C.

TRAIL DESIGNER'S TOOLBOX

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C.1 INTRODUCTION

The guidelines prepared for the Oxford County Trails Master Plan should be treated as a reference for the development and construction of the trail network including primarily off-road trail connections as well as some key on-road linkages. Although they are meant to provide guidance for the range of conditions typically encountered in a municipal-wide network, they are not intended to address every condition encountered. As a guidance document this appendix is not meant to be prescriptive nor is it intended that these 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.

When using these guidelines it may also be appropriate to consult additional guidelines on a case-by-case basis. Other useful references include but are not limited to:

- The County of Oxford Transportation Master Plan Study– Section 5.0 – Cycling
- Ontario Traffic Manual (OTM) Book 18 (Cycling Facilities)
- OTM Book 15 (Pedestrians)
- Transportation Association of Canada Bikeway Traffic Control Guidelines
- Accessibility for Ontarians with Disabilities Act, 2005, Amending O. Reg. 191/11. Part IV.1 Design of Public Spaces Standards (Accessibility Standards for the Built Environment)

C.2 HOW TO USE THE DESIGN GUIDELINES

C.2.1 THE PURPOSE

The purpose of these guidelines is to assist County and local municipal staff in making informed decisions about off-road trail and on-road cycling facility design.

C.2.2 HOW TO USE THE GUIDELINES

The guidelines provide general information on a range of trail user groups including but not limited to cyclists, pedestrians, cross county skiers, equestrians, etc. Where appropriate, summary tables are provided which highlight recommended design treatments and / or considerations when addressing key features associated with various on and off-road trail and cycling facilities proposed in the Oxford County Trails Master Plan. The information included in these guidelines is thought to represent currently accepted design practices in North America, and incorporates ongoing research and experience by the consulting team and other professionals involved with trail and cycling facility design.

Guidelines:

C-1: Adopt the trail design guidelines presented in Appendix C of the Oxford County Trails Master Plan as the basis for the design of trails County-wide.

C-2: County staff should distribute the trail design guidelines to trail designers and builders e.g. the Oxford Trails Council and conservation authorities to encourage consistent trail design and implementation County-wide.

C-3: County staff should supplement the Master Plan design guidelines with additional resources including but not limited to the Ontario Traffic Manual (OTM) Books 18 and 15 and other best practices as they emerge.

C.3 CONSIDERATIONS WHEN DESIGNING TRAILS

Many elements of trail design need to be considered when a trail is being developed, and the elements vary depending on location. Some of these include:

- New construction versus upgrading existing trails;
- Trail location;
- Context (urban, rural or suburban);
- Level of separation (on vs. off-road);
- Width;
- Surface type;
- User groups;
- Level of use;
- Seasonal versus year round use;
- Gradient;
- Accessibility;
- Degree of difficulty;
- Length;
- Ownership;
- Sustainability and ability to maintain;
- Access points;
- Transition points / linkages;
- Context sensitive conditions;
- Road crossings; and
- Signage.

Trans Canada Trail in Tillsonburg, ON
Source: MMM Group

C.3.1 TYPES OF USERS

Trail users vary in age and level of physical ability. They have their own sense of what the trail experience should be, which in part depends on the use they are interested in or what user group they consider themselves to be a part of. A "one size fits all" design approach does not apply to trails and it is important to try and match the trail type and design with the type of experience that is desired, while at the same time achieving a predictable and recognizable quality and consistency in the design. This will enhance the experience, enjoyment and safety for a range of trail users and add value to the communities the trail network travels through.

It is always important to consider the characteristics and preferences of potential user groups. In Oxford County the user groups that have been considered and are expected to be the primary users of the trail system are pedestrians and cyclists. However, other groups such as cross county skiers, snowshoers and equestrians have also been considered and are expected to be seasonal users of the system.

It is acknowledged that other user groups such as Equestrians, All-Terrain Vehicle (ATV) operators and snowmobilers currently own, operate, maintain and use some of the trails found throughout the County. Motorized trail users have not been considered within the Oxford County Trails Master Plan, though there may be some cases where trails intended for non-motorized users overlap with existing trails intended for motorized recreational users. Although the cases may be infrequent, adequate and proper signage related to safe interactions should be implemented. This is also the case for users that may surround the trail systems including the potential for in-season hunters.

The following is a brief description of the primary user groups, how they typically use the trails and design parameters which should be considered when proceeding with trail design.

Pedestrians

For the Oxford County Trails Master Plan "pedestrians" include walkers, hikers, joggers and runners. **Table C.1** provides additional design considerations for the anticipated pedestrian user groups.

Ninety-five percent of all pedestrian trips are less than 2.5km in length, though it is reasonable to expect that some walkers whose trips are motivated by exercise / health / fitness might make trips that are between 5 and 10km in length.

Table C.1 - Pedestrian User Groups

Walkers	
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 is typically community-focused and engage in trips focusing on shopping and errands and walking to work and school. • Utilitarian Walkers are typically found within more urban areas and tend to 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. • Where no sidewalks are provided and there are no shoulders (in urban and/or rural areas), pedestrians should walk on the edge of the roadway facing oncoming traffic consistent with the Ontario Highway Traffic Act. Signs warning motorists of pedestrians ahead are recommended in high use locations.
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. • Trail planners should assume that there may be hikers 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.

Cyclists

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 very well compacted granular surfaces or hard surface pavements such as asphalt.

Points to consider when designing for cyclists:

- 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.
- Cyclists have the right to access the public roadway system, with the exception of the 400 series and major provincial highways or where prohibited by law.
- Some cyclists feel unsafe sharing the road with automobiles and do not have the desire or skill level to ride in traffic.
- Some cyclists tend to prefer off-road trails, shared with pedestrians as 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 even if the pavement quality is lower than on busier roads.

The average travel speed for a cyclist on a trail is in the range of 15-20 km/h and 18-30+ km/h on a road, with speeds in excess of 50 km/h. 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 aggressive behaviour.

Cyclists other than young children should be discouraged from cycling on sidewalks because of potential conflicts with pedestrians and potentially dangerous intersections with intersecting public road, private driveways and entrances. Many municipalities have prohibited sidewalk cycling through local by-law, however, many municipalities permit sidewalks cycling for children learning to ride.

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.

