bicycle rack placement and clear zones.
- Can be used with parallel or angled parking.
- Each motor vehicle parking space can be replaced with approximately 6-10 bicycle parking spaces.
- Protect bicycles from motor vehicles with physical barriers such as curbs, bollards, or fences or through the application of other unique surface treatments.
- Establish maintenance responsibility when facility is built, particularly street sweeping and snow removal.
- Parking stalls adjacent to curb extensions are good candidates for bicycle corrals since the concrete extension serves as delimitation on one side.
- Cyclists should be able to access the corral from both the sidewalk and the roadway.
- Cyclists should have an entrance width from roadway of 1.5 – 1.8 m.
- Aisle width between sidewalk and bicycle rack is 1.0 – 1.5 m.
- Aisle width between outside delimitation and bicycle rack is 1.0 m.

On-street bicycle parking should be highly visible to drivers and bicyclists.

Discussion

Bicycle corrals (also known as "in-street" bicycle parking) consist of bicycle racks grouped together in a common area within the public right-of-way traditionally used for automobile parking. Bicycle corrals are reserved exclusively for bicycle parking and provide a relatively inexpensive solution to providing high-volume bicycle parking. Bicycle corrals can be implemented by converting one or two on-street motor vehicle parking spaces into on-street bicycle parking.

Bicycle corrals move bicycles off the sidewalks, leaving more space for pedestrians, sidewalk café tables, etc. Because bicycle parking does not block sightlines (as large motor vehicles would do), it may be possible to locate bicycle parking in 'no-parking' zones near intersections and crosswalks.

Bicycle corrals can be considered instead of other on-street bicycle parking facilities where:

- High pedestrian activity results in limited space for providing bicycle racks on sidewalks.
- There is a moderate to high demand for short-term bicycle parking.
- Sufficient on-street vehicular parking is provided
- The business community is interested in sponsoring the bicycle corral.

In many communities, including Portland, the installation of bicycle corrals is driven by requests from adjacent businesses, and is not a city-driven initiative. In such cases, the City does not remove motor vehicle parking unless it is explicitly requested. In other areas, the City provides the facility and business associations take responsibility for the maintenance of the facility. Many communities, including the City of Portland, establish maintenance agreements with the requesting business.

The bicycle corral can be visually enhanced through the use of attractive planters and vegetation to act as buffers from the motor vehicle parking area as well as the use of creative demarcation elements to separate the corral for motor vehicle traffic.

6.2. Short-Term Bicycle Parking

6.2.3. Shelters

Design Summary

- See guidelines for sidewalk bicycle rack placement and clear zones.
- To be located on-street or off-street, in areas of high potential demand, such as areas in close proximity to major employment areas, schools, or community and recreational facilities.
- Recommended height: 2.5 – 3.5 m.
- Roof area: 3.5 – 4.5 m.
- If the bicycle racks are located perpendicular to a wall, 0.6 m minimum clearance (single-side access); and 2.5 m (double-sided access).
- If the bicycle rack is located parallel to a wall, 0.45 m minimum clearance should be provided.
- A clear width of 0.9 m should be provided between rack ends to balance the maximization of bicycle parking capacity with the need for adequate bicycle manoeuvrability.

Bicycle parking shelter on a sidewalk in downtown Victoria.

Discussion

Bicycle Shelters consist of bicycle racks grouped together within structures with a roof that provides weather protection. Bicycle shelters provide convenient short-term and long-term bicycle parking. They also offer extra protection against accidental damages by providing greater separation between the bicycles and the sidewalk or parking lane. Information boards and advertising space can also be incorporated onto the bicycle shelter which is often used to post cycling or bicycle related information. Bicycle shelters provide a high level of aesthetic adaptation as each of its components (shelter, racks, roof) may be enhanced with different shapes, colours and materials.

