Ontario

Book 15

Ontario Traffic Manual

June 2014

Pedestrian Crossing Treatments

Ontario Traffic Manual

Foreword

The purpose of the Ontario Traffic Manual (OTM) is to provide information and guidance for transportation practitioners and to promote uniformity of treatment in the design, application and operation of traffic control devices and systems across Ontario. The objective is safe driving behaviour, achieved by a predictable roadway environment through the consistent, appropriate application of traffic control devices. Further purposes of the OTM are to provide a set of guidelines consistent with the intent of the Highway Traffic Act and to provide a basis for road authorities to generate or update their own guidelines and standards.

The OTM is made up of a series of 22 Books, which are being generated over a period of time, and for which a process of continuous updating is planned. Through the updating process, it is proposed that the OTM will become more comprehensive and representative by including many traffic control devices and applications specific to municipal use. Some of the Books of the OTM are new, while others incorporate updated material from the Ontario Manual of Uniform Traffic Control Devices (MUTCD) and the King's Highway Guide Signing Policy Manual (KHGSPM).

The OTM is directed to its primary users, traffic practitioners. The OTM incorporates current best practices in the Province of Ontario. The interpretations, recommendations and guidelines in the OTM are intended to provide an understanding of traffic operations and they cover a broad range of traffic situations encountered in practice. They are based on many factors which may determine the specific design and operational effectiveness of traffic control systems. However, no manual can cover all contingencies or all cases encountered in the field. Therefore, field experience and knowledge of application are essential in deciding what to do in the absence of specific direction from the Manual itself and in overriding any recommendations in this Manual.

The traffic practitioner's fundamental responsibility is to exercise engineering judgment and experience on technical matters in the best interests of the public and workers. Guidelines are provided in the OTM to assist in making those judgments, but they should not be used as a substitute for judgment.

Design, application and operational guidelines and procedures should be used with judicious care and proper consideration of the prevailing circumstances. In some designs, applications, or operational features, the traffic practitioner's judgement is to meet or exceed a guideline while in others a guideline might not be met for sound reasons, such as space availability, yet still produce a design or operation which may be judged to be safe. Every effort should be made to stay as close to the guidelines as possible in situations like these, and to document reasons for departures from them.

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1. General Information

1.1 Introduction

The purpose of *OTM Book 15 – Pedestrian Crossing Treatments* is to provide practical guidance and application information on the planning, design, and operation of pedestrian roadway crossings treatments for transportation practitioners and to promote uniformity of approaches across Ontario. The set of guidelines provided within this manual are consistent with the intent of the Highway Traffic Act (HTA)[1] with respect to the pedestrian crossing applications and provide a basis for road authorities to generate or update their own guidelines and standards.

The *OTM Book 15 – Pedestrian Crossing Treatments* includes consolidated references to relevant material that is provided in other OTM Books as applicable to pedestrian crossing treatments. For newly established practices, Book 15 will supersede the *Manual of Uniform Traffic Control Devices (MUTCD)* for Ontario, and update previously released OTM Books. A complete listing of the planned and currently available OTM volumes is found in Book 1. A new edition of Book 1 will be produced to coincide with the production of each new Book or Books in the OTM. This is necessary in order to have a master table of contents and indexes which are up-to-date at any given time. Book 1 should be read prior to the use and application of any of the other Books in the OTM. The use of any of the devices and applications discussed in those Books should be considered in conjunction with the contents of other related OTM Books as appropriate.

The OTM incorporates current best practices in Ontario. The guidelines are intended to provide an understanding of traffic operations and they cover a broad range of traffic situations encountered in practice. They are based on many factors which may determine the specific design and operational effectiveness of traffic control systems. However, no manual can cover all contingencies or all cases encountered in the field. Therefore, field experience, knowledge of application, and engineering judgement are essential in deciding what to do in the absence of specific direction from the Manual itself and in overriding any recommendations in the Manual. Similarly, municipalities may need to adopt policies that reflect local conditions. The traffic practitioner's fundamental responsibility is to exercise engineering judgment on technical matters in the best interests of the public and workers. Guidelines are provided in the OTM to supplement professional experience and assist in making those judgments.

This manual also refers to various publications produced by the Ministry of Transportation Ontario (MTO) and other agencies such as the Institute of Transportation Engineers (ITE), the Transportation Association of Canada (TAC) and the Ontario Traffic Council (OTC). Wherever applicable, the material from the previous versions of Book 15 was used in this manual.

1.2 Sections of this Book

This manual is organized in the following order:

- **Section 1, General Information** — this section provides the general introduction about the OTM books including this manual and an introduction on the specific use of terms when reading this book.
- **Section 2, Legal Framework** — this section outlines the relevant legal requirements and interpretations as they pertain to pedestrian crossings, specifically the HTA interpretation of the categories of pedestrian crossings, the rules of the road governing motorists' and pedestrians' movement at different forms of pedestrian crossings, and pedestrian's right-of-way and responsibilities. This section also highlights the purpose of Ontario Regulation 615. In addition, the section provides guidelines, and legal requirements for accessibility consideration for pedestrian crossings.
- **Section 3, Background** — this section provides the background information about this manual as it relates to pedestrian crossings.

