B.

SETTING THE CONTEXT

Multi-Use Pathway, Cawston Avenue, Kelowna, B.C.

B.1

WHAT IS ACTIVE TRANSPORTATION?

Active transportation includes any form of human-powered transportation, including walking, cycling, or rolling using a skateboard, in-line skates, wheelchair, or other wheel-based forms of human-powered transportation. It also includes winter-based active modes, water-based active modes, and horseback riding, although these modes are typically more recreational in nature.

This chapter describes these various modes of active transportation, outlines the benefits of active transportation, and provides key considerations to ensure that active transportation facilities are accessible for everyone, regardless of age, ability, location, background, or season.

TYPES OF ACTIVE TRANSPORTATION

Active transportation can take many forms and is continually evolving as new technologies emerge. Active transportation most commonly refers to people walking or cycling, but can also include people rolling, using winter-based modes, or using water-based modes. In addition, active transportation increasingly includes emerging forms of technology such as electric bicycles and small, one-person electric vehicles. Multi-modal integration is also a critical component of any active transportation network. Active transportation users often utilize many different transportation modes throughout their journey, so it is important to ensure that all modes are safe, appealing, and convenient for all users. Refer to **Chapter H.1** for further detail on multi-modal integration. A detailed list of active modes of transportation is provided below.

TYPES OF ACTIVE TRANSPORTATION

Walking includes people walking dogs, people jogging, and people using mobility devices such as wheelchairs, walkers, and strollers.

Cycling includes all people travelling by bicycle using a full range of types of bicycles such as bicycles with trailers, children's bicycles, recumbent bicycles, cargo bicycles, electric bicycles, adult tricycles, fat tire bicycles, and bicycles built for people with mobility challenges. Refer to **Chapter B.4** for further detail on different types of bicycles.

Rolling includes people skateboarding, longboarding, scootering, in-line skating, and roller skiing.

TYPES OF ACTIVE TRANSPORTATION

Winter-based modes include modes that require conditions only available during colder winter months such as cross-country skiing, snowshoeing, kicksledding, and ice skating.

Water-based modes include connections to active forms of marine transportation, such as canoeing, kayaking, and stand-up paddle boarding. Although these are more frequently considered recreational-based activities that are less viable as forms of transportation, there are opportunities for communities to provide easier access points to these activities and identify potential locations for docks and lock up stations to safely secure canoes, stand-up paddle boards, kayaks, and other devices.

Small, one-person electric vehicles include e-scooters, electric skateboards, hoverboards, segways, self-balancing electric unicycles, and other emerging modes. Refer to **Chapter H.5** for further detail on new forms of mobility.

BENEFITS OF ACTIVE TRANSPORTATION

Communities across B.C. and throughout the world are increasingly recognizing the value of investing in active transportation. Investments in active transportation can result in a more balanced transportation system that is accessible, cost-effective, and more equitable in terms of a community's infrastructure investments. There are also significant quality of life, health, safety, and economic benefits associated with investing in active transportation.

Environmental benefits. Transportation is one of the largest contributors to greenhouse gas (GHG) emissions in B.C. Active transportation can help to reduce motor vehicle trips, congestion, air pollution, and GHG emissions. Promoting active transportation also helps with efforts towards climate change mitigation while supporting the protection and improvement of the natural environment.

Economic benefits. Active transportation, as part of a balanced, efficient, and accessible transportation system, is one of the drivers of success for economic diversity and prosperity. Neighbourhoods and destinations that are accessible and attractive for people using active transportation can attract more visitors, who can in turn be patrons of local services and amenities. Active transportation also provides more choices for people travelling to work, school, services, and other daily destinations, which is essential for British Columbians who would prefer to spend less on transportation or who do not have access to motor vehicles or transit.

Health benefits. A significant body of research has found links between investments in active transportation and increased rates of physical activity and healthier communities. Regular physical activity reduces the risk of early death and numerous chronic diseases. Physical activity has been proven to improve psychological well-being and prevents weight gain and obesity. While the benefits of physical activity have been well documented, low levels of physical activity in children and adults is still prevalent and continues to increase. Active transportation is one of the most affordable and accessible ways for British Columbians to add exercise to a daily routine.

Societal benefits. Active transportation facilities provide affordable and accessible transportation choices for people of all ages and abilities. High levels of active transportation in a community is a strong indicator of sustainability and livability. Active transportation encourages social interaction, creating opportunities for face-to-face interactions with members of the community and building trust, respect, understanding, and a sense of co-operation among members of the community. Studies have shown that social interactions diminish when motor vehicle volumes increase and walking infrastructure decreases. These social connections are found to be particularly important for youth, as they can develop sustainable travel patterns at an early age that can continue later in life. Social connections are also important for older adults, enabling them to stay active for longer and maintain physical and mental health.

Safety benefits. Making B.C. roads safer is paramount. Properly designed active transportation facilities that provide dedicated spaces for active transportation users and enhance their visibility within the roadway have the potential to reduce the risk of collisions and create a safer transportation system for all road users. Roads designed for slower motor vehicle speeds feel safer for active transportation users. Furthermore, studies have shown that slower motor vehicle speeds decrease the probability of serious injury and death for active transportation users (see **Chapter B.4**).

District of Saanich, B.C.
Source: District of Saanich

District of North Vancouver, B.C.

Vision Zero

The Design Guide, along with other resources such as the B.C. Community Road Safety Toolkit, provides guidance that helps to support the provincial Vision Zero initiative. Vision Zero is an approach that is intended to bring together all of B.C.'s road safety partners towards the ultimate goal of zero traffic fatalities and zero serious injuries.

MOBILITY FOR ALL

Design professionals should aspire to create active transportation facilities that are comfortable, convenient, safe, and attractive for everyone, regardless of age or ability. This is often referred to as 'All Ages and Abilities', 'AAA', or 'Triple A' facilities in active transportation design. Planning and designing for people of all ages and abilities is a national and international best practice that should be aspired to for all active transportation facility design and network implementation. In addition, active transportation facilities should be accessible at all times of day, in all seasons, and in all weather conditions, with maintenance and operations considered at the outset of the planning and design process and on an ongoing basis.

The following considerations for inclusive mobility have shaped the recommendations in the Design Guide:

- **Equitable.** Equity as it relates to transportation refers to the distribution of impacts (benefits and costs) and whether the distribution of impacts is considered fair and appropriate. Equity impacts can include the quality of available transportation choices, indirect and external costs, transportation expenditures, and public resource allocation, among others. Well designed and maintained facilities make access to transportation more equitable by allowing active modes to travel safely and comfortably.

- **Inclusive.** The transportation system should be designed to be inclusive to everyone, regardless of their socio-economic or demographic background. The Design Guide has been developed following gender based analysis plus (GBA+) principles. GBA+ is an analytical process used to assess how diverse groups of people may experience policies, programs, and initiatives. The 'plus' in GBA+ acknowledges that GBA goes beyond biological (sex) and socio-cultural (gender) differences. This also includes ensuring that people of all incomes, cultures, and socio-economic backgrounds have access to active transportation facilities, including Indigenous communities, new immigrants, and low-income groups.
- **Age-Friendly.** In order to design a transportation system that is welcoming for people of all ages, it is critical to focus on those with unique travel needs, such as older adults and seniors, as well as children and youth. Older adults and seniors may experience slowing reflexes, vision loss, slower walking speeds, difficulty hearing vehicles, decreasing cognitive ability, and reduced endurance requiring periodic rest breaks. In addition, older adults and seniors may be less likely to drive a motor vehicle, resulting in increased reliance on active transportation, carpooling, or transit. Age-friendly active transportation facilities can help to provide older adults and seniors with the option to age in place while continuing to access community destinations.

  Similarly, children and youth typically do not have access to motor vehicles and are reliant on active transportation, carpooling, or transit to travel in their community. Children and youth have less experience at identifying hazards, have less developed depth perception, and may not be able to assess the speed of motor vehicle traffic. Due to their smaller size, children and youth are also less visible to motorists. Refer to **Chapter B.4** for more detail regarding the operational and behavioural characteristics of various active transportation users.
- **Accessible.** Accommodating people of all abilities should be a primary objective when designing active transportation facilities. Designing using universal design principles ensures that the built environment is accessible to people of all ages and abilities, regardless of any type of physical or cognitive impairment. It is important to fit the accessibility level to the context and location. Refer to **Chapter B.3** for more detail on universal design.
- **Safe.** More people will use active forms of transportation if they have safe places to walk, roll, and cycle. Increased numbers of active transportation users can also lead to 'safety in numbers,' which can raise awareness of active users and result in even safer roads. Better active transportation facilities are also directly correlated with increased safety for all road users. Poor or inadequate infrastructure forces people walking or cycling to choose between feeling safe and following the rules of the road. Not following the rules of the road can include wrong-way cycling, riding on sidewalks, or jaywalking, which are all often illegal unless noted otherwise through municipal bylaws or signage.

By applying these considerations, both the provincial government and local and regional governments can work towards creating active transportation networks and facilities that are safe and comfortable for people of all ages and abilities, all-year round.

Not every consideration may be achievable in all contexts. Design professionals should use these ideals to guide the planning and design processes, seeking to create the best possible facility within the unique constraints of each context.

Riding to the beach in Tofino, B.C.

B.2

PLANNING FOR ACTIVE TRANSPORTATION

This chapter provides an overview of the considerations and guiding principles for planning and designing active transportation facilities, covering a variety of key topics that should be considered by planning and design professionals. The planning and design of active transportation facilities can differ substantially depending on whether it is located in an urban, suburban, or rural context. This chapter introduces some of the nuances and terminology for addressing these contextual differences. Design considerations for preserving and protecting wildlife when designing active transportation facilities are also discussed.

The chapter then describes the key elements of streets, providing an overview of road classifications and the various road zones that will be referred to throughout the Design Guide. Active transportation users are also described, with notes on typical trip purpose and user characteristics. Cycling typologies are also introduced, helping to break down the potential market for bicycle facilities.

Network planning considerations are also examined, including land use and neighbourhood design, connectivity, multi-modal integration, and topography. An overview of a typical planning process is provided, along with some basic facility selection considerations. A number of retrofit strategies are provided for dealing with constrained rights-of-way.

Planning and designing for people of all ages and abilities within the transportation system is becoming a widely supported priority across the province. Reasons for prioritizing active transportation include: increasing constraints in urban areas, distance between communities, environmental factors, cost effectiveness concerns, and growing community demands for active transportation. All levels of government are now starting to think differently and adaptively about the development of active transportation networks and the application of active transportation design best practices. The planning considerations outlined in this chapter are intended to help design professionals address the considerations outlined on page B10 by understanding the existing conditions in their communities and by outlining key aspects to consider throughout the planning process.

GUIDING PRINCIPLES

The following guiding principles were developed based on national and international best practices and should be considered when planning and designing active transportation facilities. Active transportation facilities and networks should be:

- **Safe and Stress-Free**. Mitigating both real and perceived safety concerns is a crucial step in attracting active transportation users. In general, as the speed and mass differential between modes increases, so should separation between modes. Personal safety should be addressed by applying Crime Prevention Through Environmental Design principles (see **Chapter B.4**). Other health-related considerations include minimizing physiological stress (e.g. avoiding steep slopes and bumpy surfaces) and mitigating pollution from emissions and road noise.
- **Inclusive**. Active transportation facilities should consider the needs of users of all ages and abilities, including universal access for people with any form of physical or cognitive impairment (see **Chapter B.3**). Facility design should consider human behaviour and be forgiving of user error, accommodating mistakes in a way that mitigates negative outcomes.
- **Context Sensitive**. Climate, topography, land use, and other context-specific issues – both current and future – should be considered when planning and designing active transportation facilities. Active transportation facilities should support community goals and should seamlessly integrate with the public realm and other transportation facilities.
- **Cohesive and Direct**. Active transportation facilities should fit within a cohesive network that provides direct access to destinations such as commercial areas, employment areas, residential areas, and community amenities. Access to these destinations should be direct and achievable in short travel times to ensure active transportation is an attractive alternative to motor vehicles. Multi-modal cohesion is also important, with convenient connections to transit facilities, parking, and road networks.
- **Attractive and Intuitive**. Facilities should be comfortable and pleasant for people of all ages and abilities. They should be well maintained and may incorporate landscaping, public art, and amenities, making them attractive and welcoming for users. Active transportation facilities should also be predictable, recognizable, and consistent, making them intuitive for users of all modes.

URBAN, SUBURBAN, AND RURAL CONSIDERATIONS

The planning and design of active transportation facilities can differ substantially depending on whether they are located in an urban, suburban, or rural context. This context impacts land use, neighbourhood design, distance between destinations, road classification, and community expectations. In all contexts, safety for active transportation users is a key consideration that should be prioritized in all planning and design work.

In addition, the planning and design of active transportation facilities should consider the jurisdictional context. Most of the roadways under provincial jurisdiction throughout the province are high-speed numbered limited access highways. These highways focus on providing inter-regional and provincial transportation connections between communities. As such, many of these facilities are best suited for motor vehicle travel and goods movement. However, where facilities on roadways under provincial jurisdiction pass through urban, suburban, or rural contexts, and in unincorporated communities where the provincial government has jurisdiction over the road network, the considerations below may apply.

Urban Context

An urban context is typically understood to be a developed area within a city, district, town, or village. Urban environments typically provide a denser mix of land uses, which can be beneficial for active transportation. Researchers have found convincing evidence that people who live in communities characterized by mixed land use, well-connected road networks, and high residential density are more active than those who live in less dense communities.

Similar built form and mixed land uses can also appear in suburban neighbourhood centres and smaller rural communities including unincorporated communities that have relatively compact cores. In these contexts, design professionals should apply urban considerations when planning and designing active transportation facilities.

Suburban Context

A suburban context is an area of a city or a separately incorporated city or town with predominantly low-density, residential land uses. Suburbs may also contain clusters of commercial, retail, and employment areas, but land uses are typically more spread out and segregated compared to urban areas. Suburban road networks are often characterized by 'loops and lollipops' – a non-grid structure that can decrease the connectivity of the road network. Unlike most urban roads, some suburban roads may be designed without a curb, gutter, or sidewalk, similar to rural roads.

Rural Context

A rural context covers a range of community types. Rural contexts are an especially important consideration for the Design Guide. In many cases throughout the province, roadways under provincial jurisdiction pass through rural contexts, including both incorporated communities and unincorporated communities where the province has jurisdiction over all roadways.

Rural contexts can generally be divided into three categories: basic rural, outer developed rural, and developed rural cores (see **Figure B-1**). These categories do not necessarily align with municipal or regional boundaries, but rather are based on development patterns. This rural classification is conceptual and should not be considered firm classes – design professionals should consider the local context whenever planning and designing active transportation facilities.

1 **Basic Rural**. Communities with limited social or economic links to developed rural areas, with large distances between communities and destinations. In this context, many roadways may be under provincial jurisdiction, particularly for unincorporated rural communities. There may be limited demand for active transportation facilities, particularly for people of all ages and abilities.

2 **Outer Developed Rural**. Small communities from which people travel to developed rural cores for employment, services, shopping, school, or recreation. In this context, there is a greater need for active transportation facilities than basic rural areas to ensure connections to developed rural cores.

