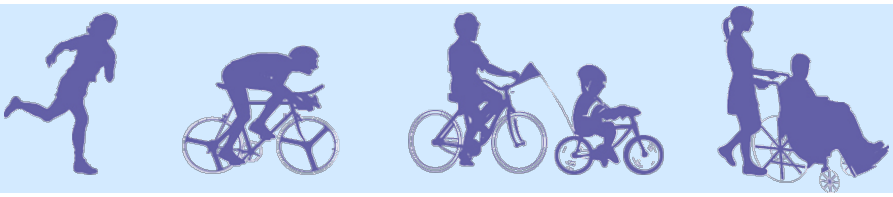


D

TRAIL & CYCLING FACILITY DESIGN: A DESIGNER'S TOOLBOX

D.1 Using the Design Guidelines

The Purpose

The purpose of these guidelines is to assist Town Staff in making informed decisions about active transportation (AT) facility design.

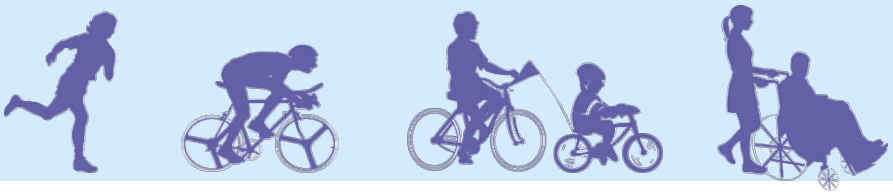
How to Use the Guidelines

The guidelines provide general information on cyclists and pedestrians and their needs. Where appropriate, summary tables are provided to highlight recommended design treatments and / or considerations when addressing key features associated with various bike and pedestrian facility types proposed for the Town of Milton.

The information included in these guidelines is thought to represent current accepted design practices in North America, and incorporates ongoing research and experience gained by the MMM team and others in Active Transportation (AT) facility design.

The guidelines are not intended to be prescriptive; they are guidelines which should be treated as a reference for the development and construction of the Trails and Cycling network. They are not intended to be inclusive of all design considerations for all locations, and are not intended to replace "sound engineering judgement". The intent is to have regard to the individual guidelines when implementing facilities at specific locations to arrive at the most appropriate solution. In some cases an interim solution may be appropriate where the desired long -term solution cannot be achieved in the short or mid-term, provided that the interim solution meets users' needs and safety considerations.

The use of the design guidelines is to be supplemented by the use of other design guidelines documents including but not limited to OTM Book 18 (bicycle facility design), OTM Book 15 (pedestrians) and the TAC Bikeway Control Guidelines.



D.2 Considerations When Designing For Cyclists and Trail Users

D.2.1 Types of User Groups

It is always important to consider the characteristics and preferences of potential users. In the Town of Milton, the user groups are expected to primarily include pedestrians and cyclists, but may also include other users such as inline-skaters and skateboarders.

Pedestrians

Definition: Walkers represent a wide range of interests and motives such as leisure, relaxation, socializing, exploring, making contact with nature, meditation, fitness, or dog walking. It is also important to consider pedestrians who walk for utilitarian or transportation purposes. This group typically:

- Is community-focused;
- Engages in trips focusing on shopping and errands and walking to work and school.

Utilitarian Walkers use sidewalks, parking lots and plazas as well as trails where they are convenient, well-designed and properly maintained. In many cases, trails provide a convenient "short cut" to traveling the sidewalk network to get to their destination.

Pedestrians may represent a significant portion of users in the downtown area of Milton.

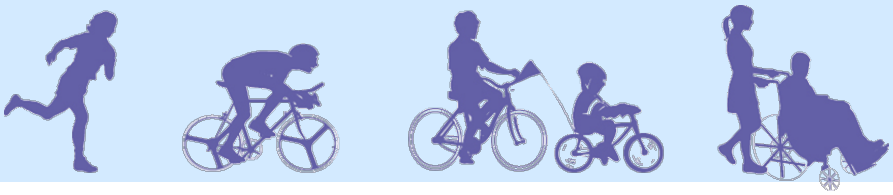
It is recommended that where no sidewalks are provided and there are no shoulders, pedestrians should walk on the edge of the roadway, facing oncoming traffic (*Ontario Highway Traffic Act)*. Signs warning motorists of pedestrians ahead are recommended.

Hikers

Definition: Hikers are often considered the elite of the recreational walking group and may challenge themselves to cover long distances and be willing to walk on sections of rural roadway shoulder considered less safe or less interesting by the majority of leisure walkers.

This group typically:

- Engages in day trips that may range between 5 and 30 km in length;
- May be more keenly interested in natural features;
- Are often more adept at map reading;
- Are more self-sufficient than leisure walkers;
- May expect fewer amenities; and
- Are often attracted to challenging terrain and rural areas.



It is important that active transportation planners assume that there will be keen pedestrian users, even in remote or highway environments despite the fact that the frequency may be very low.

Joggers / Runners

Definition: Although the primary motivation for joggers and runners may be fitness, they may share more in terms of profile characteristics with distance hikers than they do with leisure walkers.

This group typically:

- Is accomplishment oriented;
- Enjoy trails at higher speed for distances between 3 and 15 km or more; and
- Avoid hard surfaces such as asphalt and concrete and prefer to run on granular, natural (earth) and turf surfaces as they provide more cushioning effect.

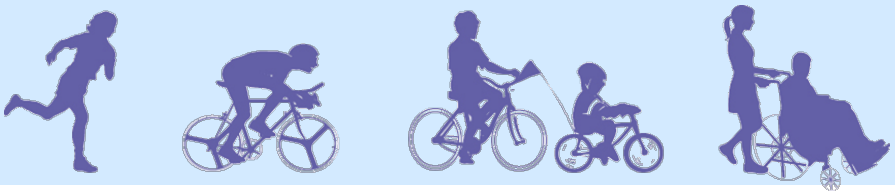
95% of all pedestrian trips are less than 2.5 km in lengthi, though it is to be expected that some walkers who are out for exercise / health / fitness purposes might make trips that are between 5 and 10 km in length.

Cyclists

Definition: Some bicycles, including the "mountain" or "hybrid" can travel easily over stone dust and gravel surfaces, whereas, traditional narrow-tired touring and racing bicycles require compacted granular surfaces or hard surface pavements such as asphalt.

It is important to consider...

- That the mechanical efficiency of the bicycle allows users of all ages to travel greater distances at a higher rate of speed than pedestrians.
- Distances covered vary widely from a few kilometres to well over a hundred depending on the fitness level and motivation of the individual cyclist.
- That cyclists have the right to access the extensive existing public roadway system, with the exception of the 400 series and major highways
- Some cyclists feel unsafe sharing the road with automobiles and do not have the desire or skill level to ride in traffic.
- Cyclists tend to prefer off-road trails, shared with pedestrians these facilities offer the less experienced and less confident cyclist a more comfortable environment.



- Cyclists that travel longer are more likely to focus a significant portion of their route on the roadway network, and often seek out quieter, scenic routes over busier roads.

Average Travel Speed for a cyclist on a trail is in the range of 15-20 km/h and on a road 15-30 km/h, speeds in excess of 50 km/h. can be attained while traveling downhill on roads and some hard surface trails. Where excessive speed is a potential issue on trails, speed limits and warnings should be posted to discourage fast riding and aggressiveness.

Cycling on Sidewalks: Cyclists other than young children should be discouraged from cycling on sidewalks because of potential conflicts with pedestrians and potentially dangerous intersections with driveways. According to the Highway Traffic Act vehicles are not permitted to use the sidewalk and since a bicycle is considered a vehicle under the Act they too are prohibited from using sidewalks. The only exception to this is for those learning to cycle (youth) and for cyclists in municipalities that have developed a by-law to permit cycling on their sidewalks e.g. City of Burlington.

When using roads, cyclists generally travel 0.5 – 1.0m from the curb or other obstruction because of the possibility of accumulated debris, uneven longitudinal joints, catch basins, steep cross slopes, or concern over hitting a pedal on the curb or handlebar on vertical obstacles. However, when cyclists use or cross a public roadway they are considered vehicles by law and are expected to follow the same traffic laws as motorized vehicles.

D.2.2 Types of Trips

Cyclists and pedestrians can also be defined by their trip purpose. These characteristics can be divided into the following three categories:

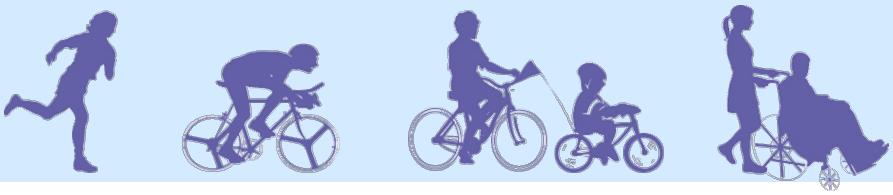
- Utilitarian;
- Recreational; and
- Touring.

Trip Purpose

Utilitarian

Definition: Those who use cycling or walking as their day to day mode of transportation to get to and from work, school, errands, etc.

It is important to consider that they often use the streets that are part of the trail and cycling network year-round in all weather conditions as opposed to those roads which do not make up part of the formal network. In some cases they may choose to use public transit or other modes of transportation during the winter season. Typically utilitarian users have good mobility skills and are cognisant of the “rules of the road”.



Recreational

Definition: These pedestrians and cyclists will typically use the network for fitness or leisure purposes.

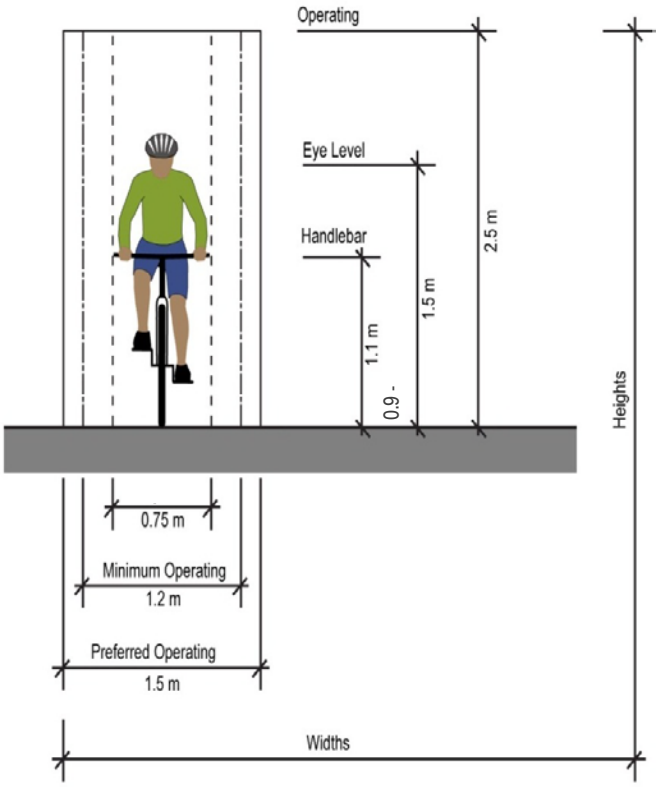
It is important to consider that their trips are typically used for travel on weekends as opposed to weekdays and will consist of trips to and from destinations of cultural or natural significance including off-road recreational trails. They will typically use the secondary / local neighbourhood connections as part of the overall network.

Touring

Definition: These pedestrians and cyclists use hiking and cycling as a means of exploring areas of significance long-distances from their point of origin.

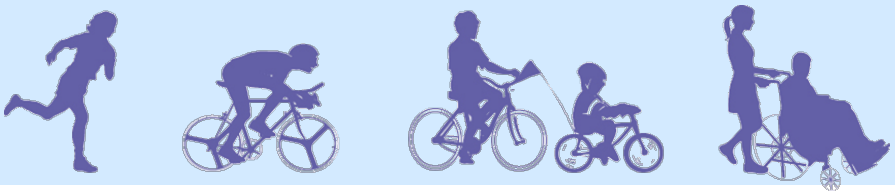
It is important to consider that their trips can vary from full day excursions to multi-day excursions. They may plan their trips in advance and are willing to spend money for accommodation and food at their destination point. In some cases they travel in groups.

Figure D.1 – Typical Operating Space
Source: Based on the AASHTO Guide for the Planning, Design and Operation of Bicycle Facilities, 2012



D.2.3 Minimum Operating Dimension

Due to the different types of bicycles as well as the variation in levels of ability between cyclists, there is a considerable difference in the physical dimensions and operating characteristics of cyclists. Cyclists require a certain amount of space to maintain stability when operating a bicycle. **Figure D.1** illustrates the Typical Cyclist Operating Space. An operating width of 1.2 metres to 1.5 metres is sufficient to accommodate forward movement by most cyclists. This width is greater than the physical width



momentarily occupied by a cyclist in order to accommodate natural side-to-side movement that varies with speed, wind, and cyclist proficiency. Cyclists do not travel in a straight line. Maneuvering space is needed to allow for side-to-side movements during operation. The operating height of 2.5 metres can generally accommodate an average adult cyclist standing upright on the pedals of a bicycle.

The design of on and off-road trail and cycling facilities require different considerations with regard to the user's operating space. The minimum operating dimensions referenced above pertain specifically to cyclists using on-road facilities. The design parameters outlined below address typical design considerations for the design of trail facilities.

General Design Parameters

Careful consideration should be given to the physical, aesthetic and environmental requirements for each multi-use pathway and trail type. In many instances physical design criteria related to operating space, design speed, alignment and clear zones are often governed by the needs of the fastest, most common user group on the majority of the trails, that being the cyclist. Therefore, many of the physical design criteria outlined in the following sections are recommended in relation to cycling. This is not to say that all multi-use pathways and trails need to be designed to meet the requirements for cyclists; however, when multi-use pathways are being designed it is prudent to use parameters for the cyclist. When considering single or specialty uses where part of the trail experience involves maneuvering through challenging conditions, such as BMX or mountain cycling, the parameters outlined below may not apply. In these instances, designers should consult directly with the user group and/or design manuals that are specific for that use.

Trail user operating space is a measurement of the horizontal space that the user requires. In the case of in-line skating and cycling, the space includes room required for side to side body motion used to maintain balance and generate momentum. **Table D.1** outlines minimum and preferred operating space for different uses.

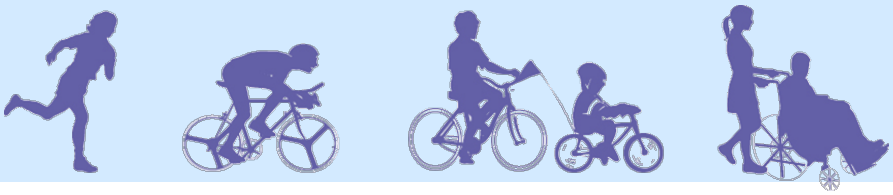


Table D.1 - Minimum and Preferred Operating Space for Trail Users

Operating Condition by Trail User Type	Minimum (metres)	Preferred (metres)
One way travel (one wheelchair user)	1.2	1.5
One way travel (two pedestrians)	1.5	2.0
One way travel (one cyclist)	1.2 (in constrained locations)	1.5+
One way travel (one in-line skater)	2.3	3.0
Two way travel (two cyclists)	2.4	3.0+
Two way travel (two wheelchair users)	3.0	3.0+

Horizontal clear distance is the space beside the trail bed that should be kept clear of protruding objects. Vertical clear distance is the space above the head of the user while using the trail (i.e. walking or mounted on their bicycle). **Table D.2** below provides minimum and preferred horizontal and vertical clear distance.

Table D.2 – Horizontal and Vertical Clear Distance

Clearance Condition	Minimum (metres)	Preferred (metres)
Horizontal clearance to stationary objects	0.5	1.0
Vertical clearance to stationary objects	2.5	3.0

Slope refers to both the measured fall over a given distance and both the centerline (longitudinal slope) and perpendicular to the centerline (cross slope). Cross slope can be configured so that all runoff is directed to one side of the trail, or so that there is centre crown and runoff is shed to either side of the trail. **Table D.3** provides guidance regarding longitudinal and cross slope.

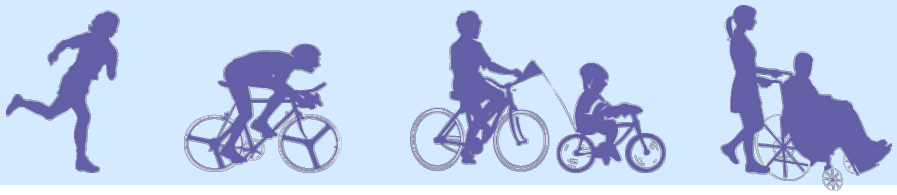
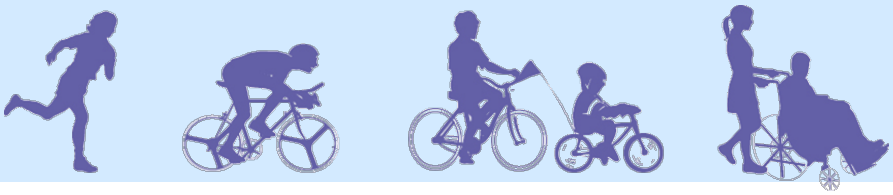


Table D.3 – Longitudinal and Cross Slope

	Longitudinal Grade or Slope
Less than 5%	Preferred slope. Note: 5% "target" maximum slope for accessible trails (AODA-refer also to D.2.9 for additional details regarding accessible trails and the Design of Public Spaces Standards).
5% to 10%	Provide additional trail width where trail segments are greater than 100m in length. Introduce level rest areas every 100 to 150m of horizontal distance. Consider design strategies such as switchbacks. Install signing to alert users of upcoming steep grades. Avoid grades over 5% for off road trails. Where steeper slopes are necessary "trail hardening" should be considered. Note: 10% over very short distances is acceptable as an absolute maximum for accessible trails (AODA - refer also to D.2.9 for additional details regarding accessible trails and the Design of Public Spaces Standards).
10% to 15%	Consider the use of structures such as steps, step and ramp combinations, or consider locating the trail elsewhere.
15% or over	Based on local experience, 15% represents the maximum possible longitudinal slope for a sustainable pathway or trail surface. Where slopes approach or exceed 15% significant washouts become and ongoing issue. Structures such as steps, step and ramp combinations and stairways should be employed. Otherwise, an alternative location for the pathway should be sought.
Cross Slope	
2%	Minimal, acceptable on hard surfaced trails, may not provide adequate drainage on granular surfaced trails.
2% to 4%	Preferred range for both hard and granular surfaced trails.
Greater than 4%	Avoid wherever possible as excessive cross slopes can be difficult and potentially dangerous for some levels of physical ability and certain user groups as they can result in difficulty maintaining balance, especially among user groups with a high centre of gravity.



Design speed is used to determine trail width, minimum curve radius, horizontal alignment and banking or super elevation to ensure that trail users have adequate space and time to safely approach and navigate sharper curves along the trail. The design speed for recreational cyclists is generally considered adequate for all self-propelled trail users including pedestrians, in-line skaters, skateboarders, scooter users and those using mobility devices such as wheelchairs. The average recreational cyclists can maintain speeds of up to 18-25 km/h on some multi-use pathways. For granular surfaced off-road multi-use pathways or trails, a design speed in the area of 25 km/h is usually adequate, whereas a design speed of 40 km/h should be considered for hard surfaced multi-use pathways and trails on steeper descents. Cautionary signing should be used to warn of upcoming steep grades and sharp curves.

Cyclists are the critical user group when designing off-road multi-use pathways and trails for self-propelled users as they have the highest average travel speed. The minimum radius of a curve on an off-road cycling facility depends on the bicycle speed and super-elevation. The AASHTO Guide for the Development of Bicycle Facilities, published in 2012 recommends that the general design speed should be 29km/h for multi-use trails where cycling is the highest speed user group. Based on research, 29km/h represents the 85th percentile for bicycle speed on granular surfaced pathways. The slightly lower design speed will allow for slightly smaller curve radii and potentially less construction impact as compared to multi-use pathways and trails requiring larger radii. Refer to **Table D.4** for suggested centerline radii for a range of design speeds and super elevation rates.

Table D.4 - Suggested Pathways and Trail Radii Based on Travel Speeds

Design speed (km/h)	Suggested Radius (m) (where super elevation is 0.02m/m)	Suggested Radius (m) (where super elevation is 0.05m/m)
25	15	14
30	24	21
35	33	30
40	47	42
45	64	57

When horizontal curves are sharp (i.e. a very small radius), facility widening should be considered to compensate for the tendency of cyclists to track toward the outside of the curve.

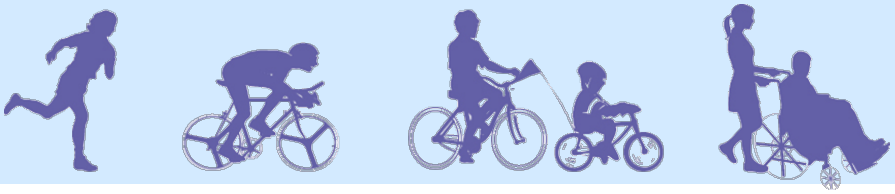


Table D.5 provides additional widening requirements for curves on multi-use pathways and trails where the radii are less than the recommended minimum for the design speed selected.

Table D.5 - Additional Trail Widening on the Outside of Curve

Radius (m)	Additional widening (m)
0-7.5	1.2
7.5-15	0.9
15-22.5	0.6
22.5-30	0.3

Stopping Sight Distance is the distance required to for the trail user to come to a full controlled stop upon spotting an obstacle. It is a function of the user's perception and reaction time. Stopping sight distances for off-road multi-use pathways and trails are typically governed by the distance required for cyclists since pedestrians and other trail users (with the exception of in-line skaters) can typically stop more immediately than cyclists, regardless of the trail configuration. From a number of experiences and observations from in-line skaters, representatives and manufacturers, it can be surmised that that a proficient in-line skater travelling near the same speed as a bicycle can stop in a distance equal to or less than that of a cyclist. Therefore, basing stopping distance on the distance required for a cyclist should accommodate all other expected self-propelled trail users including in-line skaters.