This includes an overview of basic principles important to understanding and meeting the fundamental objectives of traffic control devices; the broader walkability consideration in the planning process of pedestrian facilities; and road user characteristics.

- **Section 4, Planning** — this section provides the classification of pedestrian crossing facilities including uncontrolled, controlled and physically-separated facilities; and an overview of hierarchy of pedestrian crossing treatment systems for controlled crossings. The section further provides an introduction to the decision support tool provided in this manual for selection of pedestrian treatment system for a location. The section also includes the guiding principles for planning and decision process used for the development of the tool.
- **Section 5, Treatment System Selection** — this section outlines the methodology for selecting an appropriate pedestrian crossing treatment system for controlled crossings using the decision support tool.
- **Section 6, Pedestrian Crossing Facility Design: Controlled Crossings** — this section provides the description and specifications of various components including geometric design components, signs, signals, pavement markings, school crossing guard, and illumination, used for pedestrian crossing treatment systems for controlled crossings. The section further provides the description of each treatment system with typical installation layouts; and the table of components of each treatment system with respect to their usage as "required", "desired", or "optional". Finally, this section includes the guidance of pedestrian crossing applications for specific environments, such as roundabouts, right-turn channels, railway crossings, and temporary conditions.
- **Section 7, Pedestrian Crossing Facility Design: Uncontrolled Crossings** — this section highlights the circumstances for the need of uncontrolled pedestrian crossing and outlines the guidance for their justification. The section further provides the table of components for pedestrian treatment at uncontrolled crossings and typical installation layouts.
- **Section 8, Pedestrian Crossing Facility Design: Grade Separated Facilities** — this section provides guidelines for the application of physically separated facilities.

1.3 Use of Terms in This Book

In Ontario, many aspects of traffic control devices are specified in law (for example, the meaning of specific signal indications or traffic signs). Others are based on standards intended to establish consistency throughout the province, while other aspects are founded on recommendations established through experience. In this publication, specific terms are adopted to convey intended differences in meaning. These terms and the corresponding meanings are as follows:

"Legal Requirement(s)", "Legally Required", "Legal" and equivalent terms mean that the requirement is the law of Ontario as established under the HTA[1] and its Regulations, or Accessibility for Ontarians with Disabilities Act (AODA), 2005[3] and its Regulations, or is a legal requirement under the municipal by-laws. The requirement is typically described by the use of "shall" or "must". **"Must"** or "Shall" indicates that the requirements of the design or application of the device as described in this manual are mandatory. Some of the requirements that are necessary in principle for the safe operation of pedestrian crossing treatments are considered mandatory. They are also described in this manual by the use of "Shall" or "Must" for providing uniformity across the province, although not legally required. The term "required" used in this manual in tables of components is associated with the mandatory requirement.

"Interpretation" means the interpretations and emphasis of the legal requirements. The interpretations are not necessarily the precise wording of the Acts1,3 and Regulations. Interpretations are given in lay language and may

include some industry jargon. The requirement is typically described by the use of "shall". **"Shall"** means the same as "must".

"Recommended Practice" suggests a consistent manner in which the legal requirements and interpretations are applied using the typical procedures and equipment in use in Ontario. The recommended practices are not necessarily the only practices available based on the interpretation of the legal requirements or the selection of equipment or methods of operation. The recommendation is typically described by the use of "should". **"Should"** indicates that the action is advised; recommended but not mandatory. This term is meant to suggest good practice in most situations, but also to recognize that in some situations, for good reasons, the recommended action cannot or need not be followed. The term "desired" or "desirable" used in this manual is associated with the recommended practice and is used for components or practices that may improve the overall performance of the treatment system; however, they are not mandatory.

"Guideline" suggests a method of practical application of the legal requirements and interpretations using the typical procedures, equipment and methods of operation in use in Ontario. The guidelines are meant to provide guidance to those road authorities that may be unsure of the methods of application. A guideline has no legal connotation and several alternate methods of achieving the same result may be available. A guideline is typically described by the use of "may". **"May"** indicates a permissive condition. No requirement for design or application is intended. The term "optional" used in this manual indicates a permissive condition and is used for components and practices that may be required under certain situations or may have potential to further improve the conspicuity of a treatment system.

2. Legal Framework

In Ontario, the requirement for a driver to yield the right-of-way to pedestrians at crossings with the entire range of traffic control is included in the HTA[1] and its regulations. The HTA[1] provides all relevant definitions and rules of the road. The applicable Ontario Regulations specify the particular signs, signals, and markings that constitute each traffic control measure.

2.1 Highway Traffic Act

The Ontario Highway Traffic Act (HTA)[1] defines the rules of the road, including conditions under which pedestrians can cross a road and walk within the roadway. The HTA[1] identifies the responsibilities and rights of pedestrians and drivers at different forms of pedestrian crossings. This section provides an overall synopsis of the rules of the road as defined and interpreted in the latest version of the HTA[1] at the time of this publication.

2.1.1 Categories of Pedestrian Crossings

It can be interpreted from the HTA[1] that when a pedestrian is about to step from the side of the road onto the roadway, there are fundamentally two distinct categories of pedestrian crossings:

A controlled crossing — where vehicles are required to stop or yield to traffic legally in the intersection, which includes pedestrians, or

1. An uncontrolled crossing — where pedestrians must wait for a safe gap in traffic, sufficient for them to cross the roadway, prior to attempting to enter the roadway.