3 **Developed Rural Core**. Regional centres consisting of rural towns with concentrations of residents, services, businesses, and community destinations. In this context, design professionals should apply the urban context design considerations noted above when planning and designing active transportation facilities, and should consider the needs of people of all ages and abilities.

Population density and demand supportive of active transportation is often lower in rural areas. Nonetheless, many active transportation design features can be implemented in rural contexts. Developed rural cores can be ideal for active transportation. As networks develop, they may be comprised of varying facilities that appeal to a range of ages and abilities, such as off-street pathways, sidewalks, and bicycle lanes.

Many communities characterized as basic rural and outer developed rural are located along highways and roadways that were built to serve high-speed motor vehicle traffic, making them less desirable or comfortable for active transportation. Additionally, these communities are typically located long distances from services that are not offered within their communities. Demand for active transportation is typically lower in these areas. Over time, it is possible to redesign and retrofit these roadways to accommodate a transportation network that better accommodates active modes of transportation.

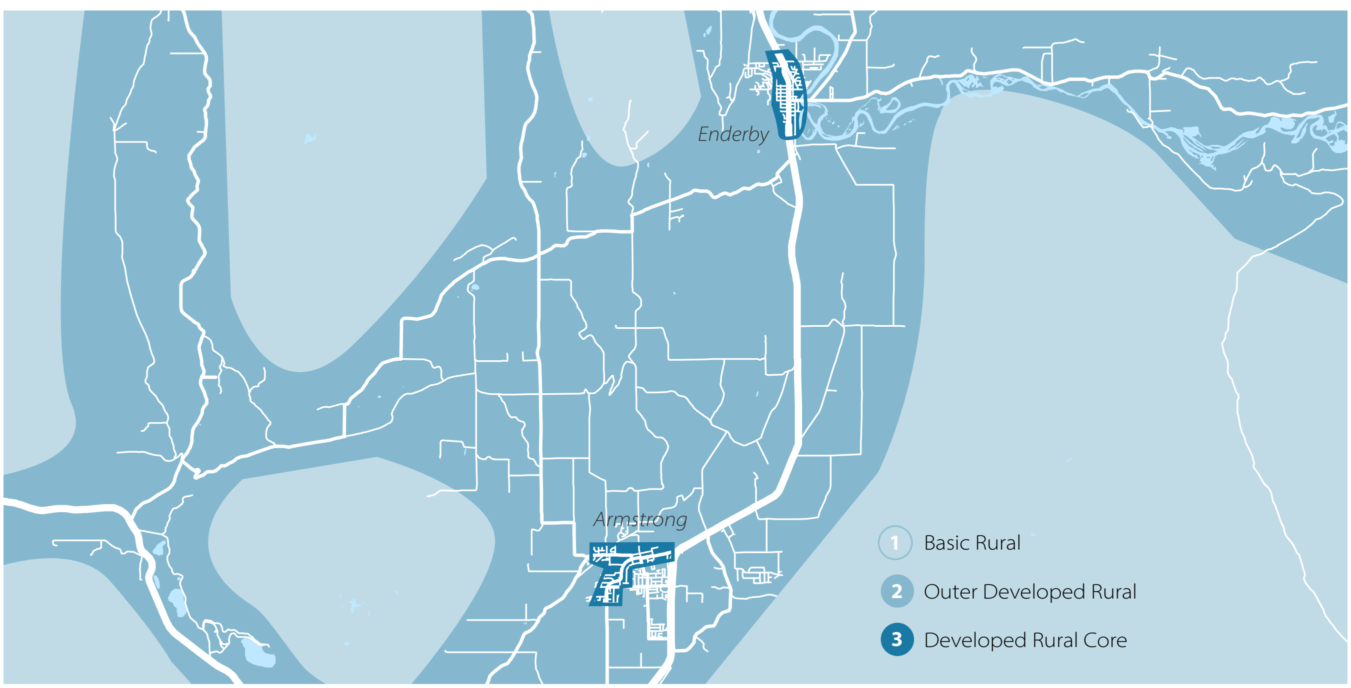


Figure B-1 // Conceptual Rural Classifications – Enderby, Armstrong, and Spallumcheen Area

Recommendations for facilities in rural contexts are provided throughout the Design Guide. Specific design guidance for rural contexts in the Design Guide is provided in the following chapters:

- **Chapter C.4**: Rural Pedestrian Design Considerations
- **Chapter D.6**: Rural Cycling Design Considerations
- **Chapter E.2**: Multi-Use Pathways
- **Chapter F.1**: Context Specific Applications
- **Section G**: Intersections + Crossings (relevant information throughout)

User comfort is an important aspect of a multi-modal network, regardless of the setting. Rural communities have great potential for creating viable networks that serve residents and visitors. Rural communities can offer access to retail businesses, schools, and other amenities within a relatively small community core. However, active transportation connections to neighbouring communities may be more challenging to accommodate, especially with facilities that are comfortable for people of all ages and abilities.

Other challenges that face rural communities may include the following:

- **Constrained Terrain**. Highways often have physical constraints that make the provision of cost effective facilities for those travelling by active means difficult.
- **Highway as a Main Street**. In some rural communities, a provincial highway is also the primary downtown main street. The highway mandate of safely and efficiently moving people and goods may conflict with the local community's desire for facilitating active transportation, commerce, and community activity. See **Chapter F.1** for more details regarding active transportation on roadways under provincial jurisdiction.
- **Safety**. High motor vehicle speeds, limited crossing opportunities, and a lack of dedicated space for active transportation may create safety concerns for active transportation users.
- **Climate and Maintenance**. Maintaining roads and active transportation networks in all weather conditions is a challenge across the province. Many local and regional governments do not have adequate resources to provide necessary snow removal or sweeping equipment.

ENVIRONMENTAL CONSIDERATIONS

In addition to considering the human context, the planning, design, and implementation of active transportation facilities should also consider and seek to mitigate impacts to the local environment. This could include:

- Impacts on wildlife habitat;
- Loss of riparian area;
- Introduction of invasive plants; and
- Erosion and sediment control.

Users of the Design Guide should investigate regulatory requirements for environmental consideration prior to initiating any infrastructure project.

DEFINING ROADS AND STREETS

Roads are designed to move people and goods from one place to another. They exist on a spectrum from high-speed, long distance links to low-speed, local connections, with a range of intended uses and roles within the transportation network. Roads are also a critical component of a community's public realm and can offer spaces for people to socialize, recreate, shop, and work. They have the potential to serve as vibrant, lively public spaces that enhance the quality of life for residents and encourage healthy, active living. Roads can also provide critical links to other types of public facilities and dedicated areas such as plazas, squares, transportation hubs, trail systems, greenways, and parks.

Complete Streets

The term 'complete streets' has been widely used to refer to roads that balance safety, access, and comfort for users of all modes, as opposed to the historic North American road design that typically prioritized motor vehicles. Complete streets are intended to be safe, comfortable, and universally accessible. They offer a wide range of benefits, including increased safety, sustainability, and cost effectiveness.

However, not every road can fulfill every function; road design is complex and must respond to varied land uses, local conditions, and constraints. Each road has a different role with unique design priorities – some are part of a public transit or goods movement network, for example, while others might be focused on prioritizing active transportation. Where priorities compete, such as where a numbered highway serves as a community's main street, there are many design challenges and trade-offs that must be negotiated.

The surrounding built form plays a large role in road function, with some roads containing street-oriented buildings and others containing non-street oriented built form as seen below. A road's function may also differ depending on the time of day, day of the week, or season.

Street Classification and Terminology

The *B.C. MVA* uses the term 'highway' to describe 'every road, lane or right of way designed or intended for or used by the general public for the passage of vehicles.' To provide greater detail, the Design Guide uses the terms 'road' and 'street' While these terms may be

RELATIONSHIP OF BUILDING TO THE STREET

Street Oriented: Typically, adjacent land hosts road-facing buildings with minimum setbacks and entrances directly connected to the road, which supports the prioritization of active transportation.

Non-Street Oriented: Building setbacks are greater and building entrances may face away from the adjacent road. Often primary access is from neighbouring surface parking.

used interchangeably, 'street' is often used to describe lower speed corridors that emphasize multi-modal transportation, as opposed to 'roads' that are often in more rural contexts and prioritize motor vehicle travel, such as highways. The term 'street' also tends to have a more urban connotation implying a curb and gutter cross-section, whereas 'roads' may have either curb and gutter or an open shoulder cross- section.

Streets and roads are generally classified based on their typical functional and operational characteristics. Road classifications can be used to recommend values for design elements such as lane widths, speeds, geometry, and intersection design. Roads can be divided into functional, service, and design classes. Further details regarding street classification can be found in Section 100.11.1.3 of the MOTI *B.C. Supplement to TAC Geometric Design Guide* and Section 2.6 of the TAC *Geometric Design Guide for Canadian Roads*.

Service Classes

Service classes describe physical design and access features. Common service classes include:

- Alley;
- Local;
- Collector;
- Arterial;
- Expressway; and
- Freeway.

Note that most freeways in B.C. are numbered highways under provincial jurisdiction. Other types of roads that may require consideration include shared streets, service or frontage roads, and cul-de-sacs.

Design Classes

Design classes are more detailed descriptions of service classes that consider the predominant characteristics of the adjacent land (e.g. urban or rural), whether the road is divided or undivided, and the design speed. Design classes are coded using alphanumeric abbreviations: Urban (U), Rural (R), Collector (C), Arterial (A), Expressway (E), Freeway (F), Divided (D), and Undivided (U). For example:

- RAU80 = rural arterial undivided street with an 80 km/h posted speed limit
- UAD70 = urban arterial divided street with a 70 km/h posted speed limit

Functional Classes

Functional classification groups streets according to the character of the service they are intended to provide. Higher function highways place more emphasis on mobility for through traffic, and lower function highways and roads place more emphasis on land access. B.C. highways are functionally classified into five groups:

- **Primary Highways** (typically freeways, expressways, or arterials);
- **Secondary Highways** (typically arterials but may include expressways or freeways);
- **Major Roads** (typically arterials but may include collectors);
- **Minor Roads** (typically collectors but may include arterials); and
- **Local Roads.**

The upper three functional classes – primary highways, secondary highways, and major roads – apply to the numbered highway system.

Street Zones

Streets can be divided into a series of zones that each serve a dedicated purpose, such as providing space for through traffic, accommodating people walking or cycling, or the installation of street furniture. **Figure B-2** shows the range of zones in an urban street setting, while **Figure B-3** shows the range of zones in a rural road setting. These are examples only – not all streets will contain each zone, and there are many street designs in both urban and rural settings. The placement and the geometry of the zones is flexible and dependent on available right-of-way, road class, and land use. The various street zones are described below.

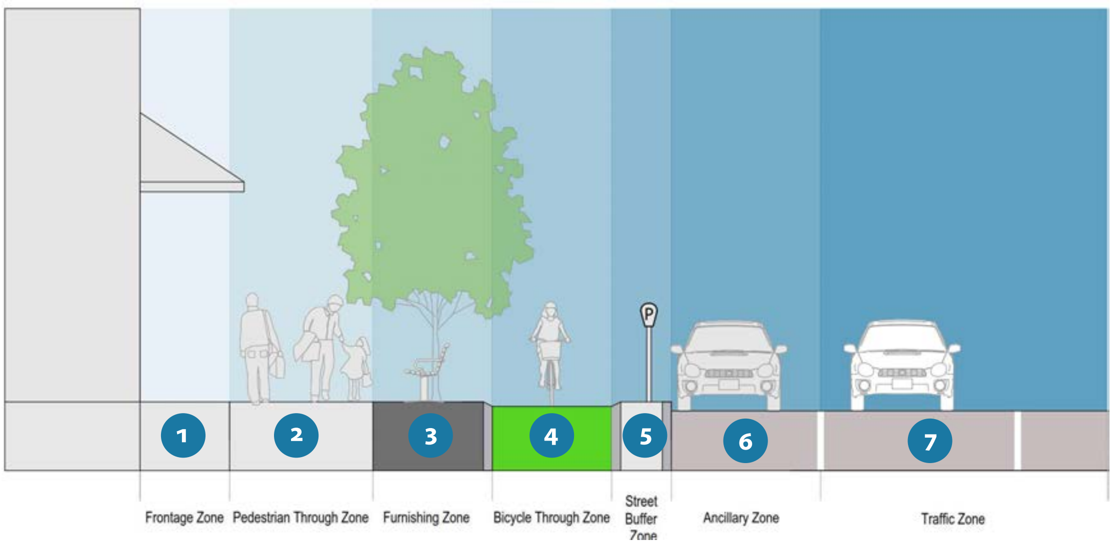


Figure B-2 // Urban Street Zones

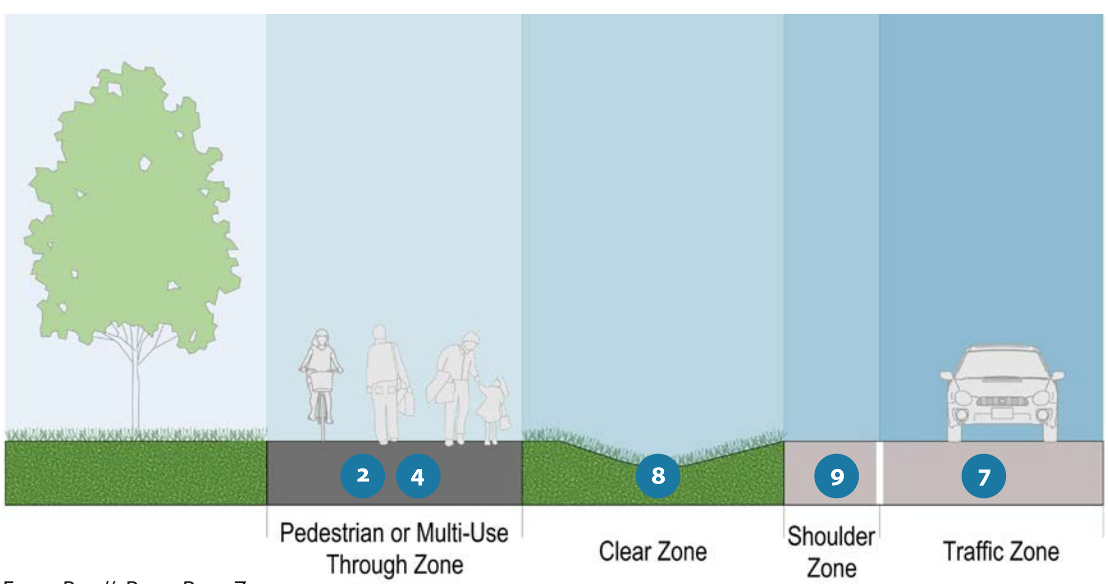


Figure B-3 // Rural Road Zones

1 Frontage Zone

The Frontage Zone is the area adjacent to properties, such as building entrances, front yards, vending, café seating, and building-related utilities. This area may be part of the public right-of way, or private, if a building setback is present. The Frontage Zone predominantly applies to an urban street context as the Frontage Zone is typically private front yard space in a local or suburban context. See **Chapter C.3** for design guidance.