Guideline 1:	The Town should refer to the minimum and preferred trail user operating space widths identified in **Table D.1** when developing or reviewing multi-use pathway designs.
Guideline 2:	The Town should refer to the minimum and preferred horizontal and vertical clear distances identified in **Table D.2** when developing or reviewing multi-use pathway designs.
Guideline 3:	The Town should refer to the longitudinal and cross slope guidelines identified in **Table D.3** when developing or reviewing multi-use pathway designs.
Guideline 4:	That Town should consider the suggested trail curve radii and additional trail widening dimensions identified in **Table D.4** and **Table D.5** when developing or reviewing multi-use pathway designs.

D.2.4 Urban, Suburban and Rural Areas

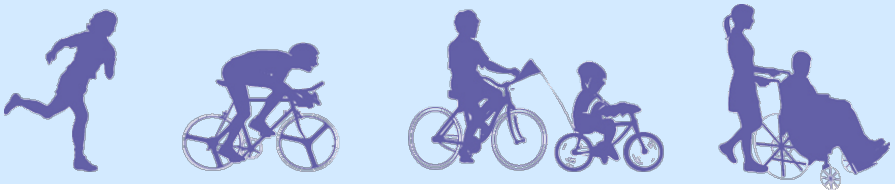
The use of the Town's Trails and Cycling Master Plan network will differ between the urban, suburban and rural users. Typically urban / suburban users live closer to their destinations than rural users. As such, they are more likely to make short trips and utilitarian / commuter trips. Urban and suburban systems will generally have a higher order of infrastructure than rural systems due to a higher density of users. The application of bike lanes, signed routes, multi-use pathways in the road right-of-way should be considered for those routes found in the urban and suburban areas. Routes in rural areas may accommodate paved shoulders, fewer designated routes and some linear off-road trails (e.g. trails along or within an active or abandoned railway or a utility corridor).

D.2.5 Freight, Transit and Emergency Service Routes

Special consideration should be made for those routes that are designated as freight, transit and / or emergency service routes. The implementation of formal cycling facilities or multi-use trails within the road right-of-way on these routes should be considered to accommodate the operating and design needs of large vehicles which conflict with those of cyclists.

Figure D.2 - Transit Stop & Cycling Facility
Source: MMM Group, Sherbourne Cycle Track, 2012

A cyclist's level of comfort and overall safety can be compromised due to the presence of large vehicles which may require the implementation of more separated cycling facilities (e.g. bike lanes and / or multi-use pathways outside of the road right-of-way) and / or alternate / parallel routes. In these scenarios the application of traffic calming measures may not be appropriate because of the potential disturbance that speed bumps tend to create and the turning space required for larger vehicles.



For those transit routes which are identified as part of the overall network, there is the potential for increased conflict points where buses are required to merge over proposed bicycle facilities to access transit stops. In these scenarios, the applications of left-side bike lanes or other design treatments could be considered to accommodate boarding passengers and to reduce the number of conflict points between passengers and cyclists. **Figure D.2** illustrates a design application of a designated cycling facility approaching a transit stop.

D.2.6 Intersections

An intersection is where two or more roadways intersect at grade. It is a point where different modes of transportation and associated facilities cross paths and therefore most conflicts between cyclists and motorists occur at intersections. The draft OTM Book 18 and TAC Bikeway Control Guidelines (2012) set out measures to decrease roadway user risk by:

- Increasing visibility for both cyclists and motorists and other roadway users (ensure cyclists and motorists can easily see each other);
- Designating and clearly marking a travel path for all roadway and intersection users including cyclists, motorists and pedestrians;
- Introducing designs that minimize the need for complex maneuvers for cyclists;
- Managing intersection access to mitigate conflict points; and
- Facilitating awareness and understanding between competing modes of transportation.

The typical potential conflict points that occur between motorists and cyclists at an intersection can be broken into right-turn conflicts and left-turn conflicts.

- Right-turn conflicts may occur when a cyclist is trying to make a through movement while a motorist is trying to make a right turn and to do so the motorist must cross over the on-road bicycle facility.
- Left-turn conflicts may occur when cyclists try to merge across one or more lanes of through vehicle traffic in order to turn left using the same path as motorized vehicles.

Both types of conflicts can be mitigated using innovative design solutions that incorporate elements such as pavement markings and signage, pavement colour, designated holding areas for cyclists, medians, and bicycle traffic signals or by adjusting signal timings to accommodate cyclists. **Figure D.3** illustrates the typical bicycle and automobile movements at an intersection which can be used to better understand the different conflict points which can occur at major intersections of multi-lane roadways.

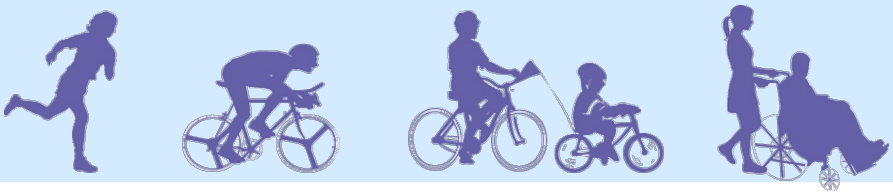
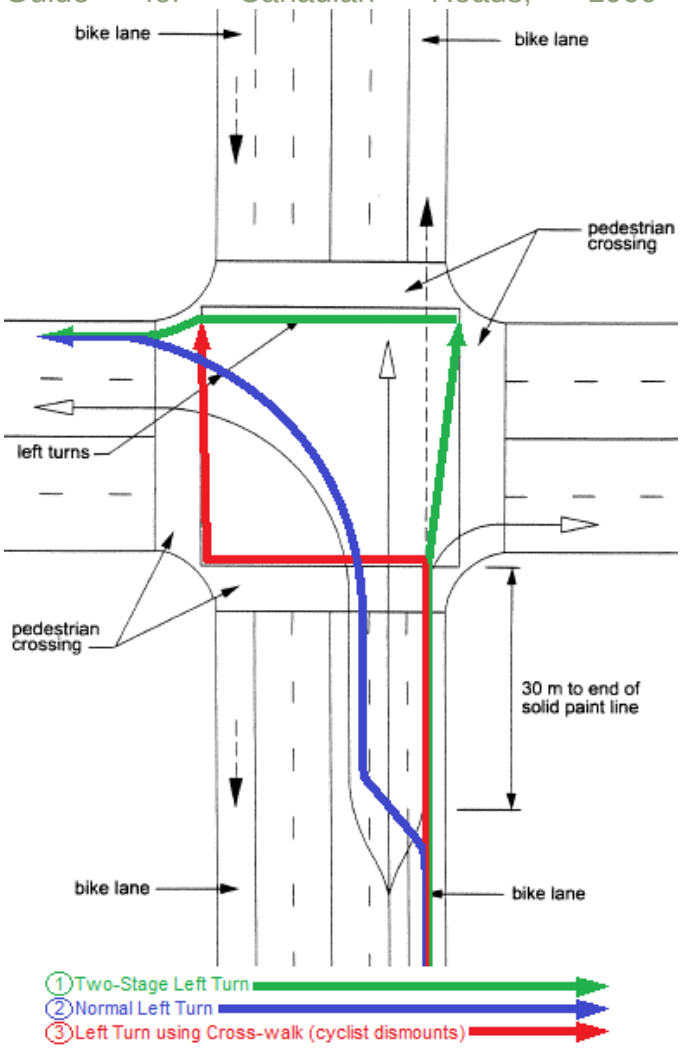


Figure D.3 – Typical Bicycle and Motorized Vehicle Movements at an Intersection of Multi-lane Roadways and associated Conflict Points

Source: Based on TAC Geometric Design Guide for Canadian Roads, 1999



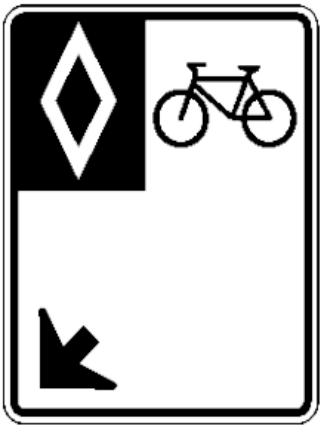
D.2.7 Interchanges

The integration of cyclists at interchanges is often more complex than that for straight roadway segments. Interchanges possess unique characteristics and functions that present challenges when designing for the integration of cyclists especially when retrofitting bicycle facilities on existing interchange structures. Cycling facilities can either be implemented for an existing interchange during an upgrade or retrofitting project or as part of a new interchange design. Within the Town of Milton there are a number of existing interchanges which are proposed as key on-road cycling connections which provide direct connections to the north of the Town. It is important to note that should the Town choose to retrofit any of their existing interchanges the following guidelines should be considered:

- For lower speed merging/diverging ramps (less than 70 km/h.), the bicycle lane should continue straight across the ramp using a white, dashed line pavement marking.
- For high speed merging/diverging ramps (more than 70 km/h.), the bicycle lane should not be carried straight across the ramp. Instead, it is recommended that for diverging ramps, designers either place a crossing further up the ramp with indicating signage or implement a "jughandle" crossing.

For more details on the design of these facilities, the Town should refer to the interchange and ramp crossing design treatments outlined in the Draft OTM Book 18 and TAC's Bikeway Traffic Control Guidelines (2012).

Figure D.4 – Transition Point Signage
Source: TAC Bikeway Traffic Control Guidelines (2012)



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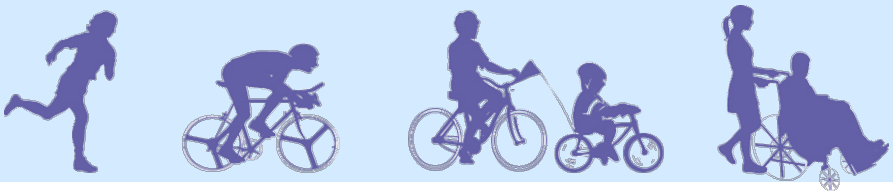
D.2.8 Transition Points

The design of cycling facilities should take into consideration maximizing the consistency for cyclists and decreasing potential conflicts with other modes of transportation. Where possible, bicycle routes and / or facilities should be built to provide direct connections to cycling destinations or provide key links as part of the overall cycling network. Facilities / routes that are isolated, only provide short connections, do not access key destinations and / or begin and end abruptly should not be considered for implementation unless previously identified as part of the Trails and Cycling Master Plan network and implementation strategy.

The network should be designed to provide smooth transition points between cycling facilities. Abrupt transition points make it difficult for cyclists to navigate through the on and off-road routes as part of the overall network and could potentially increase the number of conflict points between cyclists and other road users. The Town should design facilities to minimize these scenarios at key locations throughout the municipality.

Figure D.4 illustrates the proposed signage which can be implemented at transition points to increase driver, pedestrian and cyclist awareness of the presence of bicycle facilities. The Town should refer to the signage standards provided in the TAC Bikeway Traffic Control Guidelines 2012 and the facility design guidelines as part of OTM Book 18 (Draft).



D.2.9 Accessibility

Approximately one in eight Canadians live with a disability, including physical, sensory, cognitive, learning, and mental health. Disability increases with age: from 3.3% among children, to 9.9% among working-age adults (15 to 64), and 31.2% among seniors 65 to 74 years of age. Disability rates are highest among older seniors (75 and over), with fully 53.3% in this age group reporting a disability[ii].

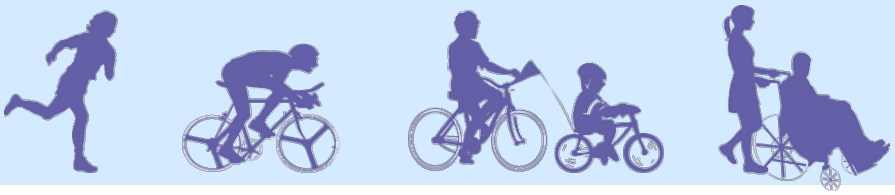
The **Accessibility for Ontarians with Disabilities Act (AODA)** states that "The people of Ontario support the right of persons of all ages with disabilities to enjoy equal opportunity and to participate fully in the life of the province[iii]". The stated goal of the AODA is "to make Ontario accessible for people with disabilities by 2025."

The **Accessibility Standards for the Built Environment** is the standard that applies to pathways and trails. The intent is that it will help remove barriers in buildings and outdoor spaces for people with disabilities. The standard will only apply to new construction and extensive renovation.

AODA Criteria which are to be considered when designing for cyclists include: operational experience, width, running slope, cross slope, total slope, surface, changes in level and signage. The guidelines and criteria set out in these documents apply to the development of trail and sidewalk facilities and are not required for consideration when designing and developing on-road cycling facilities.

When designing and implementing cycling facilities, the Town should utilize the guidelines outlined in the Built Environment Standards to ensure that the needs of all user groups are accommodated and satisfy the requirements of the AODA to the greatest extent possible, given the context of each trail's location, the surrounding environment and type of trail experience that is desired. Sections 80.8 and 80.10 of the Design of Public Spaces Standards. These standards provide the technical requirements for recreational trails, including the following:

- Minimum clear width of 1.0m
- Minimum head room clearance of 2.1m above trail
- Surfaces are to be firm, stable with minimal glare
- Maximum longitudinal slope of 10%
- Maximum cross slope of 2%
- High tonal or textural changes to distinguish edges
- Standards also address changes in level, openings in the surface, edge protection (e.g. near water)



- Signage shall be easily understood and detectable by users of all abilities. It is important to ensure that signage and mapping/messaging clearly communicates which pathways are accessible so that users can make an informed personal decision about which pathways they will use.

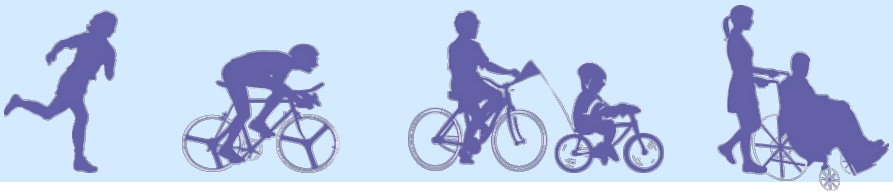
Universal Trail Design is a concept that takes into consideration the abilities, needs, and interests of the widest range of potential users. In regards to trail and multi-use pathway design, it means planning and developing a range of facilities that can be experienced by a variety of users of all abilities.

Principles of universal trail design can be summarized as follows:

- Equitable use: provide opportunity for trail users to access, share and experience the same sections of trail rather than providing separate facilities;
- Flexibility in use: provide different options for trail users in order to accommodate a variety of experiences and allow choice;
- Simple, intuitive and perceptible information: whether conveying trail information through signage, maps or a web site, communicate using simple, straightforward forms and formats with easy to understand graphics and/or text;
- Tolerance for error: design trails and information systems so as to minimize exposure to hazards, and indicate to users any potential risks or challenges that may be encountered;
- Low physical effort: trails may provide for challenge but should not exceed the abilities of the intended users; where appropriate, rest areas should be provided; and
- Size and space for approach and use: trails and amenities should provide for easy access, comfort and ease in their usage.

Ontario's Best Trails – (2006)[iv] provides an in depth discussion of Universal Design principles and their application.

Where possible and practical, trails and multi-use pathways should be designed to be accessible to all levels of ability. It must be recognized, that not all trails and multi-use pathways throughout the system can meet all of the accessibility requirements. Steep slopes are one of the most significant barriers for people with physical disabilities. Designing trails and multi-use pathways to be within the threshold (5%) for universal access will not only overcome this significant barrier but it will help to reduce the potential for erosion of the trail surface. The following are some additional considerations for making existing and new trails accessible:



- Designers should consult the most current standards available;
- Where the trail requires an accessibility solution, a representative of the local accessibility advisory committee should be consulted early on in the process to determine if it is practical and desirable to design the specific trail to be accessible;
- Where it has been determined that full accessibility is appropriate, the accessibility representative should be consulted during the detailed design process to ensure that the design is appropriate;
- Work collaboratively with the local accessibility advisory committee to consider developing signage/content to clearly indicate trail accessibility conditions, which allow users with mobility-assisted devices to make an informed decision about using a particular trail prior to travelling on it; and
- For all new trails, consult with the local accessibility advisory committee, people with disabilities, and members of the public through a meeting / consultation session.

Guideline 5:	Every effort should be made to ensure that the design of new trail facilities meet or exceed minimum accessibility requirements per Sections 80.8 and 80.10 of the Design of Public Spaces Standards.
Guideline 6:	Signage and maps should be designed to communicate which pathways and trails meet minimum accessibility requirements so that users can make their own advance decision about using the route.

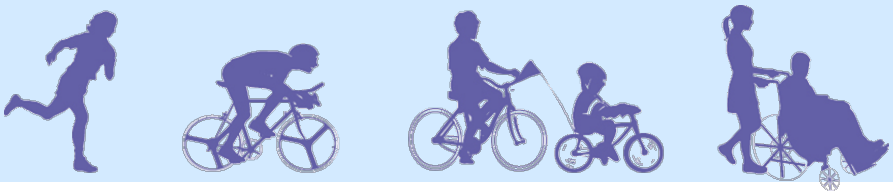
Natural Access Control Deters access to a target and creates a perception of risk to the offender.	Source: CPTED Ontario www.cptedontario.ca 
Natural Surveillance The placement of physical features and / or activities and people that maximizes natural visibility or observation.	Source: CPTED Ontario www.cptedontario.ca 
Territorial Reinforcement Defines clear borders of controlled space from public to semi-private to private, so that users of an area develop a sense of ownership.	Source: CPTED Ontario www.cptedontario.ca 
Maintenance Allows for the continued use of space for its intended purpose.	Source: CPTED Ontario www.cptedontario.ca 

D.2.10 Personal Security

To the extent that it is possible, bike and pedestrian routes should be designed to allow users to feel comfortable, safe, and secure. Although personal safety can be an issue for all, women, the elderly and children are among the most vulnerable groups. Principles of Crime Prevention Through Environmental Design (CPTED) should be considered and applied to help address security issues concerning trail use, particularly in locations where trails are lightly used, isolated or in areas where security problems have occurred in the past.

The four main underlying principles of CPTED are presented in the chart to the right.

Guideline 7:	When implementing the Town's trails and cycling network, the following principles of CPTED should always be considered: Natural Access Control; Natural Surveillance; Territorial Reinforcement; and Maintenance
Guideline 8:	Properly located entrances, exits, fencing, landscaping and lighting should direct both foot and automobile traffic in ways that discourage crime.



D.2.11 Multi-modal Integration – "Complete Streets"

There is a growing desire to evaluate transportation services of roadways from a multimodal perspective. Given the emphasis of contemporary planning concepts such as 'Smart Growth' and 'Complete Streets', alternative modes of travel – specifically transit, cycling and walking – should be considered when exploring the development of a system of on and off-road municipal cycling and trail routes.

There is not a "one-size-fits-all" solution or specific design standard that can be universally applied. The Toronto Centre for Active Transportation (TCAT) recently published a report documenting the benefits, challenges, best practices and design alternatives for complete streets which are being implemented world-wide. The Town of Milton is encouraged to use this reference as a guide for future roadway design.

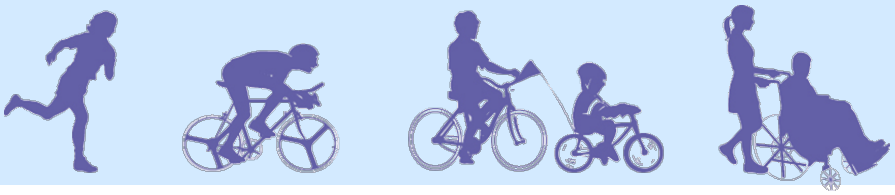
There are many kinds of complete streets and each is guided by the unique characteristics of the municipality in which it is being developed. These characteristcs include, but are not limited to: the community context and lane use, the role of the street in the overall transportation network, traffic volumes of the proposed roadway and the existing transportation modes being accommodated.

Example of Complete Street Redesign in Hamilton

Source: www.raisethehammer.org

Research shows that the implementation of complete streets can result in:

- Better and improved transportation options;
- Improved safety for cyclists and pedestrians;
- A reduction in traffic congestion;
- A reduction in greenhouse gas emissions;
- Intensification;
- The creation of a more walkable, and therefore more liveable community;
- A stimulation to economic growth with increased shopping activity, sales and property values.



It is important to note that the implementation of a "complete street" approach requires coordination and support from a number of different sources including residents, businesses, planners and policy makers, engineers and landscape architects. Their combined input provides the balance of needs required to accommodate all modes of transportation, including cycling, while designing a useable space for all.

D.3 Selecting and Designing Trail and Cycling Facilities

D.3.1 Facility Selection

Facility selection is an important component in the network development process. As planning and design of active transportation (bicycle and pedestrian) facilities continues in the Town of Milton, the Town should reference the selection process outlined in **OTM Book 18 Bicycle Facility Design**. The process will assist staff and those responsible for the future of active transportation facilities. The facility selection process provides a consistent framework that is easy to apply, technically based (was developed based on current research and knowledge of facility type selection), and allows flexibility to account for the differences in physical and operational characteristics from one site to another.

The selection tool does not tell designers when and when not to provide a certain facility type but rather sets out a process for selecting an appropriate facility type given the context and readily available data.