An uncontrolled crossing is a crossing that does not have any traffic control measure to provide a dedicated pedestrian right-of-way. Pedestrians must wait for a safe gap sufficient to fully cross the roadway or for vehicles to stop before crossing. In accordance with Ontario's HTA[1], controlled pedestrian crossings in the Province of Ontario are only at locations where vehicles are controlled by any of traffic signals, intersection pedestrian signals, mid-block pedestrian signals, pedestrian crossovers, stop signs, yield signs, or school crossings when a school crossing guard is supervising the crossing. For the definition of school crossing guard, see Section 6.2.5.

Table 1 summarizes those conditions where there are controlled crossings and those that are uncontrolled. The types of controlled crossing and the pertinent right-of-way rules as proclaimed in the HTA[1] referenced in Table 2.

The rules of the road are distinct between a controlled crossing and an uncontrolled crossing.

Table 1: Controlled and Uncontrolled Crossings

Controlled Crossings	Uncontrolled Crossings
• Traffic Control Signals • Intersection Pedestrian Signals • Mid-block Pedestrian Signals • Pedestrian Crossovers • STOP Sign • YIELD Sign • Supervised School Crossing	• Mid-block Crossings (in the absence of traffic control signals, intersection pedestrian signals or pedestrian crossover) • Designated School Crossing (in the absence of a crossing guard and without other forms of control such as traffic control signals, intersection pedestrian signals, pedestrian crossover, STOP signs or YIELD signs) • Marked Crossing (at intersection in the absence of STOP or YIELD signs)

Table 2: Pedestrian Right-of-way Designation at Controlled Crossings

Controlled Crossings	Pedestrian-Right-of-Way
Traffic Control Signals where Pedestrian Control Indications are installed, Intersection Pedestrian Signals, or Midblock Pedestrian Signals	According to the *HTA Section 144 – Traffic Control Signals and Pedestrian Control Signals,* pedestrians crossing at these signals are controlled by the WALK, FLASHING DON'T WALK and the DON'T WALK indicators. **Pedestrian Crossing** (22) Where portions of a roadway are marked for pedestrian use, no pedestrian shall cross the roadway except within a portion so marked. R.S.O. 1990, c. H.8, s. 144 (22). (24) No pedestrian approaching a traffic control signal and facing a flashing circular green indication or a solid or a flashing left turn arrow indication in conjunction with a circular green indication shall enter the roadway. R.S.O. 1990, c. H.8, s. 144 (24). **Pedestrian Control Signals - Walk** (26) Where pedestrian control signals are installed and show a "walk" indication, every pedestrian facing the indication may cross the roadway in the direction of the indication despite subsections (24) and (25). R.S.O. 1990, c. H.8, s. 144 (26). **Pedestrian Control Signals – Don't Walk** (27) No pedestrian approaching pedestrian control signals and facing a solid or flashing "don't walk" indication shall enter the roadway. R.S.O. 1990, c. H.8, s. 144 (27). **Pedestrian – Green Light** (23) Subject to subsections (24) and (27), a pedestrian approaching a traffic control signal showing a circular green indication or a straight-ahead green arrow indication and facing the indication may cross the roadway. R.S.O. 1990, c. H.8, s. 144 (23). **Pedestrian Right of Way** (28) Every pedestrian who lawfully enters a roadway in order to cross may continue the crossing as quickly as reasonably possible despite a change in the indication he or she is facing and, for purposes of the crossing, has the right of way over vehicles. R.S.O. 1990, c. H.8, s. 144 (28). **Yielding to Pedestrians** (7) When under this section a driver is permitted to proceed, the driver shall yield the right of way to pedestrians lawfully within a crosswalk. R.S.O. 1990, c. H.8, s. 144 (7).

Controlled Crossings	Pedestrian-Right-of-Way
Pedestrian Crossover	According to the HTA Section 140 – Pedestrian crossover, duties of driver: (1) Subject to subsection (2), when a pedestrian or a person in a wheelchair crossing a roadway within a pedestrian crossover, a) is upon the half of the roadway upon which a vehicle or street car is travelling; or b) is upon half of the roadway and is approaching the other half of the roadway on which a vehicle or street car is approaching so closely to the pedestrian crossover as to endanger him or her, the driver of the vehicle or street car shall yield the right of way to the pedestrian or a person in a wheelchair by slowing down or stopping if necessary. R.S.O. 1990, c. H.8, s. 140 (1). (2) When a vehicle or street car is stopped at a pedestrian crossover, the driver of any other vehicle or street car overtaking the stopped vehicle or street car shall bring the vehicle or street car to a full stop before entering the crossover and shall yield the right of way to a pedestrian or a person in a wheelchair, a) who is within the crossover upon the half of the roadway upon which the vehicle or street car is stopped; or b) who is within the crossover and is approaching the half of the roadway from the other half of the roadway so closely to the vehicle or street car that he or she is in danger if the vehicle or street car were to proceed. R.S.O. 1990, c. H.8, s. 140 (2). (4) No pedestrian or person in a wheelchair shall leave the curb or other place of safety at a pedestrian crossover and walk, run or move the wheelchair into the path of a vehicle or street car that is so close that it is impracticable for the driver of the vehicle or street car to yield the right of way. R.S.O. 1990, c. H.8, s. 140 (4).
STOP Signs	According to the HTA Section 136 – Stop at through highway: (1) Every driver or street car operator approaching a stop sign at an intersection, a) shall stop his or her vehicle or street car at a marked stop line or, if none, then immediately before entering the nearest crosswalk or, if none, then immediately before entering the intersection; and b) shall yield the right of way to traffic in the intersection or approaching the intersection on another highway so closely that to proceed would constitute an immediate hazard and, having so yielded the right of way, may proceed. R.S.O. 1990, c. H.8, s. 136 (1).