2 Pedestrian Through Zone

The Pedestrian Through Zone is the most important area of the road for safe, accessible, and efficient movement of people walking. The width of this zone depends on the road context and the volume of pedestrian activity anticipated for the corridor or block. This area should be entirely free of permanent and temporary objects. See **Chapter C.2** for design guidance.

3 Furnishing Zone

The Furnishing Zone is a space between the Pedestrian Through Zone and the road that buffers pedestrians from the Traffic or Ancillary Zone and provides space for street furniture and utilities. See **Chapter C.3** for design guidance.

4 Bicycle Through Zone

The Bicycle Through Zone exists on roads with bicycle facilities. On some roads, the Bicycle Through Zone takes the place of the Ancillary Zone, but not always. However, an Ancillary Zone with on-street parking may still be provided adjacent to a Bicycle Through Zone. See **Section D** for design guidance.

5 Street Buffer Zone

The Street Buffer Zone only occurs on streets with protected bicycle lanes. Where present, it provides a buffer between moving or parked motor vehicles and the protected bicycle lane. Uses can include landscaping, as well as street furniture, utilities, and parking metres. See **Chapter D.3** for design guidance.

6 Ancillary Zone

The Ancillary Zone is a flexible space located on-street within the roadway that is not designated for motor vehicle through traffic, but that supports the primary functions of either the roadway or the sidewalk. Uses can include on-street motor vehicle or bicycle parking, bicycle facilities, docked bike share stands, loading zones, transit stops, taxi or ride hailing zones, curb extensions, parklets, or patios. This space also includes the concrete gutter and, depending on the road design, may be used for snow storage. See **Chapter C.3** for design guidance.

7 Traffic Zone

The Traffic Zone accommodates users travelling through a road or accessing destinations along the road. Traffic Zone uses can include motor vehicle through traffic, transit, goods movement, and bicycle travel. The Traffic Zone can be divided into multiple lanes that are shared by multiple users or dedicated to certain vehicles (such as exclusive transit lanes). Medians and refuge areas can also be included within this zone.

8 Clear Zone

In highway design, design professionals shall consider roadside safety, which encompasses the area outside the travelled portion of the roadway (e.g. the Traffic Zone). This includes the shoulder, the side slopes, ditches, and any fixed objects and water bodies that could present a serious hazard to the occupants of a motor vehicle leaving the roadway. The Clear Zone is the most important element of roadside safety design.

The Clear Zone consists of the Shoulder Zone, a recoverable slope, a non-recoverable slope, and/or a clear runout area. The desired width is dependent upon the design traffic volume and speed and on the roadside geometry. The Clear Zone can also facilitate roadside drainage. Section 620 of the MOTI *B.C. Supplement to TAC Geometric Design Guide* and Chapter 7.3 of the TAC *Geometric Design Guide for Canadian Roads* provide further design guidance for the Clear Zone. See **Chapter D.6** for design guidance.

9 Shoulder Zone

In rural, suburban, or highway contexts where there are no curbs, paved and/or unpaved shoulders may be present. The Shoulder Zone is the part of a roadway contiguous with the Traffic Zone intended for emergency stopping, and/or lateral support of the roadway structure. The Shoulder Zone is primarily intended to support motor vehicle needs but can be designed to allow walking and cycling in some contexts. In rural areas, gutters are located within the shoulder zone. See **Chapter C.4** and **Chapter D.6** for design guidance.

Additional Road Elements

Curbs separate the road zones from the sidewalk zones in urban conditions. They have practical applications as they prevent water from road run-off from entering the pedestrian space, discourage vehicles from encroaching on pedestrian space, and can facilitate road sweeping and snow clearing. Curbs can also help define the pedestrian environment within the road zone. The gutter facilitates drainage.

DEFINING THE USERS

Everyone moving about a community is an active transportation user at some point in their trip. Whether running an errand on foot, cycling to work, walking to the parking lot, or connecting to transit, each and every trip begins and ends with some form of active movement. There are characteristics about active transportation users that can be useful to design professionals when planning and designing active transportation facilities.

Trip Purpose and Characteristics

Active transportation users cannot be categorized into one homogeneous group. The users of each active mode, including people walking, cycling, and using other active modes, have different characteristics and require unique design considerations. **Table B-1** provides a high-level look at some of these user characteristics. Design professionals should consider these when designing active transportation facilities, but should note that each user group may contain a broad range of users that do not necessarily meet these descriptions.

Types of Users

General characteristics and preferences of both existing and potential active transportation users are important to understand before selecting and designing an active transportation facility. A variety of factors influence an individual's decision to travel by active transportation, such as neighbourhood characteristics, motor vehicle volumes and speeds, the quality of existing facilities, distance between destinations, and personal preferences. There are a range of existing and potential users who each may have different motivations, barriers, preferences, and needs. People who travel by active transportation can be categorized in a number of ways, including by demographics, trip purpose, or by level of experience.

Categorizing active transportation trips as 'recreation' vs. 'transportation' is discouraged, as mobility needs are similar for both groups and such categorization may be misleading. The generally accepted way to categorize people who cycle is based on people's willingness to use a bicycle for transportation. The City of Portland was the first to classify the general population into a 'bicycle rider spectrum' made up of the following four groups of bicycle users, ordered by their level of stress and risk tolerance from high to low (see **Figure B-4**):

- **Strong and Fearless** (approximately 2-6% of the population): People who are generally comfortable riding on major roads, regardless of motor vehicle volumes or speeds, weather conditions, or the presence of existing bicycle facilities. These people often prefer to use the most direct routes to their destination, regardless of whether bicycle facilities are provided.
- **Enthused and Confident** (approximately 9-28% of the population): People who are generally comfortable on most roads with bicycle facilities. These people may select a route with lower motor vehicle volumes or speeds, or separated facilities where provided, over a more direct route.
- **Interested but Concerned** (approximately 37-60% of the population): These people often own a bicycle but do not ride frequently due to concerns about the safety of cycling. They are interested in cycling more, but usually restrict their riding to roads with physically protected facilities or lower motor vehicle volumes and speeds. The 'interested but concerned' segment of the population is typically found to be the largest segment of the population in communities of all sizes and contexts. There is a significant opportunity to focus on the needs of this large market segment to achieve a substantial increase in regular bicycle ridership. To do so, many communities throughout B.C. are now focusing on developing bicycle networks with an emphasis on all ages and abilities facilities.
- **No Way, No How** (approximately 25-38% of the population): This group may be uninterested or unable to ride a bicycle, or they may perceive severe safety issues with cycling in motor vehicle traffic. A significant portion of this group will likely never choose to ride a bicycle under any circumstances, although some may eventually choose to ride given enough time and education.

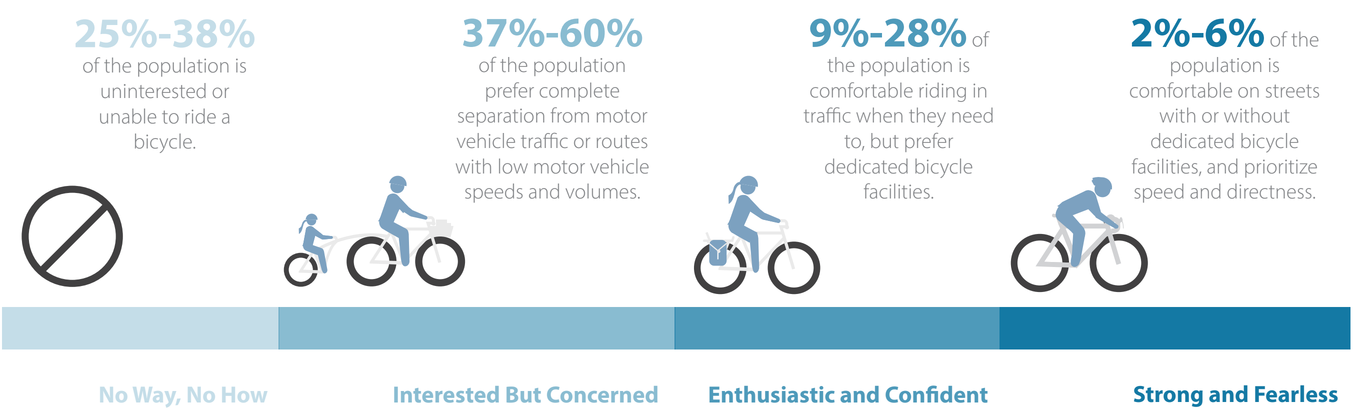


Figure B-4 // Bicycle Rider Spectrum

TABLE B-1 // TYPICAL ACTIVE TRANSPORTATION USER CHARACTERISTICS

USER GROUP	TYPICAL TRIP LENGTH	UNIQUE CONSIDERATIONS
Walking	0-2 km	▪ Includes all trip types, including errands, commuting, social, and recreation. ▪ Used for trip chaining to combine with other modes, as all trips begin or end on foot. ▪ Users include people of all ages and abilities. ▪ Special consideration needs to be given to accommodating people with visual and mobility impairments.
Cycling	2-10 km	▪ Tends to include a greater proportion of commuting trips than other modes. ▪ Also includes other trip types including recreation, errands, and social trips. ▪ Can be used for trip chaining by combining with other modes such as transit. ▪ A variety of bicycle types exist, each with unique design considerations. ▪ Electric bicycles can increase the typical trip length and expose cycling to new user types, including those with mobility impairments.
Skateboarding, in-line skating, and small, one-person electric vehicles.	0-4k m	▪ Commonly used to commute to work and school, as well as for recreation and other trip purposes. ▪ Large range of devices with diverse operating characteristics, including unique considerations such as wider operating requirements (such as in-line skating and roller skiing) or different stopping requirements. ▪ Not all of these modes are currently approved for operation on local or provincial roadways. Refer to **Chapter H.5** for further detail on micro-mobility.
Water-based active modes	0-5k m	▪ Less commonly used for transportation - most trips are recreational in nature. ▪ Devices tend to be much larger than other active mode devices, requiring parking/storage considerations. ▪ Users typically have more gear that needs storage and may require change room or locker facilities due to wet clothing.
Winter active modes	0-4k m	▪ Less commonly used for transportation – most trips are recreational in nature. ▪ Large range of winter active mode operating considerations and trip lengths. Snowshoeing, for example, is similar to walking, whereas cross-country skiing and skating have very different characteristics. ▪ Users typically have more gear that needs storage and may require change room or locker facilities due to wet clothing.

PLANNING PROCESS

Before designing individual active transportation facilities, it is important to first ensure that a long-term plan for developing the active transportation network along with support programs and policies is in place. This plan can take the form of an active transportation plan, separate bicycle and pedestrian plans, and/or be part of an integrated multi-modal transportation master plan, which includes considerations for walking, cycling, driving, transit, and goods movement. A list of high-level planning steps is provided below in order to assist planning and design professionals in beginning the process of developing a plan to promote active transportation.

- **Assess existing conditions:**
    - *Collect data (e.g. bicycle and pedestrian counts) and conduct technical analysis to understand existing baseline conditions for active transportation*
    - *Work with community officials and stakeholders to identify issues and opportunities*
    - *Identify connections that are missing or requiring improvement*
- **Establish a vision and goals:**
    - *Work with stakeholders to identify needs, priorities, and desires*
    - *Consider local and regional connections*
    - *Develop a vision statement with supporting goals and measurable targets*
- **Develop a long-term plan:**
    - *Identify significant destinations and desire lines, considering existing conditions and future land development*
    - *Explore all relevant local and regional plans and policies*
    - *Consider the transportation network as a whole, including multi-modal and regional connections*
    - *Assess local needs and draft recommendations*
    - *Work iteratively with stakeholders to achieve community validation and establish a preferred network*
- **Develop an implementation plan:**
    - *Analyze network scenarios*
    - *Assess the cost and timelines of each individual improvement*
    - *Create a project schedule, prioritizing short-, medium-, and long-term priorities, including identifying immediate needs that could be addressed through quick-build solutions*
    - *Identify key stakeholders and departments who are responsible for implementing specific parts of the plan*
- **Develop a monitoring and evaluation plan:**
    - *Establish a plan for gathering data and feedback once construction begins*
    - *Utilize the data and feedback in an iterative process to update the plan and improve the active transportation network*

NETWORK PLANNING CONSIDERATIONS

Establishing a complete, connected, and convenient network of active transportation facilities is critical to encouraging more trips by active transportation. This section describes four key factors that influence the planning, design, and ultimately, the success of an active transportation network: land use and neighbourhood design, connectivity, multi-modal integration, and topography.

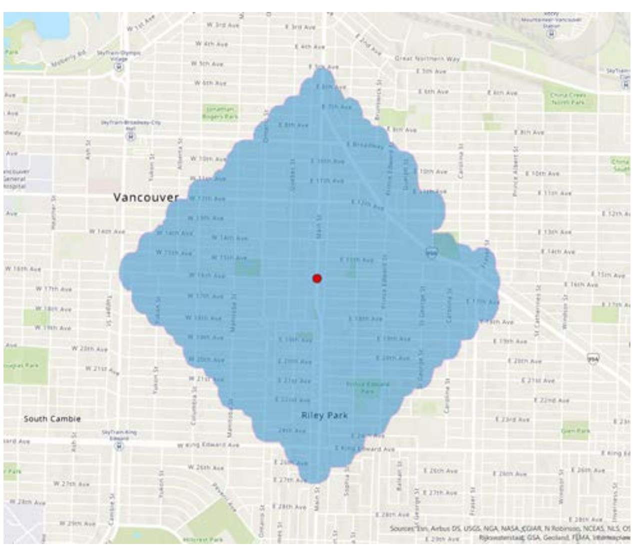
Land Use and Neighbourhood Design

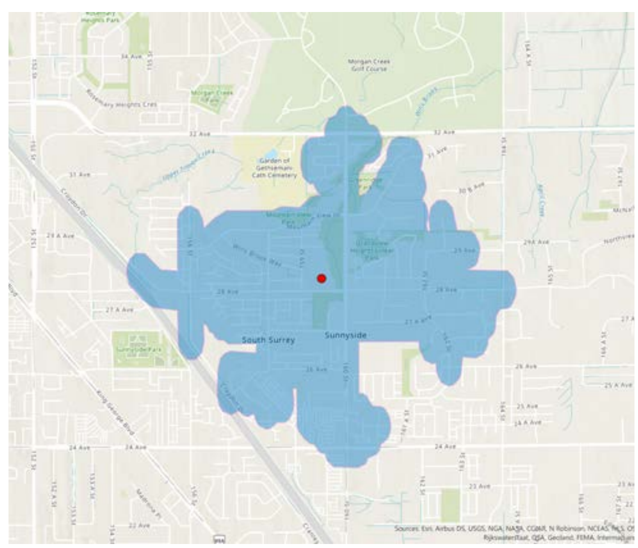
Land use is a key consideration for active transportation planning as it directly influences distances to destinations, environmental quality, and user convenience and experience. Road design and active transportation network planning should consider the type and concentration of adjacent land uses, as these factors influence how the road will be used. Key active transportation generators include: commercial areas, healthcare facilities, post-secondary institutions, and other institutions, particularly those generating employment. Schools, parks, and other community amenities are also key active transportation generators, serving as community gathering places.