D.3.2 Trail and Cycling Facilities

Trail and cycling facilities can be divided into three main categories: **on-road facilities**, including active transportation paths (in-boulevard multi-use facilities) and **off-road facilities**. The table below describes these three categories:

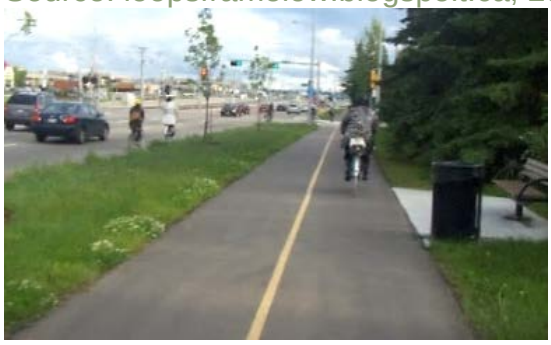
On-Road Facilities

Source: www.ibiketo.ca, 2007

"On-road facility" refers to facilities within the roadway right-of-way that are located on or along an existing road and may be incorporated into the existing or future street network.

Separated Facilities

Source: loopsframelow.blogspoit.ca, 2011



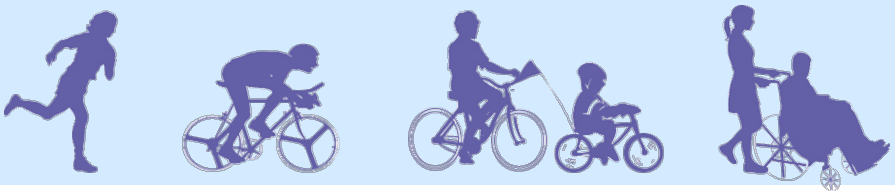
The Boulevard Multi-use Trail or "Active Transportation Pathway" is a facility that is **within the road right-of-way** but is physically separated from motor vehicle traffic by a landscape buffer or "verge".

Off-Road Facilities

Source: Unknown

"Off-road facility" refers to facilities that are outside the roadway right-of-way through open spaces, valleys and parklands, as well as linear corridors such as abandoned railway lines, unopened road allowances and utility corridors.

Within these three categories, there are a range of different facility types. The facility types are often described in terms of their degree of separation from motor vehicles. As mentioned above, the information presented in this document should be supplemented with the bicycle and pedestrian facility design guidelines outlined in the **TAC Manual, OTM Book 18 Bicycle Facility Design and OTM Book 15 Pedestrian Facilities.**



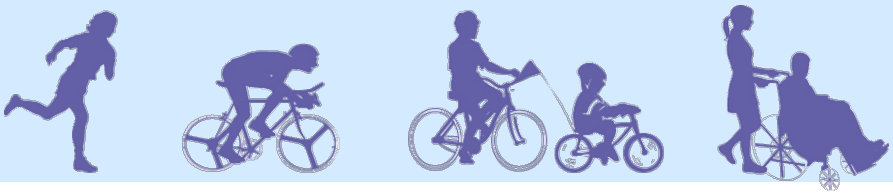
List of Typical Cycling and Trail Facility Types, According to Level of Separation.

Most Separated	Least Separated
Generally associated with higher volume, higher speed roads	Generally associated with lower volume, lower speed roads

Separated Facilities	Dedicated Facilities	Shared Facilities
Two-way in-Boulevard Shared-use Facilities Off-road Multi-use Trails Rails with Trails	Bicycle Lanes Re-allocation of Space - "Road Diet" Separated (Buffered) Bicycle Lanes	Signed Bicycle Routes on Local Roads Signed Bicycle Route with Optional "Sharrow" Wide Signed Bicycle Route with Optional "Sharrow" Bikeway Boulevards (Bicycle Priority Streets) Urban Shoulders Signed Bicycle Route with Paved Shoulder

Key Considerations:

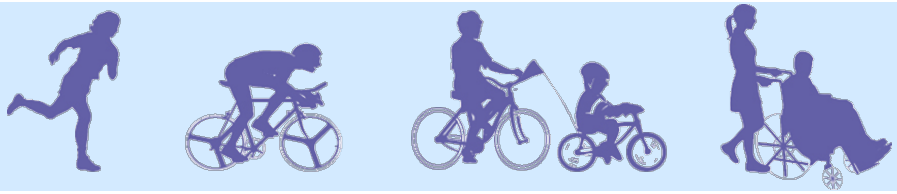
1. Pedestrians and cyclists vary widely in levels of skill, experience and confidence;
2. No single type of active transportation facility design alternative will suit every user;
3. Designers need to gather information on existing and future conditions in order to identify the needs and safety concerns for users in a specific location;
4. The choice to provide a separated versus non-separated facility is not a simple "yes or no" answer, it is based on the consideration of a number of factors described throughout this chapter;
5. Criteria or thresholds to select one facility type over another need to be flexible to accommodate each site's unique set of circumstances; and
6. No facility design can overcome a lack of operator skill or lack of attention by the user.



In terms of public policy, it is important to acknowledge that *a bicycle is formally recognized as a vehicle by the Province of Ontario, as outlined in the Highway Traffic Act, R.S.O., 1990*. Therefore, cyclists have the right to share all classes of roadways, including highways, arterials, collectors and local streets, with the exception of the 400 series highways or other highways/roads where cycling has been prohibited by municipal by-laws. Motorists are prohibited by municipal by-law from driving or stopping in designated bike lanes, except for emergency avoidance maneuvers or breakdowns. A key Principle for Roadway Design is that:

"Every road is a cycling road"

Guideline 9:	When designing or redesigning roadways, considerations should be given to the application of bicycle friendly design principles even if the roadway is not part of the designated pedestrian and cycling network for the Town of Milton.
Guideline 10:	On streets designated as routes as part of the bike and pedestrian network in Milton, provisions for pedestrians such as sidewalks should be provided where cyclists are directed to use the roadway.



SIGNED BICYCLE ROUTE ON LOCAL ROAD

Definition: Signed-only Bike Routes are routes where both motorists and cyclists share the same vehicular travel lane and 'Bicycle Route Marker' signs are used to provide route guidance. Aside from 'Bicycle Route Marker' signs, there are generally no other provisions used for Signed-only Bike Routes.

Considerations:

- Bicycles and motor vehicles share the right-most travel lane, no physical space is dedicated for bicycle use only;
- Design does not include pavement markings for bicycles;
- Marked with 'Bicycle Route Marker' signs which may be supplemented by optional 'Share the Road' signs;
- Should typically only be signed as on-road bike routes where acceptable (e.g. lower) motor vehicle operating speeds and traffic volumes exist;
- Should be supported by education programming for both cyclists and motorists;
- Typically applied on roadways with a maximum posted speed of 60 km/h or less; and
- Where this is not the case, alternative routes should be investigated or paved shoulders/bike lanes implemented.

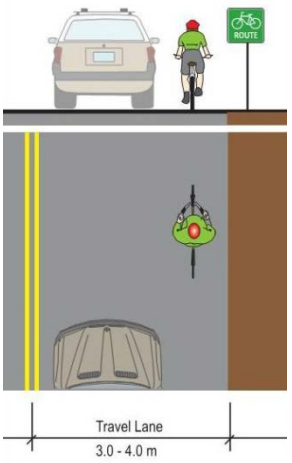
Typical Application: Typical for residential streets where motor vehicle traffic volumes and speeds are low, and rural roads where traffic volumes are low.

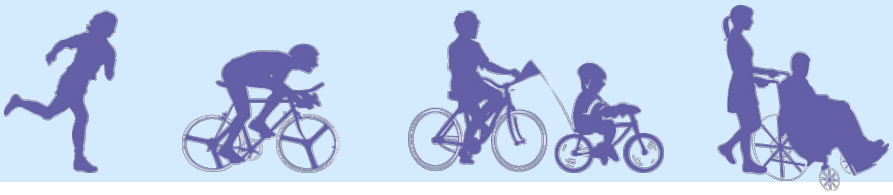
Pedestrian Uses: Pedestrians use the sidewalk in residential areas, and may use the road shoulder in rural areas.

Guideline 11:

Signed-only Bike Routes may be used on roads where traffic volume is considered relatively low and adequate sightlines exist. Adding edge lines in urban areas may be suitable where there is sufficient width or removal of on-street parking for bike lanes is not supported by the local neighbourhood.

Signed-only Cycling Route
Source: Richmond Hill, 2010 OTM Book 18





SIGNED BICYCLE ROUTE WITH OPTIONAL SHARROW

Definition: Shared use lane markings, also called “sharrows”, are symbols placed on the pavement surface in the intended area of bicycle travel. Sharrows provide added route guidance and help cyclists position themselves appropriately in the travelled lane. Sharrows also increase driver awareness of the presence of cyclists and help deter unsafe passing maneuvers by motorists.

Considerations:

- Bicycles and motor vehicles share the right-most travel lane;
- Pavement markings indicate appropriate positioning for cyclists. Cyclists align their front wheel with the point on the chevron;
- Especially useful in congested areas where traffic is generally moving slowly (e.g. a “downtown” street or urban centre);
- Clear pavement markings and signs illustrate the concept of “Share the Road” within space-confined roadways; and
- Can be an appropriate solution for urban downtown / main street areas where on-street parking cannot be removed to implement dedicated bike lanes.

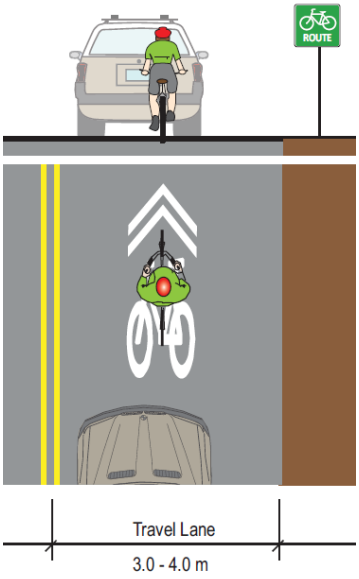
Typical Application: Placement of the Sharrow symbol indicates to cyclists where they should be traveling on the road (e.g. approximately 1.0m from the curb where there is no on-street parkign and 3.4m from the curb where there is on-street parking on a multi-lane road).

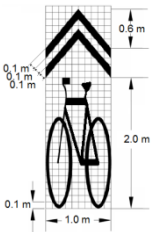
Pedestrian Uses: Pedestrians use the sidewalk in urban areas, and may use the road shoulder in rural areas.

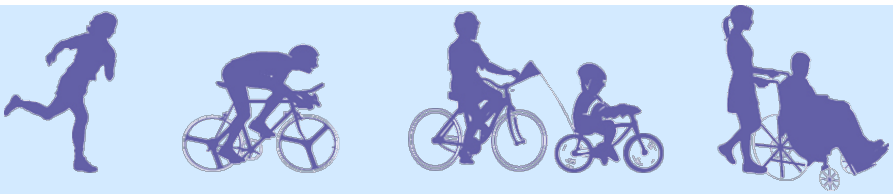
Guideline 12:

Signed-only Bike Routes with sharrows may be used on congested local roads where the traffic generally moves slowly and at pinch points to make both cyclists and motorists aware of narrow zones.

Signed Route with Sharrow
Source: pedbikeimages.org, Heather Bowden. OTM Book 18







WIDE SIGNED BICYCLE ROUTE WITH OPTIONAL SHARROW

Definition: Similar to Signed-only Bike Routes with the exception that the travel lane shared by motorists and cyclists is wider than the standard motor vehicle travel lane (e.g. 4.0 to 5.0m). The extra width allows motorists and cyclists to travel side-by-side more comfortable. Travelled lane widths should not be more than 5.0m wide as this may encourage unsafe passing by motorists.

Considerations:

- Bicycles and motor vehicles share the right-most travel lane, no physical space is dedicated for bicycle use only;
- Design does not include pavement markings for bicycles;
- Marked with 'Bicycle Route Marker' signs which may be supplemented by optional 'Share the Road' signs;
- 'Share the Road' signs and sharrows should be considered at pinch points;
- Wide travelled lanes should have sufficient width to allow motorists to pass cyclists without encroaching on an adjacent travel lane (if one exists).

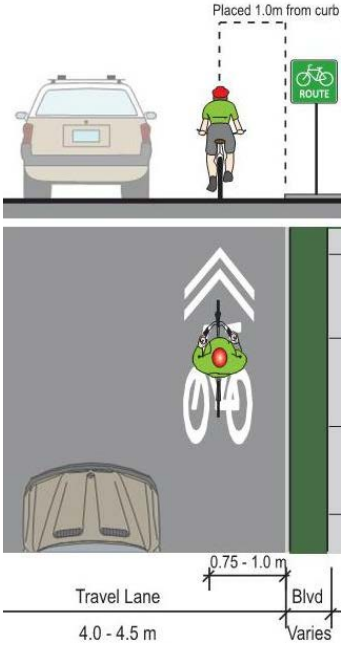
Typical Application: Placement of the Sharrow symbol indicates to cyclists where they should be traveling on the road (e.g. approximately 1.0m from the curb where there is no on-street parkign and 3.4m from the curb where there is on-street parking on a multi-lane road).

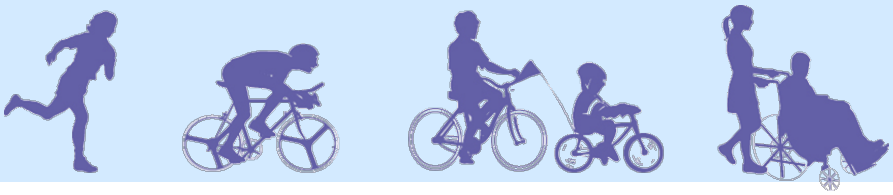
Pedestrian Uses: Pedestrians use the sidewalk in urban areas, and may use the road shoulder in rural areas.

Guideline 13:

Signed-only Bike Routes on Wide Travelled Lanes may be retrofitted on 4-lane cross-sections by narrowing the inside travel lane. Supplementary 'Share the Road' signs and sharrows should be considered at pinch points to make both cyclists and motorists aware of narrow zones.

Signed-only Route on Wide Travel lane
Source: Schuster, 2011. OTM Book 18





BIKEWAY BOULEVARD (BICYCLE PRIORITY STREETS)

Definition: In some areas, particularly residential neighbourhoods, traffic calming techniques such as through travel restrictions for care, traffic circles and reduction in the number of stop signs can be used to create “bicycle priority streets” which allow the cyclist to travel more efficiently by not having to break momentum and stop at frequently placed four way stops.

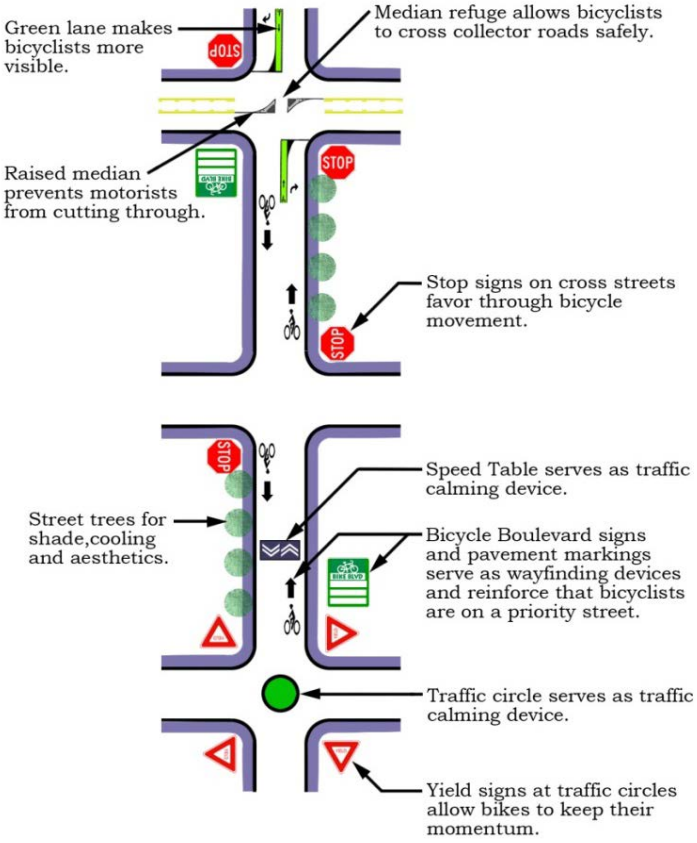
Considerations:

- Design strategies and elements are employed to encourage through-travel for cyclists and enable them to maintain momentum, yet discourage or restrict through travel by motorists.

Typical Application: Typically reserved for local roadways and residential street and include traffic calming measurs to encourage an increased comfort level for cyclists.

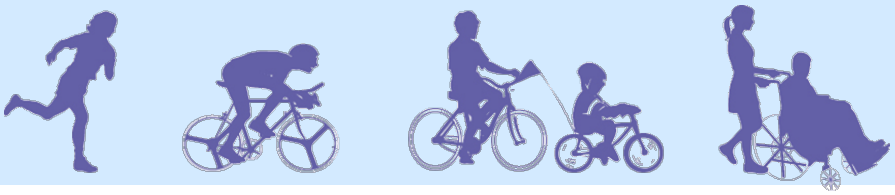
Pedestrian Uses: Pedestrians use the sidewalk in urban areas, and may use the road shoulder in rural areas.

Typical Bikeway Boulevard Application
Source: ahtd.info.com



Guideline 14:

Bikeway Boulevards or Bicycle Friendly Design Applications may be used on local roads and residential streets where a formal bicycle facility is not required. However, with the introduction of traffic calming measures cycling may increase due to a greater sense of comfort.



URBAN SHOULDERS

Definition: Signed-only Bike Routes may be supplemented with edge lines to create urban shoulders. Edge lines are a creative way of providing cyclists with operating space outside the motor vehicle travelled portion of the roadway without affecting on-street parking since on-street parking is still permitted. This shared facility may be an interim step towards implementing future bicycle lanes where the removal of on-street parking is challenging.

Considerations:

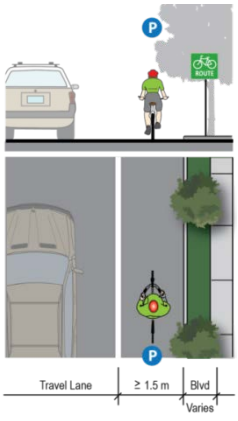
- Bicycles and parked motor vehicles share the space to the right of the edge line;
- Design does not include pavement markings for bicycles;
- Marked with 'Green Bicycle Route Marker' signs but does not include the application of a bicycle lane sign which prohibits motorists to park over-top the line;
- Should only be signed as on-road bike routes where acceptable (e.g. lower) motor vehicle operating speeds and traffic volumes exist;
- Should be supported by education programming for both cyclists and motorists; and
- Design alternative requires cyclists to maneuver around parked cars. As such, additional signage or education about proper use of the facility may be required.

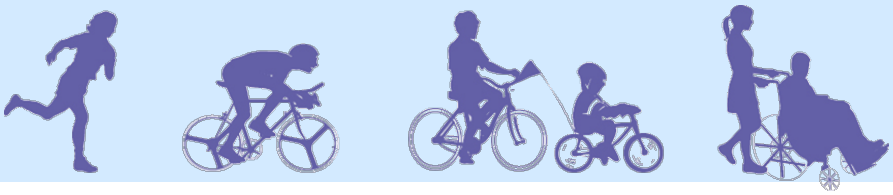
Typical Application: Typical for residential streets where motor vehicle volumes are low and speeds are low to moderate. Urban Shoulders may be a useful first step towards implementing future bicycle lanes on roads where on-street parking removal is an issue but parking demand is low.

Pedestrian Uses: Pedestrians use the sidewalk in urban areas, and may use the road shoulder in rural areas.

Guideline 15: Urban Shoulders may be considered as an option in residential areas with on-street parking where providing cyclist operating space outside the motor vehicle travelled portion of the roadway is desired but providing dedicated bicycle lanes are not feasible or appropriate given the context.

Urban Shoulder (Halton Hills)
Source: MMM Group. OTM Book 18.





SIGNED BICYCLE ROUTE WITH PAVED SHOULDER

Definition: Signed Bike Routes with Paved Shoulders provide a convenient place for cyclists to ride on a road with a rural road cross section (no curbs). A buffer made up of two edge lines with or without diagonal hatching or with a rumble strip in between can be used to provide cyclists riding on the paved shoulder with added separation.

Considerations:

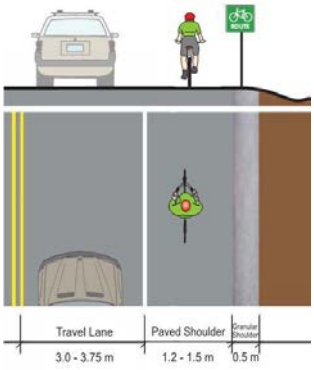
- Provide a space for cyclists on rural road cross-sections (no curb and gutter);
- Where motor vehicle speeds or volumes are high, a wide shoulder and/or painted buffer enables more separation between the cyclists and the motor vehicle, and also reduces the impact of wind-shear on the cyclist;
- The paved shoulder provides a convenient location for cyclists to travel;
- Rumble strips can be added to the painted buffer as an additional cue, provided that there are clearly marked breaks at regular intervals, allowing the cyclists to move in or out of the paved shoulder areas to overtake slower moving cyclists, safely pass stalled vehicles or to make a left turn;
- 'Bike Route Marker' signs and 'Share the Road' signs may be used; and
- For designated cycling space, additional maintenance will be required by the engineering services department. Winter maintenance should be a priority for roads with a more separated cycling facility.

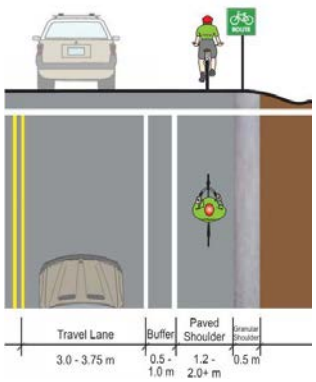
Typical Application: Implemented on rural cross-sections (no curbs) where motor vehicle traffic volume and speeds are higher.

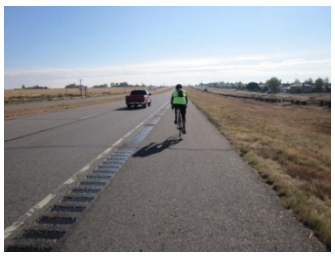
Pedestrian Uses: Pedestrians use the sidewalk in urban areas, and may use the road shoulder in rural areas.