Controlled Crossings	Pedestrian-Right-of-Way
YIELD Signs	According to the HTA Section 138 – Yield right-of-way signs: (1) The driver or operator of a vehicle or street car approaching a yield right-of-way sign shall slow down to a speed reasonable for the existing conditions or shall stop if necessary as provided in clause 136 (1) (a) and shall yield the right of way to traffic in the intersection or approaching on the intersecting highway so closely that it constitutes an immediate hazard and having so yielded may proceed with caution. R.S.O. 1990, c. H.8, s. 138 (1).
School Crossing Guard	School crossing guards may also provide a designated right-of-way for school children as vehicles must yield to a crossing guard. According to the HTA Section 176 – School crossings: 1) School crossing guard means a person sixteen years of age or older who is directing the movement of persons across a highway and who is, (a) employed by a municipality, or (b) employed by a corporation under contract with a municipality to provide the services of a school crossing guard. R.S.O. 1990, c. H.8, s. 176 (1); 2005, c. 14. 1 (1). 2) A school crossing guard about to direct persons across a highway with a speed limit not in excess of 60 kilometres per hour shall, prior to entering the roadway, display a school crossing stop sign in an upright position so that it is visible to vehicles approaching from each direction and shall continue to so display the school crossing stop sign until all persons, including the school crossing guard, have cleared the roadway. 2005, c. 26, Sched. A, s. 29 (1). **Vehicles approaching guard displaying sign** (3) Where a school crossing guard displays a school crossing stop sign as provided in subsection (2), the driver of any vehicle or street car approaching the school crossing guard shall stop before reaching the crossing and shall remain stopped until all persons, including the school crossing guard, have cleared the half of the roadway upon which the vehicle or street car is travelling and it is safe to proceed. 2005, c. 26, Sched. A, s. 29 (1).

Pedestrians do not have the right-of-way at uncontrolled crossings.

2.1.2 Pedestrian's Rights and Responsibilities

Notwithstanding the distinction between controlled and uncontrolled crossings, the rights and responsibilities for pedestrians are recognized in the HTA[1]:

1. In the absence of statutory provisions or by-law, a pedestrian is not confined to a street crossing or intersection and is entitled to cross at any point, although greater care may then be required of him or her in crossing. However, pedestrians crossing the highway must look to ensure the crossing can be made safely or possibly be held responsible for any ensuing collision.

2. Pedestrians must exercise due care even when they are lawfully within a crossing and have right-of-way. It is not an absolute right and they must still exercise care to avoid a collision with a vehicle.

3. If there is a crosswalk at a signalized intersection, pedestrians have to walk within the crosswalk (see Section 6.2.1.1 for the definition of crosswalk):

Section 144 (22) – Duty at Traffic Control Signals — Pedestrian Crossing – where portions of a roadway are marked for pedestrian use, no pedestrian shall cross the roadway except within a portion so marked.

2.1.3 Ontario Regulations

The HTA[1] Section 182 provides for the regulation of various signs, their type and location on the roadway. The criteria and specifications for applications, dimensions, location and orientation of regulatory signs are prescribed and illustrated under Regulation 615. Ontario Regulation 615[2] Section 20 also specifies the signs, flashing beacons, and markings for different Pedestrian Crossovers.

2.2 Accessibility

2.2.1 General

Road users' range of abilities varies with respect to mobility, vision, hearing, and cognition. Physical and mental impairments often inhibit many individuals from performing certain routine functions and limit their ability as pedestrians at crossings. The ability of individuals, however, shall not preclude them from the right to use any facilities including pedestrian crossings. Provision of pedestrian facilities must therefore address the range of capabilities exhibited by the individuals that might use them. This Section outlines the overall consideration for accessible crossing and further references the Ontario standard.

2.2.2 Legislative Requirements

The Accessibility for Ontarians with Disabilities Act, 2005 (AODA)[3] sets out the legal requirements for the purpose of improving accessibility standards for Ontarians with physical or mental disabilities. The goal of the AODA is to:

> *"achieve accessibility for Ontarians with disabilities with respect to goods, services, facilities, accommodation, employment, buildings, structures and premises by January 1, 2025"[3].*

The requirements of the AODA includes the legal authority, framework, and processes for the Ontario Government to develop, implement and enforce the accessibility standards, under which the public and private sectors must comply based on the mandatory schedule.