Neighbourhood design is another key consideration. Active transportation use is positively associated with dense land use, especially residential and commercial density. Mixed use development also facilitates active transportation by locating destinations in closer proximity to each other, enabling people to meet their daily needs using active transportation. A compact, grid-like road network, common in larger urban centres and some smaller communities, provides greater connectivity over non-grid road networks (see **Figure B-5**). Connectivity may be improved in non-grid road layouts by providing cut-throughs (active transportation-only pathways that cut through developments, creating a short-cut between two roads).

Connectivity

A well-connected active transportation network enables users to safely and easily travel to their destinations. Block length, street and pathway network density, number of intersections, connections to off-street pathways, and the presence of well-maintained and high-quality facilities are typical measurements of transportation network connectivity. These can impact how often an individual chooses to travel by active modes. Connectivity can be broken down into four components, each of which contributes to a fully connected network:





A one-kilometre walkshed in Vancouver's grid-like Mount Pleasant neighbourhood (left) compared to a one-kilometre walkshed in Surrey's North Grandview Heights neighbourhood, which is characterized by more curvilinear, dead-end roads (right).

Figure B-5 // Neighbourhood Design and Connectivity

- **Completeness.** The active transportation network should be well-connected to let users travel virtually anywhere they need to go by active means. They should have access to all or most of the full transportation network. Any gaps identified in the active transportation network should be prioritized, especially when connecting to key destinations. A traveller encountering an unexpected gap in the network is forced to either detour to a safer route, which often requires local knowledge, or to continue through substandard or potentially hazardous conditions. Where active modes are not supported, such as along highways or freeways, alternative routes should be provided.
- **Directness.** Users should not be required to go out of their way in order to safely access their destination. Providing direct routes that connect to key destinations will ensure that active transportation – particularly cycling – is competitive with motor vehicles in terms of convenience. Communities are encouraged to develop a network comprised of primary routes and supplemented with secondary routes providing connections between dedicated bicycle facilities.
- **Density and Diversity.** Users should have a range of route options. Small blocks with frequent intersections contribute to more convenient networks. Where large blocks exist, cut-throughs can increase permeability. Research conducted by the Cycling in Cities Program at the University of British Columbia found that while comfortable cycling facilities are important, people cycling need to be able to access these routes quickly and easily. The study found that people cycling are unlikely to detour more than approximately 400 metres to find a route with a bicycle facility[1]. As a result, the study concluded that a bicycle network with designated facilities spaced a minimum of every 500 metres apart should be the goal for areas where there is a desire to increase the modal share of cycling. It has also been recommended that a dense bicycle network should be located within urban centres and areas of high cycling potential. Smaller communities should ensure routes that connect neighbourhoods or neighbouring communities include cycling facilities.
- **Comfort.** A comfortable and complete active transportation network includes a variety of facility types that appeal to a wide range of users, providing equitable and convenient access for all residents, commuters, and visitors. Ideally, active transportation users should be provided with a dedicated facility that is separated from motor vehicle traffic or that is located on a quiet street with low motor vehicle volumes and speeds (see **Research Note** on following page). Further details regarding cycling safety and route preferences is provided in **Chapter D.1**. It should also be well maintained and provide adequate lighting and sightlines, helping to alleviate personal safety concerns. The network should be universally accessible and should contribute to a pleasant travel experience.

1Meghan Winters et al., How Far Out of the Way Will We Travel?: Built Environment Influences on Route Selection for Bicycle and Car Travel (Transportation Research Board, 2010).

Research Note

Research conducted by the Cycling in Cities Program at the University of British Columbia found that most people who cycle prefer those facilities that are protected from motor vehicles or are located on quiet streets with low motor vehicle speeds and volumes[1]. These are also generally the safest type of bicycle facilities[2].

The studies from the Cycling in Cities Program found that these preferences were similar among various demographics and cycling experience levels. For example, it found that all users, including men, women, more experienced bicycle users, and less experienced bicycle users, preferred facilities that are physically separated from motor vehicle traffic or on quiet streets.

1 Chris Monsere et al., Lessons from the Green Lanes: Evaluating Protected Bike Lanes in the U.S. Final Report (Portland State University, 2014).

2 Anne Lusk et al., Risk of injury for bicycling on cycle tracks versus in the street (Injury Prevention, 2011).

Multi-Modal Integration

Not all trips are possible or desirable using active transportation. However, providing seamless integration between active transportation and other modes – especially transit – can ensure that active transportation makes up a component of the trip and encourages sustainable transportation. Refer to **Chapter H.3** for more details on multi-modal integration.

Topography

Topography is a significant factor in many B.C. communities. The coastal and mountainous geography can create appealing vistas, but it also presents significant challenges to the adoption of active transportation. Steep grades can make walking , cycling, and other forms of active transportation difficult or uncomfortable for many users. Furthermore, wet or snowy weather conditions can exacerbate the negative impacts of topography. Design professionals should strive to place active transportation facilities along less steep routes, creating routes with accessible grades wherever possible. Design guidance for mitigating the impact of topography in the pedestrian network is provided in **Chapter C.2**.

FACILITY SELECTION CONSIDERATIONS

There are a number of important context-specific considerations that go into active transportation facility selection. The selection considerations listed below apply to any type of active transportation facility and should inform the choice of facility. The final facility selection decision will also depend in part on the experience and judgement exercised by design professionals.

Refer to **Chapter C.1** for further details on pedestrian facility selection and **Chapter D.1** for further details on bicycle facility selection, including decision support tools that lay out when each type of facility is appropriate. The decision support tools in these chapters are based on the following selection considerations.

Motor Vehicle Speed and Volume

One of the biggest factors influencing the use of active modes of transportation is motor vehicle speed and volume. **Chapter B.4** outlines key safety concerns associated with motor vehicle collisions. For people walking, separation from motor vehicles is always preferred. For people cycling, different types of facilities are appropriate in different road environments. For example, on roads with low motor vehicle speeds and volumes, facilities such as neighbourhood bikeways are most appropriate. As motor vehicle speeds and volumes increase, there is an increasing preference for separation from motor vehicle traffic. Alternatively, traffic calming elements may be used to reduce motor vehicle speeds and volumes where appropriate (see **Chapter D.2**).

Road Width

Available right-of-way and road width can influence the type and design of an active transportation facility. The most cost-effective facilities in retrofit situations are implementable within the available road width and do not require any road widening. However, in new construction or reconstruction situations, it may be possible to widen the road, allowing for a more comfortable facility to be built that accommodates all users. Retrofit strategies for dealing with constrained rights-of-way are discussed later in this chapter.

Users

Wherever feasible, active transportation facilities should be universally accessible, accommodating the full spectrum of potential users with all levels of experience. Facility design should also consider the full range of active transportation devices that must be accommodated on that facility (see **Chapter B.4**). Consideration should be given to the skills, needs, and preferences of the types of users who are anticipated to use the facility. For example, facilities near parks, schools, and residential neighbourhoods are likely to attract a higher percentage of recreational users and children, who prefer a greater degree of separation from high motor vehicle speeds and volumes. The majority of the population falls into the 'interested but concerned' category of bicycle users. As such, this group is the preferred design user group, especially in urban and suburban contexts as well as developed rural cores.

On-Street Motor Vehicle Parking

The presence of on-street motor vehicle parking can provide a buffer between the Traffic Zone and the Pedestrian Through Zone, which can be beneficial to people walking. However, the turnover and density of on-street parking can negatively impact cycling safety due to the potential for motor vehicle doors opening into the Bicycle Through Zone or the potential for motor vehicles to pull in or out of a parking space. Safety concerns can be mitigated by considering the removal or consolidation of on-street parking where possible, or by ensuring there is sufficient buffer space to avoid the risk of motor vehicle doors opening into the path of people cycling. Moving people who cycle off-road, or positioning them between the parking lane and the sidewalk, can also decrease risk and increase user comfort.

Truck and Bus Traffic

The presence of trucks, buses, and other large, heavy vehicles can cause unique challenges for active transportation users, especially people cycling. Where heavy vehicles make up more than 5% of motor vehicle traffic, consideration should be given to providing increased separation between people cycling and motor vehicles or providing alternative routes for active transportation. Potential conflicts at loading zones and transit stops, in addition to pavement deterioration, should also be considered.

Conflict Points

Intersections, crossings, and transition points present potential conflict points between users. A high percentage of collisions involving active transportation users occur at these conflict points; therefore, it is vital to give careful design consideration to mitigating these conflicts. Facility selection should consider strategies to minimize exposure to conflicts wherever possible. Some facility types, such as bi-directional protected bicycle lanes and off-road facilities, are less appropriate where there are a high number of crossing points. See **Section G** for a variety of strategies for minimizing conflicts at intersections.

Aesthetics

Providing attractive facilities can help attract users and promote active transportation. Certain facility types provide greater opportunity for aesthetic improvements – for example, planters can be used along the Street Buffer Zone, and pedestrian facilities can include creative pavement decorations. Street trees provide aesthetic appeal while also providing a windbreak and shade. Aesthetic elements must not restrict sightlines or become a distraction to other road users.

Costs/Funding

Facility selection will normally involve a cost analysis of alternatives, and the availability of funding may limit the types of facility that can be considered. The decision to implement an active transportation facility should be made with a commitment to properly design and construct the facility, in addition to a conscious, long-term commitment to proper maintenance. When funding is limited, lower-cost improvements such as signage, pavement markings, and low-cost traffic calming measures may be more feasible and should be considered instead of not providing facilities.

Maintenance

All-season maintenance is a key component of a safe and comfortable active transportation facility. At the outset of the design process, maintenance requirements should be considered, including noting local conditions and maintenance practices. Active transportation facilities that facilitate and simplify maintenance will help ensure effective use of the facility throughout the year. Refer to **Chapter I.3** for more detail on maintenance.

Land Use Context

Land use is a key consideration for both network planning and facility selection. The predominant land use (commercial, residential, industrial, etc.) as well as the greater context (urban, suburban, or rural) should be considered.

RETROFIT STRATEGIES

Retrofitting existing roads to add or improve active transportation facilities can be a challenge that often involves working within constrained conditions. Design professionals should evaluate trade-offs to come up with a feasible solution that best accommodates all modes of transportation that are using the road. Note that there are minimum design criteria (such as travel lane widths for each road class) that need to be met in order for each transportation mode to function safely and efficiently. When considering facility retrofits, design professionals should apply sound professional judgement and should reference the TAC *Geometric Design Guide for Canadian Roads*, the MOTI *B.C. Supplement to TAC Geometric Design Guide* and any other applicable local, provincial, or national design standards to ensure that retrofits continue to meet minimum standards. Different considerations may be required on local and provincial rights-of-way.

When faced with limited right-of-way, one or more of the following strategies can be used to make room for active transportation facilities:

Reduce Lane Widths

Where appropriate, lane widths within the Traffic Zone may be reduced. In addition to providing additional space for active transportation facilities, narrower lane widths result in reduced crossing distances, increased visibility of active transportation users, and slower motor vehicle travel speeds. Wider travel lanes are correlated with faster motor vehicle speeds, with each additional 0.1 metre of lane width resulting in faster travel speeds of approximately 1.5 km/h[2]. Therefore, narrowed travel lanes can reduce motor vehicle travel speeds and are an asset for increasing safety for other modes.

While narrower lanes can be beneficial for active transportation, careful consideration is required before reducing lane widths. Design professionals should consider the road class, motor vehicle speeds and volumes, and required design vehicle. When reducing lane widths, special consideration should be given to larger, heavy vehicles such as buses, trucks, and emergency vehicles.

Travel lane widths for motor vehicle traffic are context specific and can vary from community to community and setting to setting. Motor vehicles can operate within lanes as narrow as 3.0 metres. However, trucks and transit vehicles typically require a lane width of at least 3.3 metres. In many cases, a hybrid approach is feasible whereby inner lanes are reduced to approximately 3.0 metres and wider curbside lanes are maintained for large vehicle access. If a design is located on a transit route, design professionals should consult with the local transit agency to confirm minimum lane width requirements and that the design will not adversely impact transit operations.

Reduce the Number of Lanes

Reducing the number of travel lanes can free up space to create active transportation facilities, but may impact motor vehicle traffic operations and transit operations. Design professionals should analyze current and projected motor vehicle volumes along the corridor prior to reducing the number of lanes and should consider the potential of motor vehicle traffic shifting to adjacent roads. If a design is located on a transit route, design professionals should consult with the local transit agency to confirm that the design will not adversely impact transit operations.

Remove On-Street Parking

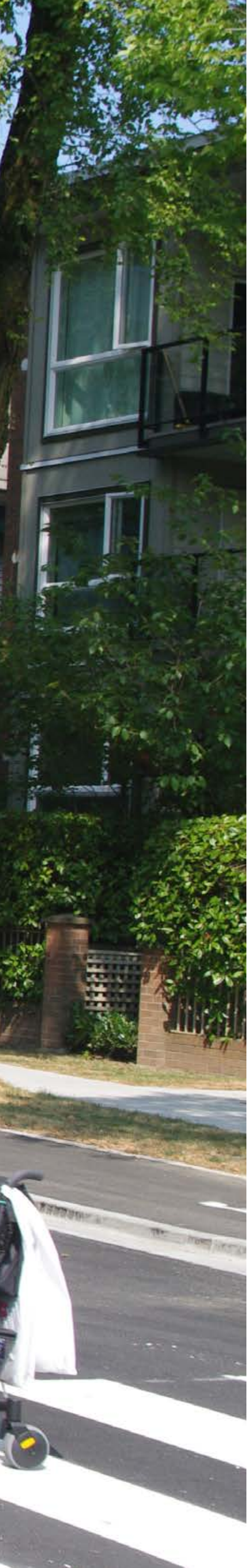
On-street parking may be repurposed as active transportation facilities. A parking assessment should be completed prior to removal. The parking assessment should analyze current parking usage and existing or potential on- and off-road parking capacity in the surrounding area. The removal of on-street parking can be controversial, especially in residential and commercial areas. However, by assessing parking demand and identifying alternatives, design professionals can mitigate negative impacts and community push back.

Widen the Roadway

Before widening the roadway, it is recommended that the above three strategies are considered first, especially where wide travel lanes exist. The most cost-effective facilities in retrofit situations are implemented within the existing roadway. However, in new construction or reconstruction situations, it may be possible to widen the roadway, allowing for a more comfortable active transportation facility to be built that accommodates all users. Widening the roadway may not be possible due to a number of constraints, including topography and right-of-way constraints.

2 K. Fitzpatrick et al., Design Factors That Affect Driver Speed on Suburban Streets (Transportation Research Record: Journal of the Transportation Research Board, 2000).

West 10th Avenue, Vancouver, B.C.



B.3

UNIVERSAL DESIGN

Universal design ensures that the built environment is accessible to people of all ages and abilities, regardless of any type of physical or cognitive impairment. Universal design is a fundamental design principle that should be applied in all contexts but is especially important for designing active transportation facilities and accommodating people walking.