Bicycle shelters are warranted anywhere that bicycle racks may be located, particularly:

- Major commercial and retail areas, particularly in the major commercial nodes.
- Areas with sufficient space on sidewalks, promenades or public plazas, or curb extensions, so that adequate sidewalk width can be maintained.
- Demand for bicycle parking is oriented more towards long-term parking.

The location chosen for the bicycle shelter should be central to all surrounding activities so cyclists can park and walk conveniently to their final destination.

Bicycle parking area signage should be provide to indicate to cyclists and pedestrians that the bicycle shelter is intended exclusively for bicycle use and to alert pedestrians and motorists that they can expect higher bicycle volumes in the area.

6.3. Long-Term Parking

Long-term facilities protect the entire bicycle, its components and accessories against theft and against inclement weather, including snow and wind-driven rain. Long-term parking facilities are more expensive to provide than short-term facilities, but are also significantly more secure. Potential locations for long-term bicycle parking include transit stations, large employers and institutions where people use their bikes for commuting, and not consistently throughout the day.

6.3.1. Bike Lockers

Design Summary

- Place in close proximity to building entrances or transit exchanges, or on the first level of a parking garage.
- Provide door locking mechanisms and systems.
- A flat, level site is needed; concrete surfaces preferred.
- Enclosure must be rigid.
- Transparent panels are available on some models to allow surveillance of locker contents.
- Integrated solar panels have been added to certain models for recharging electric bicycles.
- Minimum dimensions: width (opening) 800 mm; height 1,900 mm; depth 1,150 mm.
- Stackable models can double bicycle parking capacity.

Bike lockers at a transit station.

Discussion

Although bicycle lockers may be more expensive to install, they can make the difference for commuters who are deciding whether or not to cycle. Bicycle lockers are large metal or plastic stand-alone boxes and offer the highest level of bicycle parking security available.

Some lockers allow access to two users - a partition separating the two bicycles can help ensure users feel their bike is secure. Lockers can also be stacked, reducing the footprint of the area, although that makes them more difficult to use.

Security requirements may require that locker contents be visible, introducing a tradeoff between security and perceived safety. Though these measures are designed to increase station security, bicyclists may perceive the contents of their locker to be less safe if they are visible and will be more reluctant to use them. Providing visibility into the locker also reduces unintended uses, such as use as homeless shelters, trash receptacles, or storage areas. Requiring that users procure a key or code to use the locker also reduces these unintended uses.

Traditionally, bicycle lockers have been available on a sign-up basis, whereby cyclists are given a key or a code to access a particular locker. Computerized on-demand systems allow users to check for available lockers or sign up online. Models from eLocker and CycleSafe allow keyless access to the locker with the use of a SmartCard or cell phone. With an internet connection, centralized computerized administration allows the transit agency to monitor and respond to demand for one-time use as well as reserved lockers.

Lockers available for one-time use have the advantage of serving multiple users a week. Monthly rentals, by contrast, ensure renters that their own personal locker will always be available. Bicycle lockers are most appropriate:

- Where demand is generally oriented towards long-term parking.
- At transit exchanges and park-and-rides to help encourage multi-modal travel.
- Medium-high density employment and commercial areas and universities.
- Where additional security is required and other forms of covered storage are not possible.

6.3. Long-Term Parking

6.3.2. Bicycle Compounds/Cages

Design Summary

- See guidelines for bicycle rack placement and clear zones.
- A cage of 5.6 m feet by 5.5 m can accommodate up to 20 bicycles and uses the space of approximately two automobile parking spots.
- Improve surveillance through public lighting and video cameras.
- Bicycle compounds shall have an exterior structure consisting of expanded metal mesh from floor to ceiling.
- In an attended parking facility, locate within 30 m of an attendant or security guard or must be visible by other users of the parking facility.
- Entry doors must be steel and at least 75 cm in width, with "tamper proof" hinges. A window may be provided in the door to provide permanent visual access.
- Accommodate a maximum of 40 bicycles, or 120 if the room is compartmentalized with expanded metal mesh with lockable industrial-grade doors into enclosures containing a maximum of 40 bicycles.