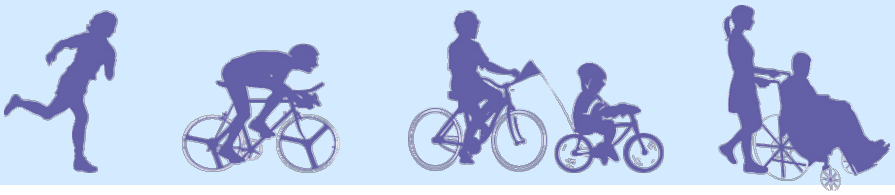
Guideline 16: Signed Bike Routes with paved shoulder may form part of the Town's Trail and Cycling Network along rural road cross sections.

Left: Paved Shoulder, Right: Buffered Shoulder Source: Unknown. OTM Book 18.









BICYCLE LANES

Definition: A Bicycle Lane is a portion of a roadway which has been designated by pavement markings and signage for preferential or exclusive use by one way cyclist traffic often along the right-most curb or edge of road.

Considerations:

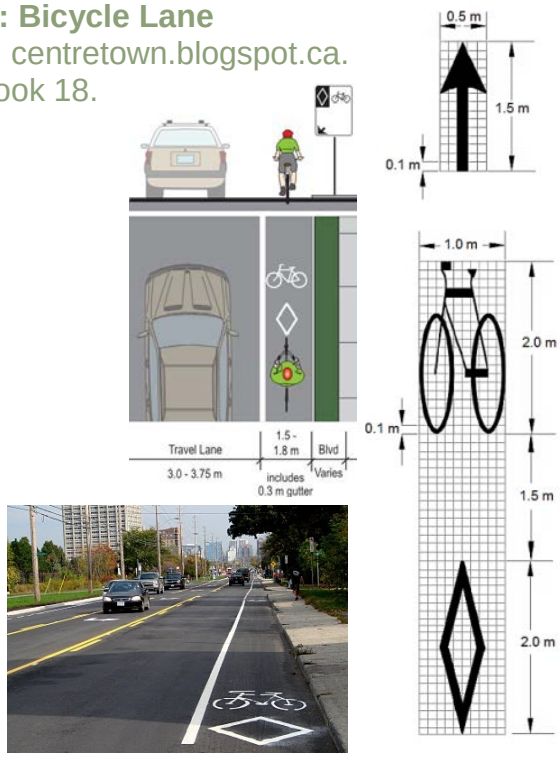
- Motor vehicles are typically not permitted to park or stand in the bike lane, but right turning motor vehicles can enter the bike lane at intersections to complete their turn (enforced through municipal bylaw);
- Width of the bike lane (or adding a buffer zone) should be increased (to a maximum of 2.0 m) where motor vehicle traffic volumes, percentages of trucks and commercial vehicles and motor vehicle speeds are higher;
- Sufficient space should be provided to mitigate conflict between cyclists and open car doors on streets where on-street parking is permitted; and
- Consistency in the design and signing of bike lanes and other bikeway facilities is crucial to educate and inform cyclists and motorists on their proper use.

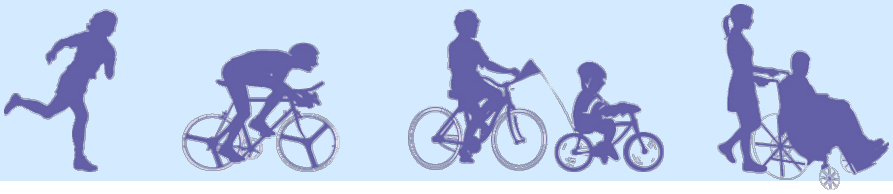
Typical Application: Typically implemented on a cross-section road where motor vehicle traffic volume and speeds are higher than typical threshold values for shared space routes.

Pedestrian Uses: Pedestrians use sidewalks in urban areas (sidewalks would be installed on at least one side of the road along designated AT routes where none currently exist in the urban area).

Guideline 17: Bike lanes should be provided on urban arterial and major collector roads that are part of the AT network where traffic volume and speed are higher. Bike lanes should also be clearly identified on roadways with bicycle symbol pavement markings and 'Reserved Bicycle Lane' signs.

Ottawa: Bicycle Lane
Source: centretown.blogspot.ca.
OTM Book 18.





RE-ALLOCATION OF SPACE – "ROAD DIET"

Definition: Retrofitting existing roadways without roadway widening involves the reallocation of existing space for the implementation of bicycle lanes.

Considerations:

- Narrowing of vehicular travel lane where practical and safe;
- Reducing the number of through vehicular travel lanes;
- Reconfiguring on-street parking or removing it on roadways with low demand;
- Redistributing existing road space to accommodate cycling facilities can in some cases be a more appropriate and affordable solution.

Typical Application: Wide curb lanes may allow for easy implementation of shared lane markings (sharrows) or even conventional bicycle lanes. On rural road cross-sections, gravel shoulders may be paved to provide cyclists with an area for riding that is adjacent to vehicular travel lanes offering separation between bicycle traffic and vehicular traffic.

- Bicycle lanes have a preferred design width of 1.5m to edge of pavement (design minimum of 1.5m to face of curb) and 1.8 – 2.0m wide if adjacent to a parking lane.
- Additional width can be obtained from the adjacent travel lanes and parking lanes.
- In constrained corridors, over short distances, bicycle lanes should not be less than 1.2 m wide including the gutter.

Pedestrian Uses: N/A.

Guideline 18: Where applicable, the Town should consider retrofitting existing roadways to accommodate cycling facilities including edge lines or bike lanes at a minimum width of 1.5m to the edge of the pavement or 1.8m to 2.0m wide if beside a parking lane.

Halton Hills Road Retrofitting from four lane Collector Road
Solution #1: Second image
Solution #2: Third image
Source: MMM Group

SEPARATED (BUFFERED) BICYCLE LANES

Definition: Buffered Bike Lanes provide additional space/separation between the cyclist and motor vehicles and can use a number of separation alternatives to address this, including pavement markings, rumble strips, planters, etc.

Considerations:

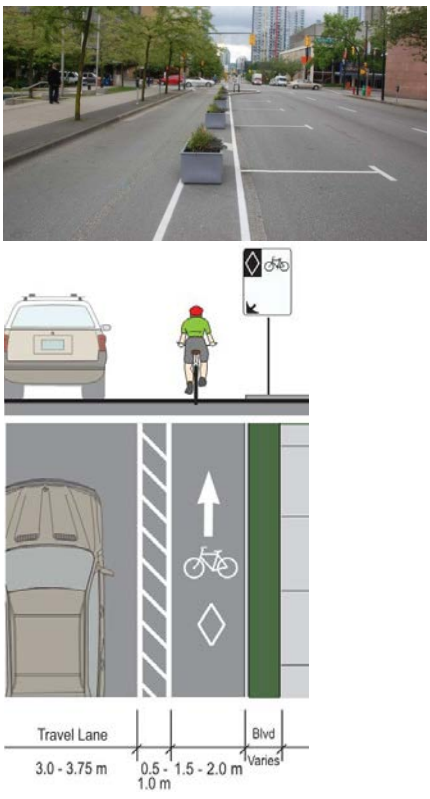
- There are various types of physical buffers that are available and can be used to create separation but not at all barrier types completely restrict the encroachment of motorized vehicles inot the bicycle lane.
- Where a barrier is used to separate the bike lane from vehicle traffic (e.g., bollard, curb, planters etc.), this type of facility is commonly referred to as a Cycle Track.
- For a separated bicycle facility, a designated buffer space separates the bicycle lane from the adjacent motor vehicle travel lane.
- Signage and wayfinding provide additional guidance to cyclists, motorists and other road users.

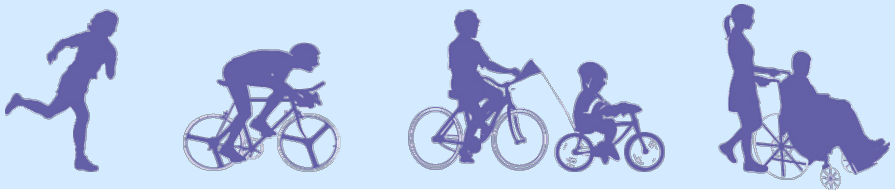
Typical Application: Typically implemented along urban roadways with high motor vehicle volumes and/or speed where increased separation is required. Could also be implemented on roadways with on-street parking and high parking turnover where double parking is an issue or major corridors that provide direct and convenient access to key destination points (i.e., corridors with heavy cycle traffic) or in front of schools.

Pedestrian Uses: Pedestrians use sidewalks in urban areas (sidewalks would be installed at least on one side of the road along designated AT routes where none currently exist in the urban area).

Guideline 19: Buffered Bike Lanes should be provided on urban arterial and major collector roads that are part of the AT network where traffic volume and speec exceed threshold levels for the implementation of Conventional Bike Lanes.

Separated Bike Lane with Planter
Source: Vancouver, ON. OTM Book 18.





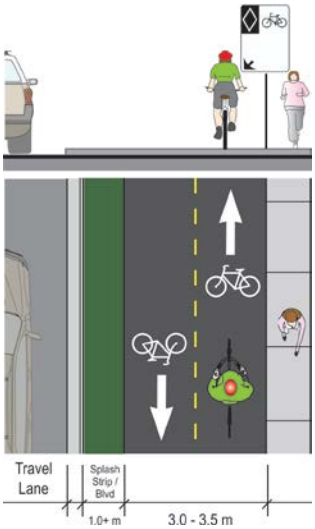
TWO-WAY IN-BOULEVARD SHARED-USE FACILITIES

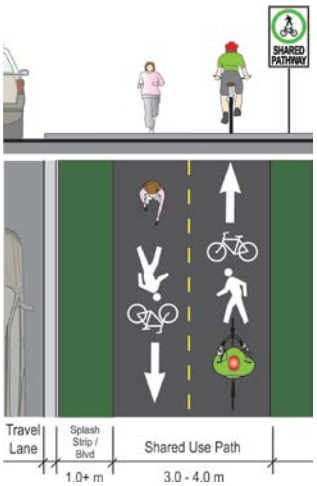
Definition: Is a bicycle path or a combined bicycle/pedestrian path physically separated from motor vehicle traffic by a strip of grass (often referred to as a "boulevard" or "verge") within the roadway right-of-way or in place of an existing or previously proposed sidewalk. This facility type is typically designed for a wide range of non-motorized users including pedestrians, cyclists, in-line skaters, and skateboarders.

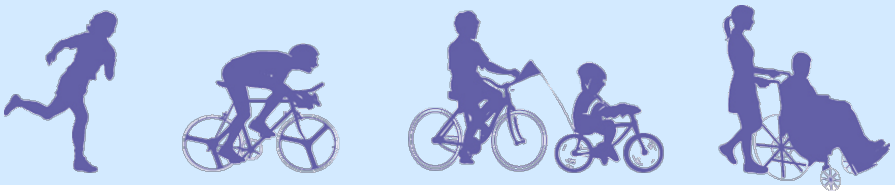
Considerations:

- Surface may be compacted granular (e.g. Limestone Screening) or hard surface (e.g. Asphalt) to accommodate different users and a yellow lane may be used on busier asphalt surfaces;
- Should not be applied in locations where lot frontages are narrow and there are numerous intersections per kilometre;
- Separation or setback from the road is a very important consideration. Where separation cannot be achieved, one direction of cycling traffic is required to ride against motor vehicle traffic;
- When the available right-of-way is too narrow it may be prudent to consider a reduction of the existing or proposed widths of elements such as travel lane and shoulder widths (any reduction to less than MTO, TAC, AASHTO or municipal approved design criteria should be supported by a documented engineering analysis);
- Some cyclists may continue to use the roadway even if an multi-use pathway is provided which may lead to conflicts with motorists who feel all cyclists should be on the path provided; and
- Consideration should be given to motorists who falsely expect cyclists to stop or yield at all cross-streets and driveways.

Parc Lafontaine, Montreal: Multi-use Pathway with a Sidewalk
Source: http://cityphil.com, OTM Book 18







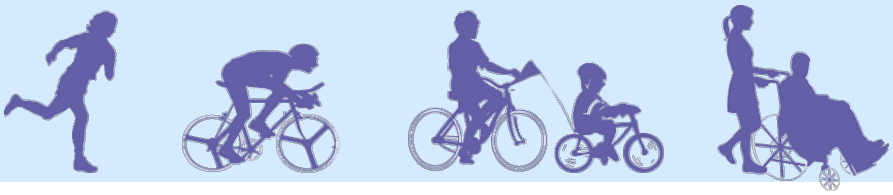
Typical Application: The application of Multi-use Pathways adjacent to a roadway, especially as a cycling facility, should only be considered for cycling when an on-road facility is not feasible or when a municipality seeks to provide a primarily recreational path for pedestrians and cyclists and cannot or chooses not to provide a parallel on-road facility for cycling. This is an appropriate facility choice in areas where there is high cycling demand and a large proportion of the users are youth or seniors with a low to moderate level of experience and where there are few intersections/conflict points per kilometre.

Pedestrian Uses: An Active Transportation Pathways can take on two forms, one where the bicycle path is distinct from the sidewalk and the other where a single path is shared by cyclists and pedestrians. On the Shared Use Active Transportation Path pedestrians are able to use the facility type along with cyclists and other user groups (e.g., in-line skaters, skateboarders, etc.

Guideline 20:

Multi-use Pathways (in place of sidewalks) should be considered in areas where there is high cycling demand, a large proportion of the users have a low to moderate level of experience, and where there are few intersection /conflict points per kilometre. This is typical for residential streets where motor vehicle traffic volumes and speeds are low, and rural roads where traffic volumes are low.

Lake Shore Blvd. Multi-use Trail
Source: WendyGillis, 2010



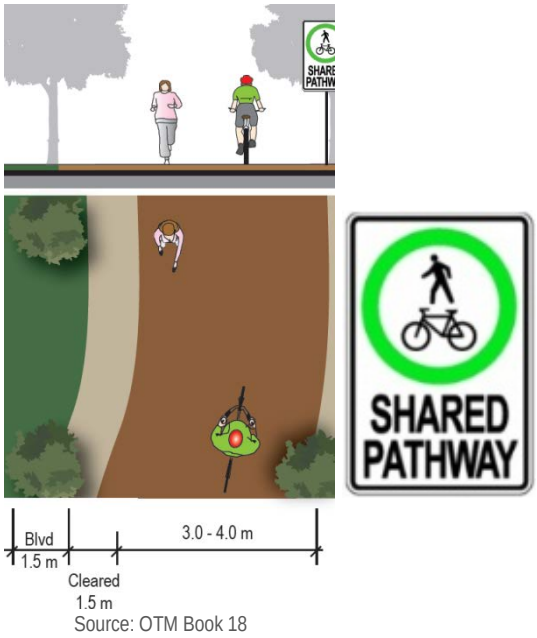
OFF-ROAD MULTI-USE TRAILS

Definition: Off-Road Multi-Use Trails are shared facilities located outside the road right-of-way for use by cyclists and other non-motorized users. If permitted, multi-use trails may also be used by recreational motorized vehicles.

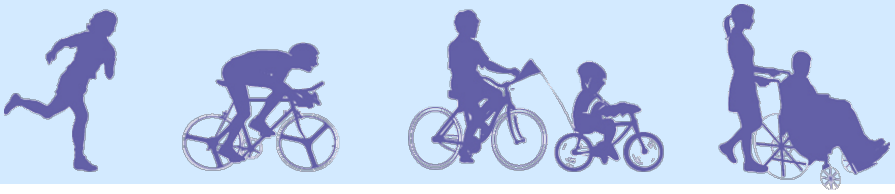
Considerations:

- Generally used to provide a recreational opportunity and may also be appropriate to provide a direct cycling commuter route in corridors not served directly by on-road facilities.
- Surface may vary, may be granular in rural areas and asphalt in urban areas to accommodate a wider range of users.
- Designers must consider the specific users when determining the operating and design of the off-road facility.
- Signage and/or painted centrelines can be utilized to identify separate lanes for opposing directions of travel and encourage the practice of keeping to the right side of the trail.
- The design of the 1.5m boulevard separating the travel lane and multi-use path could include the application of a splash strip, sod or planted beds. The landscaping treatments may form a visual buffer and would help to enhance the pedestrian and cyclist trail user experience.

Off-Road Multi-Use Trail
Source: Town of East Gwillimbury, ON. OTM Book 18.



Source: OTM Book 18

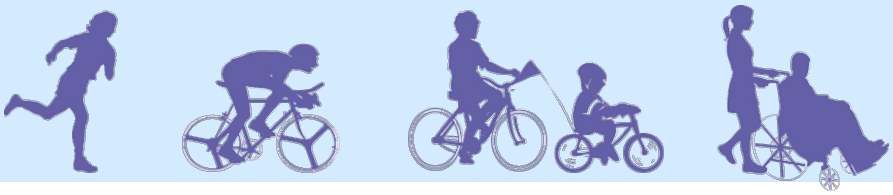


Typical Application: Typically located outside the road right-of-way through a park, public open space corridor, along a utility corridor, or other linear facilities such as within an abandoned railway corridor. Multi-use paths (in place of a sidewalk) should be considered in areas where there is a high demand for cycling. A large proportion of users with low to moderate levels of experience and areas with few intersections / conflict points per kilometre may be ideal locations for these facilities.

Pedestrian Uses: Multi-use trails accommodate the widest range of Active Transportation user groups including cyclists, pedestrians, in-line skaters, skateboarders, and wheelchair users depending on the trail surface. If permitted, equestrians and recreational motorized vehicles including snowmobile and all-terrain vehicles may also be permitted to use certain sections of a multi-use trail outside of the road right-of-way.

Guideline 21:

Off-Road Multi-use Trails provide for the widest range of user ability and should be considered as an integral part of an active transportation network. They also provide connections to local/secondary trails.



RAILS WITH TRAILS

Definition: Rails with Trails are off-road trail facilities which are implemented adjacent to abandoned or existing railways.

Considerations:

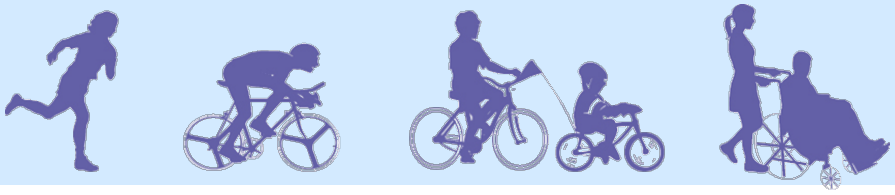
- Under certain conditions active rail rights-of-way may also be able to accommodate an active transportation function.
- In cases where abandoned rail lines currently host multi-use trails and need to be converted to active rail use in the future, consideration should be given to reinstating rail infrastructure without losing the use of the multi-use trail by moving the trail to the edge of the right-of-way.
- Ongoing communication with rail authority is necessary to identify opportunities.
- Land arrangement and maintenance will also need to be addressed with the rail authority.

Typical Application: Candidates for "rails with trails" are those with a wide enough right-of-way to safely accommodate a multi-use trail in addition to existing rail operations, low speed, and low frequency railways.

Pedestrian Uses: Traits accommodate cyclists as well as pedestrians in both urban and rural applications.

Guideline 22: Where applicable, Rails with Trails should be considered to best utilize active or non-active railways throughout the Town and to accommodate, in a safe and effective manner, for both pedestrians and cyclists.

Guelph TCT Rail Trail (Top) and Rail Trail (Bottom)
Source: MMM Group, 2012



The Town of Milton Engineering and Parks Standards Manual contains a number of design details for trails and related items including:

- Environmental Buffer;
- Woodlot Buffer Conveyance;
- Woodland Mulch Trail;
- Asphalt Paving - Heavy Duty;
- Limestone Screening Paving;
- Trail Culvert;
- Pedestrian and Vehicle Service Bridge;
- Single Gate / Trail Access Barrier – Plan and Elevation; and
- Offset Gate / Trail Access Barrier – Plan and Elevation.

Several draft details have been developed as part of the Trails and Cycling Master Plan Update. It is recommended that the Town review these details with consideration for inclusion in the next revision of the Manual. The draft details include:

- 3.0m wide Asphalt Multi-use Trail;
- Heavy-Duty Boardwalk;
- Boardwalk;
- Signalized and unsignalized mid-block crossing;
- Typical Major Staging Areas; and
- Cyclist Rub Rail.

These details can be found at the end of this appendix.

In order to maintain consistency with new Provincial guidelines, Ontario Traffic Manual 18-Bicycle Facilities, should be consulted, in particular for the design of on-road cycling facilities.

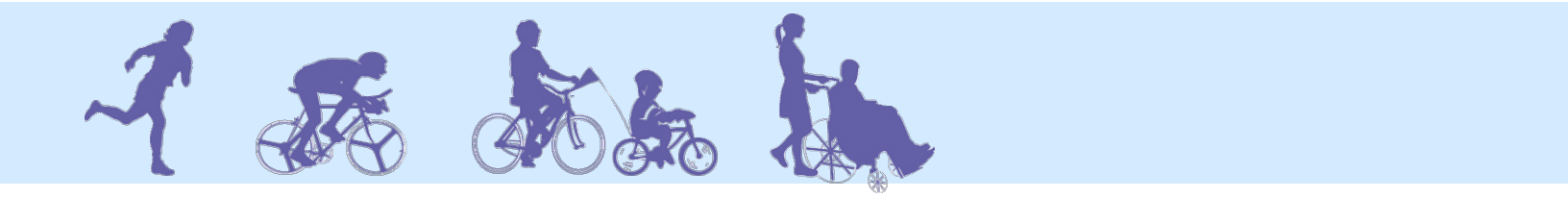
D.3.3 Designing for Intersections & Crossings

A significant challenge when implementing a trail and cycling system is how to accommodate users when crossing various physical barriers and roads. This section provides guidance on crossing design.