This chapter describes the importance of providing universal accessibility and introduces key universal design principles and strategies. It also provides an overview of the various accessibility challenges that should be considered in the design of active transportation facilities, including impairments to mobility, vision, hearing, comprehension, and strength and dexterity.

UNIVERSAL DESIGN: INCLUSION FOR ALL

The goal of universal design, which is also referred to as barrier-free or inclusive design, is quite simply 'inclusion for all.' Universal design principles should be applied in all types of planning and design, including the design of active transportation facilities. Article 2 of the *United Nations Convention on the Rights of Persons with Disabilities* (ratified by the Government of Canada in 2010) defines universal design.

What is Universal Design?

'Universal design' means the design of products, environments, programs and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. 'Universal design' shall not exclude assistive devices for particular groups of persons with disabilities where this is needed.

Universal design can be applied to any design activity, program, service, or business practice where people interact with the physical, virtual, or social environment. The underlying concept of universal design is that when the environment is designed to be universally accessible, everyone benefits. It is important to note that universal design should not be treated as a special requirement for only a small group of people. According to the Rick Hansen Foundation, one in seven Canadians currently lives with a disability that impacts their mobility, vision, or hearing.[1] As the population ages, this number is predicted to rise to one in five within the next 20 years. Therefore, creating universally accessible active transportation networks is crucial for enabling Canadians to live active lives.

Universal Design Principles

There are seven guiding principles for universal design (see **Table B-2**), which were conceived by a working group of designers, architects, and researchers led by architect and accessibility advocate Ronald Mace.[2] These principles apply to indoor and outdoor environments as well as product design and communications.

Universal Design In Active Transportation

In the design of active transportation facilities, the most relevant universal design principles are those related to outdoor circulation, spaces, and amenities pertaining to the transportation network, with a focus on the pedestrian realm. There are numerous examples of universal design in the design of active transportation facilities. For example, curb ramps are intended primarily to provide road access for wheelchair users. However, they also benefit parents with strollers, people pulling luggage or delivery carts, small children cycling, seniors using walkers, and many others who may not have been the original impetus for the design. There are a variety of other examples of universally designed products and environments, including automatic doors, lever door handles, and smooth walking surfaces.

Currently, there are no national or provincial universal design standards for the design of accessible active transportation facilities. However, there are a number of resources that provide excellent guidance, including guidelines developed by standards associations, agencies, non-profit associations, and municipalities. The TAC *Geometric Design Guide for Canadian Roads* and *Pedestrian Crossing Control Guide* consider accessibility in their design recommendations.

Another key guiding document is the *Standard B651-18: Accessible Design for the Built Environment*. These standards were authored by the CSA, an independent

1 'Become Accessible,' Rick Hansen Foundation, accessed May 21, 2019, *https://www.rickhansen.com/become-accessible*

2 'About UDI,' RL Mace Universal Design Institute, accessed May 21, 2019, *https://www.udinstitute.org/about*

TABLE B-2 // UNIVERSAL DESIGN PRINCIPLES

PRINCIPLE	GUIDELINES
1: Equitable Use The design is useful and marketable to people with diverse abilities.	▪ Provide the same means of use for all users: identical whenever possible; equivalent when not. ▪ Avoid segregating or stigmatizing any users. ▪ Provisions for privacy, security, and safety equally available to all users. ▪ Make the design appealing to all users.
2: Flexibility in Use The design accommodates a wide range of individual preferences and abilities.	▪ Provide choice in methods of use. ▪ Accommodate right- or left-handed access and use. ▪ Facilitate the user's accuracy and precision. ▪ Provide adaptability to the user's pace.
3: Simple and Intuitive Use Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.	▪ Eliminate unnecessary complexity. ▪ Be consistent with user expectations and intuition. ▪ Accommodate a wide range of literacy and language skills. ▪ Arrange information consistent with its importance. ▪ Provide effective prompting and feedback during and after task completion.
4: Perceptible Information The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.	▪ Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information. ▪ Provide adequate contrast between essential information and its surroundings. ▪ Maximize 'legibility' of essential information. ▪ Differentiate elements in ways that can be described (e.g. make it easy to give instructions or directions). ▪ Provide compatibility with a variety of techniques or devices used by people with sensory limitations.
5: Tolerance for Error The design minimizes hazards and the adverse consequences of accidental or unintended actions.	▪ Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded. ▪ Provide warnings of hazards and errors. ▪ Provide fail safe features. ▪ Discourage unconscious action in tasks that require vigilance.
6: Low Physical Effort The design can be used efficiently and comfortably and with a minimum of fatigue.	▪ Allow user to maintain a neutral body position. ▪ Use reasonable operating forces. ▪ Minimize repetitive actions. ▪ Minimize sustained physical effort.
7: Size and Space for Approach and Use Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.	▪ Provide a clear line of sight to important elements for seated or standing users. ▪ Make reach to all components comfortable for any seated or standing user. ▪ Accommodate variations in hand and grip size. ▪ Provide adequate space for the use of assistive devices or personal assistance.

organization that publishes building, equipment, and construction standards that may be used as the basis for building bylaws and provincial building codes. Universal design principles, including recommendations from TAC and CSA, have been woven into the design recommendations provided throughout the Design Guide.

Context-specific trade-offs and considerations are necessary when designing facilities in order to achieve the highest possible level of accessibility for active transportation facilities. Design professionals are encouraged to aim for the highest level of universal accessibility. However, it may not always be feasible to meet every universal design principle. There are three levels of accessibility that may be considered:

- **Basic Access Requirements**: Design considers safety and liability issues, seeks to comply with the current geometric design and/or building code access requirements, and aims to provide meaningful basic access.
- **Inclusive Access Requirements**: Design is intended to address important issues that are not covered by current building code access requirements, plus additional, cost-effective measures to improve access across the full range of disability groups.
- **Full Access Strategy**: Identifies a best practice approach specific to the project needs and goals through a combination of national and international guidelines and standards, community preferences, and the practical application of universal design.

While universal design strategies have been imbedded throughout the Design Guide, it should be noted that the strategies listed do not cover every possible access feature that could be deployed. Design professionals should consider all best practice accessibility resources when designing a facility and should work with stakeholders in the disability community to test out designs.

ACCESSIBILITY CHALLENGES

Universal design covers people of all ages and abilities, with a focus on those people facing accessibility challenges in the transportation network. Universal design is not simply about mobility (such as wheelchair access) – there are other physical, sensory, and cognitive challenges that should be considered. It is important to understand the capabilities and traits of a facility's expected users in order to determine how to best to meet their needs. Design professionals should strive to ensure that when a barrier is removed for one group, a new barrier is not being introduced to a different group. Accommodating people with disabilities is a core component of universal design. 'Disabilities' is an umbrella term covering impairments, activity limitations, and participation restrictions:

- An **impairment** is a problem in body function or structure;
- An **activity limitation** is a difficulty encountered by an individual in executing a task or action; and
- A **participation restriction** is a problem experienced by an individual during involvement in day to day situations.

Disability is thus not just a health problem – it is a complex phenomenon reflecting the interaction between features of a person's body and features of the society in which that person lives. Overcoming the difficulties faced by people with disabilities requires interventions to remove environmental and social barriers. Universal design also considers people who may not conventionally be considered disabled but who still encounter barriers to movement. For example, children may have difficulty navigating the active transportation network due to their smaller size, slower walking speed, and developing depth perception and decision-making capabilities.

The following section describes some of the key aspects that can limit ease of movement through the public realm.

Mobility

Locomotion difficulties are a common impairment, especially among older demographics. This group includes:

- People who use mobility devices such as wheelchairs and mobility scooters;
- People who can walk but require an aid such as a cane or walker; and
- People who may walk without an aid but require frequent rests.

Table B-3 summarizes the recommended distance between resting spots for different groups[3]. Weather conditions, gradients, and the presence of supports such as hand rails can also influence walking distances. The provision of resting spots with accessible seating is crucial. Standing for prolonged periods may also be difficult for many people, so consideration should be given to providing seating along pedestrian routes and anywhere that people have to wait, such as at transit stops.

Table B-3 // Typical Walking Distances Between Resting Spots

GROUP	RECOMMENDED DISTANCE BETWEEN RESTING SPOTS (METRES)
Mobility impaired people using a cane	50
Mobility impaired people without walking aid	100
Wheelchair users	150
Visually impaired people	150

Walking speed is another important mobility consideration for universal design, especially at road crossings. **Chapter B.4** outlines typical travel speeds for adults, children, and people using mobility devices. Crossing times should consider the slowest user, providing ample time to safely cross the road (see **Chapter G.2**). Design elements such as curb extensions and median refuge islands may be used to shorten crossing distances and allow people walking to cross the road in stages (see **Chapter G.3**).

Vision

Vision impairments exist on a spectrum from completely blind to partially-sighted, with variations including: limited field of vision, loss of central vision, loss of peripheral vision, night blindness, and loss of overall acuity (blurriness). Approximately 85% of people who are classified as legally blind possess some remaining vision[4].

Vision impairments reduce a person's ability to see or identify objects that are necessary for navigating the road, including traffic signs and signals, crosswalks, obstructions, and other road users. Vision impairments may impact depth perception, the ability to judge the speed of bicycles and motor vehicles, and the ability to see colour or visual contrast. This can make it challenging to identify tripping hazards and different pavement materials. Vision impairments can also affect a person's ability to negotiate movement with other road users, as interactions between users are often communicated through eye contact, hand gestures, and other visual forms of communication.

3 City of Vancouver, Engineering Design Manual, 1st ed. (2018), accessed May 21, 2019, *https://bids.vancouver.ca/bidopp/RFA/Documents/PS20181461-CityofVancouver-EngineeringDesignManualFirstEdition2018.PDF*

4 Federal Highway Administration, Accessible Shared Streets – Notable Practices and Considerations for Accommodating Pedestrians with Vision Disabilities (U.S. Department of Transportation, 2017).

People with vision impairments rely on a variety of non-visual strategies to navigate roads and public spaces, including:

- **Touch**: 'shorelining' by following detectable edges. Detectable edges include building faces, curbs, score lines, or tactile walking surface indicators. Touch can also include identifying curb ramps, driveway slopes, and different pavement materials under foot or cane.
- **Audible information**: navigating by sounds produced by motor vehicles and active transportation users, echolocation, and accessible pedestrian signals.
- Noting the **direction of sun or wind** to maintain orientation.
- **Visual contrast** based on tone or colour.

Visually impaired people may also use navigational aids, including:

- Long white canes;
- Guide dogs;
- Human guides;
- Telescopes and low vision aids (for reading signs); and
- Emerging techniques (digital wayfinding applications and hand-held ultrasonic echo-location devices).

Shared streets and open plazas may present navigational challenges due to the atypical road layout and the lack of curb or other detectable edge (see **Chapter E.4**). Skewed or non-standard intersections may also be problematic for people with visual impairments, as motor vehicle traffic may not be travelling perpendicular to pedestrian crossings. Additionally, the inconsistent application of detectable edges such as tactile walking surface indicators (see page B4139) makes it challenging to rely on these for navigation.

Hearing

According to the World Health Organization, 'normal hearing' is defined as hearing thresholds of 25 dB or better in both ears.[5] Anyone who is not able to hear as well as someone with normal hearing is said to have hearing loss. Hearing impairments may be mild, moderate, severe, or profound. People who are 'deaf' typically have profound hearing loss, which implies little or no ability to hear. Hearing impairments make it more difficult for people to communicate with each other as they travel and to detect other road users, such as fast-moving bicycles and motor vehicles.

Strength and Dexterity

Many people experience challenges related to reaching, stretching, dexterity, and strength, frequently as a result of arthritis, muscular dystrophy, or nervous system complaints. Strength and dexterity challenges can influence the design of pedestrian amenities and accessibility treatments. Examples of designs to avoid include pedestrian signals with pressure resistance on call buttons and non-graspable hand rails.

Comprehension

People with cognitive impairments or learning disabilities may encounter difficulties interpreting signage, wayfinding, and other complicated information or using machines such as transit ticket machines. The same may be true for people with language barriers. Active transportation facilities should be designed to be intuitive and easy to navigate, with layers of information provided to aid navigation without too much complexity in colour patterns.

5 World Health Organization, *Deafness and hearing loss* (World Health Organization, 2019).

UNIVERSAL ACCESSIBILITY DESIGN TOOLBOX

A number of design elements may be used to make active transportation facilities universally accessible, including mobility, tactile, audible, and visual aids. These elements are introduced here and have been embedded in design recommendations throughout the Design Guide.

Mobility

Universally accessible facilities need to accommodate people using mobility devices such as wheelchairs, walkers, canes, and mobility scooters. This requires:

- Providing **accessible slopes and grades**, with appropriate landing areas and resting spots;
- Providing **accessible ramps** where applicable;
- Ensuring that **surfaces** are smooth, firm, slip-resistant, and free of tripping hazards;
- Providing **curb ramps** for road access;
- Maintaining a **Pedestrian Through Zone** that is clear of vertical and horizontal obstructions; and
- Providing **year-round monitoring and maintenance**.

Section C provides detailed guidance on pedestrian facilities, covering most of these elements. **Chapter I.3** provides guidance on with maintenance, while **Chapter G.6** provides guidance on ramps and staircases.

Langley City, B.C.

Tactile

Detectable Warning Surfaces

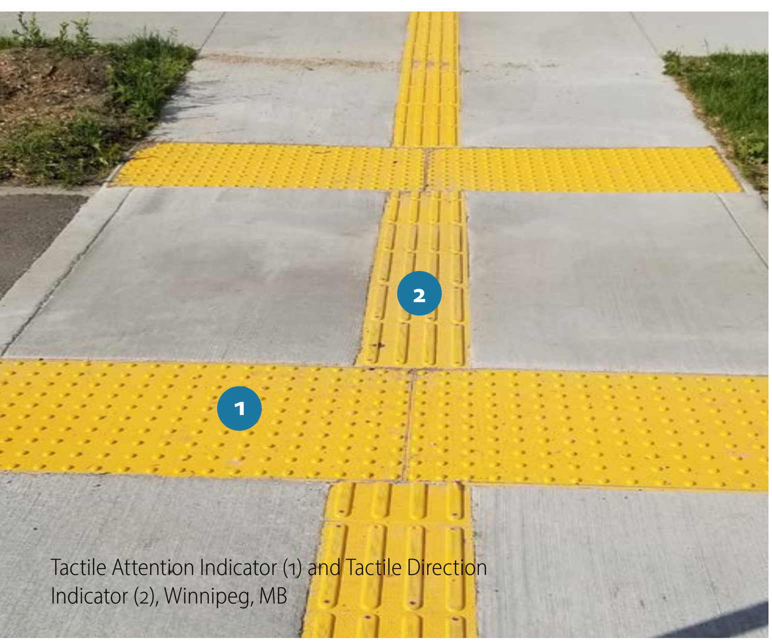
Detectable warning surfaces are detectable underfoot or by a cane and alert and/or guide people with blindness or low vision. Tactile walking surface indicators (TWSIs) are recommended by the CSA as the standardized detectable warning surface treatment. CSA Standard *B651-18: Accessible Design for the Built Environment* provides detailed guidance on TWSI construction and placement. TWSIs should have a visual contrast of 75% from the pavement (yellow is typically used). They are most effective when placed adjacent to smooth pavement so that the difference is easily detected. There are two types of TWSIs, each with distinct functions, as described below. They should not be used interchangeably.