This bike cage in Penn Station, New York City provides wave racks and uses a passcard for access.

Secure Parking Area (SPA) in Portland, OR use both inverted 'u' racks (right) and racks that stack bicycles.

Discussion

Bicycle compounds are fully enclosed, stand-alone bicycle parking structures. Compounds should not only have a locked gate but should also allow for the frame and both wheels to be locked to a rail, as other users also have access to the enclosure. Bicycle compounds are recommended for employment or residential bicycle parking areas, or for all-day parking at transit exchanges, workplaces and schools. They can be located at street level or in parking garages.

Bicycle Secure Parking Areas (SPAs) are a new concept implemented for TriMet (Portland, Oregon's transit agency). They provide high capacity, secure parking areas for 80-100 bicycles at light rail and bus transit centres. The Bicycle SPAs are semi-enclosed covered areas that are accessed by key cards and monitored by security cameras. The increased security measures provide an additional transportation option for those who may not be comfortable leaving their bicycle in an outdoor transit station exposed to weather and the threats of vandalism. They also include amenities that make the Bicycle SPA more attractive and inviting for users such as benches, bicycle repair stations, bicycle tube and maintenance item vending machines, as well as hitching posts which allow people to leave their locks at the SPA.

6.3. Long-Term Parking

6.3.3. Bicycle Rooms

Design Summary

- See guidelines for bicycle rack placement and clear zones.
- Improve surveillance through public lighting and video cameras.
- Walls should be solid and opaque from floor to ceiling.
- Entry doors must be steel and at least 75 cm in width, with "tamper proof" hinges. A window may be provided in the door to provide permanent visual access.
- Install a panic button so as to provide a direct line of security in the event of an emergency.
- Accommodate a maximum of 40 bicycles, or 120 if the room is compartmentalized with expanded metal mesh with lockable industrial-grade doors into enclosures containing a maximum of 40 bicycles.

Bike rooms can be provided in office or apartment buildings.

Discussion

Bicycle Rooms are locked rooms or cages which are accessible only to cyclists, and which may contain bicycle racks to provide extra security against theft. Bicycle rooms are used where there is a moderate to high demand for parking, and where cyclist who would use the bicycle parking are from a defined group, such as a group of employees. Bicycle rooms are also popular for apartment buildings, particularly smaller ones in which residents are familiar with one another.

The bicycle parking facilities shall be no further from the elevators or entrances than the closest motor vehicle parking space, and no more than 50 m from an elevator or building entrance. Buildings with more than one entrance should consider providing bicycle parking close to each entrance, and particularly near entrances that are accessible through the bicycle network. Whenever possible, bicycle parking facilities should allow 24-hour secure access.

Dedicated bicycle-only secure access points shall be provided through the use of security cards, non-duplicable keys, or passcode access. The downside is that bicyclists must have a key or know a code prior to using the parking facilities, which is a barrier to incidental use.

6.3. Long-Term Parking

6.3.4. Showers and Lockers

Design Summary

- Locate within the building in which the employee works, adjacent to secure bicycle parking facilities, ideally at a distance of no more than 60 m.
- Locker minimum dimensions: 45 cm deep, 30 cm wide, 90 cm high.
- Locker recommended dimensions: 50 to 55 cm deep to accommodate business clothes stored on hangers; 180 cm tall so that pants and dresses can be stored without wrinkling.
- Showers shall be located in separate men's and women's locker rooms.
- Changing rooms should include at least one grooming station for each shower provided. Each grooming station should provide a mirror, a wash basin, a countertop, and an electrical outlet.
- All lockers rooms must be secure and accessible only to appropriate personnel.
- Where possible, lockers may be vented with forced air or heat-traced to dry cycle clothing for return trips home.