Cycling on Off-road Trails
Source:
blog.hembrowcyclingholidays.com

Equestrians

Trail riding on horseback is most desirable in quiet, natural settings, however there are occasions when equestrian users require access to public roads, trails and road rights-of-way.

According to the Ontario Highway Traffic Act, equestrians are permitted on provincial roads, although many municipalities place restrictions on equestrians in urban areas. Safety is a significant consideration when horses must mix with motorized vehicles and other trail users. Trail width should include a minimum shy distance of 0.6m, to allow for uneasy horses to move to one side of the trail, and pull-out sections should be regularly located to allow for passing of other equestrians or other trail users. The trail edge and passing areas should be free of protruding or sharp objects, wires, etc. as these can frighten horses and hinder horse and rider safety. Visual barriers such as vegetation or solid fences are recommended where trails are adjacent to roadways or areas of high activity, such as sports fields where sudden movements may alarm the horse. At road crossings, increased visibility and open sight lines are necessary so that both equestrians and oncoming motorists have a clear view of each other, and equestrians can decide when it is appropriate to cross.

When designing a trail to accommodate equestrians, a gravel surface is typically preferred over an asphalt surface, and a route that is at a minimum 5km in length is advised. Where possible, routes of 20km or greater are encouraged for long-distance riding. At staging areas trailer parking, loading areas and hitching posts should be provided to facilitate loading/unloading and gearing up.

Where bollards are used to limit trail access, it should be noted that mounted riders generally cannot pass through bollards spaced less than 1.5m apart, unless they are under 0.9m in height. Note however that the 1.5m wide opening also allows the passage of many ATV and some snowmobile models. In areas where ATV use is to be restricted, but equestrian use permitted, a "step-over" gate design should be considered.

For the purposes of the Oxford County Trails Master Plan, equestrians will be permitted on some of the County-wide trails to provide connections between major communities and to privately owned equestrian trails. The provision of recreational trails with varied terrain will generally be the responsibility of private equestrian clubs and landowners, working independently or in collaboration with Oxford County, local municipalities and the Oxford County Trails Council.

All-Terrain Vehicles (ATVs)

Rapidly expanding recreational ATV use in Ontario has created an increased demand for trails, primarily in rural and urban edge areas. While many ATV clubs develop and maintain their trail networks on privately owned land through private landowner agreements there are occasions when access to public trails and road rights-of-way is desired, potentially bringing ATV users into conflict with other trail users.

Safety of all trail users is of particular concern, as ATVs can reach high speeds on straight and flat trail sections. Nevertheless, with proper design to reduce ATV travel speeds, clear signage restricting ATV use of predominantly pedestrian and cycling trails, and adequate enforcement of trail regulations, it is possible for non-motorized and motorized trail users to coexist.

ATV use will generally be restricted on the County's on and off-road trail linkages. The provision of other recreational ATV trails will be the responsibility of privately owned and operated ATV organizations which follow the Ontario Federation of Snowmobile Club's management model.

Speed limits should be posted along all trails where ATV use is permitted (the County's existing Gold Trails). 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. At 40km/h, an ATV rider has a sight stopping distance of approximately 34m, thus all potential hazards, including trail intersections, should be signed at least 45m in advance. Slower speeds can be encouraged by including curves, grade changes and trail narrowing, although these design features should be accompanied by signage indicating that the ATV rider should reduce speed.

In these shared use trail locations the trail surface should be hard and smooth, with no rocks or roots protruding more than 7.5cm, no depressions larger than 0.6m wide or 15cm deep, and trail clear width should be a minimum of 0.6m beyond the edge of the trail bed. To allow safe passing of other trail users, pull-out sections of at least 8m in length should be added at regular intervals along the trail.

ATV and Snowmobile Use of Trails
Source: gunflint-trail.com

An additional characteristic of ATVs to consider when designing shared trails is weight of the vehicle. The combined weight of an ATV and rider can exceed 350kg, which has the potential to result in significant wear on the trail bed and surface. In abandoned rail corridors where the rail bed is in place, the trail bed can be assumed to be capable of supporting the weight of an ATV, however trail surfaces should be sufficiently stabilized to resist deformation and erosion, and they should be inspected and maintained regularly to repair potholes and ruts that may result from ATV use. Similar design guidelines should be applied to snowmobile use in winter, on trails where ATV use is permitted.

Hunting should not be permitted on trails or from trails, although hunters may be using parts of the trail system to access hunting areas at certain times of the year. It should also be noted that hunting may be permitted at certain times of the year in some County forests where trails are also located. Where hunters are using trails to access hunting areas, firearms must not be loaded. Trailhead signage should clearly communicate hunting prohibitions / seasonal permissions and advise trail users that hunters may be present on lands surrounding some trails at certain times of the year. Rules related to hunting must be strictly enforced to ensure safety for all users.

C.3.2 GENERAL DESIGN PARAMETRES

Cyclists require a certain amount of space to maintain stability when operating a bicycle. **Figure C.1** illustrates the typical Cyclist Operating Space. Generally an operating width of 1.2m to 1.5m is sufficient to accommodate forward movement by most cyclists, however there can be considerable difference in the physical dimensions and operating space requirements depending a cyclist's age and skill level. Cyclists do not travel in a straight line and manoeuvring space is needed to allow for side-to-side movements during operation.

The 1.2m to 1.5m operating 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. The operating height of 2.5 metres can generally accommodate an average adult cyclist standing upright on the pedals of a bicycle.

Careful consideration should be given to the physical, aesthetic and environmental requirements for each multi-use 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.