1 **Tactile Attention Indicator**: A TWSI comprising truncated domes that alert people of an impending change in elevation, conflicts with other transportation modes, and/or other potential hazards. Locations where tactile attention indicators may be appropriate include:

- *The base of curb ramps;*
- *The edge of depressed corners;*
- *The border of medians;*
- *The border of raised crosswalks and intersections;*
- *The edge of transit platforms; and*
- *Rail crossings.*

2 **Tactile Direction Indicator**: A TWSI that uses elongated, flat-topped bars to facilitate wayfinding in open areas. The elongated bars indicate the travel direction. Locations where tactile direction indicators may be appropriate include:

- *Inside transit stations;*
- *At the boarding area at transit stops;*
- *Comprehensively on sidewalks, especially in high traffic areas; and*
- *In open spaces such as shared streets and plazas, where there is no curb or other standard navigational elements.*



Tactile Attention Indicator (1) and Tactile Direction Indicator (2), Winnipeg, MB


Tactile walking surface indicators at floating transit stop, McDermot Avenue, Winnipeg, MB

Score Lines

Score lines, also known as parallel grooves, are a series of parallel lines that are embedded or troweled into concrete pavement. These are detectable under foot or cane and are used on curb ramps, driveway ramps, and alleyway crossings. Score lines provide directional wayfinding for people who are visually impaired. The score lines should be aligned with the crosswalk and the receiving curb ramp, ensuring that visually impaired people are guided in the correct direction. They may be used in conjunction with other tactile guidance, such as TWSIs.

Tactile Wayfinding Information

Static tactile information consisting of braille or raised map elements may be used on signage and wayfinding to allow use by visually impaired people. Static tactile information may be used in conjunction with large font and high colour contrast.

Visual

Signage, pavement markings, and wayfinding are important tools for visual navigation and are described in **Chapter H.3**. Contrasting pavement materials may also be used to differentiate between different road zones (see **Chapters C.2** and **C.3**). Countdown timers may be installed at crosswalks to show pedestrians how long they have to cross the road (see **Chapter G.2**). Finally, wherever feasible, adequate lighting is recommended along all active transportation facilities (see **Chapter H.4**). Road lighting may be augmented with LED surface or guidance indicators in areas such as crosswalks.

Audible

Audible pedestrian signals that make sounds to indicate when to cross a road are designed to help visually impaired people to safely navigate intersections. Audible pedestrian signals are a universal design element that benefits all users. See **Chapter G.2** for guidance on signals. Emerging technologies such as digital navigation aids are increasingly being used to help visually impaired people navigate by giving audible GIS-based wayfinding updates. Communities can help to improve the accuracy of these devices by ensuring that on-line GIS databases are accurate and up to date.


Score lines on curb ramp, Vancouver, B.C.

Audible pedestrian signal and countdown timer, Vancouver, B.C.

Traffic circle on a neighbourhood bikeway in Vancouver, B.C.
Source: Modacity

B.4

OPERATIONAL AND BEHAVIOURAL CHARACTERISTICS

This chapter introduces the safety considerations surrounding active transportation planning and design, including traffic safety and personal safety. It then describes the operational and behavioural characteristics for people walking, cycling, and using other forms of active transportation. This includes details on the design user concept, operating space requirements, clearance from obstructions, performance characteristics, and operating speed for a variety of active modes. Finally, this chapter explains how measurements are calculated throughout the Design Guide.

SAFETY CONSIDERATIONS

Safety concerns can be a significant barrier to active transportation. Mitigating safety concerns, both substantive and perceived, should be a priority when planning and designing active transportation facilities. **Substantive safety** refers to collision, injury, fatality, and crime rates; whereas **perceived safety** refers to individual risk tolerance and stress levels, which can vary from person to person. Design professionals should consider substantive and perceived concerns related to both traffic safety (such as the risk of motor vehicle collisions) and personal safety (such as crime-related concerns). Safety should be emphasized for people of all ages and abilities, at all times of the day, and in all weather conditions.

Traffic Safety

The largest safety risk associated with active transportation is the potential for collisions between motor vehicles and people walking, cycling, or using other forms of active transportation. In a collision, the risk of serious injury and death is directly correlated to the speed, weight, and size of the parties involved. When speeds are greater and there is a larger speed or weight differential, the likelihood of serious injury or death increases.

Research has shown that the severity of collisions involving vulnerable road users and motor vehicles increases greatly with motor vehicle speed.[6] This is outlined in **Figure B-6**, which shows the likelihood of pedestrian fatality when hit by a motor vehicle travelling at various speeds. Collisions at 30 km/h or less correlate with a lower probability of death (10%), whereas at motor vehicle speeds above 40 km/h, the probability of death increases significantly. Furthermore, collisions between pedestrians and light trucks have an additional severity equivalent to being hit by a passenger car travelling approximately 10% faster.[7] Larger motor vehicles such as buses and full-sized trucks present even greater risks for active transportation users.

Developing designs that are simple and intuitive tends to facilitate predictable movements among all road users. Other strategies for reducing both substantive and perceived safety concerns along active transportation facilities include:

- **Managing motor vehicle speeds and volumes**;
- Providing **physical separation between users** – generally, as speed differentials increase, separation between users should increase and conflicting movements should be more strongly controlled and clearly delineated;
- Improving **intersections and crossings**, and reducing conflict zones (see **Section G**);
- Providing **adequate lighting** for all modes for guidance and wayfinding;
- **Maintaining transportation facilities** in all seasons to avoid build up of snow, ice, wet plant matter, gravel, and debris; and
- Providing **accessible slopes and clear travel paths** that are free of obstructions and tripping hazards.

Collisions between people walking and faster-moving active transportation users such as people cycling should also be considered. While the risk of severe injury and death is lower than when motor vehicles are involved, the speed and mass differential between people cycling and people walking can still be significant. Separating slower and faster active transportation users can help prevent or reduce severity of collisions. Refer to **Section E** for design guidance on when and how to separate active transportation users on multi-use facilities.

6 Dewan Karim, Narrower Lanes, Safer Roads (Regina: Canadian Institute of Transportation Engineers, 2015).

7 American Automobile Association, Impact Speed and a Pedestrian's Risk of Severe Injury or Death (Heathrow FL: American Automobile Association, 2011).

Personal Safety

Concerns over personal safety can be a barrier to active transportation, especially walking. Crime prevention through environmental design (CPTED) is a suite of design strategies that can reduce the threat of crime to those travelling by active means. CPTED reduces the opportunity for crime to occur and increases both substantive and perceived safety, which in turn promotes active transportation as a safe and attractive mobility option. Special considerations for lighting, sightlines, fencing, and maintenance are important in designing active transportation facilities.

Neighbourhood and building design can also have a significant impact on personal safety. One of the most important components of personal safety is providing passive surveillance. This involves ensuring that there are 'eyes on the street' and enough people around to dissuade criminal activity. Placing active transportation facilities in active, lively areas can create safer facilities. Furthermore, urban planning that promotes mixed-use development and road-facing buildings, with windows looking out onto the road and activity at all times of day, can ensure that passive surveillance occurs even when people are indoors.

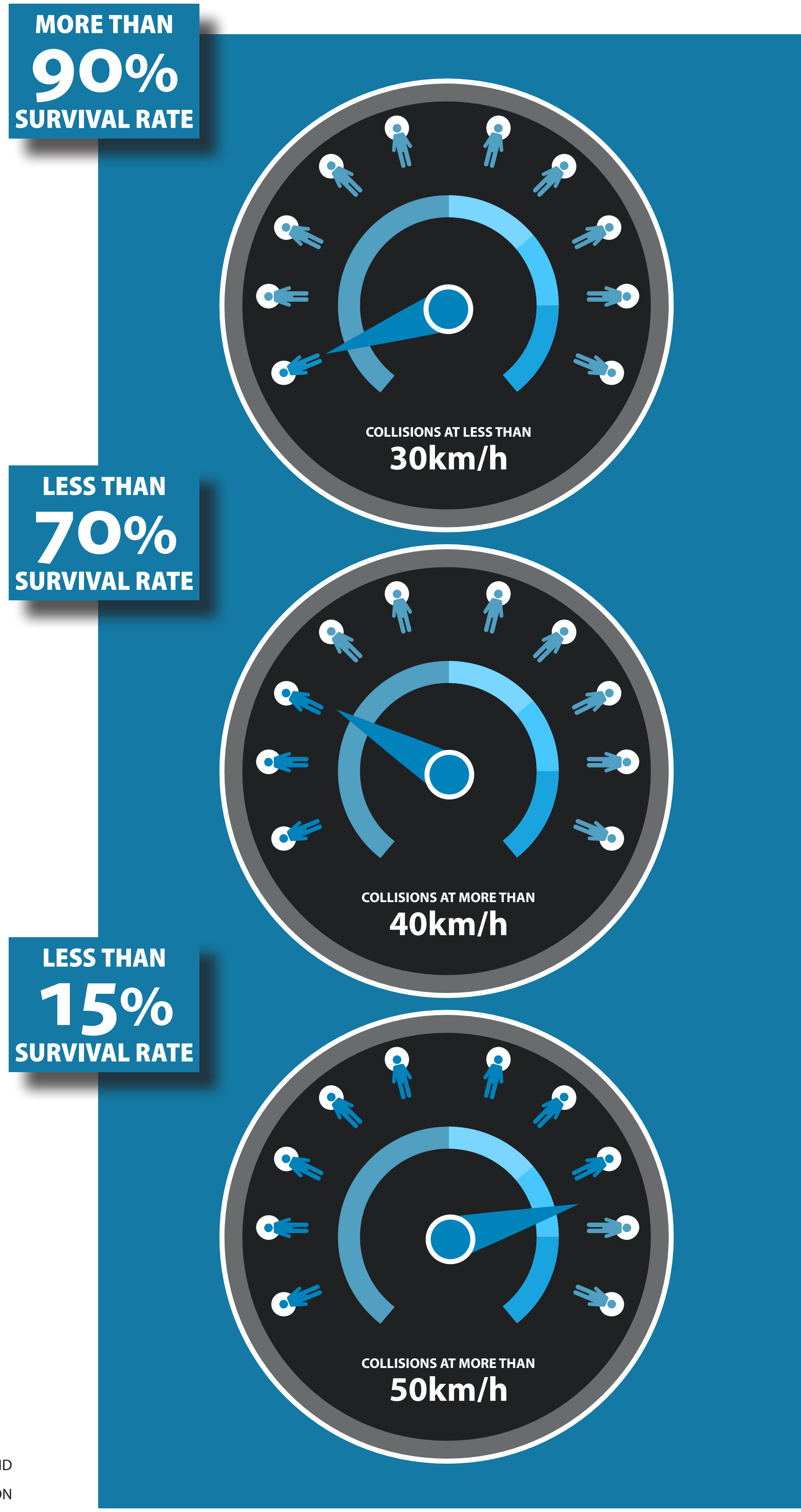


Figure B-6 // Relationship Between Motor Vehicle Speed and Pedestrian Fatality Risk in a Collision

OPERATIONAL AND BEHAVIOURAL CHARACTERISTICS

This section introduces the concept of design domain and summarizes active transportation user operating space, behavioural characteristics, and design considerations.

Design Domain

The design domain is a concept used in the TAC *Geometric Design Guide for Canadian Roads* that provides a range of values describing the fitness-for-purpose of the design element. The value chosen for construction will have unique benefits and constraints in terms of operational performance, user experience, and construction and maintenance costs. While all values within the range of design domain are acceptable, some may be better than others for a given situation. The TAC *Geometric Design Guide for Canadian Roads* includes four levels within the design domain: practical lower limit, recommended lower limit, recommended upper limit, and practical upper limit.

For the purposes of the Design Guide, the primary focus is on those levels that TAC identifies to be part of the recommended lower limit (referred to as **constrained limit** in the Design Guide) or recommended higher limit (referred to as **desirable** in the Design Guide). Although the preference is to remain within this range of values, the Design Guide also outlines **minimum** values that should only be considered in exceptional circumstances. Refer to **Chapter A.1** for more discussion surrounding these three levels and the use of professional judgement in facility design.

For cases where one or more design elements fall outside the recommended design domain values, a design exception may be required, depending on the community's approving authority. Further details regarding the design domain concept as well as the criteria and process for identifying design exceptions are provided in Chapter 1 of the TAC *Geometric Design Guide for Canadian Roads*. The design exception process for roadways under provincial jurisdiction is outlined in the MOTI *Design Exception Process Technical Circular T-05/18*.

Design User and Operating Space

A 'design vehicle' is the vehicle whose dimensions and speed potential are used to dictate the minimum design requirements for a given road or facility. A 'design user' is the person operating the vehicle, or in the case of people walking without a vehicle or mobility device, simply refers to the person. When designing an active transportation facility, the design vehicle – or design user – should be determined based on the expected user of the facility.

People Walking

In the case of pedestrian facilities, people walking and using mobility devices are the design users. This covers a large range of people of all sizes, ages, and abilities. **Figure B-7** shows the typical physical space taken up by an adult walking.

People using manual wheelchairs, electric wheelchairs, and mobility scooters may require special consideration in order to create universally accessible facilities. A person using a mobility device will have a

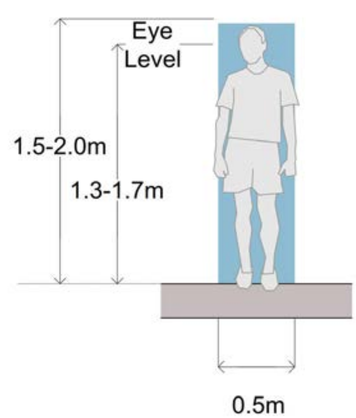


Figure B-7 // Typical Dimensions of an Adult Pedestrian lower eye level and a limited forward and side reach, which should be considered when placing objects such as a pedestrian activated signal.

The design width of a person using a manual wheelchair is 0.75 metres, although a minimum floor area of 0.8 metres is required to accommodate the hand motion that propels the wheelchair. Electric wheelchairs and mobility scooters are typically 0.8 metres wide and are often longer than manual wheelchairs. Mobility scooters have a typical length of 1.35 metres. However, the CSA recommends using a footprint that is 1.5 metres long to accommodate all mobility scooters, as these devices are increasingly getting larger.

In addition to the physical height and the width of the user and their device (if applicable), the required horizontal and vertical operating envelopes should be considered. Furthermore, turning area is a key consideration for wheelchair and mobility scooter users.

Figure B-8 illustrates the typical horizontal and vertical operating envelopes for people walking. The vertical operating envelope for a pedestrian is 2.1 metres. The horizontal operating envelope for an adult is 0.75 metres, which accounts for lateral sway when walking.

People with shopping bags, pushing a stroller, or using a guide cane have horizontal operating envelopes between 0.9 and 1.0 metres. An adult walking with a child, a service animal, or large luggage can take up to 1.2 metres of horizontal space.