Showers and locker enable commuters to bicycle to work and look professional at the office.

Discussion

Providing showers and clothing lockers at workplaces is a critical component to encouraging bicycle use, particularly among bicycle commuters who have a long commute or who require professional clothing attire.

The City of Victoria is proposing the following development guidelines for showers and clothing lockers:

- Showers and clothing lockers shall be provided at all non-residential developments which have requirements for long-term bicycle parking in the City's Zoning Bylaw, including commercial, industrial, institutional, and cultural and recreational developments. Showers and clothing lockers are intended to be used primarily by employees who may be commuting long-distances.
- The number of showers shall reflect the amount of long-term bicycle parking required on site. For smaller bicycle parking facilities with four or fewer long-term bicycle parking spaces, a minimum of one shower must be provided. For larger developments, one shower must be provided for each gender for every 30 bicycle parking spaces that are installed.
- To ensure the security of personal belongings, the number of clothing lockers must be at least equal the number of required long-term bicycle parking spaces. Clothing lockers shall be distributed equally for men and women.
- Wash basins shall be provided equalling the number of showers provided.
- Where facilities are provided on-site as part of an employee fitness centre, meet or exceed the requirements for showers and clothing lockers, and are accessible to cyclists before and after their work shifts, additional shower and change facilities for cyclists are not required.

6.3. Long-Term Parking

6.3.5. Automated Bicycle Parking

Design Summary

- **Bike Trees** use smart card technology and move bicycles up into an umbrella-shaped cover, to reduce theft and vandalism. They can be a symbol of the organization's commitment to high-quality facilities for cyclists. They do not however, provide space to store accessories.
- **Bicibergs** are multi-level automated bicycle parking facilities. Spain and Japan have developed Bicibergs to store a large number of bicycles. Bicibergs are automated systems that store the bicycle locker underground. The advantage is that users can store bags and raingear in the locker without fear of theft. In Japan, the bicycle is rolled onto a platform, which descends into the parking facility and is rolled into an underground storage unit. Usage fees are often minimal.
- **Bikedispenser** has been recently developed in Europe and is in use in the Netherlands. Bikedispenser is a fully automatic, weather-protected, and secure intake- and issue- station that can hold 30 to 100 bicycles. A Bikedispenser can be implement at-grade or underground.

Bike tree automated parking.
Source: www.biketree.com

Bike dispenser underground parking.
Source: www.bikedispenser.com

Discussion

Automated bicycle parking provides secure, unmonitored outdoor parking. There are several different types of automated parking in use around the world. Most of them have a hook, slot, or other mechanism, on which the user places the bicycle, and which removes the bicycle from street level. These units can be accessible at all hours of the day for users to retrieve their bicycles. Automated parking is a good option for a location that requires bicycle parking to have a small footprint or in situations where surveillance may be difficult.

Some European and Asian cities have constructed underground, automatic parking systems. These facilities can receive and return bicycles on street level or at a platform in less than 30 seconds. The facility utilizes a chip card access system and allows the user to keep additional items such as a helmet and back pack with their bicycle. An alternative to lockers, automated bicycle parking provides secure, unmonitored outdoor parking. There are several different types of automated parking in use around the world. Most of them have a hook, slot, or other mechanism, on which the user places the bicycle, and which removes the bicycle from street level. These units can be accessible at all hours of the day for users to retrieve their bicycles. Automated parking is a good option for a location that requires bicycle parking to have a small footprint or in cases where surveillance may be difficult.

6.3. Long-Term Parking

6.3.6. Bike Depot

Design Summary

- Typically provide space for between 1,000 and 4,000 bicycles
- Minimum components: building, permanent staff for services, management and administration, end of trip facilities (lockers, showers, changing rooms, shops, etc.) and passive and active surveillance.
- While each depot is unique, they often provide:
  - Attended or restricted-access parking spots
  - Shared-use bicycle rentals
  - Access to public transportation
  - Commute trip-planning information

BikeStation™ Seattle operates out of a storefront.