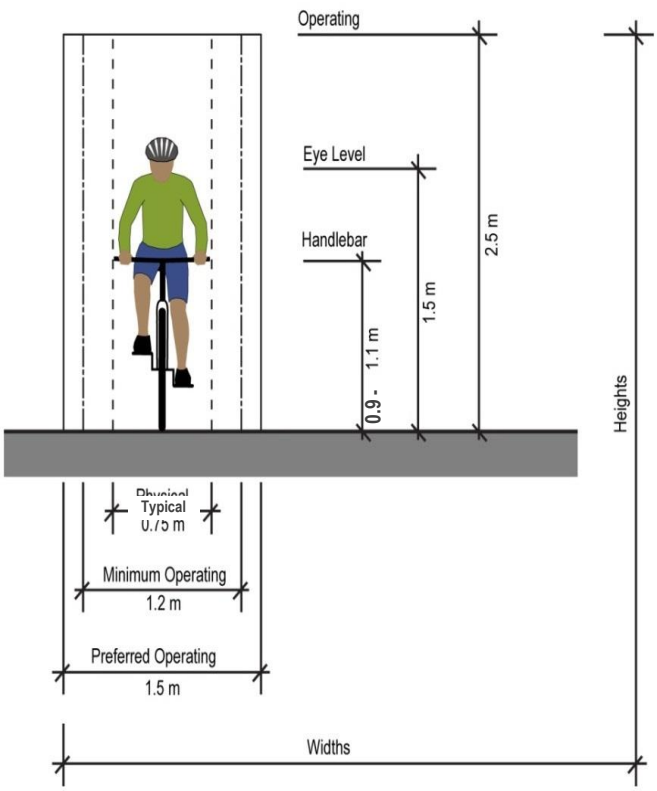


Figure C.1 – Typical Cyclist Operating Space
Source: Based on information from the AASHTO Guide for the Planning, Design and Operation of Bicycle Facilities, 2012

Therefore, many of the physical design criteria outlined in the following sections are recommended for to cycling. This is not to say that all multi-use trails need to be designed to meet the requirements for cyclists; however, when multi-use trails are being designed it is prudent to use design 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 C.2** outlines minimum and preferred operating space for different uses.

Table C.2 – Minimum and Preferred Operating Space

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
One way travel (one equestrian)	1.7-2.4	4.3-5.5
Two way travel (two cyclists)	3.0	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 C.3** provides minimum and preferred horizontal and vertical clear distance.

Table C.3 – Horizontal and Vertical Clear Distance

Clearance Condition	Minimum (metres)	Preferred (metres)
Horizontal clearance to stationary objects	0.3	1.0
Vertical clearance to stationary objects	2.5	3.0

Slope refers to both the measured fall over a given distance along the centerline (referred to as longitudinal slope) and perpendicular to the centerline (referred to as 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 C.4** provides guidance regarding longitudinal and cross slope.

Table C.4 – Longitudinal and Cross Slope

Longitudinal Grade or Slope	
0% to 3%	• Preferred
5%-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 when slopes approach 10% • 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: 10:1 (horizontal distance or run: vertical distance or rise), or 10% is the maximum permissible slope for meeting accessibility standards. Level landings or rest areas are required at regular intervals.
10% to 15%	• Consider the use of structures such as steps, step and ramp combinations, or stairways • Consider locating the trail elsewhere
15% or over	• 15% represents the maximum possible longitudinal slope for a sustainable trail surface. Where slopes approach or exceed 15% significant washouts become an 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 5%	• 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 cyclist 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 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 trails. 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 C.5** for suggested centerline radii for a range of design speeds and super elevation rates.

Table C.5 – Suggested Pathways and Trail Radii Based on Travel Speeds

Design Speed (km / h)	Suggested Radius (m) where super elevation = 0.02 m/m	Suggested Radius (m) where super elevation = 0.05 m / 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 C.6** 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 C.6 – Additional Trail Widening on the Outside of the 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 distances for off-road multi-use trails are typically governed by the distance required for cyclists since pedestrians and other trail users can typically stop more quickly than cyclists, regardless of the trail configuration.

Guideline(s):

C-4: The County, local municipalities and representatives from the Oxford Trails Council should refer to the minimum and preferred trail user operating space widths identified in **Table C.2** when developing or reviewing multi-use trail design concepts.

C-5: The County, local municipalities and representatives from the Oxford Trails Council should refer to the minimum and preferred horizontal and vertical clear distance identified in **Table C.3** when developing or reviewing multi-use trail design concepts.

C-6: The County, local municipalities and representatives from the Oxford Trails Council should refer to the longitudinal and cross slope guidelines identified in **Table C.4** when developing or reviewing multi-use trail design concepts.

C-7: County, local municipalities and representatives from the Oxford Trails Council should consider the suggested trail curve radii and additional trail widening dimensions identified in **Table C.5** when developing and reviewing multi-use trail design concepts.

C.3.3 TYPES OF USER TRIPS

Trail users can also be defined by their trip purpose and intent. Trip purpose can be divided into the following three (3) categories – utilitarian, recreational and touring. Additional details regarding each of these groups are presented in **Table C.7**.

Table C.7 - Trail User 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. • Utilitarian trail users often use the on and off-road linkages that make up the trails network year-round in all weather conditions as opposed to those roads which do not make up part of the designated 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. • 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 off-road or secondary connections as part of the overall network.
Touring	
Definition:	• These pedestrians, cyclists and other seasonal trail users use trails as a means of exploring areas of significance long-distances from their point of origin. • 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.

C.3.4 ACCESSIBILITY

Approximately one in eight Canadians suffer from some type of physical disability. Mobility, agility, and pain-related disabilities are by far the most common types, each accounting for approximately 10% of reported disabilities nationally. 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.

Accessible Trail User – Source: anythingispossibletravel.com

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." 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. The guidelines and criteria set out in these documents apply to the development of recreational trail and sidewalk facilities, and are not mandatory for the design of on-road cycling facilities.

AODA criteria which are to be considered include: operational experience, width, longitudinal / running slope, cross slope, total slope, surface, changes in level and signage.

When designing and implementing cycling facilities, the County and local municipalities should refer to the guidelines outlined in the Built Environment Standards to ensure that the needs of all user groups are accommodated and to 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 Accessibility Standards for the Built Environment provide the technical requirements for recreational trails: These include:

- Minimum clear width 1.0m
- Minimum head room clearance of 2.1m above trail
- Surfaces are to be firm, stable with minimal glare
- Maximum running/longitudinal slope of 10%
- Maximum cross slope of 2%
- High tonal or textural changes to distinguish the edge
- 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 communicate which trails 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 possible 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) provides an in depth discussion of the application of Universal Design principles and their application.

Where possible and practical trails 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 accessibility requirements. Steep slopes are one of the most significant barriers for those with physical disabilities. Designing trails to be below the threshold (5% longitudinal slope) 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 use the most current standards;
- Where the trail requires an accessibility solution that is above and beyond what is normally encountered, 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 accessibility is feasible, the accessibility representative should be consulted during the detailed design process to ensure that the design is appropriate; and
- 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.

Guideline(s):

C-8: Every effort should be made to ensure that primary trails meet or exceed minimum accessibility requirements. Secondary multi-use trails will be designed to meet minimum accessibility requirements where feasible and practical.