D.3.3.1 Minor Roads

In the case of lower volume, lower speed roads, the crossing should include the following:

- Creation and maintenance of an open sight triangle at each crossing point;
- Access barriers to prevent unauthorized motorized users from accessing the pathway;
- Advisory signing along the roadway in advance of the crossing point to alert motorists to the upcoming crossing;
- Signing along the pathway to alert users of the upcoming roadway crossing;



- Alignment of the crossing point to achieve a perpendicular crossing of the roadway, where possible, to minimize the time that users are in the traveled portion of the roadway;
- Concrete ramp in boulevard between the sidewalk and roadway; and
- Curb ramps on both sides of the road.

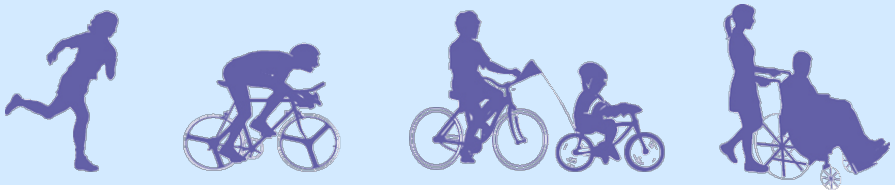
Pavement markings, to delineate a crossing, should not be considered at "uncontrolled" trail intersections with roads as trail users are required to wait for a gap in traffic before crossing at these locations. Pavement markings designed to look like a pedestrian crossover may give pedestrian and trail users the false sense that they have the right-of-way over motor vehicles, which is contrary to the Highway Traffic Act of Ontario for uncontrolled intersections.

In some locations signing on the trail may not be enough to get trail users to stop before crossing the road. Under these circumstances or in situations where the sight lines for motorists are reduced and/or where there is a tendency for motorists to travel faster than desirable, the addition of other elements into the trail crossing may be necessary. Changing the trail alignment may help to get trail users to slow and stop prior to crossing. Changes to the streetscape may also provide a cue and traffic calming effect for vehicles.

D.3.3.2 Crossing with Median Refuge Island

Pedestrian refuge islands are medians that are placed in the centre of the roadway separating opposing lanes of traffic. They allow trail users to cross one direction of traffic at a time, resting on the refuge island in the centre. They are particularly suited for roadways with multiple lanes since the cognitive requirements to select a gap in traffic traveling in two directions in multiple lanes is considerably higher than that required to cross two lanes of traffic. A number of jurisdictions have implemented pedestrian refuge islands. Guidelines for the typical design elements for a pedestrian refuge island are as follows:

- Islands are typically a minimum of 6 m in length;
- Islands should be at least 1.8 m wide, but 2.4 m is preferred to accommodate wheelchairs 1.2 m wide plus 0.6 m wide detectable warning devices on each side. The 2.4 m width also accommodates bikes;
- Curb ramps are provided to allow access to the roadway and island for wheelchair users, and detectable warning devices (0.6 m in width) should be placed at the bottom of the curb ramps;



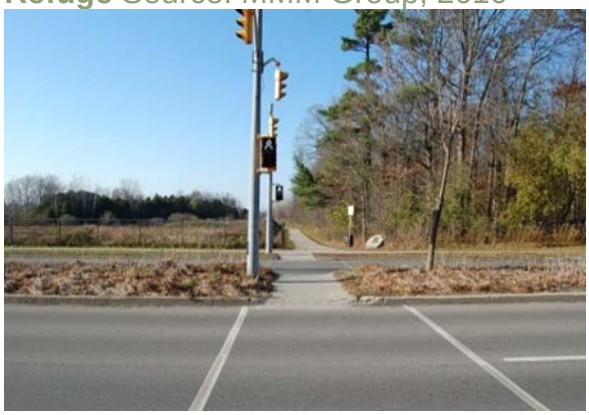
- The pathway on the island is constructed of concrete, not asphalt. The visually impaired can better detect the change in texture and contrast in colour along with the detectable warning devices to locate the refuge island;
- Appropriate tapers are required to diverge traffic around the island based on the design speed of the roadway;
- The pathway on the island can be angled so that pedestrians can view on-coming traffic as they approach the crossing;
- Illumination should be provided on both sides of the crossing;
- Signage associated with the pedestrian refuge island includes “Keep Right” and “Object Marker” warning signs installed on the island facing traffic, and “Pedestrian Crossing Ahead” warning signs installed on the roadway approaching the crossing. “Wait for Gap” warning signs can be installed on the far side of the crossing and on the refuge island if pedestrians are failing to cross in a safe manner;
- Crosswalk markings are not provided unless the crossing is at an intersection controlled by signals, stop or yield signs, or controlled by a school crossing guard; and
- Railings on the island to control pedestrian access are not recommended because they are a hazard in potential collisions. Some pedestrians will walk in front of or behind the island to avoid the railings, a less safe refuge location than on the island.

Guideline 23:

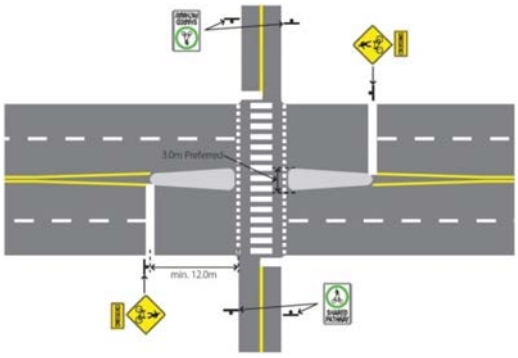
Trail crossing of local minor roads at mid-block locations include advance advisory pedestrian crossing signs on the roadway approaches and a yield or stop sign on the trail approaches.

D.3.3.3 Midblock Pedestrian Signal

Mid-block Pedestrian Signal with Median Refuge Source: MMM Group, 2010



Mid-block Crossing
Source: OTM Book 18 – Bicycle Facilities Guidelines, 2014



Guideline 24: At-grade mid-block multi-use pathways crossings collector and arterial roadways should be controlled by a pedestrian signal or pedestrian crossover where possible.

The midblock pedestrian signal is a device to assist pedestrians crossing major streets and is a more positive and effective pedestrian crossing device than a pedestrian crossover (PXO).

A midblock pedestrian signal includes:

- Standard traffic signal indications to control traffic on the major street; and
- Standard pedestrian "Walk" and "Don't Walk" signals, activated by push buttons, for pedestrians wishing to cross the major street at the designated crossing point.

Midblock pedestrian signals may be considered when:

- A multi-use path or trail crosses a high volume and / or multi-lane road;
- A grade separation is not practical; and
- There is no other controlled intersection or crossing nearby.

Mid-block Pedestrian Signal without Median Source: MMM Group, 2012

D.3.3.4 Active Railways

Currently, in order to establish a pathway crossing of an active rail line, proponents must submit their request directly to the railroad company. Submissions need to identify the crossing location and its basic design. Designs should be consistent with Draft RTD-10, Road/Railway Grade Crossings: Technical Standards and Inspection, Testing and Maintenance Requirements (2002) available from Transport Canada. In the event that an agreement cannot be reached on some aspect of the crossing, an application may be submitted to the Canadian Transportation Agency, who will mediate a resolution between the parties.

Newmarket, ON: At-Grade Trail Crossing of a Railway
Source: MMM Group, 2012

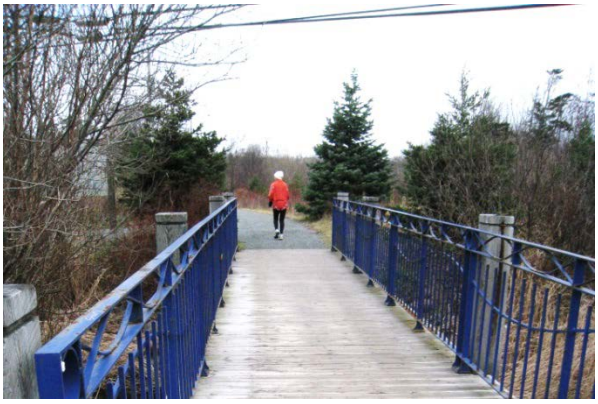
D.3.3.5 Bridges

Where possible, the multi-use pathway network should make use of existing bridges, including pedestrian bridges, vehicular bridges and abandoned railway bridges in appropriate locations. In cases where this is not possible a new structure will be needed. The type and design of a structure should be assessed on an individual basis. The following are some general considerations:

- In most situations the prefabricated steel truss bridge is a practical, cost effective solution;
- In locations where crossing distances are short, a wooden structure constructed on site may be suitable;
- Railings should be considered if the height of the bridge deck exceeds 60cm above the surrounding grade, and should be designed with a “rub rail” to prevent bicycle pedals and handlebars from becoming entangled in the pickets;
- When considering barrier free access to bridges, an appropriate hardened surface should be employed on the trail approaches and bridge decking should be spaced sufficiently close to allow easy passage by a person using a mobility-assisted device;

- Decking running perpendicular to the path of travel is preferred over decking running parallel, as the latter is more difficult for use by wheelchairs, strollers, in-line skates and narrow tired bicycles;
- Maintenance consideration; and
- Accessibility.

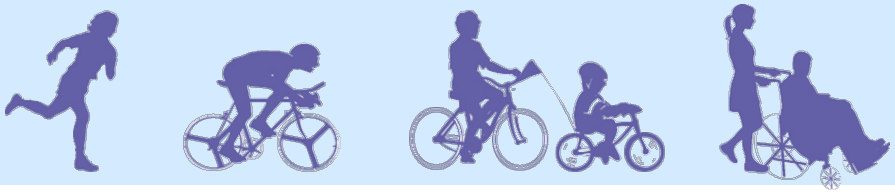
Sample Pathways on Bridges Top: Brampton, ON; Bottom: St. John's, NFLD.
Source: MMM Group, 2012



D.3.3.6 Underpasses & Tunnels

Often an underpass or tunnel is the only way to cross significant barriers such as elevated railways and multi-lane highways. Designing trails through underpasses and tunnels can be challenging because of the confined space. Underpasses should be wide enough to accommodate all trail users whether they are traveling by foot, bicycle, in-line skates, wheelchair or other forms of active transportation. Where feasible, it is suggested that trail widths through underpasses be equal to or greater than that of the approaching trail. The guidelines provided below outline key considerations for the development of an underpass crossing. Additional design considerations for the implementation of bridges and overpasses include:

- Minimum recommended underpass or tunnel width for a multi-use pathway is 3.5m. Where the structure exceeds 20m in length, in high traffic and/or urban areas the width should be increased to 4.2m or greater where possible;
- For shorter length underpasses, a vertical clearance of 2.5m is usually sufficient;
- For longer structures a vertical clearance of 3.0m should be considered. If service and/or emergency vehicles are to be accommodated within the underpass, an increase in vertical clearance may also need to be provided;



- Underpasses and tunnels can be a security concern and also present maintenance challenges. To address these issues, tunnels should be well lit with special consideration made to security, maintenance and drainage. Approaches and exits should be clear and open to provide unrestricted views into and beyond the end of the structure wherever possible;
- Abutments should be appropriately painted/marked with reflective hazard markings; and
- Ideally, the transition between the multi-use pathway and underpass crossing should be level and provide for accessibility. In the case where an underpass crosses beneath ground-level travel/road ways, ramps should be provided to allow a transition down to the lower grade under the passage, with grade or alignment changes being taken up by the access ramps wherever possible.

D.3.4 Trail Surface & Base Alternatives

There are a number of options for trail surfaces, each with advantages and disadvantages related to cost, availability, ease of installation, lifespan, and compatibility with various trail use groups. **Table D.6** is a summary of the most commonly used trail surfacing materials along with some advantages and disadvantages for each. There is not one surface material that is appropriate in all locations, and material selection during the design stage must be considered in the context of the anticipated users and location.

Guideline 25: Refer to the design considerations in sections D.3.3.5 and D.3.3.6 when selecting locations for, and designing grade-separated trail crossings.

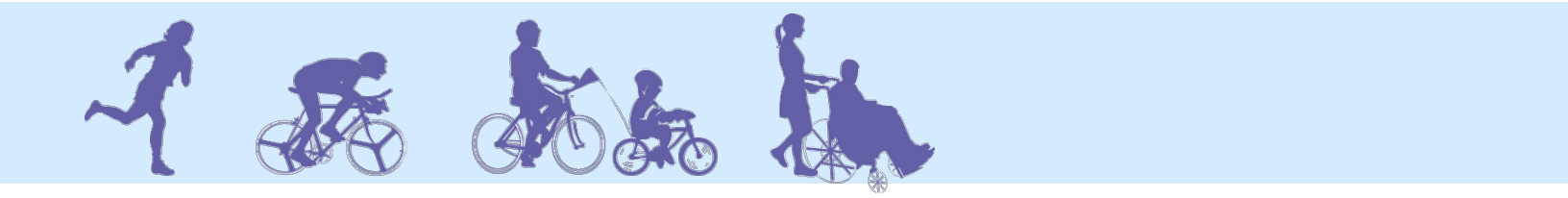
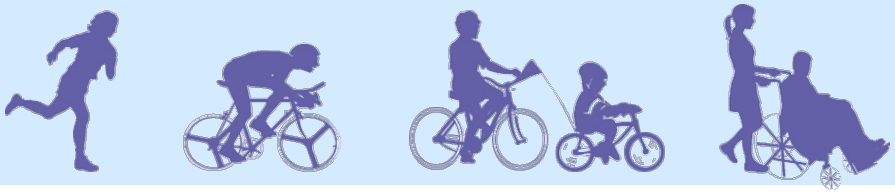
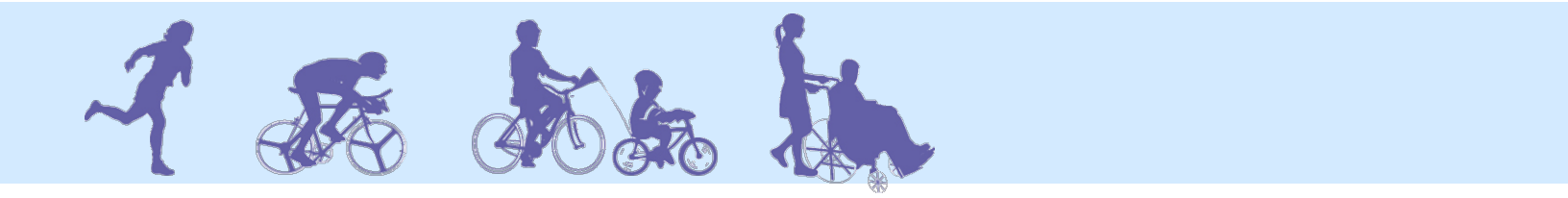


Table D.6 – Comparison of Trail Surfacing and Base Materials

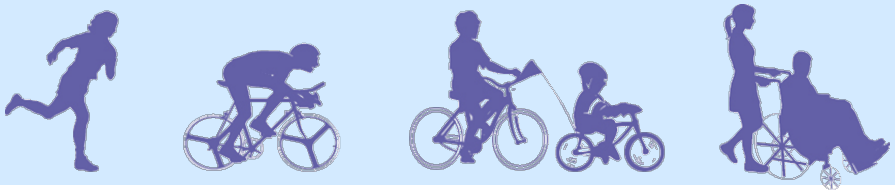
Type	Advantages	Disadvantages
Concrete	Smooth surface, can be designed with a variety of textures and colours, providing flexibility for different urban design treatments. Long lasting, easy to maintain.	High cost to install. Requires expansion joints which can create discomfort for users with mobility aids. Must be installed by skilled trades people. Is not flexible; Cracking can lead to heaving and shifting, sometimes creating large step joints.
Unit Pavers	Relatively smooth surface, available in a variety of patterns and colours to meet urban design needs. Long lasting, can be easily repaired by lifting and relaying.	High cost to install. Users with mobility aids may find textured surface difficult to negotiate. Must be installed by skilled trades people.
Asphalt	Smooth surface, moulds well to surrounding grades, and is easily negotiated by a wide range of trail user groups. Patterned and coloured surface treatments are available, however patterning in surface may be difficult for some user groups to negotiate. Retains heat and dries more quickly in comparison to other materials, allowing for easier use during the winter months.	Moderate-high cost to install. Must be installed by skilled trades people. Has a lifespan of 15-20 years depending on the quality of the initial installation. Poor base preparation can lead to significant reduction in lifespan. Cracking and “alligatoring” occurs near the edges, grass and weeds can invade cracks and speed up deterioration. Must be appropriately disposed of after removal.
Granular Bases	Pit Run: Mixed granular material “straight from the pit” containing a range of particle sizes from sand to cobbles. Excellent for creating a strong sub base, relatively inexpensive (for bases only) ‘B’ Gravel: Similar characteristics to Pit Run with regulated particle size (more coarse than ‘A’ Gravel). Excellent for creating strong, stable and well drained sub bases and bases. Relatively inexpensive. (for bases only)	Not appropriate for trail surfacing Not appropriate for trail surfacing.



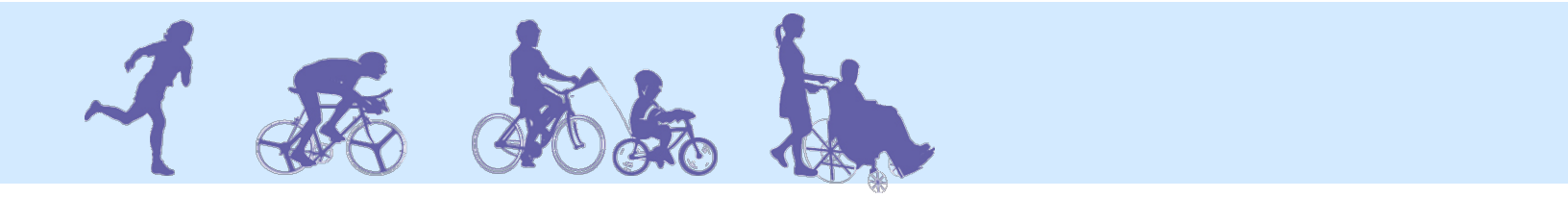
Type	Advantages	Disadvantages
Granular Bases	'A' Gravel: Similar characteristics to 'B' Gravel, with smaller maximum particle size. Excellent for trail bases, may be appropriate for trail surfacing of rail trails in rural areas and woodlands. Easy to spread and regrade where surface deformities develop. (for bases only)	Subject to erosion on slopes. Some users have difficulty negotiating surface due to range in particle size and uneven sorting of particles that can take place over time with surface drainage.
Granulars	Clear stone: Crushed and washed granular, particles of uniform size, no sand or fine particles included. Excellent bedding for trail drainage structures and retaining wall backfilling. If properly leveled and compacted, makes an excellent base for asphalt trails. (for bases only)	Not appropriate for trail surfacing
	Stone fines (Screenings): Mixture of fine particles and small crushed stone. Levels and compacts well and creates a smooth surface that most trail users can negotiate easily. Easy to spread and regrade where defects develop. Inexpensive and easy to work with. Widely used as surface of choice for most granular surfaced trails. (for Secondary Multi-use Pathways, Park Access Trails, Internal Park Trails and some locations along Hiking/Foot Trails)	Subject to erosion on slopes Wheelchair users have reported that stone shards picked up by wheels can be hard on hands. May not be suitable as a base for hard surfaced trails in some locations.
	Crushed 3/8" Limestone material. This surfacing material has been used successfully to make repairs in some areas where finer stonedust has washed out but this material has remained in place longer	



Type	Advantages	Disadvantages
Mulches and Wood Chips	Bark or wood chips, particle size ranges from fine to coarse depending on product selected, soft under foot, very natural appearance that is aesthetically appropriate for woodland and natural area settings. Some user groups have difficulty negotiating the rough, soft surface. Mulches and woodchips can be used to discourage some uses such as cycling. They may also be useful in reducing the speed of some users and potentially reducing conflicts between different user groups. May be available at a very low cost depending on source, and easy to work with.	Breaks down over time, therefore requires "topping up". Source of material must be carefully researched to avoid unintentional importation of invasive species (plants and insects).
Earth / Natural Surface	Native soils from the area surrounding the trail. Only cost is labour to clear and grub out vegetation and regrade to create appropriate surface. Appropriate for trails in natural areas provided that desired grades can be achieved and that soil is stable (do not use organic soils).	Subject to erosion on slopes. Different characteristics in different locations along the trail can lead to soft spots. Some user groups will have difficulty negotiating surface.



Type	Advantages	Disadvantages
Soil Cement and Soil Binding Agents	Soil Cement is a mixture of Portland Cement and native/parent trail material. When mixed and sets it creates a stable surface that can be useful for "trail hardening" on slopes, particularly in natural settings. Soil Binding Agents are a mix of granulars and polymers that create a solid, yet flexible surface that may be appropriate for "trail hardening" on slopes in natural areas. Limits volume and weight of materials to be hauled into remote locations.	Useful for specific locations only. Soil binding agents tend to be expensive and have been met with mixed success.
Wood	Attractive, natural, renewable material that creates a solid and level travel surface. Choose rough sawn materials for deck surfacing for added traction.	Requires skill to install, particularly with the substructure. Wood gradually decomposes over time, this can be accelerated in damp and shady locations, and where wood is in contact with soil. Expensive to install.