Discussion

Bike depots generally refer to full-service parking facilities typically located at major transit locations and commuter destinations, including downtowns and other commercial and employment centres that offer secure bicycle parking and other amenities. There is no universally accepted terminology to describe different types of full-service bicycle parking facilities. Bike depots or bike stations are very popular in Europe, particularly in the Netherlands and Germany and are increasingly being implemented throughout North America, including Seattle, Chicago and several communities in California.

Visibility of the bike depot is crucial to its success. The depot should be located in a central area, where users do not have to deviate greatly from their routes to access. In addition, successful depots are linked to complementary businesses such as coffee shops, bike shops, bike rentals, or similar businesses.

The company BikeStation™, which runs several parking facilities in California and Washington, offers free parking during business hours and key-card access after-hours for members. Paying members enjoy a number of services. Services, which differ by location, may include bicycle repairs, bicycle rentals, sales and accessories, restrooms, changing rooms and showers, and access to vehicle-sharing, such as ZipCar.

Seattle Bikestation™ members receive discounted ZipCar and Bicycle Alliance of Washington memberships, as well as access to repair services, rentals, and a library of bicycling resources. They also offer a guaranteed ride home program, which reduces the fear of being stranded by a flat tire or other malfunction.

6.4. Bicycle Parking Maintenance and Management

Proper maintenance of bicycle parking facilities is critical to ensuring the safety, convenience, and attractiveness of cycling. Maintenance requirements differ based on the type of bicycle parking provided.

6.4.1. On-Street Bicycle Parking Maintenance

Design Summary

- Locate bicycle racks in a highly visible area to allow for regular monitoring to discourage theft and vandalism.
- Ensure the area around the bicycle parking facility is free of garbage, dirt, and other debris.
- Clear snow from the bicycle parking area.
- Manually inspect bicycle racks regularly to ensure that bolts and anchors remain secure and to identify any damage.
- Repaint, repair or replace damaged parts in a timely fashion.
- Monitor use of bicycle lockers, including signs of misuse, through master keys or other systems that allow access to the lockers.
- Encourage cyclists to report any vandalism or security concerns. Contact information should be clearly visible so that problems may be reported.
- Some bicycle lockers, particularly those provided outdoors, may suffer corrosion of locking mechanisms, which will need to be regularly serviced or replaced.
- Remove abandoned and derelict bicycles.

6.4.2. Off-Street Bicycle Parking Maintenance

Design Summary

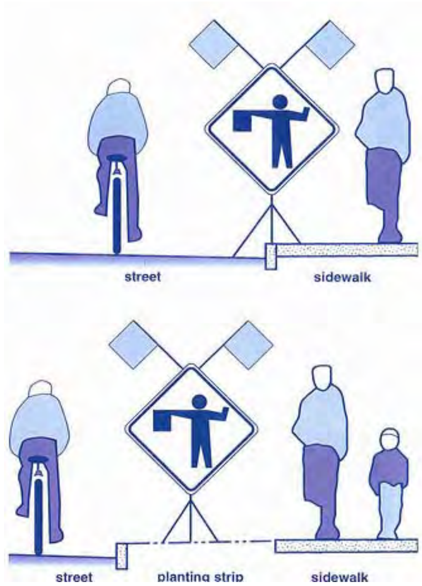
- Develop a registration system to aid in the regulation and monitoring of users. This could include a security pass card system or employee access cards that can be programmed to allow access to a bicycle cage or bicycle room. Key and/ or card lock systems should be periodically changed to prevent "leakage" of access or security.
- Ensure regular security surveillance through video and periodic foot patrols.
- Reserve the facility for the exclusive use of bicycles. Regular monitoring is required to prevent misuse, such as storing items other than bicycles.
- Encourage cyclists to report any vandalism or security concerns. Contact information should be clearly indicated to report problems.
- Ensure the facility is well-lit and that lighting is resistant to tampering and damage. The facility should be checked regularly for burnt-out bulbs.
- Develop a system of tagging bicycles one week before their removal in order to warn cyclists and help distinguish abandoned bicycles from ones that area in use.