C-9: Signage and maps should be designed to communicate which pathways and trails meet minimum accessibility requirements so that users can make their own decisions in advance about using the route.

C.3.5 PERSONAL SECURITY

To the extent that it is possible trail 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, 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 **Table C.8**.

Some specific trail design strategies that other jurisdictions have employed include:

- Providing good visibility for other by having routes pass through well-used public spaces.
- Providing the ability to find and obtain help using signage that tells users where they are along the trail system.
- Providing signs near entrances to isolated areas to inform users and suggest alternative routes.
- Providing escape routes from isolated areas at regular intervals.
- Maintaining sight lines and sight distances that are appropriately open to allow good visibility by users.
- Providing trailhead parking in highlight visible areas.
- Minimizing routes close to features that create hiding places such as breaks in building facades, stairwells, dense shrubs and fences.
- Designing underpasses and bridges so that users can see the end of the feature as well as the areas beyond.

Table C.8 – Guiding Principles of CPTED for trail Design

Natural Access Control	
Deters access to a target and creates a perception of risk to the offender.	 Credit: CPTED Ontario www.cptedontario.ca
Natural Surveillance	
The placement of physical features and / or activities and people that maximizes natural visibility or observation.	 Credit: CPTED Ontario www.cptedontario.ca

Table C.8 – Guiding Principles of CPTED for trail Design

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.	 Credit: CPTED Ontario www.cptedontario.ca
Maintenance	
Allows for the continued use of space for its intended purpose.	 Credit: Friends of King Gap www.friendsofkingsgap.org

Guideline(s):

C-10: When implementing the trails network, the underlying principles of CPTED should be considered including natural access control, natural surveillance, territorial reinforcement and maintenance.

C-11: Properly located entrances, exists, fencing, landscaping and lighting should direct both foot and automobile traffic in ways that discourage crime.

C.3.6 URBAN, SUBURBAN AND RURAL AREAS

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 will generally have a higher order and density of infrastructure than rural systems due to the higher density of users.

The application of bike lanes, paved shoulders, signed routes, multi-use trails in the road right-of-way should be considered for those routes found in the County's and local municipal urban and suburban areas. Routes in rural areas may include paved shoulders, fewer designated routes, some linear off-road trails (e.g. trails within abandoned railway or utility corridors), and destination trails at conservation areas.

C.4 TRAIL DESIGN ALTERNATIVES

The trail network for Oxford County is divided into three main categories: on-road facilities, multi-use trails within active road ROW and multi-use trails outside of active road ROWs. **Table C.9** provides a general description of each

Table C.9 – General Design Categories

Multi-use Trail within an Active Road Right-of-way
Multi-use trails within active road rights-of-way (also referred to as a boulevard multi-use trail or Active Transportation Pathway) is a type of on-road facility that is within the roadway right-of-way but is physically separated from motor vehicle traffic where possible by a buffer.

Table C.9 – General Design Categories

Multi-use Trail outside of an Active Road Right-of-Way
These include trails of varying width, alignment and surface type that are located through conservation areas, public open spaces, valleys and parklands, as well as linear corridors such as abandoned railway lines, unopened road allowances and utility corridors.

On-Road Linkages
"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.

C.4.1 OFF-ROAD ROUTES

There are a range of off-road trail types which could be considered for implementation as part of the Oxford County Trails Network. The selection of the preferred design concept should be confirmed by County and local municipal staff based on a detailed assessment of existing characteristics and natural surroundings.

The design concepts and guidelines prepared for Oxford County are intended to be used by County staff as well as those responsible for the design and implementation of trail facilities throughout the County including but not limited to the applicable conservation authorities, representatives from the Oxford County Trails Council, local municipalities as well as private land owners. The following trail design concepts should be considered as the County moves forward with the implementation of the master plan as well as the design and development of trail facilities.

Each of the design concepts includes a description of its definition, the user groups that are accommodated on the trail, the types of materials which could be used to design the trails as well as some other design consideration.

Figures C.2 – C.24 illustrate the different trail design concepts that are proposed for consideration by Oxford County. Additional descriptions / details regarding some of the design concepts are provided later in the appendix.

C.4.2 ON-ROAD LINKAGES

One of the primary objectives of the County's Trails Master Plan is to develop a trail system that is off-road wherever possible. However, in some cases this will not be possible and on-road connections will need to be implemented. Typically, this is the case in the rural areas of the County where long distance connections will need to be made to link key off-road trail systems.

This may also be the case in urban and suburban areas in older residential neighbourhoods where public space is confined to road rights-of-way and centralized park lands.

Where public land (other than the road right-of-way) is not available and access agreement for trails on private lands are not feasible, it is necessary to provide connecting links using the road network. Where this is the case, pedestrians are expected to use the sidewalk network in urban areas and road shoulders in rural areas. Cyclists are expected to use on-road facilities of multi-use / active transportation pathways in place of a sidewalk.

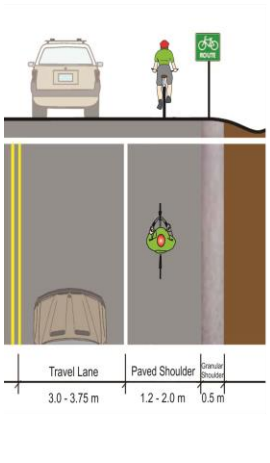
As mentioned above, for those on-road linkages found within the County's trails network, County and local municipal staff are encouraged to use the County's Transportation Master Plan – Cycling Component, OTM Book 18 and 15 as well as the TAC Bikeway Traffic Control Guidelines (2012) to evaluate and confirm the most appropriate cycling facility type.

OTM Book 18 sets out a facility selection process that can assist staff and those responsible for the design and implementation of on-road trail 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.

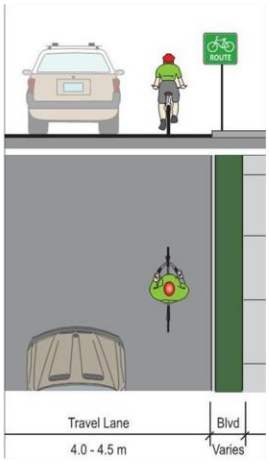
The selection tool does not tell designers when and when not to provide a certain facility type but rather sets out a process for selecting an appropriate facility type given the context and readily available data.