The Accessibility standard for pedestrian crossings within public right-of-ways is defined as part of the Design of Public Spaces Standards (Accessibility Standard for Built Environment) prescribed by Ontario Regulation 413/12[4]. The information on the regulation is also available on the Ontario Ministry of Community and Social Services[6] website under Built Environment Standard.

2.2.3 Designing for Accessibility

Pedestrian crossings shall provide a continuous, clear and linear path across the vehicular route. An accessible path must be barrier-free and designed to address a range of capabilities as exhibited by the individuals that might use them. Consideration shall be given to the expected number and type of users in determining the design parameters that will enable independent, safe, and efficient use of the crossings by individuals of all ages and abilities.[7]

A barrier-free environment means the elimination of physical or information barriers. Physical barriers such as curbs, steep slopes or obstacles may restrict movements of pedestrians with mobility impairments; while information barriers such as the lack of tactile or audible cues will limit pedestrians with visual or hearing impairments in their ability to recognize the conditions of the environment.

According to the Accessibility Standards for Built Environment (Ontario Regulation 413/12[4] or Ontario Regulation 191/11 with amendment Regulation 413/12)[5], treatments to enhance accessibility applicable to pedestrian crossing treatments within the scope of this manual include the following:

- Curb Ramps (Sub-section 80.26)
- Depressed Curb (Sub-section 80.27)
- Accessible Pedestrian Signals (Sub-section 80.28)

2.2.3.1 Curb Ramps

Curb ramps provide access for people on wheelchairs or scooters at crossings where there is an elevation change between the sidewalk and the street level crossing. Curb ramps must be considered for all controlled pedestrian crossings and may be considered for uncontrolled crossings, where pedestrian demand can be reasonably expected, or where pedestrian crossing is not prohibited, subject to municipal by-laws. However, not all pedestrians with mobility impairments will benefit from the use of curb ramps. For some pedestrians who use walking aids such as canes, crutches or walkers, it may in fact be physically demanding for these users to travel on the slope of the ramp. To accommodate both wheelchair access and pedestrians who rely on walking aids, the ramp will have to be sufficiently wide. Pedestrians with visual impairments are another user group that may find challenges with curb ramps. Pedestrians with visual impairments rely on curbs to identify the transition from sidewalk to crosswalk. The lack of vertical edge can create information barriers. Therefore, it is also necessary to install detectable warnings to mark the boundary of the transition as part of the design.

Curb ramps to be included as a component of any pedestrian crossing treatment must address the needs of pedestrians with mobility impairments and pedestrians with visual impairments. The design of curb ramps must consider the following as prescribed in the Accessibility Standards for Built Environment Standard, Ontario Regulation 413/12 Sub-Section 80.26 (1)[4].

> *"Where a curb ramp is provided on an exterior path of travel, the curb ramp must align with the direction of travel and meet the following requirements:*
>
> - *The curb ramp must have a minimum clear width of 1,200 mm, exclusive of any flared sides*
> - *The running slope of the curb must,*
>   - *be a maximum of 1:8, where elevation is less than 75 mm, and*
>   - *be a maximum of 1:10, where elevation is 75 mm or greater and 200 mm or less*
> - *The maximum cross slope of the curb ramp must be no more than 1:50*
> - *The maximum slope on the flared side of the curb ramp must be no more than 1:10.*

Where the curb ramp is provided at a pedestrian crossing, it must have tactile walking surface indicators that,

- *have raised tactile profiles,*
- *have a high tonal contrast with the adjacent surface,*
- *are located at the bottom of the curb ramp,*
- *are set back between 150 mm and 200 mm from the curb edge,*
- *extend the full width of the curb ramp, and*
- *are a minimum of 610 mm in depth.*[5]

2.2.3.2 Depressed Curbs

Curb ramps may be cut through a curb or built up to a depressed curb. The design of depressed curbs, if used, must consider the following as prescribed in the Accessibility Standards for Built Environment Standard, Ontario Regulation 413/12 Sub-Section 80.26 (1)[4].

"Where a depressed curb is provided on an exterior path of travel, the depressed curb must meet the following requirements:

- *The depressed curb must have a maximum running slope of 1:20.*
- *The depressed curb must be aligned with the direction of travel.*
- *Where the depressed curb is provided at a pedestrian crossing, it must have tactile walking surface indicators that,*
    - *have raised tactile profiles,*
    - *have high tonal contrast with the adjacent surface,*
    - *are located at the bottom portion of the depressed curb that is flush with the roadway,*
    - *are set back between 150 mm and 200 mm from the curb edge, and*
    - *are a minimum of 610 mm in depth.*

2.2.3.3 Accessible Pedestrian Signals

Accessible Pedestrian Signals (APS) are auxiliary devices that supplement traffic control signals to aid pedestrians with visual or visual and hearing impairments to cross the road. APS devices communicate information in a non-visual format to provide cues at both ends of a crossing, such as audible tones, verbal messages, and/or vibrotactile indications.

APS devices that have speakers mounted in, on, or near pedestrian pushbuttons emit a sound such as a bell, buzz, tone or birdcall (typically cuckoo and chirp) during the WALK interval. Additional equipment may produce tones to locate the pushbuttons, tones to acknowledge the button has been pushed, and tones to indicate the direction to start crossing. The sound of APS signals should be capable of being heard above ambient traffic noise.