7. Maintenance and Construction

7.1. Bicycle and Pedestrian Access through Construction Areas

Design Summary:

- Bicyclists and pedestrians should not be led into conflicts with work site vehicles, equipment, moving vehicles, open trenches or temporary construction signage.
- Efforts should be made to re-create a bike lane (if one exists) to the left of the construction zone. If this is impossible, then a standard-width travel lane should be considered or alternative detour.
- Construction signage actions:
  - Place in a location that does not obstruct the path of bicyclists or pedestrians (see graphic).
  - Detour and closure signage related to bicycle travel may be included on all bikeways where construction activities occur. Signage should also be provided on all other roadways.
  - Use signs indicating "share the lane" or "single file" as appropriate.
- Recommendations for bicycle travel around steel grates:
  - Ensure that steel plates do not have a vertical edge greater than 7 mm without an asphalt lip.
  - Using non-skid steel plates w/o a raised steel bar.
  - Requiring temporary asphalt (cold mix) around plates to create a smooth transition.
  - Using steel plates only as a temporary measure during construction, not for extended periods.
  - Use warning signage where steel plates are in use.



Recommended signage placement.

Discussion

Safety of all roadway users should be considered during road construction and repair. Wherever bicycles are allowed, measures should be taken to provide for the continuity of a bicyclist's trip through a work zone area. Only in rare cases should pedestrians and bicyclists be detoured to another street when travel vehicle lanes remain open. Contractors performing work for the CRD should be made aware of the needs of bicyclists and be properly trained in how to safely route bicyclists through or around work zones.

Steel Plates

Plates used to cover trenches tend to not be flush with pavement and have a 25-50 mm vertical transition on the edges. This can puncture a hole in a bicycle tire and cause a cyclist to lose control. Bicyclists often are left on their own to merge with vehicles in the adjacent travel lane. Although it is common to use steel plates during non-construction hours, these plates can be dangerously slippery, particularly when wet.

Guidance

Additional guidance for accommodating cyclists and pedestrians through construction areas will be developed for the CRD.

- Manual on Uniform Traffic Control Devices-Canada (MUTCD-C)
- TAC Bikeway Traffic Control Guidelines for Canada.
- MoTI *Traffic Control Manual for Work on Roadways.*
- Worksafe BC http://www.th.gov.bc.ca/publications/eng_publications/TCM/Traffic_Control_Manual.htm

7.2. Sidewalk Maintenance

Design Summary:

- Minimize barriers for pedestrians, particularly with mobility and sensory impairments, by providing a level surface with a minimum of 7 mm grade changes.
- Trim tree limbs to leave at least 2.5 m of clear space above the sidewalk.

Subsurface tree roots can lift concrete sidewalk slabs, causing the surface to become uneven.

Discussion

Root Protection

Street trees are a highly desirable part of the pedestrian environment, especially large-canopied shade trees. Two common causes of sidewalk damage are from the wrong tree in the wrong place and from soil freeze and thaw causing inflexible infrastructure to crack and heave. To minimize sidewalk damage from trees, choose appropriate trees based on the climatic conditions, such as water and light availability, the quantity of air, and root space available at the specific location.

Grates

Designers should consider using tree well grates or treatments such as unit pavers in high pedestrian use areas.

All grates within the sidewalk should be flush with the level of the surrounding sidewalk surface, and should be located outside the Through Pedestrian Zone. Ventilation grates and tree well grates shall have openings no greater than 15 mm in width.

Tree well grates can create uneven sidewalk conditions.