Pedestrian facilities should be wide enough to allow people to walk side-by-side or pass one another. Two adults walking side-by-side have an operating envelope of 1.5 to 1.8 metres. The lower end of this range is the minimum physical operating space, while the upper end of the range accounts for providing personal space. Personal space preferences are highly variable, but proxemics (personal space) research indicates that designing for 0.8 metres of personal space between people walking is typically appropriate.[8] Three people walking side-by-side have a horizontal envelope of 2.25 to 3.0 metres.

8 Edward Hall, The Hidden Dimension (Garden City NY: Random House Inc., 1966); Anna Frohnwieser, Richard Hopf, and Elisabeth Oberzaucher, Human Walking Behaviour: the Effect of Pedestrian Flow and Personal Space Invasions on Walking Speed and Direction (Human Ethology Bulletin, 2013), 20-287

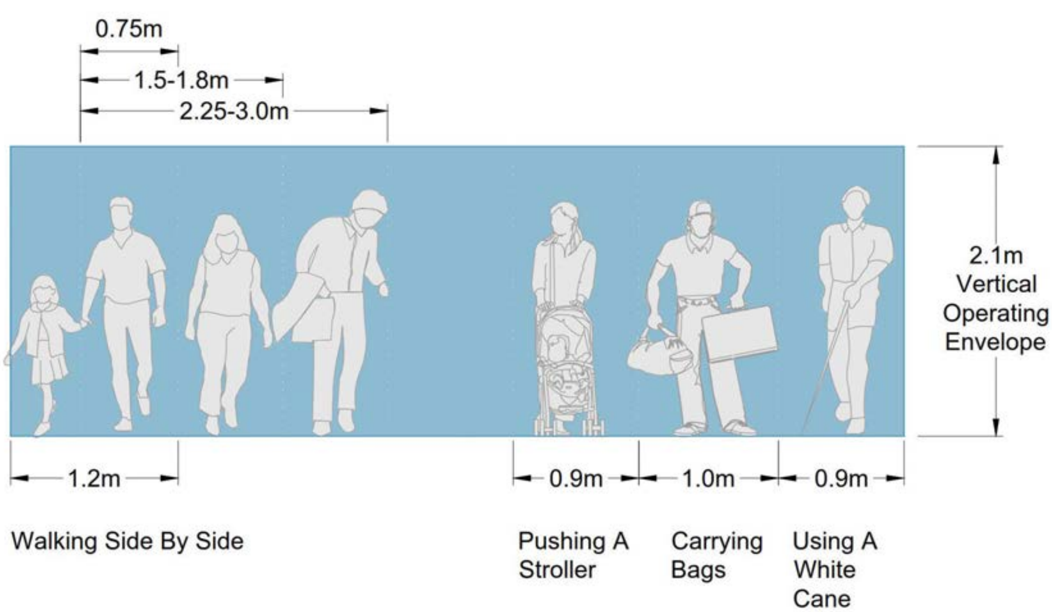


Figure B-8 // Typical Pedestrian Operating Space Requirement

The horizontal operating envelope of a wheelchair is 0.9 metres. Two wheelchairs require 1.8 metres to pass each other or travel side by side, as shown in **Figure B-9**. This measurement establishes the constrained limit width of the Pedestrian Through Zone (see **Chapter C.2**).

Figure B-10 shows the turning space required for various wheelchairs. The lateral width required for a manual wheelchair to make a 180° turn is 1.7 metres. Electric wheelchairs typically require 2.25 metres, while larger mobility scooters may require up to 3.15 metres.

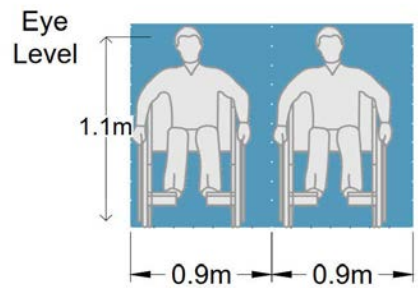


FIGURE B-9 // SPACE REQUIRED FOR TWO WHEELCHAIRS SIDE-BY-SIDE

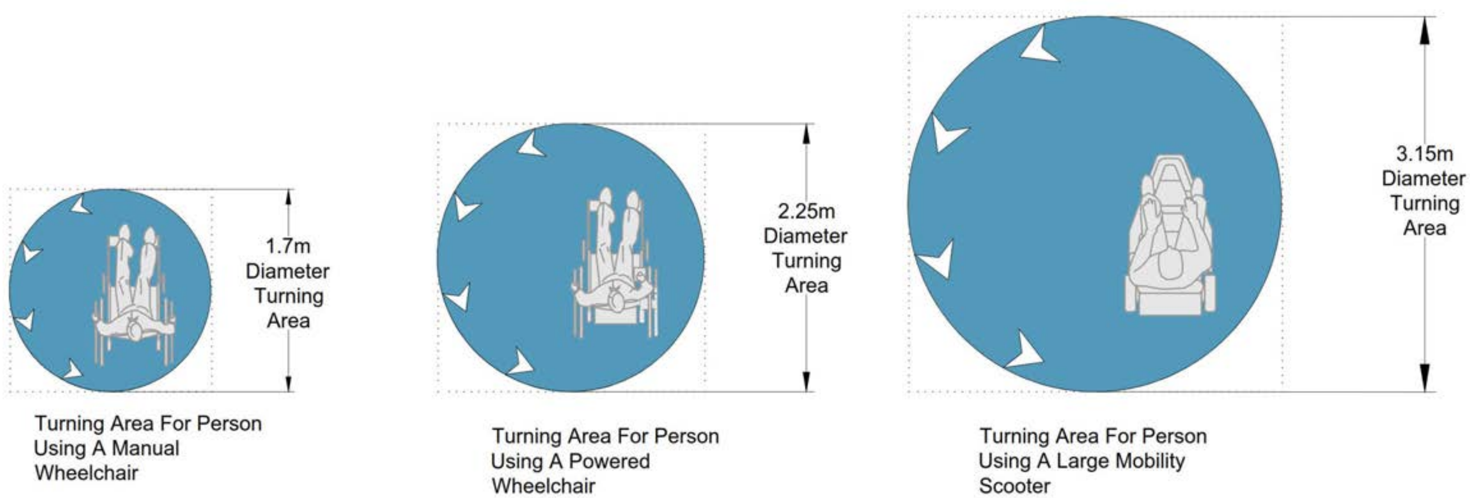


FIGURE B-10 // TYPICAL WHEELCHAIR TURNING DIAMETRES

People Cycling

For multi-use facilities and dedicated bicycle facilities, the bicycle is used as the design vehicle. It is important to note that bicycles are not uniform in size or operating style. **Figure B-11** shows a sample of the different types of bicycles. This is not to be considered an exhaustive list; bicycles come in many different configurations, with 'non-standard' designs becoming increasingly popular in B.C. Multi-use facilities and dedicated bicycle facilities should accommodate the full range of bicycles, including standard bicycles such as road, touring, mountain, and hybrid styles, children's bicycles, tricycles, bicycles with trailers, cargo bicycles, recumbent bicycles, handcycles, bicycles built for people with mobility restrictions, and electric bicycles (e-bikes), among others.

Bicycle facilities are typically designed for a standard adult bicycle that is 1.8 metres long. Where a higher number of non-standard bicycles is expected, it may be appropriate to design facilities – especially intersections, crossings, and refuge areas – for a design vehicle of 3.0 metres in length. Bicycle parking and other end-of-trip facilities should also be designed with the full range of bicycle types in mind (see **Chapter H.2**).

Where bicycles and other devices are concerned, there is a wide range of user preferences, physical abilities, and levels of training or experience, all of which contribute to the operation of the device. For example, family members may wish to bicycle side-by-side, either for social purposes or when a parent is helping to guide or teach a young child.

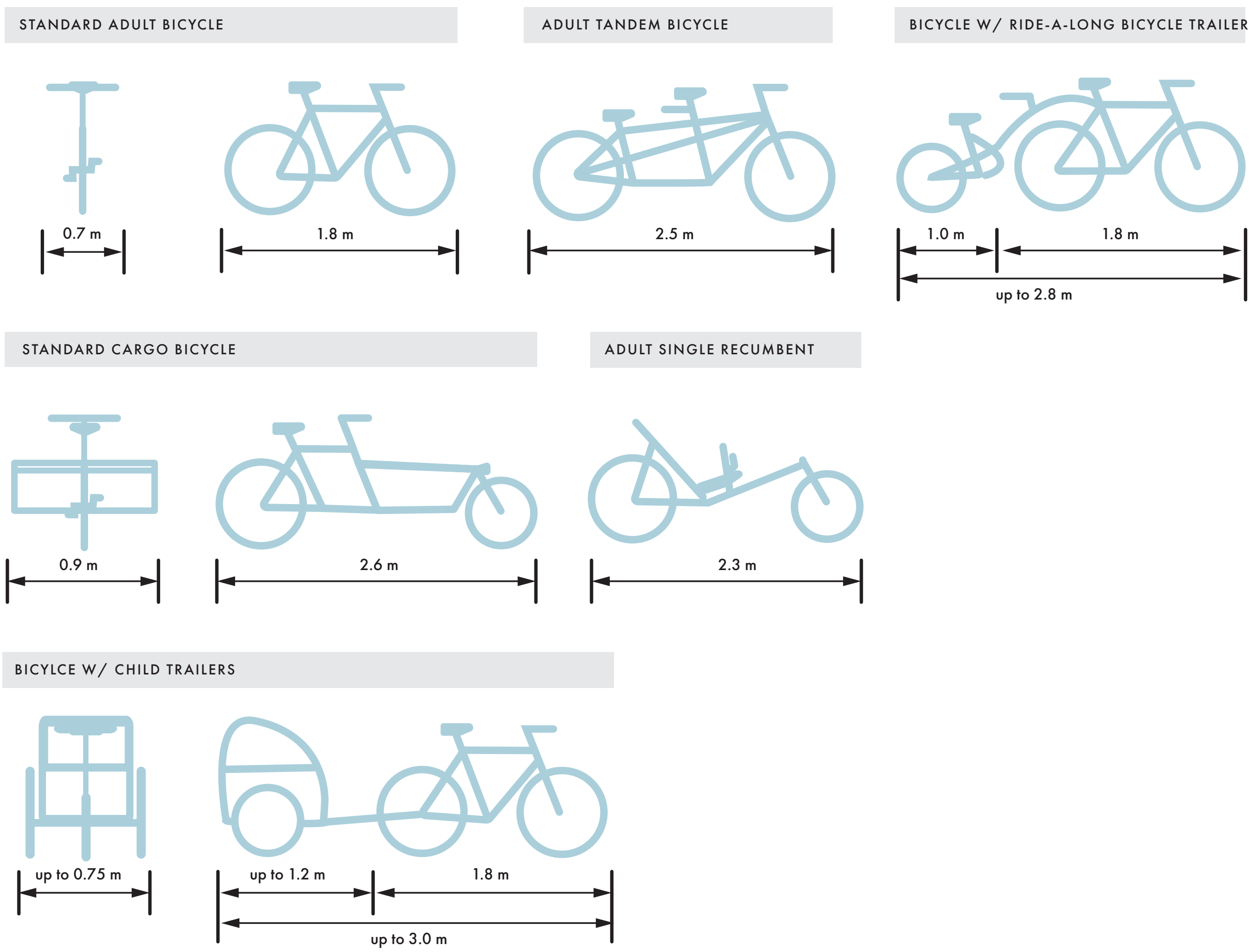


FIGURE B-11 // TYPICAL BICYCLE DESIGNS AND DIMENSIONS

Figure B-12 illustrates the horizontal and vertical operating envelopes for people cycling. These dimensions form the basis of the design parameters for bicycle facilities. People cycling have a typical vertical operating envelope of 2.5 metres. Eye level (typically 1.5 metres) and handlebar height (0.9 to 1.1 metres) are also important considerations.

A single person cycling requires a horizontal operating envelope of 1.2 to 1.5 metres, which allows for variations in lateral movement, which is common when riding uphill and when moving at full speed. However, active transportation facilities should be wide enough to accommodate occasional side-by-side riding and passing. A comfortable horizontal operating envelope for people riding side-by-side or passing is 2.5 metres. For this reason, a horizontal envelope on the higher end of the design domain should be used on bicycle facilities with steep grades.

For optimal usability and comfort, physically separated facilities such as off-street pathways and protected bicycle lanes should be designed to be wide enough for comfortable passing and side-by-side cycling. A desired operating width of 2.5 metres is recommended on uni-directional facilities, while a desired operating width of 3.0 metres is recommended on bi-directional facilities.

Facilities designed with this range of users in mind will accommodate the majority of existing and potential bicycle users and should also accommodate most other active transportation devices. These other active modes, such as skateboarding, in-line skating, and others, have unique operational and behavioural characteristics that should be considered. For example, in-line skating and roller skiing have wider operating envelopes due to their style of movement. Where a larger proportion of facility users are expected to be devices other than bicycles, consideration should be given to adjusting the facility geometry accordingly.

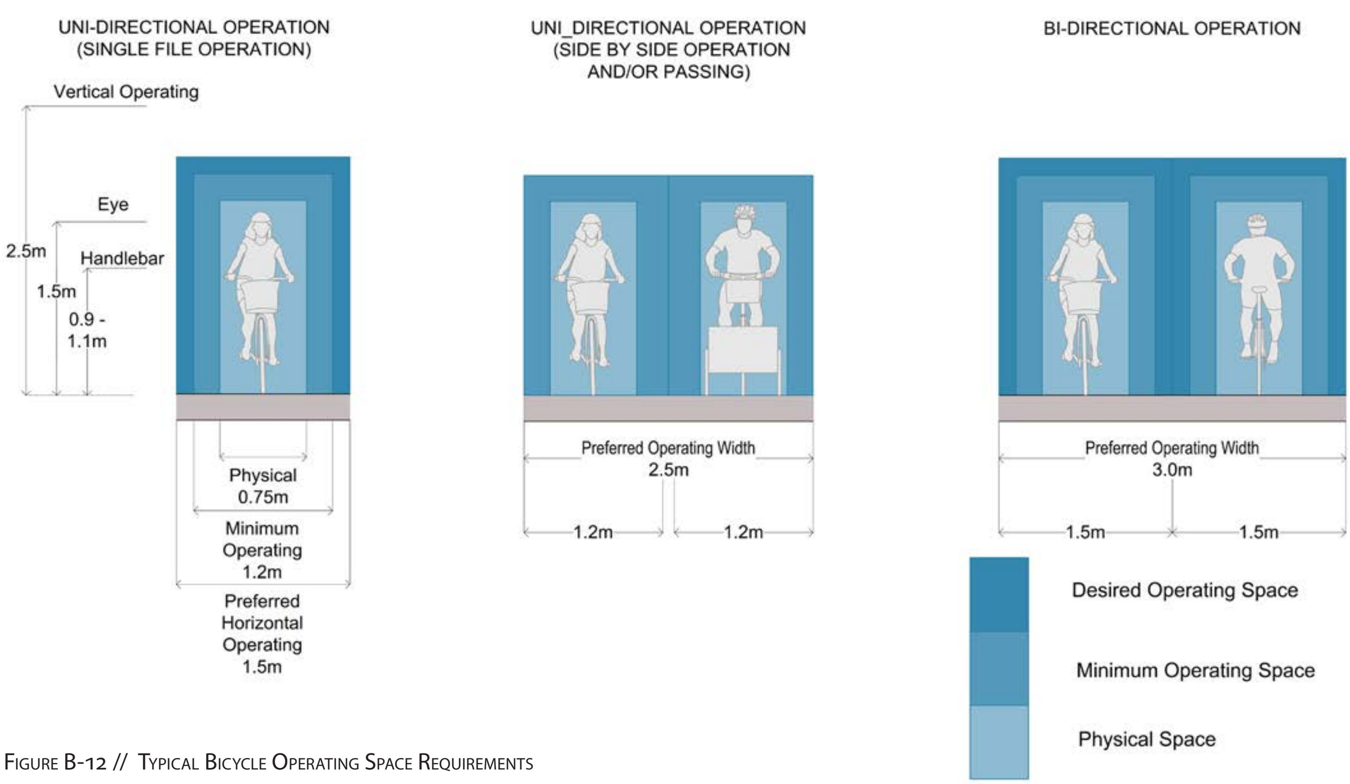


Figure B-12 // Typical Bicycle Operating Space Requirements

CLEARANCE FROM OBSTRUCTIONS

In addition to considering operating space, it is necessary to provide adequate vertical and horizontal clearance from obstructions above and alongside active transportation facilities.