In Oxford County, a number of options exist for on-road cycling routes including but not limited to signed bicycle routes, edgelines, bike lanes and paved shoulders. In addition to the commonly encountered situations where standard design guidelines and treatments can be applied, there are other situations where the proper design requires a more context sensitive solution where more innovative techniques need to be employed by a design specialist who is well versed in emerging trends and best practices.

The graphics included on page C-25 illustrate some of the proposed on-road cycling facility types which are proposed for the County to consider and are consistent with the OTM Book 18 guidelines and standards.

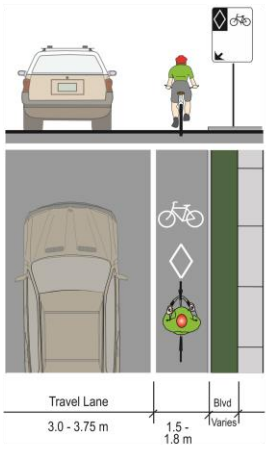


Signed Bike Route with Paved Shoulder

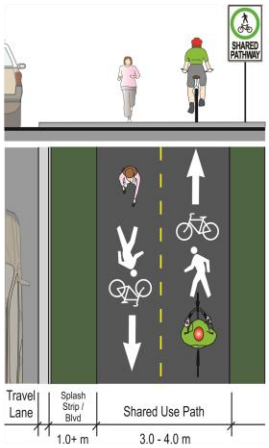


Signed Bike Route on Local Roadway

Signed Bike Route with Sharrow



Bike Lane



Multi-use Trail within the Road Right-of-Way

C.4.3 ROUTES CROSSING 400 SERIES HIGHWAYS AT INTERCHANGES

The integration of pedestrians and 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.

Trails as well as individual pedestrian and 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 Oxford County Highway 401 and 403 are considered key barriers to trail network connectivity. In order to ensure that the on and off-road system of trails and cycling facilities provides linkages to local municipalities and key community destinations, a number of interchanges have been selected which are proposed as on-road trail links.

It is important to note that should the County and / or local municipalities choose to retrofit any of their existing interchanges the following guidelines should be considered:

- For lower speed merging/diverging ramps (< 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 (> 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 County and local municipalities should refer to the interchange and ramp crossing design treatments outlined in the OTM Book 18 and TAC's Bikeway Traffic Control Guidelines (2012).

C.4.4 SURFACE TYPES & 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 users groups. **Table C.10** is a summary of the most commonly used trail surfacing materials along with some advantages and disadvantages for each. There is no 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.

Table C.10 – Comparison of Trail Surfacing Materials

Type	Advantage	Disadvantage
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	• 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.

Table C.10 – Comparison of Trail Surfacing Materials

Type	Advantage	Disadvantage
Asphalt	• Smooth surface, moulds well to surrounding grades, and is easily negotiated by a wide range of trail user groups. Relatively easy to install by skilled trades. • Patterned and coloured surface treatments are available, however patterning in surface may be difficult for some user groups to negotiate, and may not satisfy AODA requirements. • 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.
Granulars (for bases only)	• 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)	• Not appropriate for trail surfacing
	• '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
	• '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

Table C.10 – Comparison of Trail Surfacing Materials

Type	Advantage	Disadvantage
	• Stone dust (Screenings): Mixture of fine particles and small diameter crushed stone. Levels and compacts very well and creates a smooth surface that most trail users can negotiate easily. Easy to spread and regrade where surface deformities develop. Inexpensive and easy to work with. Widely used and accepted as the surface of choice for most granular surfaced trails. • Crushed 3/8" Limestone material. This surfacing material has been used successfully by some municipalities where finer stone dust has washed out.	• 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.
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 softer surface, therefore this surface can be used to discourage some uses such as cycling. Generally does not meet AODA requirements • 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	• Using existing soil from the trail corridor. Only cost is labour to clear and grub out vegetation and regard 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). • May not meet AODA requirements.	• 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.

Table C.10 – Comparison of Trail Surfacing Materials

Type	Advantage	Disadvantage
Soil Cement and Soil Binding Agents	• Soil Cement = 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 = mix of granulars and polymers that create a solid, yet flexible surface that may be appropriate for "trail hardening" on slopes in natural areas. • May not meet AODA requirements • 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.

C.4.5 TRAIL LIGHTING

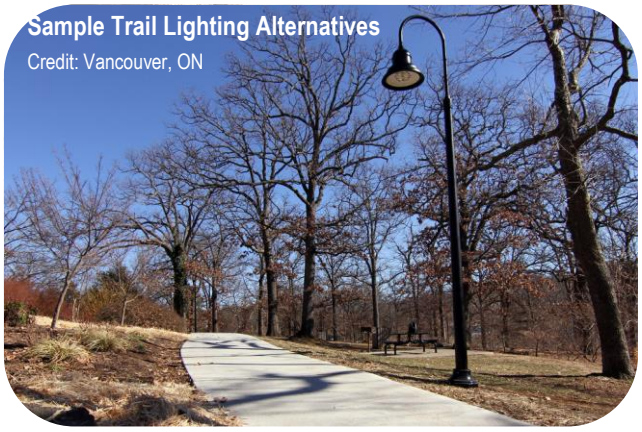
Lighting multi-use pathways must be carefully considered. Very few municipalities make the decision to light their entire trail system for a number of important reasons, including:

- 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 be designed to protect bulbs;
- Energy consumption, however, options for energy-efficiency 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 to one another.

Although generally not recommended there may be some locations along multi-use pathways where lighting may be appropriate. 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 major parks;
- 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.



Sample Trail Lighting Alternatives
Credit: Vancouver, ON

C.5 ADDITIONAL DESIGN CONSIDERATIONS

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

C.5.1 TRAIL CROSSINGS

C.5.1.1 Minor Roads

In the case of lower volume, and / or 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 as close to possible a perpendicular crossing of the roadway, 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 cross over 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.

Guideline(s):

C-12 Trail crossing of local minor roads at mid-block locations include advance advisory pedestrian crossing signs on the roadways approaches and a yield or stop sign on the trail approaches.

C.5.1.2 Crossing with Median Refuge Island

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 for 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 a width of at least 1.8 m wide, but 2.4 m is preferred to accommodate wheelchairs in a level landing 1.2 m wide plus 0.6 m wide detectable warning devices on each side. The 2.4 m width will also accommodate bicycles in the refuge;
- 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. Users with low vision or complete visual impairment can better detect the change in texture and contrast in colour supplemented by 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 are able to 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 (spearing of driver or pedestrian). Some pedestrians will walk in front of or behind the island to avoid the railings, a less safe refuge location than on the island.