Hatch Covers

Hatch covers must have a surface texture that is rough, with a slightly raised pattern. The surface should be slip-resistant even when wet. The cover should be flush with the surrounding sidewalk surface.

Curb Ramp Maintenance

It is critical that the interface between a curb ramp and the street be maintained adequately. Asphalt street sections typically have a shorter life cycle than a concrete ramp, and can develop potholes at the foot of the ramp, which can catch the front wheels of a wheelchair. Existing ramps, and crossings without ramps, must be brought to current accessibility standards during reconstruction periods.

Guidance

- Manual on Uniform Traffic Control Devices-Canada (MUTCD-C)
- TAC Bikeway Traffic Control Guidelines for Canada.

7.3. Bikeway Maintenance

Design Summary:

- Guidelines for regularly maintaining bicycle facilities are provided below.

Discussion

Sweeping

Bicyclists often avoid shoulders and bike lanes filled with gravel, broken glass and other debris; they will ride in the roadway to avoid these hazards, causing conflicts with motorists. Debris from the roadway should not be swept onto sidewalks (pedestrians need a clean walking surface), nor should debris be swept from the sidewalk onto the roadway. A regularly scheduled inspection and maintenance program helps ensure that roadway debris is regularly picked up or swept.

Action items involving sweeping activities include:

- Establish a seasonal sweeping schedule that prioritizes roadways with major bicycle routes.
- Sweep walkways and bikeways whenever there is an accumulation of debris on the facility.
- In curbed sections, sweepers should pick up debris; on open shoulders, debris can be swept onto gravel shoulders.
- Pave gravel driveway approaches to minimize loose gravel on paved roadway shoulders.
- Provide extra sweeping in the fall where leaves accumulate.

Recommended Walkway and Bikeway Maintenance Activities

Maintenance Activity	Frequency
Inspections	Seasonal – at beginning and end of Summer
Pavement sweeping/blowing	As needed, twice a year
Pavement sealing	5 - 15 years
Pothole repair	1 week – 1 month after report
Culvert and drainage grate inspection	Before Winter and after major storms
Pavement markings replacement	1 – 3 years
Signage replacement	1 – 3 years
Shoulder plant trimming (weeds, trees, brambles)	Twice a year; middle of growing season and early fall
Tree and shrub plantings, trimming	1 – 3 years
Major damage response (washouts, fallen trees, flooding)	As soon as possible

Roadway Surface

Bicycles are more sensitive to subtle changes in roadway surface than motor vehicles. Some paving materials are smoother than others, and compaction/uneven settling can affect the surface after trenches and construction holes are filled. Uneven settlement after trenching can affect the roadway surface nearest the curb where bicycles travel. Sometimes compaction is not achieved to a satisfactory level, and an uneven pavement surface can result due to settling over the course of days or weeks. When resurfacing streets, the CRD should use the smallest chip size and ensure that the surface is as smooth as possible to improve safety and comfort for bicyclists.

Recommended action items involving maintaining the roadway surface include:

- On all bikeways, use the smallest possible chip for chip sealing bike lanes and shoulders.
- During chip seal maintenance projects, if the pavement condition of the bike lane is satisfactory, it may be appropriate to chip seal the travel lanes only.
- Ensure that on new roadway construction, the finished surface on bikeways does not vary more than 7 mm.
- Maintain a smooth surface on all bikeways that is free of potholes.
- Maintain pavement so ridge build-up does not occur at the gutter-to-pavement transition or adjacent to railway crossings.
- Inspect the pavement 2 to 4 months after trenching construction activities are completed to ensure that excessive settlement has not occurred.

7.3. Bikeway Maintenance

Discussion (continued)

Gutter-to-Pavement Transition

On streets with concrete curbs and gutters, 30-60 cm of the curbside area is typically devoted to the gutter pan, where water collects and drains into catch basins. On many streets, the bikeway is situated near the transition between the gutter pan and the pavement edge. It is at this location that water can erode the transition, creating potholes and a rough surface for travel.