Infrared transmitters located at the pedestrian head can transmit a speech message to hand-held receivers. Messages may identify the location and direction of travel of the pedestrian, give the name of the street to be crossed, and provide real time information about WALK and DON'T WALK intervals.

APS devices may have vibrating features that operate in parallel with the audible sounds.

For comprehensive guidelines on APS applications, practitioners should refer to TAC's Guidelines for Understanding Use and Implementation of Accessible Pedestrian Signals, May 20088. The guideline replaced the audible signal provisions in TAC's Manual of Uniform Traffic Control Devices (MUTCD), 1991 as amended 20089, which provides information on the basic standards and pushbutton operation options. The guideline itself is a stand-alone document that provides additional details on all stages of an APS installation.

This includes:

- The understanding of steps taken by pedestrians with vision loss to cross a street
- Guidelines on liaising with local communities and recognized agency or body trained in the needs of the visually impaired
- Establishing installation priorities based on pedestrian safety, pedestrian usage, and traffic conditions
- APS operational guidelines on:
    - Pedestrian way finding through pushbutton locating tones
    - Orientation guidance through the use of information signs, tactile arrows and lettering, Braille, audible (voice) orientation message
    - APS actuation
    - Types of APS indications
    - Traffic control signal operations and phasing
- APS design guidelines on the:
    - Overall layout and intersection configurations
    - Pushbutton location, mounting height, and alignment
    - Beacon mounting height and alignment
    - Pedestrian information signing
- APS deployment guidelines on installation strategies
- APS maintenance and adjustments

The legal requirements for APS as prescribed in the Accessibility Standards for Built Environment Standard, Ontario Regulation 413/12 Sub-Section 80.28 (1)[4] are as follows:

"Where a new traffic control signal system with pedestrian control signal heads is being installed at an intersection or an existing traffic control signal system with pedestrian control signals heads is being replaced at an intersection, the pedestrian signals must be accessible. The "intersection" includes any portion of a highway indicated by markings on the surface of the roadway as a crossing place for pedestrians.

The APS must meet the following requirements:

- *They must have a locator tone that is distinct from a walk indicator tone*
- *They must be installed within 1,500 mm of the edge of the curb*
- *They must be mounted at a maximum of 1,100 mm above ground level*
- *They must have tactile arrows that align with the direction of crossing*
- *They must include both manual and automatic activation features*
- *They must include both audible and vibro-tactile walk indicators.*

Where two APS assemblies are installed on the same corner, they must be a minimum of 3,000 mm apart.

Where the above requirement of 3,000 mm apart cannot be met because of site constraints or existing infrastructure, two APS assemblies can be installed on a single post, and when this occurs, a verbal announcement must clearly state which crossing is active." [5]

3. Background

Traffic control and management relies on a system of traffic control devices for conveying messages to the road users. The objective of these messages is to advise road users (see Section 3.1) of traffic regulations to enable observance of the law, warn them of roadway characteristics or road hazards, and provide them with the necessary tools and information for informed decision-making. Meeting these objectives improves safety and convenience for road users, and promotes the efficient movement of people and goods and the orderly flow of traffic.

The underlying fundamental principles encompass:

- understanding of the intent of the pedestrian / vehicle right-of-way rules as set out in the HTA[1] (see Section 2),
- safety and human factors considerations of different road users such as pedestrians and motorists, including pedestrian groups requiring special needs (e.g., school children, the elderly, persons with a mobility limitation), and
- design consistency (see Section 3.1 – Section 3.4).

3.1 Road Users

A road user may include a pedestrian, a driver or a passenger of a vehicle, a rider of a motor bike or bicycle, a ridden or herded animal, or an animal-drawn vehicle; wherein for the purposes of this book the following definitions apply:

1. A pedestrian includes:
    a) A person who is not in or upon a vehicle, motorized or otherwise propelled
    b) A person in a wheelchair driven by muscular or any other kind of power
    c) A person pushing a bicycle, or a wheelchair
2. A vehicle includes a motor vehicle, trailer, traction engine, farm tractor, road-building machine, bicycle, and any vehicle drawn, propelled or driven by any kind of power, including muscular power, but does not include a motorized snow vehicle or streetcar.

It is pertinent to note that HTA[1] considers bicycles as vehicles and are required to yield right-of-way to pedestrians on controlled crossings similar to other vehicles. While using a pedestrian crossing, cyclists must dismount and walk across the pedestrian crossing.

3.2 Right-of-Way Conflict Resolution

Applications of pedestrian crossing control must be consistent with the HTA[1] that governs the control and the rules of the road for right-of-way determination. The legal requirements within the context of pedestrian crossing facilities and right-of-way conflict resolution can be referred to in Section 2.

3.3 Understanding of Safety

Within the context of traffic operations, safety is defined as the degree to which road users are free from the occurrence of danger, loss or injury (real or perceived).

Safety in the Transportation Environment: In the road transportation environment, the probability of harm exists primarily from motor vehicle conflicts and collisions. The three elements that comprise the transportation system are: the road user, the vehicle and the road environment. Any or all of these elements can contribute to conflicts and collisions. Collisions occur as a result of an error or fault that can be attributed to one or more of the contributing elements.