There are a number of design alternatives which could be used to ensure the safe crossing of roadways by pedestrians and cyclists when on trails. One of the design alternatives that has recently emerged is a Cross-Ride. A cross-ride can be used by pedestrians and cyclists when crossing a roadway and provides a designated space for both users and helps to prevent possible conflict areas at crossings. Recently implemented in communities such as the City of Mississauga the Burlington, this innovative design features is now endorsed and promoted by OTM Book 18. In addition, there may be some instances where proposed trail crossings are identified in urban areas within the County of Oxford. In these instances, the County or its local municipality is encouraged to explore the design and implementation of an urban trail crossing.

C.5.1.3 Midblock Pedestrian Signals

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
- Crossing nearby.

The graphic above illustrates an application of a midblock pedestrian signal.

Guideline(s):

C-13: At-grade mid-block multi-use pathways crossings of collector and arterial roadways should be controlled by a pedestrian signal or pedestrian cross over where possible.

Mid-block Pedestrian Signal Without Median
Credit: MMM Group, 2012

C.5.1.4 Active Railways

Currently, in order to establish a pathway crossing of an active rail line, proponents must submit their request directly to the railway 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, then an application may be submitted to the Canadian Transportation Agency, who may mediate a resolution between the parties.

The graphic below illustrates an at-grade crossing of an active railway in Newmarket, ON and some design concepts and considerations which could be explored for a similar location.

At-Grade Trail Crossing of a low frequency Railway
Location: Newmarket, ON
Credit: MMM Group, 2012

C.5.1.5 Abandoned Rail Lines

In rural areas where abandoned rail corridors are being considered for multi-use trails, owners of farming operations who have property on both sides of the corridor and/or are using a portion of the corridor to gain access to their fields are sometimes apprehensive when plans are made for trails as they see this important access being restricted or discontinued.

Where site specific concerns are identified it is important for trail designers and managers work with the adjacent landowner(s) to develop a mutually beneficial solution.

Successful solutions have been developed elsewhere in Ontario and have included:

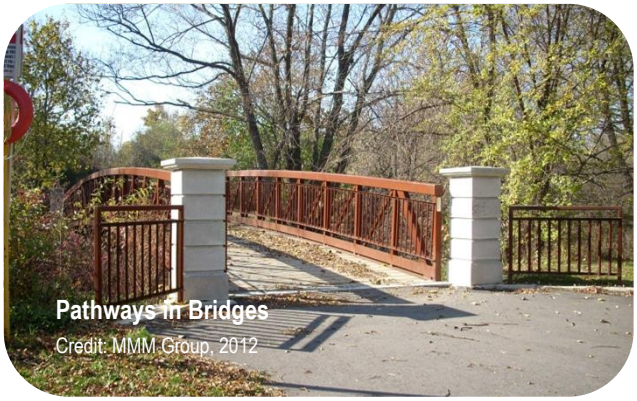
- Post and wire fencing along both sides of the corridor in the section of concern;
- Lockable wire or metal gates in locations that serve the landowner's needs, with a local that remains in the possession of the landowner;
- Access ramp(s) to reach the trail bed, which may already be in place and require only minor improvements such as grading, culverts or drainage;
- Trail widening where the machinery must cross and / or along the length of the segment that the owner may be required to travel on the trailbed (in the case of a diagonal or offset crossing);
- Cautionary signs to warn trail users in advance of the crossing point or zone that the machinery needs to use the trailbed; and
- Signs at trailheads to forewarn trail users that they may expect to encounter farm machinery crossing or using the trail, and that this may be more frequent during certain times of the year.

C.5.1.6 Bridges

Where possible, the trail 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 and the type and design of a structure needs to 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 considerations; and
- Accessibility.

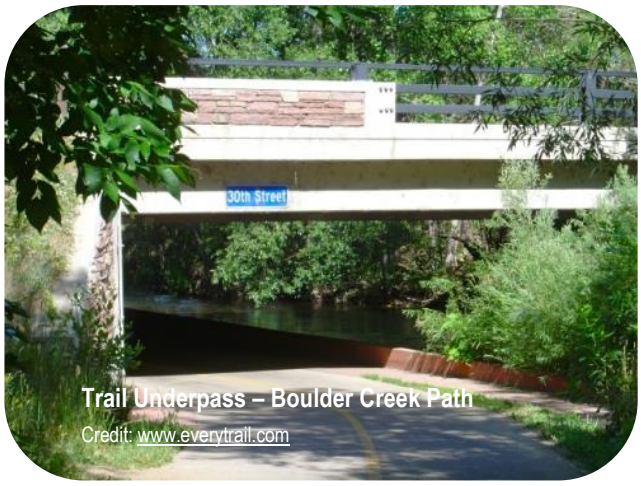
The graphic below illustrates a pedestrian bridge in Brampton, ON.



C.5.1.7 Underpasses and 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. The following graphics illustrate some sample trail underpasses.



Trail Underpass – Boulder Creek Path
Credit: www.everytrail.com

Guideline(s):

C-14:

- The 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.

C.5.2 TRAIL STRUCTURES

C.5.2.1 Gate and Barrier System

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. There are many designs for trail access barriers in use by different trail organizations, some are more successful than others. In general, it should be assumed that the design of the gates and bollards should be done to encourage cyclists to dismount. They can generally be grouped into three categories – Bollards, Offset Swing Gates and Single Swing Gates.

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.

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 and 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.

In urban areas the single swing gate or bollard is quite effective for most applications. For large parks, park service access/pathway routes, more rural settings and locations where unauthorized access is an ongoing problem, a more robust single swing gate should be employed.

C.5.2.2 Boardwalks

Where multi-use pathways and trails pass through sensitive environments 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 these areas are left untreated, 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 yet effective methods for some trails. The turnpike is a low tech, low cost method that works very well in areas where organic soils are encountered. 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 an 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 is likely to include 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- Boardwalk Foundation on Helical Piles (Halton Hills) (bottom)
Credit: MMM Group

C.5.2.3 Switchbacks and Stairs

Pedestrian 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 an 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 graphics illustrate a sample switch-back design concept and design concept for stairs which could be implemented on a steep trail.