The pavement on many streets is not flush with the gutter, creating a vertical transition between these segments. This area can buckle over time, creating a hazardous environment for bicyclists. Since it is the most likely place for bicyclists to ride, this issue is significant for bike travel.

Action items related to maintaining a smooth gutter-to-pavement transition include:

- Ensure that gutter-to-pavement transitions have no more than a 7 mm vertical transition.
- Examine pavement transitions during every roadway project for new construction, maintenance activities, and construction project activities that occur in streets.

Drainage Grates

Drainage grates are typically located in the gutter area near the curb of a roadway. Drainage grates typically have slots through which water drains into the municipal wastewater system. Many grates are designed with linear parallel bars spread wide enough for a tire to become caught so that if a bicycle were to ride on them, the front tire would become caught and fall through the slot. This would cause the cyclist to tumble over the handlebars and sustain potentially serious injuries. The CRD should consider the following:

- Continue to require all new drainage grates be bicycle-friendly, including grates that have horizontal slats on them so that bicycle tires and assistive devices do not fall through the vertical slats.
- Create a program to inventory all existing drainage grates and replace hazardous grates as necessary – temporary modifications such as installing rebar horizontally across the grate is no alternative to replacement.

Pavement Overlays

Pavement overlays represent good opportunities to improve conditions for cyclists if done carefully. A ridge should not be left in the area where cyclists ride (this occurs where an overlay extends part-way into a shoulder bikeway or bike lane). Overlay projects offer opportunities to widen a roadway, or to re-stripe a roadway with bike lanes. Action items related to pavement overlays include:

- Extend the overlay over the entire roadway surface to avoid leaving an abrupt edge.
- If there is adequate shoulder or bike lane width, it may be appropriate to stop at the shoulder or bike lane stripe, provided no abrupt ridge remains.
- Ensure that inlet grates and manhole and valve covers are within 7 mm of the pavement surface and are made or treated with slip resistant materials.
- Pave gravel driveways to property line to prevent gravel from spilling onto shoulders or bike lanes.

Signage

Signage is crucial for safe and comfortable use of the bicycle and pedestrian network. Such signage is vulnerable to vandalism or wear, and requires regular maintenance and replacement as needed. The CRD should consider:

- Check regulatory and wayfinding signage along bikeways for signs of vandalism, graffiti, or normal wear.
- Replace signage along the bikeway network as-needed.
- Perform a regularly-scheduled check on the status of signage with follow-up as necessary.
- Create a Maintenance Management Plan (see below).

7.3. Bikeway Maintenance

Discussion (continued)

Landscaping

Bikeways can become inaccessible due to overgrown vegetation. All landscaping needs to be designed and maintained to ensure compatibility with the use of the bikeways. After a flood or major storm, bikeways should be checked along with other roads, and fallen trees or other debris should be removed promptly. Landscaping maintenance action items include:

- Ensure that shoulder plants do not hang into or impede passage along bikeways.
- After major damage incidents, remove fallen trees or other debris from bikeways as quickly as possible.

Maintenance Management Plan

Bikeway users need accommodation during construction and maintenance activities when bikeways may be closed or unavailable. Users must be warned of bikeway closures and given adequate detour information to bypass the closed section. Users should be warned through the use of standard signing approaching each affected section (e.g., "Bicycle Lane Closed," "Trail Closed"), including information on alternate routes and dates of closure. Alternate routes should provide reasonable directness, equivalent traffic characteristics, and be signed.

Action items related to a Maintenance Management Plan include:

- Provide fire and police departments with map of system, along with access points to gates/bollards.
- Enforce speed limits and other rules of the road.
- Enforce all trespassing laws for people attempting to enter adjacent private properties.

Guidance

- Manual on Uniform Traffic Control Devices-Canada (MUTCD-C)
- TAC Bikeway Traffic Control Guidelines for Canada.