People Walking

With the exception of doorways, the vertical clearance in pedestrian areas should be a minimum of 2.05 metres. In order to accommodate people with vision impairments, obstructions should be cane detectable. According to the CSA, any object protruding more than 100 millimetres from walls, columns, or free-standing supports should be cane-detectable at or below 685 millimetres from the floor or should have their underside at a height of at least 2.05 metres (see **Figure B-13**).

People Cycling and Other Active Transportation Users

Figure B-14 shows the desired vertical clearance for people cycling. The recommended vertical clearance should range from a constrained limit height of 3.0 metres to a desirable height of 3.6 metres (**Table B-4**). A vertical clearance of 3.6 metres also accommodates most small service vehicles and provides a comfortable buffer beyond the 2.5 metres required for people cycling. In exceptional circumstances, a minimum vertical clearance of between 2.7 and 3.0 metres can be considered. However, this minimum clearance is less comfortable for people cycling and should only be used for short distances (under 100 metres).

Figure B-14 also shows the required horizontal clearance from lateral obstructions of varying height. Minimum horizontal clearances from lateral

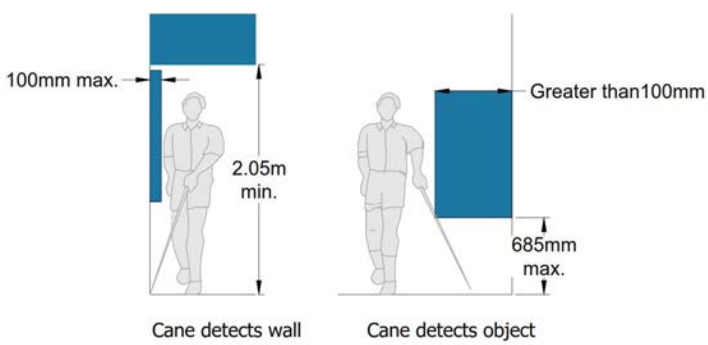


FIGURE B-13 // CLEARANCE FROM OBSTRUCTIONS FOR PEOPLE WALKING

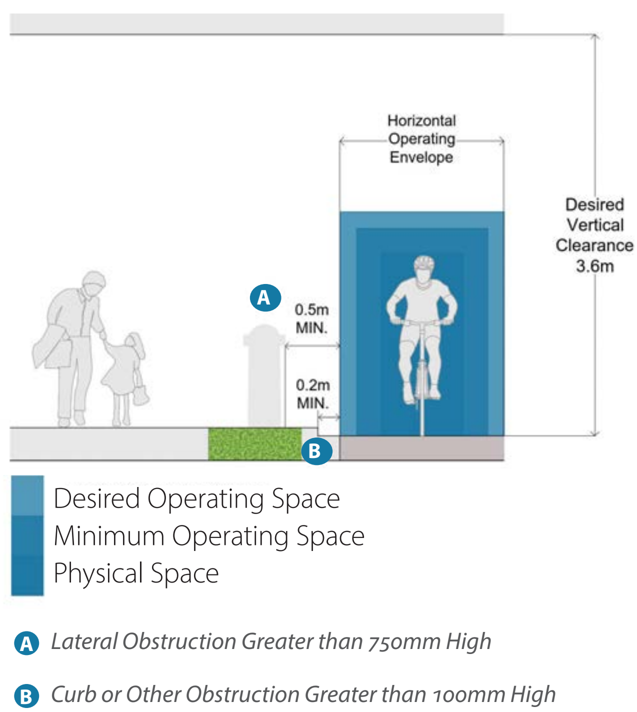


FIGURE B-14 // CLEARANCE FROM OBSTRUCTIONS FOR PEOPLE CYCLING obstructions are determined by the typical height of bicycle pedals and handle bars. Lateral obstructions can include lane delineators, street trees, railings, fences, and curbs. Horizontal clearances vary by object height as follows:

- **Objects less than 100 millimetres in height:** These objects should be shorter than a bicycle pedal; no additional horizontal clearance is required.
- **Lateral obstructions between 100 and 750 millimetres in height:** A minimum 0.2 metre horizontal clearance is desirable.
- **Lateral obstructions greater than 750 millimetres in height:** A minimum 0.5 metre horizontal clearance is desirable.

Table B-4 // Bicycle Operating Vertical Clearance

PARAMETER	DESIRABLE (M)	CONSTRAINED LIMIT (M)
Vertical clearance (bicycle facility surface to overhead structures/ foliage)	3.6	3.0

PERFORMANCE CHARACTERISTICS

Performance characteristics are particularly relevant for bicycles and other active transportation devices. In addition to factoring in the operating dimensions of bicycles and their users, the attributes that enable the safe and comfortable operation of a bicycle should be considered when designing bicycle facilities. These attributes include the surface type, connectivity of the bicycle network, and ability to maintain consistent cycling speeds. These requirements are applicable to all types of active transportation facilities, including on-street and off-street facilities. Maintenance is another key factor in assuring safe bicycle operation and is discussed in **Chapter I.3**.

Maintaining momentum is important for all modes of transportation, including cycling, as it takes a disproportionately large amount of energy to return to the desired operating speed after stopping or slowing. As a result, active transportation routes should be designed to reduce the need to frequently slow down or stop wherever possible. This can be accomplished by minimizing rough surfaces, tight corners, steep gradients, intersections, and the need to yield to others.

OPERATING AND DESIGN SPEED

Design speed is a fundamental design control used to determine geometric features of active transportation facilities as well as signal timing and road crossing parameters. The speed of an active transportation user is dependent on several factors, including:

- Age and physical condition of the user;
- Type and condition of the user's equipment;
- Purpose and length of the trip;
- Condition, surface material, location, and grade of the facility;
- Prevailing wind and direction; and
- Number and types of other users on the facility.

Figure B-15 shows the typical operating speed range for a variety of active transportation users.

People Walking

Walking speeds are a key consideration for signal timing (**Chapter G.2**) and Pedestrian Through Zone width (**Chapter C.2**). Pedestrians have a range of typical walking speeds, with children, older pedestrians, and people using mobility aids moving more slowly and requiring more time to cross the road at intersections. The TAC *Pedestrian Crossing Control Guide* recommends using the following pedestrian walking speeds when considering the design and operation of pedestrian crossings.[9]

- Use 0.8 m/s walking speed where at least 20% of pedestrians crossing the signalized intersection use assistive devices for mobility (e.g. near hospitals or nursing homes);
- Use 0.9 m/s walking speed where at least 20% of pedestrians crossing the signalized intersection are older pedestrians (age 65 and older); or
- Use 1.0 m/s walking speed to accommodate the general population.

People Cycling and Other Active Transportation Users

Typical adult cycling speeds are used to establish design speeds and basic geometric design requirements for stopping sight distance, horizontal and vertical alignment, and cross slopes. This is because higher speeds require more conservative geometric design components. Facilities designed in this fashion will accommodate slower bicycle users, including children, seniors, and less confident users. The typical adult travels at average speeds of 15 km/h to 30 km/h on flat level terrain. Electric bicycles can provide power assist up to a maximum of 32 km/h (see **Chapter H.5**). Using a design speed of 30 km/h is an appropriate speed in most contexts.

Adjustments to design speed should consider grade and facility surface, as follows:

- For every 1% increase in downhill grade, cycling speed increases by approximately 0.9 km/h; however, design speed should not exceed 50 km/h.
- For every 1% increase in uphill grade, cycling speed decreases by approximately 1.4 km/h.
- When designing unpaved paths, a slower design speed (20 km/h) should be used.

Design speeds slower than the typical adult bicycle user should be considered for some elements of design, as follows:

- Using 3.3-4.2 m/s (12-15 km/h) as the design speed for intersection crossings will account for slower bicycle users who need more time to cross intersections, such as children and seniors, and should be used for signal timing.
- For urban bicycle facilities with a variety of users and frequent conflicts or constraints, a lower design speed should be used (15 km/h). Geometric design and traffic control devices should be included in the design to reduce the speeds of bicycle users and motor vehicles at conflict points.

9 Jeannette Montufar, Garreth Rempel, and Sarah Klassen, Pedestrian Walking Speed for Traffic Operations in Canada (Ottawa: Transportation Association of Canada, 2013).

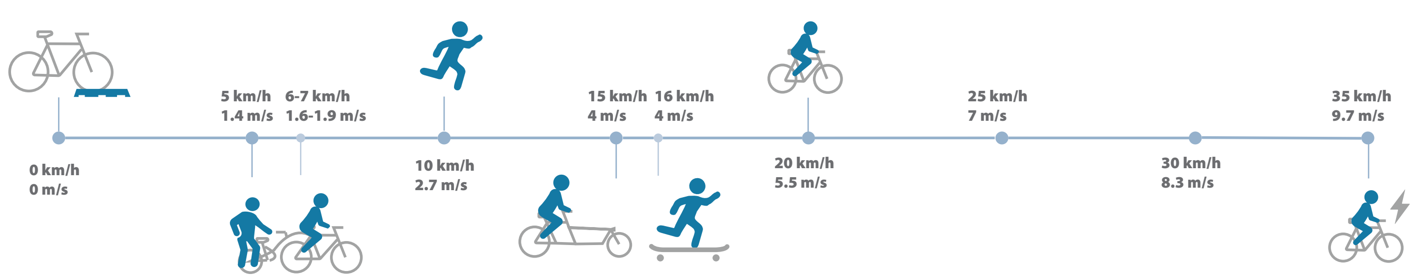


Figure B-15 // Typical Active Transportation User Speeds

Calculating Measurements

Where there is a curb and/or gutter, all measurements in the Design Guide are measured from the lip of gutter (as opposed to the face of curb) and exclude the gutter pan (see **Figure B-16**). Where there is no curb and/or gutter, all measurements in the Design Guide are measured to the edge of pavement. In addition, measurements to longitudinal pavement markings are calculated to the centre of the painted line.

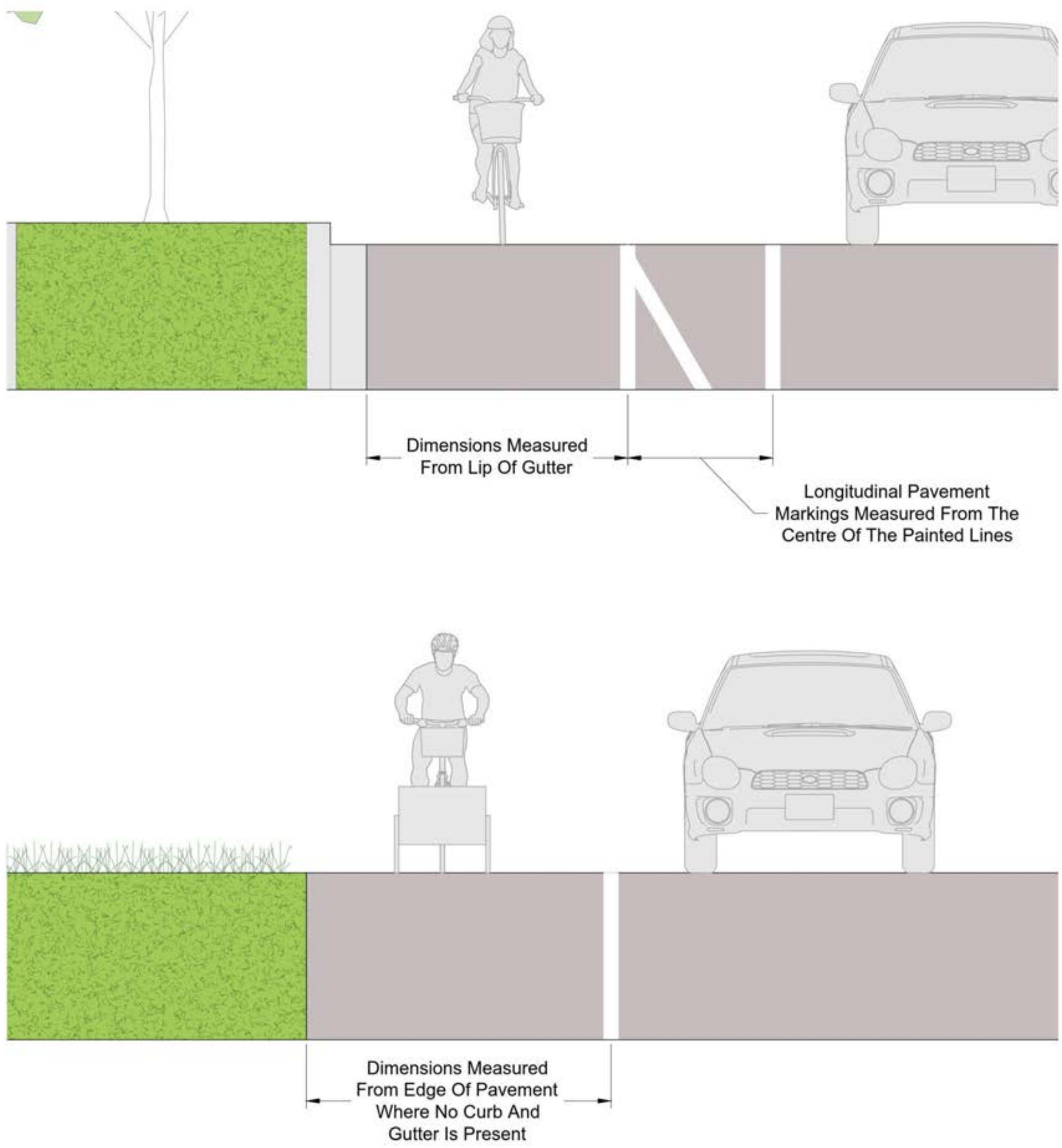


Figure B-16 // Calculating Measurements

10th Avenue Bikeway in Vancouver, B.C.
Source: Victor Wang