Quantifying Safety: Safety of any transportation facility is typically measured by the collision history over time. Traffic safety practitioners have developed statistically reliable methods for quantifying the safety of various transportation facilities. For example, the safety of a specific facility, such as an intersection, pedestrian

crossing or roadway section can be measured by comparing the average collision frequency to the statistically estimated collision frequency for that type of facility for a given time period. In simple terms, an existing facility is considered to have a lower potential for safety improvement if the average number of collisions is lower or equal to the expected frequency. Because collisions are relatively unpredictable events, proxy measures of safety may be used, such as the number of conflicts observed during a fixed period of time. A conflict is defined as a traffic event involving the interaction of two or more road users where an evasive action such as braking or swerving occurs to avoid a collision.[10]

Qualifying Security: Security is the perception of how safe a road user feels in the road environment, as opposed to the actual level of safety. Road users' perception that a facility is "safe" or "safer" is based on their experience and knowledge. For a given state, the road environment and vehicle generally behave in a repeatable, predictable fashion. However, for a given situation, the human element in the system has a wide range of responses, some unexpected. Driver and pedestrian behaviour is at least partly based on their perception of risk, and road users do not always evaluate risk consistently. Therefore, road users' actions can be attributed to their acceptance of perceived level of risk.

Influencing Safety and Security: The installation or modification of a transportation facility may or may not yield the desired change in either safety or security. It is up to practitioners to use their best engineering judgment to understand the environment and the road users and to predict as accurately as possible the effects of the modification. Practitioners should also consider that improving safety may still not improve the sense of security for the user and vice versa.

Higher levels of safety occur where there is the proper level of right-of-way control for the road type, roadside environment, volume of pedestrians, age / type of pedestrians, volume of vehicles, and related factors. It also occurs when pedestrians and drivers have a clear understanding of what they are supposed to do and what other road users are likely to do, enough information (including clear sight lines and appropriate guidance) to make safe decisions, and the ability to make those decisions and execute them.

It is imperative that practitioners have a full understanding of the details of available research in order to assess the applicability of research findings to their roadway environment. Alternatively, jurisdictions can develop their own quantifiable before and after study processes to quantify safety impacts.

3.3.1 Factors Influencing Safety

Contributing factors that influence the level of safety within the context of pedestrian roadway operations may include:

- The degree of pedestrian-vehicle interaction
- Vehicle speeds
- Road users' expectancy
- Road users' perception
- Road users' awareness
- Pedestrian's ability (mobility, vision, hearing and cognition)
- Road users' understanding of the rules of the road

These factors are shown in Table 3.

3.3.2 Walking Considerations

Walkability is a measure of the level of integration of pedestrian facilities (such as sidewalks, trails and crossings). It considers the ease in which pedestrians can move through the transportation network enjoyably and safely. A walkable environment serves to encourage a healthier lifestyle by promoting walking or the use of non-motorized means of transportation.

Table 3: Factors Influencing Safety

Factors Influencing Safety	Related Impacts and Considerations for Treatment of Pedestrian Crossings
Degree of pedestrian-vehicle interaction	The potential for conflicts and collisions is directly affected by the level of interaction between road users. A higher exposure of pedestrians interacting with vehicles (from higher vehicle and/or pedestrian volumes, or a higher number of potential conflict points) will generally result in a higher potential for pedestrian collisions.
Vehicular speed	The higher the vehicular speed at the time of impact, the higher the probability of fatality of pedestrians. Relatively small changes in speed can have a large impact on the severity of a pedestrian collision (particularly between 40 km/h and 60 km/h). [11]
Driver and pedestrian expectancy	Expectancy influences the speed and accuracy of information processing; and conditions that meet or reinforce expectancies help drivers and pedestrians to respond quickly, efficiently and without error. Violations of expectancy increase the chance of inappropriate decisions that lead to conflicts or inability to control vehicles safely.
Perception (visual acuity and visual contrast)	There is an inherent limitation in drivers' or pedestrians' ability to detect objects, especially under low visibility conditions. Furthermore, the difference between visual acuity and visual contrast should also be considered. Visual acuity is a measure of the ability to identify black symbols on a white background at a standardized distance. Visual contrast is the ability to distinguish between various shades of gray. At night, a driver's visual contrast is much more important for detecting pedestrians than visual acuity. Both visual acuity and visual contrast decline continuously with age.
Level of awareness (positive guidance and driver workload)	Humans behave as a single channel processor, which means they are able to conduct one task consciously at a time. A more complex driving environment will therefore require a higher level of mental effort and reduce one's ability to focus upon the driving tasks. Positive guidance considers a driver's workload and reduces the occurrence of multiple potential conflicts. As defined in OTM Book 1C, "Positive Guidance is provided when that information is presented unequivocally, unambiguously and conspicuously enough to meet decision sight distance criteria and enhances the probability of drivers making appropriate speed and path decisions."
Pedestrian ability	Pedestrians differ in terms of their mobility, their speed, and their ability to perceive and react to potential conflicts, and recognize and understand traffic control devices. Designs for crossing devices should have regard for the needs of all pedestrians (i.e., the elderly, the young, and persons with a disability). It is also important to note that under the AODA[3] , design elements as part of pedestrian crossings must meet the mandatory accessibility standards (see Section 2.3).
Rules of the road	The rules of the road under the HTA[1] provide the basis that governs and manages competing traffic movements; however, inconsistent interpretation, ignorance, or disregard of the law leads to potential for conflicting actions. A balance of continuous education and enforcement contributes to the general population's awareness and understanding, which contributes to the overall safety.