D.3.5 Multi-use Trail Lighting

Lighting of multi-use pathways must be carefully considered. Very few municipalities make the decision to light their entire trail system for a number of important reasons, including:

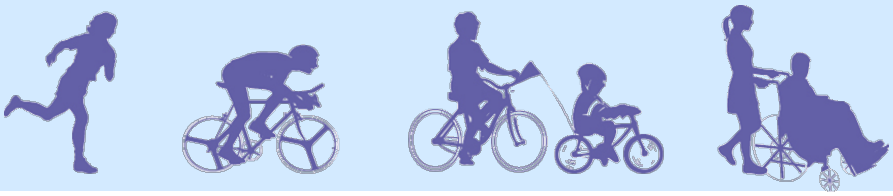
- The cost of initial installation can be prohibitive. General budget figures range from $130,000 to $160,000 per kilometre including cabling, transformers, power supply and fixtures;
- Staff time and material cost to properly monitor, maintain lamp fixtures and replace broken and burned out bulbs on an ongoing basis;
- A tendency for vandals to target light bulbs, however, light fixtures can designed to protect bulbs;
- Energy consumption; however, options for energy-efficient lighting are available;
- Excessive light pollution, especially in residential rear yards and adjacent to natural areas (though this can be controlled with proper shielding);
- Potential detrimental effects on flora and fauna, especially with light pollution in natural areas such as woodlands and tributary buffers;
- Lighting can promote use which may create greater security if users increase their presence; and
- Inability of the human eye to adapt to the high contrast resulting from brightly lit and dark shadowed areas adjacent one another.

Lighting the entire multi-use pathway may not be required or feasible. The decision of whether or not to light segments of the multi-use pathway network should be made on a location-specific basis.

Some criteria for pathway lighting include:

- Main connections to important attractions such as major parks;
- Main connections between key use areas within a park or Town-owned property;
- Heavily used commuter routes (anecdotal information on volume of use supported by user counts);
- Key school routes; and
- Numerous requests for lighting, supported by similar results through public consultation.

Where it has been determined that lighting is appropriate, the quality and intensity of lighting should be consistent with prevailing standards that fit the setting being considered.



D.4 Additional Design Considerations for Trail and Cycling Facilities

The provision of additional design considerations and features is a key and sometimes overlooked element in the design of the trail and cycling network. Developing and maintaining a comprehensive network of on-road and off-road trail and cycling facilities does not automatically mean people will use the network. The network has to be promoted, users' need to feel comfortable and safe using it and they should have access to adequate cycling and trail facilities at strategic locations. This section outlines many of the amenities that should be considered during the design and implementation of the trail and cycling network.

D.4.1 Multi-use Trail Structures

D.4.1.1 Gate and Barrier Systems

Access barriers are intended to allow free-flowing passage by permitted user groups, and prohibit access by others. Barriers typically require some mechanism to allow access by service and emergency vehicles. Depending on site conditions, it may also be necessary to provide additional treatments between the ends of the access barrier and limit of the multi-use pathway right of way to prevent bypassing of the barrier altogether. Each access point should be evaluated to determine if additional treatments are necessary. Additional treatments can consist of plantings, boulders, fencing or extension of the barrier treatment depending on the location. Some locations may have concerns such as unauthorized access which need to be addressed.

There are many designs for trail access barriers in use by different trail organizations and some are more successful than others. Barriers can generally be grouped into three categories:

- Bollards;
- Offset Swing Gates; and
- Single Swing Gates.

The Town currently uses P-gates installed in an off-set configuration at its main trail entrances. In some locations it may be appropriate to consider an alternative to the standard (i.e. a heavy duty single swing gate trails in rural areas). It is important that the options for access barriers be discussed with those responsible for the ongoing maintenance of the trail and cycling facilities.

Bollards

The bollard is the simplest and least costly barrier, and can range from permanent, direct buried wood or metal posts, to more intricately designed cast metal units that are removable by maintenance staff. An odd number of bollards (usually one or three) are placed in the multi-use pathway bed to create an even number of "lanes" for users to follow as they pass through the barrier.

Although the removable bollard system provides flexibility to allow service vehicle access, they can be difficult to maintain as the metal sleeves placed below grade can be damaged by equipment and can become jammed with gravel and debris from the trail bed.

Application of Trail Bollards at Mid-Block Trail Crossing
Source: www.americantrails.org

Swing Gates

The single swing gate combines the ease of opening for service vehicle access, with the ease of passage of the bollard. Gates also provide a surface/support for mounting signage. The swing gate should provide a permanent opening to allow permitted users to flow freely through the barrier. The width of the permanent opening must be carefully considered so that it will allow free passage by wheelchairs, wide jogging and double strollers, bicycle trailers and electric scooters, yet not allow passage by unauthorized vehicles such as snowmobiles and all terrain vehicles.

The offset gate is similar to the single swing gate, except that barriers are paired and offset from one another. Although they can be effective in limiting access by unauthorized users and can be easily opened by operations staff, some groups including cyclists, especially cyclists pulling trailers and wheelchair users, can have difficulty negotiating the offset swing gate if the spacing between the gates is not adequate.

D.4.1.2 Boardwalks

Where multi-use pathways and trails pass through sensitive environments (see Section A.9) such as marshes, swamps, or woodlands with a large number of exposed roots, an elevated trailbed or boardwalk is usually required to minimize impacts on the natural feature. If a trail is not created and

defined, trail users tend to walk around obstacles such as wet spots, gradually creating a wider, often braided trail through the surrounding vegetation. The turnpike and low profile boardwalk are two relatively simple and effective methods for some local park trails and hiking/foot trails.

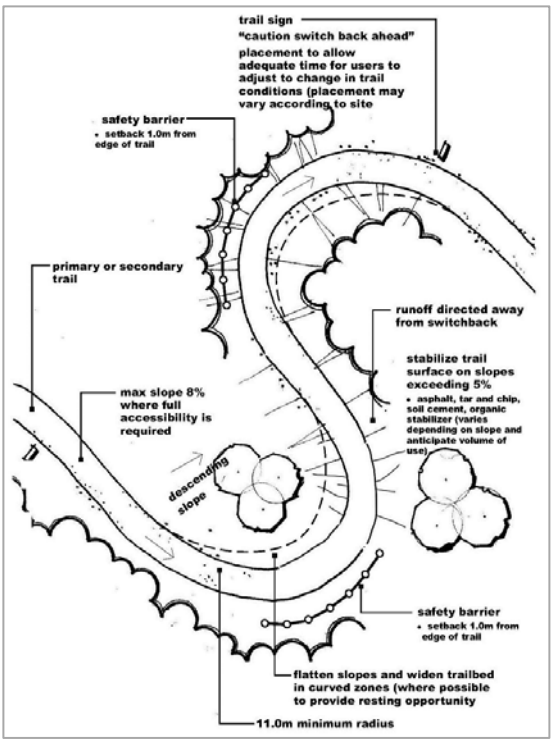
Turnpike

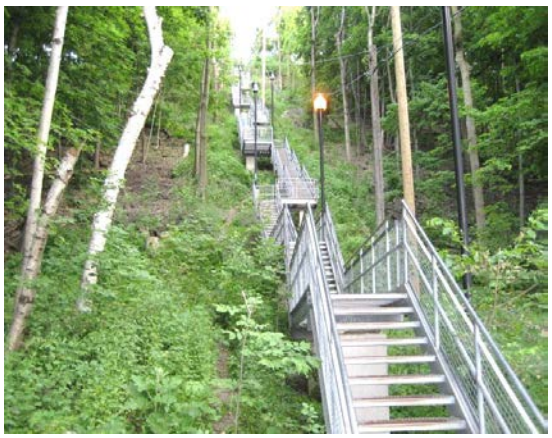
The Turnpike or Raised Trailbed is a low tech, low cost method that works very well in areas where organic soils are encountered. Turnpikes are used to elevate the trail above wet ground. The technique uses fill material to build up the trail base higher than the surrounding water table. Turnpike construction is used to provide a stable trail base in areas of high water table. Various geosynthetic products have also been successfully used to overcome difficult soil conditions.

Low profile boardwalks have been successfully employed by trail managers across Ontario. In some cases, the simple construction method provides a great opportunity for construction by supervised volunteers where precast “deck blocks” have been used for the foundation of the boardwalk. Where the trail is in a high profile location, where it is necessary to provide a fully accessible trail, or where the trail surface must be greater than 60cm above the surrounding grade, a more sophisticated design and installation is necessary. This includes engineered footings or abutments, structural elements and railings. A professional who is trained in structural design and approval requirements should be retained for these types of applications.

Boardwalk Examples and Boardwalk Foundation on Helical Piles - Top: Hamilton, ON; Bottom: Halton Hills, ON
Source: MMM Group

Top: Switchback Example; Bottom: Woven Metal Stairs, Dundurn Stairs in Hamilton, ON Source: MMM Group





D.4.1.3 Switchbacks and Stairs

Pedestrians and some self-propelled users are capable of ascending grades of 30% or more whereas some users are limited to grades of less than 10%. For example, a slope of 5% is the threshold for a fully accessible facility. Once trail slopes exceed this threshold and slopes are long (i.e. more than 30m) it is important to consider alternative methods of ascending slopes. Two alternatives to consider are switchbacks and stairs.

Where construction is feasible, switchbacks are generally preferred because they allow wheeled users such as cyclists to maintain their momentum, and there is less temptation to create shortcuts as might be the case where stairways are used. Switchbacks are constructed with turns of about 180 degrees and are used to decrease the grade of the multi-use pathway. A properly constructed switchback also provides outlets for runoff at regular intervals, thus reducing the potential for erosion. Switchbacks typically require extensive grading and are more suited to open locations where construction activity will not cause major disruption to the surrounding environment. Switchbacks can be difficult to implement in wooded areas without significant impacts to surrounding trees.

The preferred design alternative for the Town's Operations Division is a switch back as opposed to stairs. This is due to the ease of winter maintenance and overall costs.

When slopes exceed 15%, or where there is inadequate room to develop a switchback or another accessible solution, a stairway system should be considered. In these situations the site should be carefully studied so that the most suitable design can be developed.

The following are some considerations for stairway design:

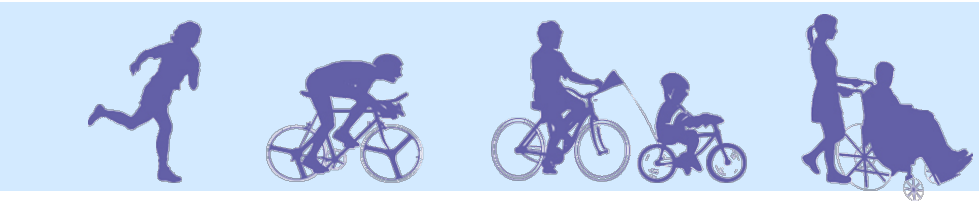
- Provide a gutter integrated into the stairway for cyclists to push their bicycles up and down (where appropriate to have bicycles);
- Develop a series of short stair sections with regularly spaced landings rather than one long run of stairs;
- For long slopes, provide landings at regular intervals (e.g. every 8-16 risers) and an enlarged landing at the mid-way point complete with benches to allow users the opportunity to rest;
- On treed slopes, lay the stairway out so that the minimum number of trees will be compromised or removed
- Use slip resistant surfacing materials, especially in shady locations.
- Incorporate barriers on either side of the upper and lower landing to prevent trail users from bypassing the stairs; and
- Provide signs well in advance of the structure to inform users that may not be able to climb stairs

Guideline 26: Refer to the design considerations in section D.4.1.3 when locating and designing stairways.

D.4.2 Trip End Facilities for Commuters

Installation of showers and lockers at workplaces and educational institutions help to promote the use of the network for utilitarian purposes. Lockers can be used to store personal belongings such as cycling accessories and a change of clothing. Businesses or institutions with employees who commute by bicycle, in-line skating, or other modes should be encouraged to offer these facilities. The facilities which could be considered may include:

- Bicycle parking which can include a variety of types from the simple post and ring style rack for 2 bicycles to larger and more elaborate systems for large numbers of bicycles at destinations where use/demand is high; and
- Change and Shower Facilities at the cyclist's destination.



Guideline 27: The Town of Milton and its partners should provide trip-end facilities for employees and visitors at all public buildings where feasible, and the private sector should be encouraged to do the same for residential, commercial and institutional developments.

D.4.3 Transit Connections

Providing defined access for cyclists to and from a bus stop is extremely important. Transit stops, particularly bus stops, should be designed in a way that provides safe, convenient, and comfortable places for people to wait. Desirable features at bus stops also include waste-recycling receptacles, seating, lighting and bike racks.

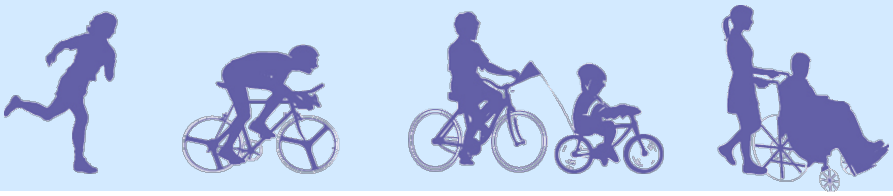
Bike racks on buses are one example of a cycling-transit link. This allows cyclists to ride their bike to a transit stop or station, attach it to a bus-mounted bike rack, travel to their stop, disembark and continue on their bicycle to their final destination.

Figure D.5 illustrates a covered bike parking shelter installed at a GO Transit Station. **Figure D.6** illustrates the application and use of a bicycle rack on a Town of Milton bus.

Guideline 28: Transit terminals and hubs (e.g. the GO / VIA train station) within the Town of Milton should provide safe and convenient cycling access, including direct links to sidewalks, trails and major destinations.

Figure D.5 – Bike Parking & Transit Hub
Source: www.bikesandtransit.wordpress

Figure D.6 – Bike Rack on Milton Bus
Source: Town of Milton



The cycling-transit link can also make access to transit less expensive. In suburban neighbourhoods, population densities are often too low to offer transit service within the typical walking distance of 500 metres of every commuter. Within the last 20 years, many transit agencies built expansive motor vehicle park-and-ride lots or centralized depots as an alternative to costly feeder bus service. Many of these facilities are within easy cycling distance, provide opportunities to increase cycling and transit ridership and reduce taxpayer costs, traffic congestion and air pollution.

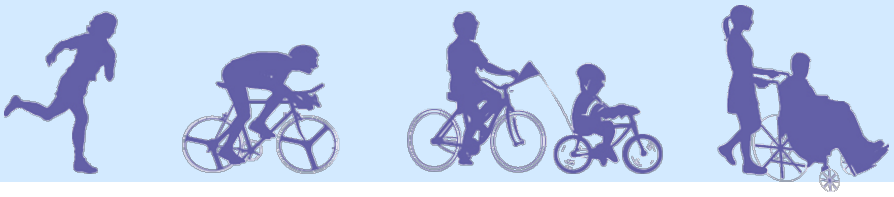
D.4.4 Bicycle Parking

The Town currently installs bike racks at its recreation centres, facilities and parks. Continuing this practice is essential for encouraging more bicycle use in the Town of Milton. The lack of adequate bicycle parking supply or type can deter many from considering using their bicycle as a basic mode of transportation. Bicycle parking can be divided into two categories: bicycle racks and bicycle lockers.

Bicycle Racks

When designing bicycle racks the following components must be considered. Additional considerations and guidelines can be found in the TAC Manual as well as OTM Book 18.

The Rack Element	The Rack	The Rack Area
Definition The portion of a bike rack that supports the bicycle.	**Definition** A grouping of rack elements.	**Definition** The “bicycle parking lot” or area where more than one bicycle rack is installed. Bicycle racks are separated by aisles, much like a typical motor vehicle parking lot.



The Rack Element	The Rack	The Rack Area
Key Considerations Can be joined on any common base or arranged in a regular array and fastened to a common mounting surface. May be used to accommodate a varying number of bicycles securely in a particular location. Various types of available bicycle rack designs e.g. “Ribbon” rack, the “Ring” rack, the “Ring and Post” rack and the “Swerve” rack. Rack should support the bicycle by its frame in two places and prevent the wheel from tipping over. Should allow front-in parking and back-in parking with a U-lock able to lock the front and the rear wheel.	**Key Considerations** Consist of a grouping of the rack elements either by attaching them to a single frame or allowing them to remain as single elements mounted in close proximity to one another. Should be securely fastened to a mounting surface to prevent the theft of a bicycle attached to a rack. Be easily and independently accessed by the user. Should be arranged to allow enough room for two bicycles to be secured to each rack element. Be arranged in a way that is quick, easy and convenient for a cyclist to lock and unlock their bicycle to and from the rack.	**Key Considerations** The minimum width between aisles should be 1.2 m. Aisle widths of 1.8 m are recommended in high traffic areas. A 1.8 m depth should be provided for each row of parked bicycles. Large bicycle rack areas with a high turnover rate should have more than one entrance to help facilitate user flow. If possible, the rack area should be sheltered to protect the bicycles from the elements. Bicycle racks should be placed as close as possible to the entrance, no more than 15 m, and should be clearly visible along a major building approach line but not impede pedestrian traffic. To avoid excessive bicycle riding on the grass, bicycle racks should only be placed on grass surfaces located within close proximity to a paved cycling route, such as on off-road multi-use trail, or an on-road route.

The Rack Element	The Rack	The Rack Area
Additional Considerations		
Bicycle racks should not only allow for a secure lock between the bicycle and the rack, but should also provide support for the bicycle frame itself. The rack element should also be designed to resist being cut or detached by common hand tools such as bolt and pipe cutters, wrenches and pry bars which can easily be concealed in backpacks.	N/A	Bicycle Racks should not be placed in the following areas: Bus loading areas; Goods delivery zones; Taxi zones; Emergency vehicle zones; Hotel loading zones; Within 4.0 m of a fire hydrant; Within 2.5 m of a driveway or access lane; and Within 10.0 m of an intersection.

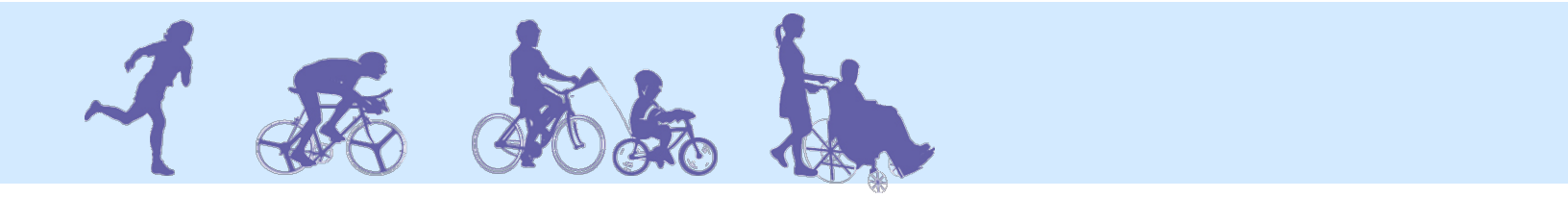
Bicycle Lockers

Definitions: Bicycle lockers are individual storage units. They are weather-protected, enclosed and operated by a controlled access system that may use keys, swipe card (key fob) or an electronic key pad located on a locker door. Some locker systems are set up for multiple users (i.e. coin operated or secured with personal locks). On average, two standard car parking spaces (of 5.6 m x 2.6 m each) can accommodate 10 individual bicycle locker spaces but this may differ depending on the locker model.

Key Considerations:

- Security and durability are important to consider when selecting a bicycle locker.

Figure D.7 – Bike racks at Milton Leisure Centre and Milton Sports Centre
Source: Town of Milton



Design Alternatives:

- Transparent panels are available on some models to allow surveillance of locker contents;
- Stackable models can double bicycle parking capacity on site;
- Options for customer access can vary from a simple, single-use key system to a multi-user system that allows secure access through smart card technology or electronic key pads;
- Bike Lockers require a level surface, clearance for locker doors and should be located close to building entrances or on the first level of a parking garage and within range of security surveillance. Bicycle Lockers are best placed away from sidewalks and areas with high pedestrian traffic. High quality, durable models should be able to withstand regular use, intense weather conditions and potential vandalism; and
- The installation of lockers and showers at workplaces and educational institutions helps to promote the use of cycling for utilitarian purposes. Businesses or institutions with more than 20 employees commuting by bicycle should be encouraged to offer these facilities.

As per the Town's Comprehensive Zoning By-law – Section 5.14 – Bicycle Parking Spaces (156-2000), bicycle parking "shall be provided for any new building on an addition to an existing building". This is supplemented by other by-laws for the location of bicycle parking spaces (155-2012), the size of the parking space and aisles and space requirements (155-2012). In addition to the design considerations noted above, the Town should continue to apply, where appropriate, the bicycle parking requirements and standards.

Guideline 29:	Using the criteria outlined as well as the specifications identified in the Town's Comprehensive Zoning By-law, the type of bicycle parking facility, number of available spaces and location should be done on a site-by-site basis.
Guideline 30:	The Town of Milton should build upon the infrastructure previously put in, and consider initiating a program to install post and ring style racks on a request basis for destinations throughout the Town. The design of a signature post and ring style rack could be used as a common branding element throughout the Town.

D.4.5 Bicycle-Friendly Catch Basin Cover

Catch basin grates and utility covers are potential obstructions to cyclists, as well as in-line skaters. Therefore, bicycle-safe grates should be used, and grates and covers should be located in a manner which will minimize severe and/or frequent manoeuvring by the cyclist. Catch basin grates with slots parallel to the roadway, or a gap between the frame and the grate, can trap the front wheel of a bicycle, causing loss of steering control. If the slot spacing is wide enough, narrow bicycle wheels can drop into the grates. Conflicts with grates may result in serious damage to the bicycle wheel and frame as well as injury to the cyclist.