- 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.

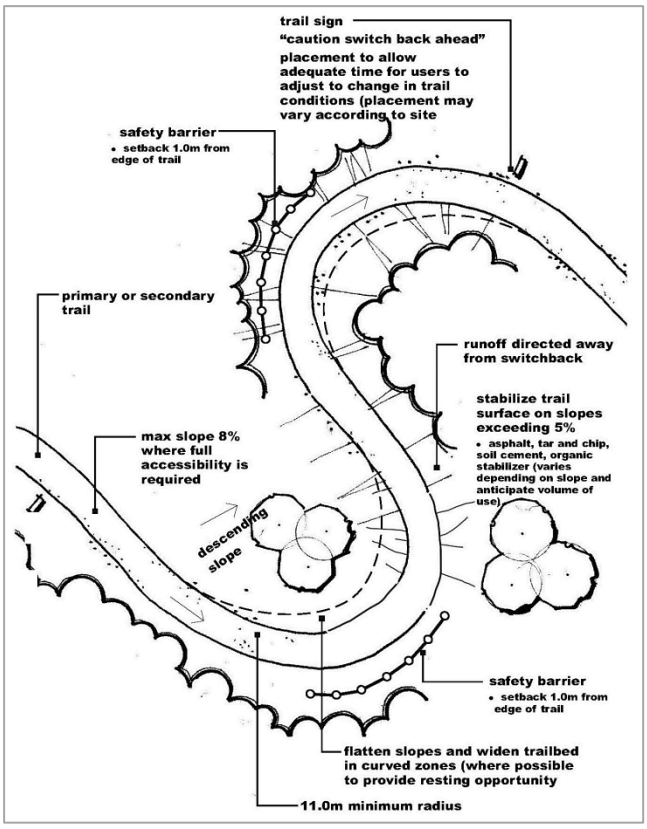
In addition, there are a number of design concepts which can be considered for trails which are designed in a space with a greater than permitted slope.

Guideline(s):

C-15: 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.



Switchback Example (top) and Woven Metal Stairs, Dundurn Stairs, Hamilton (bottom)
Credit: MMM Group, Word Press

C.5.3 TRIP END FACILITIES & STAGING AREAS

C.5.3.1 Seating and Rest Areas

Seating provides the opportunity to pause along the trail at points of interest or just to rest. Young children, older adults and those with disabilities will need to rest more frequently than others.

Benches are the most common form of seating, but walls of appropriate height and width, large flat boulders, and sawn logs are some alternatives depending on the trail setting. Where seating/rest areas are planned, the design should consider a 1m wide level area with a curb or other appropriate wheel stop for mobility-assisted devices.

Staging areas, trail nodes and heavily used trails typically require a higher density of seating opportunities. For heavily used trails it is reasonable to provide some form of seating at approximately 500m intervals.

C.5.3.2 Waste Receptacles & Washrooms

Waste receptacles should be located at regular intervals and in locations where they can be easily serviced. Mid-block crossing points, staging areas, trail nodes and in association with other site amenities such as benches and interpretive signs are ideal locations. They must be monitored and emptied on a regular basis to prevent unsightly overflow.

Washrooms should be provided along or near the trail at key locations. Typically, they are located at major trailheads and where possible make use of existing facilities (i.e. at community centres and in major parks). As trail use continues to increase, and as the network becomes denser, it may be necessary to provide additional facilities. Where this is necessary, they must be placed where they can be easily accessed for maintenance and surveillance.

Pathway Seating & Rest Areas

Credit: (Bottom) MMM Group Caledon, Dufferin, ON (Top) MMM

Many trail groups have used portable washrooms prior to installing permanent facilities, which provides the opportunity to determine the most appropriate location before the investment is made in design and construction of permanent facilities.

C.5.3.3 Bicycle Parking

The provision of bicycle parking facilities is essential for encouraging more bicycle use throughout Oxford County. 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

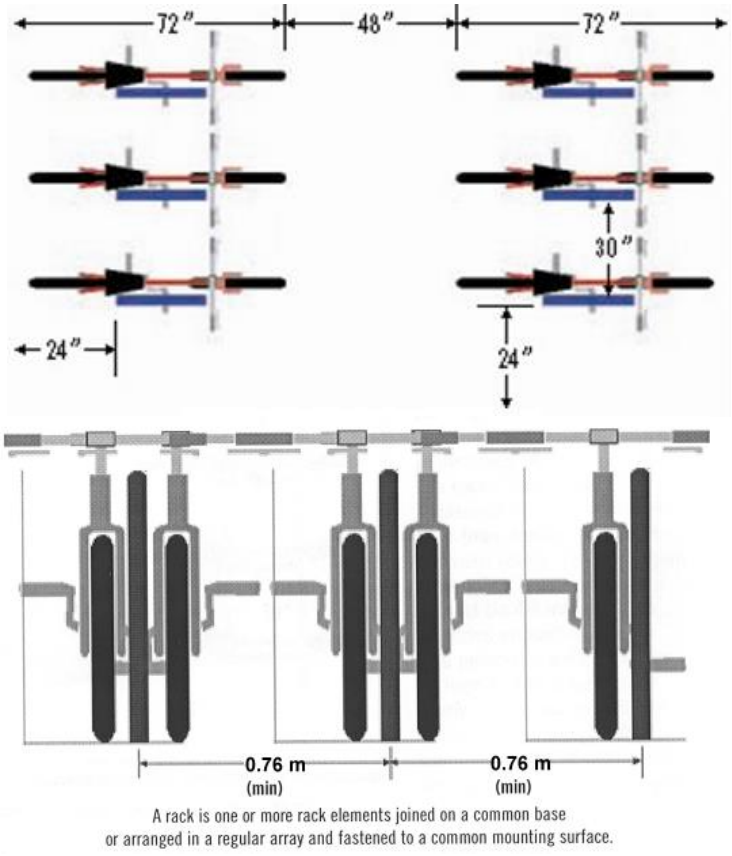
When designing bicycle racks the following components presented in **Table C.11** must be considered. Additional considerations and guidelines can be found in the TAC Manual as well as OTM Book 18.