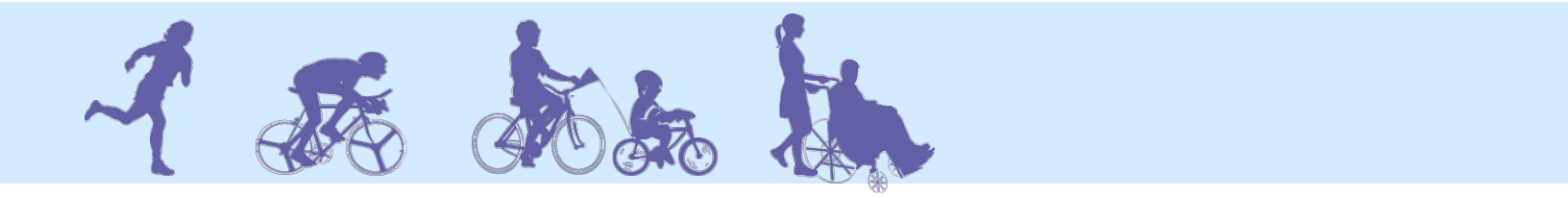
These grates should be replaced with bicycle-safe, hydraulically efficient versions. All on-road cycling facilities in urban areas with curb gutter and storm drains should be made bicycle-friendly through the provision of bicycle-friendly catch basin covers. The Town of Milton may want to consider a standard similar to the one used in Niagara and develop a standard bicycle-friendly catch basin cover.

Key Considerations:

- When new curbed roadways are constructed or rehabilitated, curb face inlets should be considered to minimize the number of potential obstructions.
- Catch basin grates and utility covers should be placed or adjusted to be flush with the adjacent pavement surface.

Figure D.8 – Sample Design for Bicycle-Friendly Catch Basin Covers
Source: www.dandyhorsemagazine.com

Guideline 31: The Town of Milton should ensure that all catch basin covers are bicycle-friendly. Catch basin covers on proposed bicycle routes as part of the Town of Milton Trails and Cycling Network should receive priority for adjustments.



D.4.6 Rest and Staging Areas

Where

- Rest areas should be provided along routes where users tend to stop, such as stations, lookouts, restaurants, museums and other attractions / services which are logical locations for rest areas.
- Ideally, there should be a rest area at least every five kilometres on popular rural recreational trails or at major intersections and gathering places near on-road facilities or along sidewalks and boulevard trails.
- In urban centres rest areas should be provided more frequently, in areas where trail/AT route demand is high such as popular urban trails, trails with high use by active seniors and along pathways in public parks. Opportunities for resting/seating should be much more tightly spaced (e.g. consider intervals of 100-250m).

Additional Considerations

In addition to seating, a number of other amenities should be considered for rest areas including:

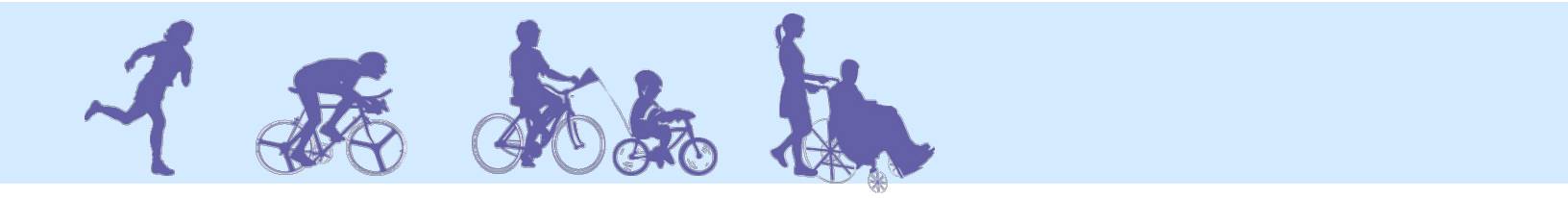
- Tables;
- Washrooms and potable water;
- Waste receptacles;
- Shade;
- Parking for automobiles;
- Information signing complete with mapping; and
- Bicycle parking facilities.

Guideline 32:

Rest and staging areas should be provided at strategic location such as gathering points, attractions and destinations, as well as other locations where cyclists and pedestrians are expected to stop. The Town of Milton and its partners should work together to identify and implement rest and staging areas where necessary.

Figure D.9 – Pathway Seating and Rest Areas Source: Top: MMM Group Caledon Trailway; Bottom: MMM Group, Confederation Trail Georgetown, PEI

The graphics above illustrate elements which could be considered for implementation along the proposed trail and cycling network within the Town of Milton.



D.5 Signing the Trail and Cycling Network

In Milton, the trail signage program should be reviewed in light of the existing sign program used in parks and open spaces and the requirements of the AODA.

The design and construction of the network should incorporate a hierarchy of signs, each with a different purpose and message. This hierarchy is organized into a "family" of signs with unifying design and graphic elements, materials, and construction techniques. The unified system becomes immediately recognizable by the user and can become a branding element. Generally the family of signs includes:

1. Orientation & Trailheads

- Typically located at key destination points and major network junctions.
- Provide orientation to the network through mapping, network information and rules and regulations.
- Useful landmark where network nodes are visible from a distance.
- Used as an opportunity to sell advertising space to offset cost of signs.

Guideline: Orientation signs could be considered for implementation when entering the Town or at trail junctions.

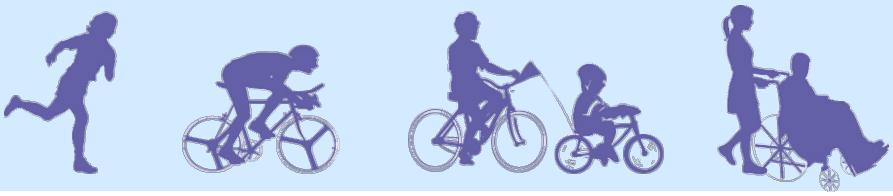
2. User Etiquette

- Should be posted at public access points to clearly articulate which trail uses are permitted, regulations and laws that apply, as well as trail etiquette, safety and emergency contact information.
- At trailheads, this information can be incorporated into trailhead signs.
- In other areas, this information can be integrated with access barriers.

Guideline: Etiquette signs should be considered for implementation at public access points or where trailheads are located.

3. Regulatory

- Required throughout the system. Where traffic control signs are needed (stop, yield, curve ahead, etc.), it is recommended that recognizable traffic control signs be used (refer to the TAB Bikeway Control Guidelines or OTM Book 18).
- Intended to control particular aspects of travel and be used along the on-road or off-road network.
- Warning signs are used to highlight bicycle route conditions that may pose a potential safety or convenience concern to users.
- These signs are more applicable to cycling routes and multi-use trails than pedestrian systems.



Guideline: Signs should be considered for implementation along proposed multi-use trails or in locations where conditions may change drastically enough that users should be made aware.

4. Interpretive

- Should be located at key trail features having a story to be told. These features may be cultural, historical, or natural. Interpretive signs should be highly graphic and easy to read.
- Should be located carefully in high visible locations to minimize the potential for vandalism.

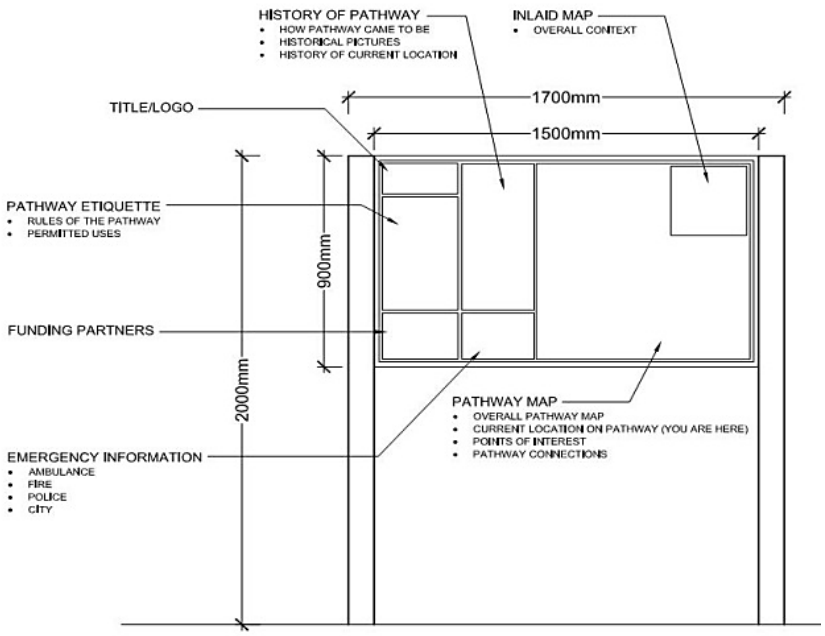
Guideline: Signs should be implemented throughout the network in locations where cultural or historical information should be highlighted.

5. Route Marker & Trail Directional

- Should be located at key network intersections and at regular intervals along long, uninterrupted sections of network.
- Purpose is to provide a simple visual message to users that they are travelling on the pathway network.
- May include the network logo or “brand” and communicate other information to users such as directional arrows and distances in kilometres to major attractions and settlement areas.
- Should be mounted on standard sign poles and be located on all legs of an intersection or off-road trail junction, as well as at gateways.

Guideline: Signs should be considered as part of the overall network to identify a route brand and provide users with directional/way finding information.

Orientation & Trailhead Examples



Ottawa, ON: Trailhead Sign Examples
Source: MMM Group

Regulatory Sign Examples

Examples of Typical Regulatory Signs
Source: OTM Book 18, TAC

Interpretive Sign Examples

Interpretive Sign Examples: Top Left: Erin, MMM Group; Bottom Left: Fundy National Park, MMM Group; Top Right: Tobermory, MMM Group; Bottom Right: Sauble Beach, MMM Group.

Route Marker and Trail Directional Sign Examples

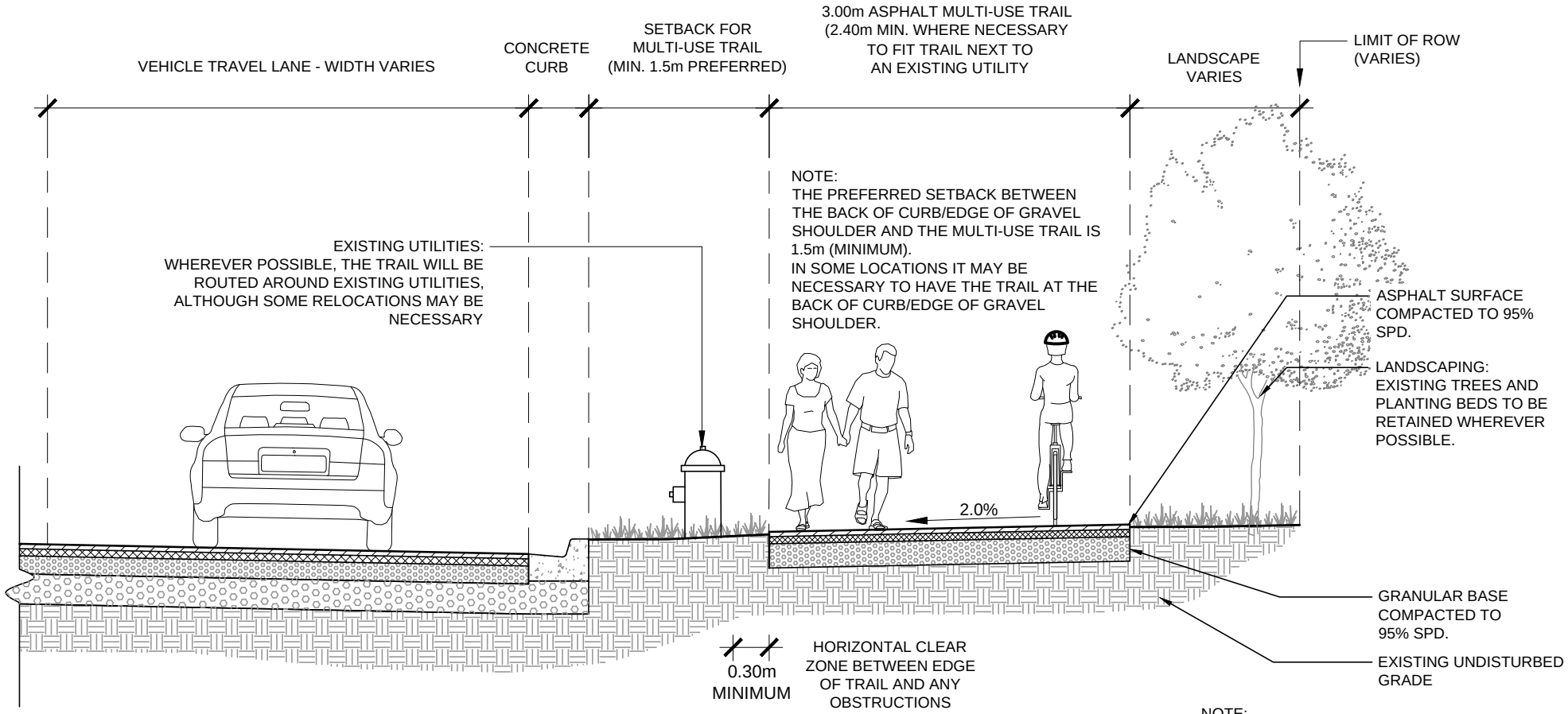
Route Marker & Trail Directional Sign Examples from left to right: Essex, Essex Region Conservation Authority; Guelph/Eramosa: Kissing Bridge Trail, MMM Group; Halton Hills, MMM Group; Confederation Trail, MMM Group.

i Transportation Tomorrow Survey, Source: datamanagementgroup – Department of Civil Engineering – University of Toronto. Hamilton Cycling Master Plan, 1996.

ii Canada. Canadian Social Research Links. Social Development Canada. Web. Spring 2010. <http://www.canadiansocialresearch.net/index.htm>.

iii Canada. Province of Ontario. Ministry of Community and Social Services. Accessibility for Ontarians with Disabilities Act. By Ministry of Community and Social Services. 2005. Web. Spring 2010. <http://www.mcss.gov.on.ca/en/mcss/programs/accessibility/OntarioAccessibilityLaws/2005/index.aspx>.

iv Accessibility News. Trails for All Ontarians Collaborative (TAOC), 2006. Web. Spring 2010. <http://www.accessibilitynews.ca/cwdo/resources/resources.php?resources=72>.



NOTE:
EXISTING VEGETATION IS TO BE MAINTAINED TO PROVIDE A VERTICAL CLEAR ZONE OF AT LEAST 2.5m FROM THE MULTI-USE TRAIL SURFACE TO THE LOWEST BRANCHES / LEAVES AND A HORIZONTAL CLEAR ZONE OF AT LEAST 0.3m FROM THE EDGE OF THE MULTI-USE TRAIL.

TRAIL TYPES - MULTI-USE TRAIL WITHIN A ROAD RIGHT-OF-WAY

SCALE = 1:50

3.0m WIDE ASPHALT BOULEVARD MULTI-USE TRAIL

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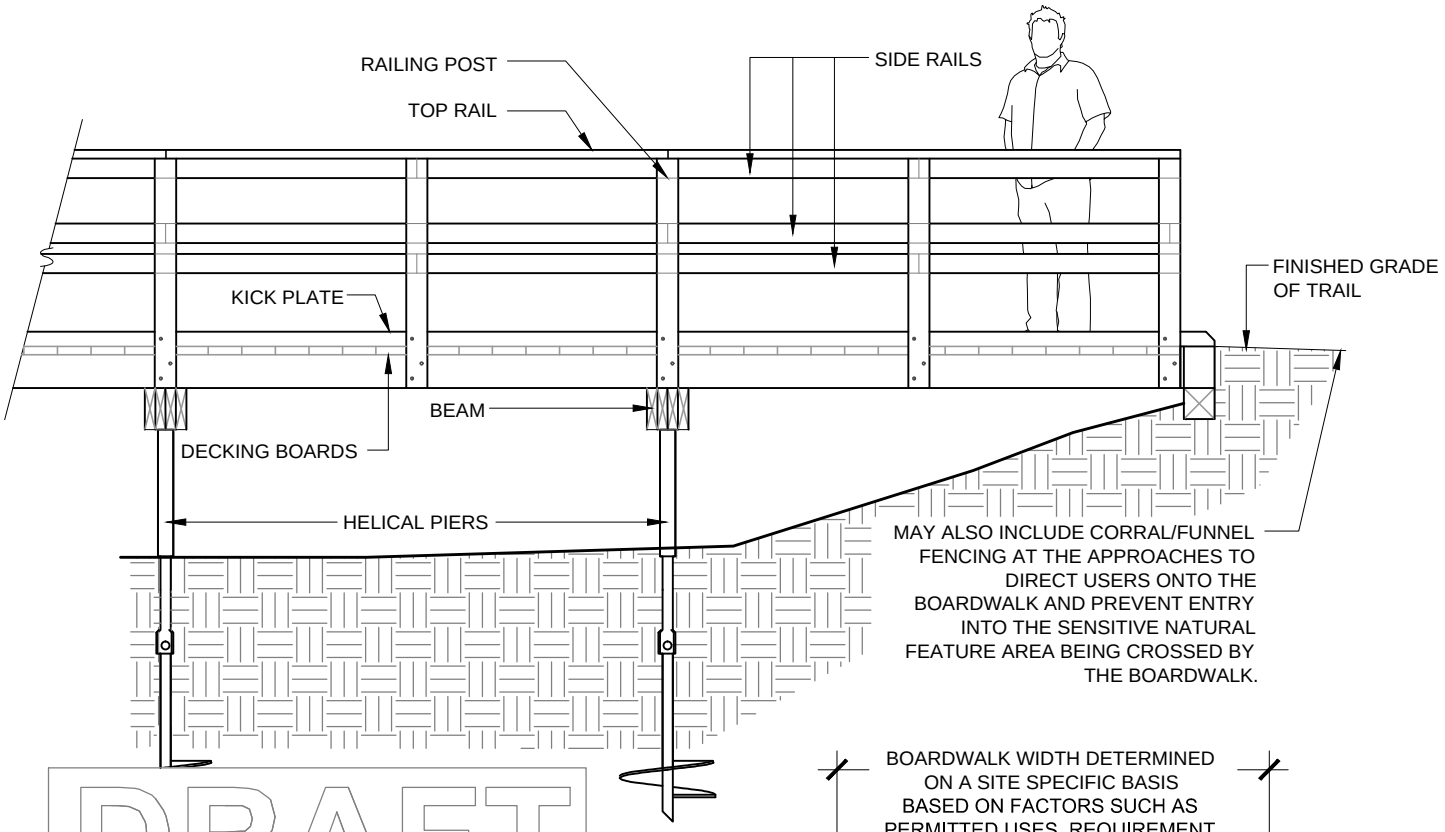

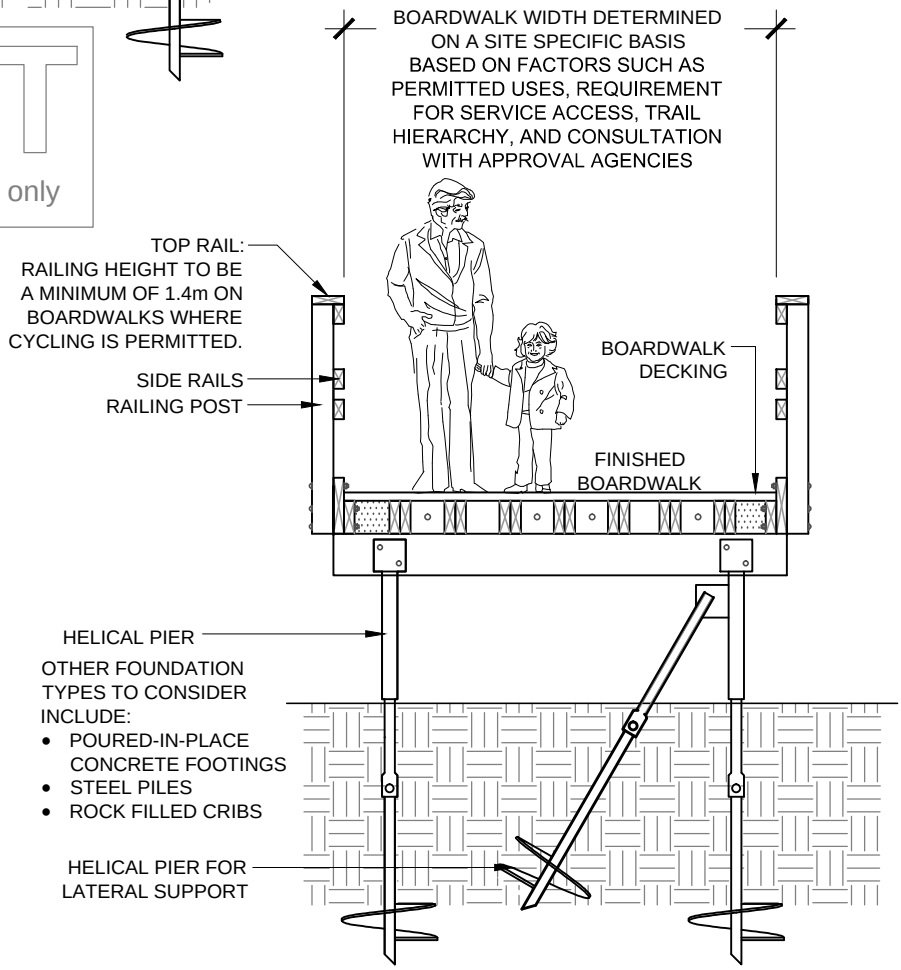

NOTE:

- THIS DETAIL CAN BE USED IN SEASONALLY WET AREAS AND LOCATIONS WITH PERMANENT STANDING WATER. IT CAN ALSO BE USED IN UPLAND SETTINGS (E.G. HUMMOCKY SENSITIVE WOODLOTS, AREAS WITH FRAGILE, SHALLOW SOILS OVER BEDROCK ETC.) WHERE IT IS DESIRABLE TO HAVE THE TRAIL RAISED ABOVE THE SURROUNDING GRADE AS ONE STRATEGY TO KEEP USERS ON THE TRAIL AND CONTROL USER IMPACTS.
- HEIGHT ABOVE GRADE SHOULD BE DETERMINED BASED ON CONSIDERATION OF FACTORS SUCH AS WATER LEVELS (WHERE APPLICABLE), TOPOGRAPHY, INCLUDING ELEVATION AND SLOPE OF THE SURROUNDING LAND AT THE TRAIL APPROACHES, WILDLIFE MOVEMENT NEEDS, ETC.. ADDITIONAL STUDIES MAY BE REQUIRED TO UNDERSTAND HOW THESE AND OTHER FACTORS INFLUENCE THE DESIGN.
- BOARDWALK HEIGHT SHOULD BE CONSIDERED WHEN DESIGNING SHOULD A RAILING NOT BE DESIRED.
- DEPENDING ON THE LOCATION, A SEDIMENT CONTROL BARRIER MAY BE REQUIRED TO DEFINE LIMITS OF WORK AND PREVENT MIGRATION OF MATERIALS INTO SURROUNDING AREA.
- REVIEW AND CERTIFICATION BY A STRUCTURAL ENGINEER IS RECOMMENDED TO DETERMINE LOAD AND STRUCTURAL DESIGN REQUIREMENTS. THIS NEED MAY BE DETERMINED ON A CASE BY CASE BASIS.