Table C.11 - Design Considerations for Bicycle Racks

The Rack Element	The Rack	The Rack Area
Definition: The portion of a bicycle 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.
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	**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. • Should be arranged in a way that is quick, easy and convenient for a cyclist to lock and unlock their bicycle	**Key Considerations:** • The recommended 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. • Rack area should be sheltered to protect bicycles from the elements. • Bicycle racks should be placed as close as possible to the entrance, no more than 15m, and should be clearly visible along a major building

Table C.11 - Design Considerations for Bicycle Racks

The Rack Element	The Rack	The Rack Area
lock the front and the rear wheel.	to and from the rack.	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.
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.



A rack is one or more rack elements joined on a common base or arranged in a regular array and fastened to a common mounting surface.

Sample Bicycle Parking Design Concepts and Applications

Credit: APBP

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.

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.

Guideline(s):

C-16: Using the criteria outlined the type of bicycle parking facility, number of available spaces and location should be carefully considered on a site by site basis.

C-17: Oxford County, local municipalities and partners should build upon any infrastructure previously implemented and consider initiating a program to install racks on an as requested basis for destinations throughout the County.

Sample Design for Bike Lockers
Credit: www.transportation.ubc.ca (top) and www.winnipegtransit.com (bottom)

C.5.4 CLOSURES AND REHABILITATION

From time to time it will be necessary to temporarily close sections of trails or entire routes to public access. Situations such as inundation by water, culvert washout or general trail construction are typical reasons for temporary trail closures. As these situations arise, users must be informed well in advance of the closure. If the closure is planned advance notices should be placed at all access points for the affected section(s). In the event of an emergency closure, notices must be placed at these locations immediately following the discovery of the problem.

Signing and temporary barricades, notification in community newspapers, on local radio stations and the County and local municipal webpages are possible methods of informing users of about temporary trail closures.

Permanent trail closures may also be required at some point in the life cycle of the trail, especially in the case of trails in woodlots and other natural settings. It is important when closing a trail to rehabilitate the landscape to match the surrounding conditions, inform trail users that it has been closed, and to provide reasons for the closure. Depending on the location, appropriate rehabilitation measures in natural/naturalized settings may include:

- Slope stabilization, using engineered materials and methods for severely eroded slopes.
- Terracing, using locally collected low-tech materials for eroded slopes of moderate and low severity.
- Live staking using locally collected cuttings from appropriate species.
- Plantings with appropriate native species (may include plants salvaged from nearby sites.
- The application of erosion blankets and mulches, and/or seeding with mixes that are appropriate for the site in which they are to be applied.
- Scarification of the surface of the trail to be closed and covering it with forest litter (leaves, branches, and limbs) in a naturalistic manner which can help to reinforce the message that the trail is closed, reduce erosion, and supply nutrients to plants during establishment.
- Erecting signage describing the closure to inform users of the conditions and "Water Me" signs for newly planted trees.

C.6 SIGNING THE TRAIL NETWORK

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:

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 County, one of its local municipalities or at trail junctions.

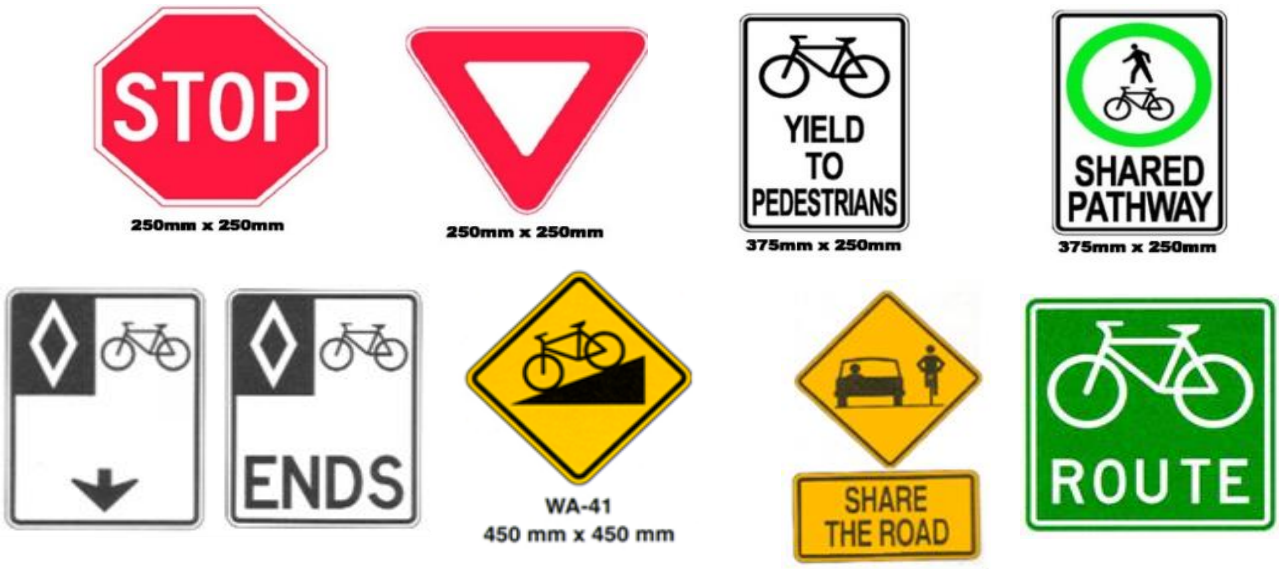
Regulatory, Warning and Information

- 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 TAC Bikeway Control Guidelines or OTM Book 18).
- Intended to control particular aspects of travel and be used along the road or off-road network.
- Warning signs are used to highlight bicycle route conditions that may pose a potential safety or convenience concern to network 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 enough that users should be made aware.

"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. • Information can be integrated with access barriers.
Guideline: Etiquette signs should be considered for implementation at public access points or where trailheads are located.
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 highly visible locations to minimize the potential for vandalism.
Guideline: Signs should be implemented throughout the network in locations where cultural or historic information should be highlighted.
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 / wayfinding information.

Regulatory Sign Examples



Examples of Warning and Informtation Sign – Regulatory, Warning and Information
Source: OTM Book 18, TAC

Interpretive Signs Examples

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

Route Marker & Trail Directional Sign Examples

Route Marker & Trail Directional Sign Examples - Essex (Left)-Photo Essex Region Conservation Authority; Kissing Bridge Trail, Guelph / Eramosa (Second from left) Photo MMM Group; Halton Hills (Third from Left)-Photo MMM Group; Confederation Trail (Right) Photo MMM Group