TRAIL TYPES - OUTSIDE OF ROAD RIGHT-OF-WAY

SCALE = 1:40

HEAVY-DUTY BOARDWALK

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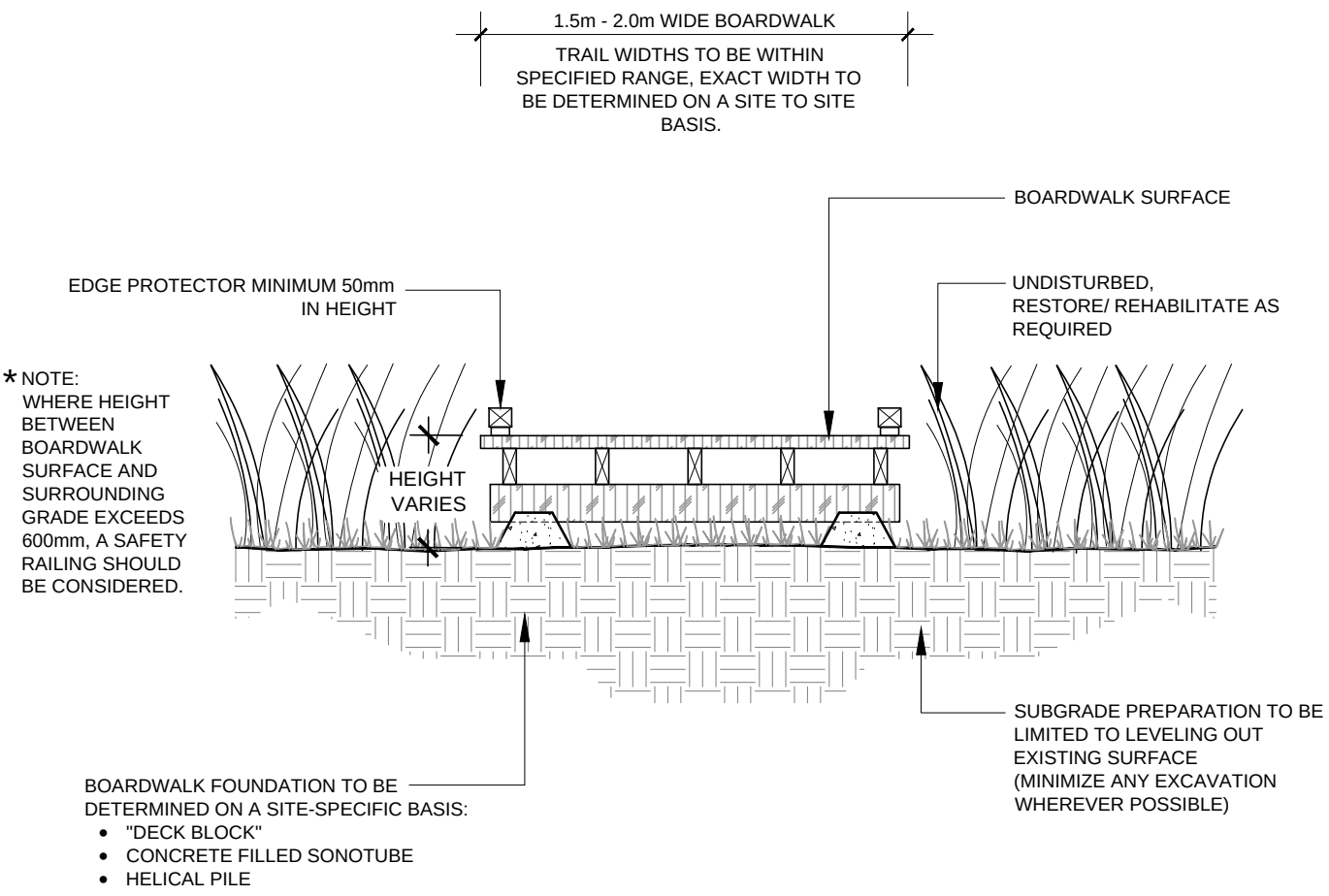

NOTE:

- BOARDWALK HEIGHT SHOULD BE CONSIDERED WHEN DESIGNING SHOULD A RAILING NOT BE DESIRED.
- DEPENDING ON THE LOCATION, A SEDIMENT CONTROL BARRIER MAY BE REQUIRED TO DEFINE LIMITS OF WORK AND PREVENT MIGRATION OF MATERIALS INTO SURROUNDING AREA.

TRAIL TYPES - OUTSIDE OF ROAD RIGHT-OF-WAY | SCALE = 1:40

LOW PROFILE BOARDWALK

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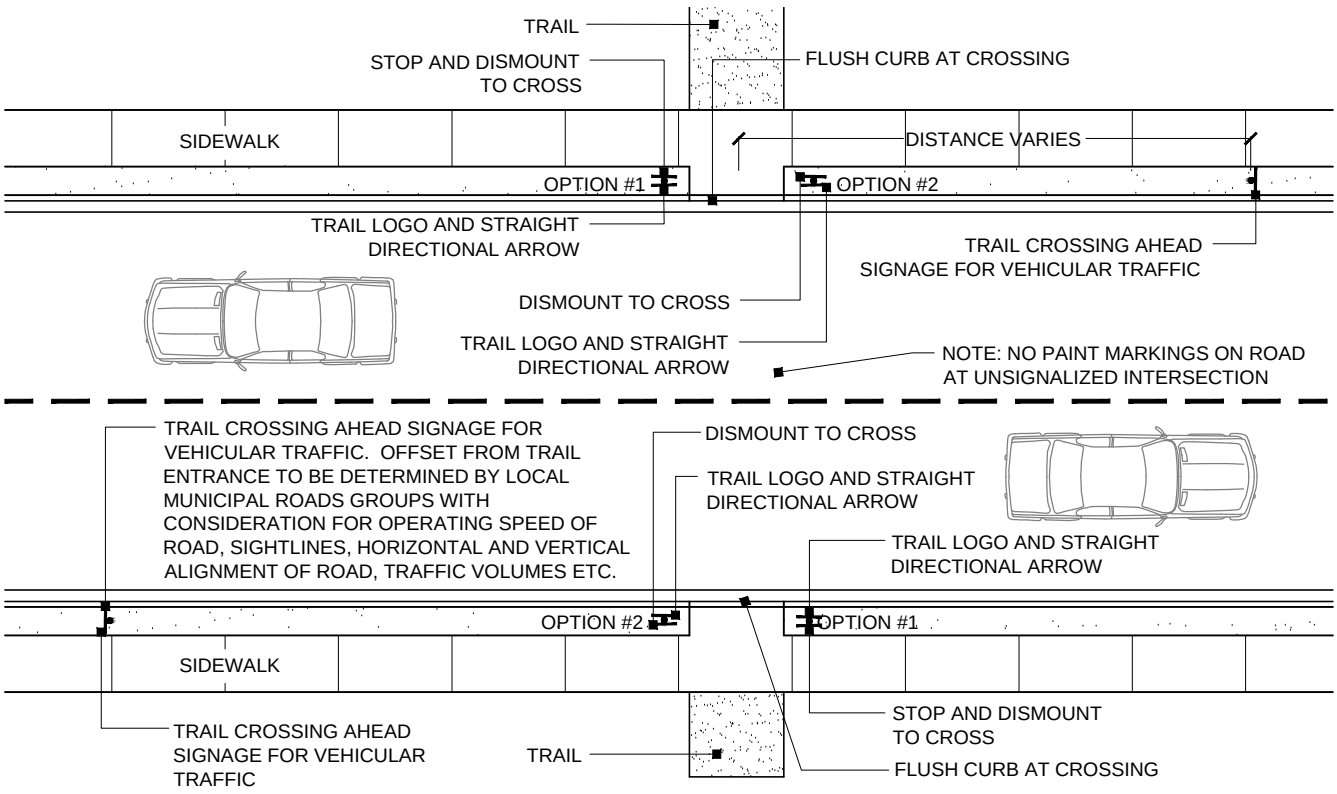
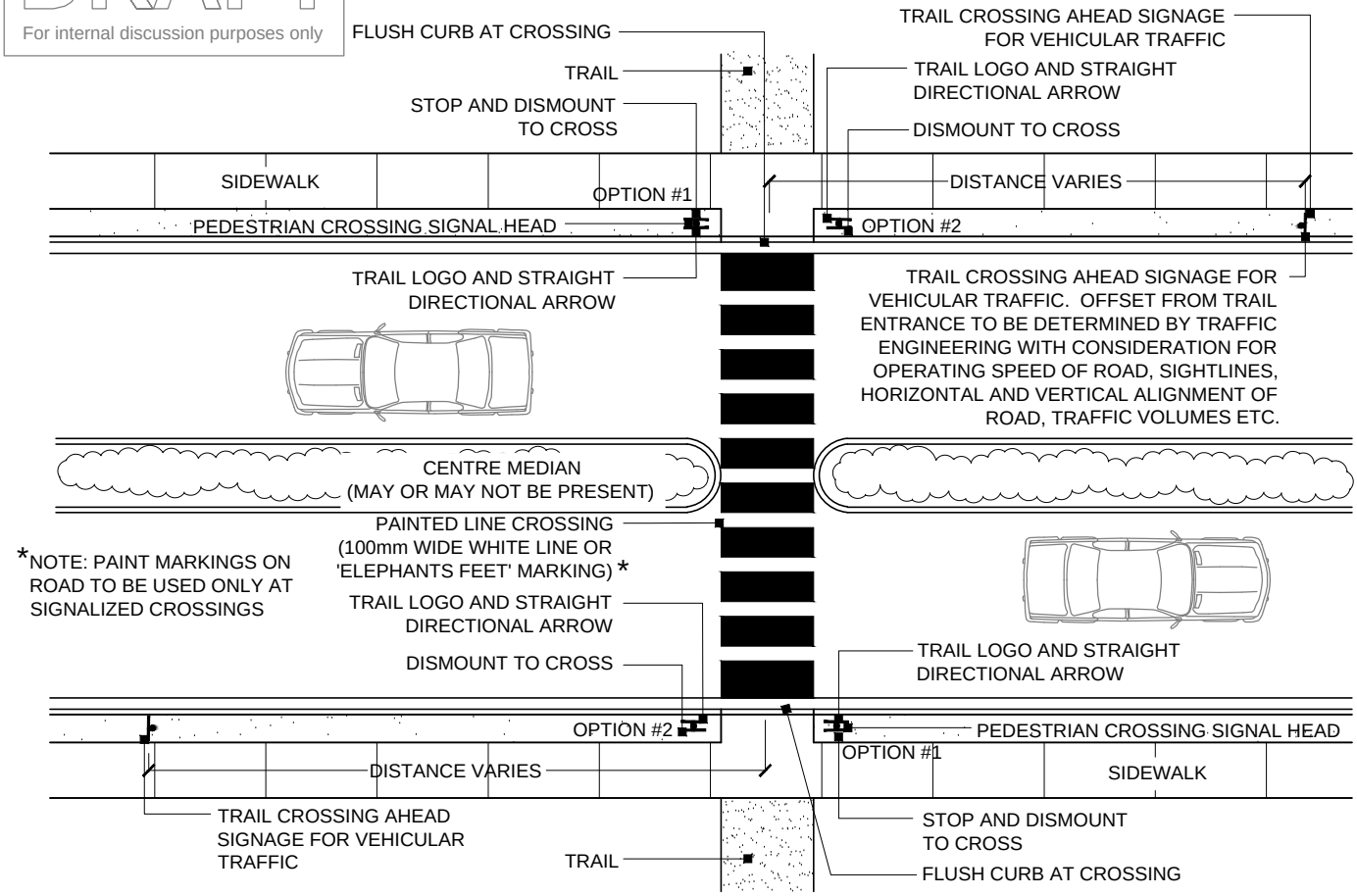


UNSIGNALIZED MID-BLOCK CROSSING

DRAFT
For internal discussion purposes only



SIGNALIZED MID-BLOCK CROSSING

ROAD CROSSINGS

SCALE = NTS

SIGNALIZED AND UNSIGNALIZED MID-BLOCK CROSSING

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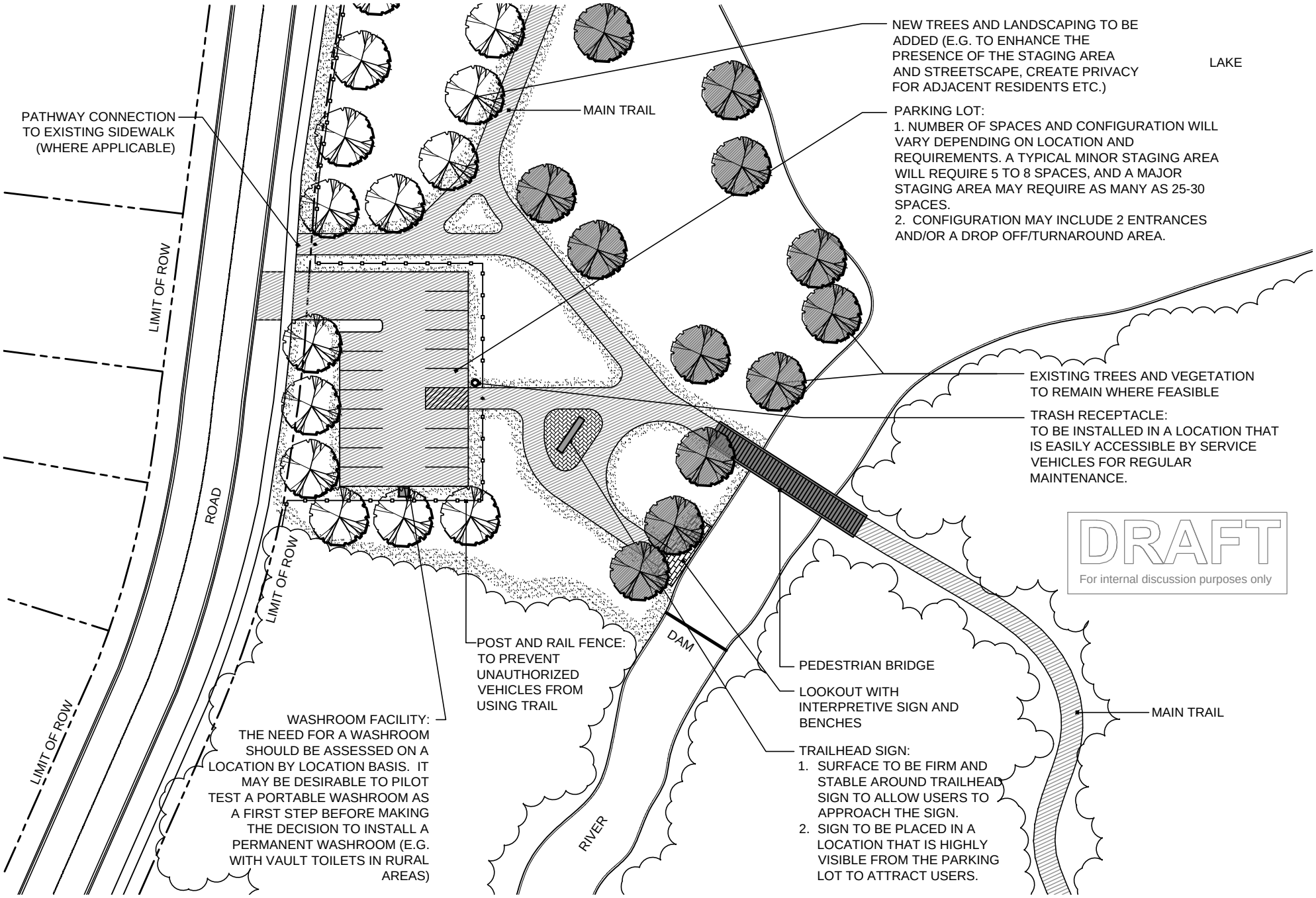

TRAIL ACCESS

SCALE = NTS

TYPICAL MAJOR STAGING AREA

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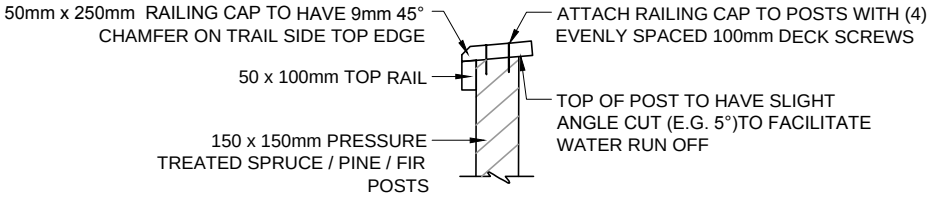
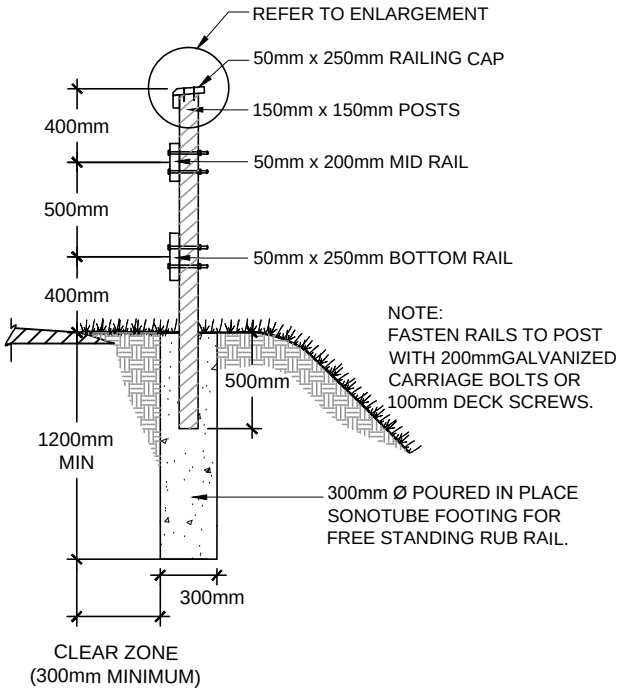
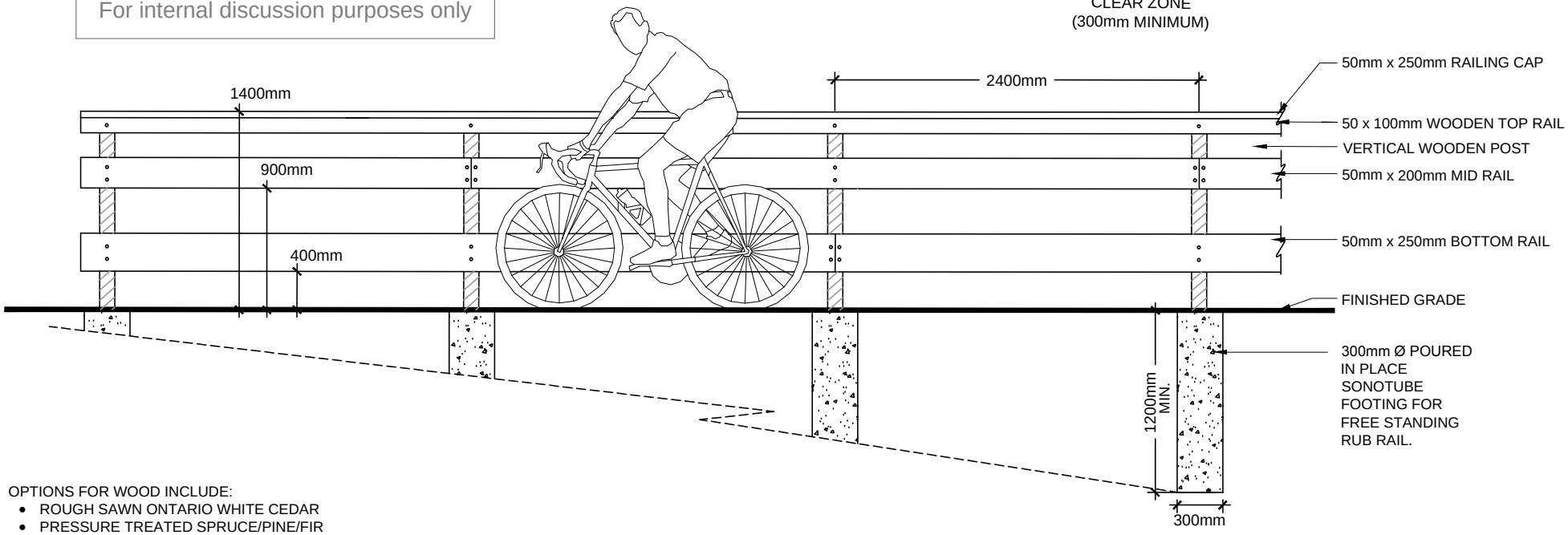


ENLARGEMENT





OPTIONS FOR WOOD INCLUDE:

- ROUGH SAWN ONTARIO WHITE CEDAR
- PRESSURE TREATED SPRUCE/PINE/FIR

TRAIL TYPES

SCALE = 1:40

1.4m HIGH CYCLIST RUB RAIL

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