Pedestrian crossings are a critical element among the many factors that influence the overall walkability of an environment. The factors that can affect walkability are shown in Table 4 and include, but are not limited to, distance of the trip, perceived safety and security of the route, and the comfort and convenience of walking versus the alternative modes of transportation.

Table 4: Walkability Considerations

Factor	Description
Distance of the trip	Most people are willing to walk 5 to 10 minutes at a comfortable pace to reach a destination, with walking trips averaging a distance of 0.4 km. The threshold for walking trips is approximately 1.6 km in distance. As a result, land-use patterns, community design and population density are great determinants in trip distance and ultimately determine whether a community is walkable.
Perceived safety and security of the route	Walkway design can impact the perceived safety and security by pedestrians. The following are examples of elements that directly impact the perceived and actual safety of pedestrians: • Sidewalks that are too narrow and / or adjacent to vehicular traffic • Pedestrian crossings that have confusing signal indications • Pedestrian crossings that have excessive crossing distances • Pedestrian crossings with fast-turning vehicles • Absence of other pedestrians • Inadequate illumination (poorly lit areas) • Excessive vehicular speeds adjacent to the pedestrian walkway • Passage through secluded areas
Comfort and Convenience	The decision to walk is also influenced by comfort, convenience, visual interest and the existence of potential destinations along the route. Unlike motorists, the slower speed of pedestrians results in a preference for more rather than less environmental stimuli. Some factors that create a visually interesting environment that is conducive to walking include: • A good mix of land use • Continuous and connected pedestrian facilities • Ample separation of pedestrian facilities from high-speed vehicular traffic • Safe, convenient and unambiguous street crossings • Streetscaping and street furniture • Air quality • Shade or sun in appropriate seasons • Proper maintenance of facilities • Access to mass transit

3.4 Road User Characteristics

Walking has become increasingly important as various jurisdictions strive to make the transportation system more sustainable. In many jurisdictions there is a growing need to provide options for the safe and efficient accommodation of pedestrians and other vulnerable road users. However, in order for people to walk, the system must be able to properly accommodate them.

The proper accommodation of pedestrians is a function of understanding their unique characteristics to provide adequate mobility and accessibility opportunities that will serve them in a safe and equitable manner.

The Institute of Transportation Engineers (ITE) Traffic Engineering Handbook, 2009 (ITE Handbook)[13] explains the necessity of providing accessibility for all pedestrians, including those with disabilities: "Accommodating pedestrians includes considering those with visual, hearing, or cognitive impairments"[13]. Measures for providing pedestrian accessibility to persons with disabilities include: APS, fixed roadway lighting, curbs, curb ramps, islands, audible signals, and other way finding cues. It is important to combine auditory, tactile, and kinaesthetic information to aid in pedestrian movements, particularly at atypical intersections and mid-block crossing locations [13].

TAC's Pedestrian Crossing Control Guide[14] (PCCG) refers to ITE Handbook[13], which indicates that there are various elements interacting with each other in the street-crossing task. Some of these include road user age, physical ability, and knowledge, and understanding of the way in which traffic moves. ITE Handbook[13] states that older road users may be affected by failing sensory and information-processing capabilities and slower information processing, while children may have problems with the ability to estimate available and required crossing gaps due to their limited search and attention capacity.

TAC's PCCG[14] indicates that "understanding human factors issues is essential in a holistic approach to planning, designing and operating a road system. Pedestrians, crossing unexpectedly, may make it impossible for a driver to respond in time to avoid them. Research has shown that major human factors issues contributing to pedestrian collisions are[14]:

- Driver response to unanticipated pedestrian movements
- Visual obstacles such as parked vehicles, windshield pillars, newspaper stands, and vegetation
- Limited sight distance due to horizontal and vertical alignments to approaches
- Pedestrian and driver inattentiveness
- Poor visibility due to darkness
- Alcohol use by pedestrians and drivers
- Speeding by drivers
- Children's inexperience in traffic

The following sections discuss some of the unique characteristics associated with aging road users and children as pedestrians relative to younger adults (20-64 years old).

3.4.2.1 Aging Road Users

It is a known fact that as people age, their visual, mental, and physical capabilities diminish, and the incidence of disability can also increase. People can experience reductions in acuity, contrast sensitivity, and visual field. They can also experience restrictions in the area of visual attention, increased sensitivity to glare, decreased dark adaptation, and decreased motion sensitivity. Furthermore, people can experience a reduction in their selective attention, divided attention, perception and reaction time, and their working memory. The aging process can also result in reduced strength, flexibility and range of motion in the upper arm, shoulder, lower leg, and the neck and upper torso[16].

Research conducted by Montufar et al.[16] found that for pedestrian walking speed, using a design value

of 1.2 m/s for pedestrians crossing at signalized intersections excludes about 40 percent of older pedestrians (≥ 65 years old), 90 percent of older pedestrians with walkers or canes, and 10 percent of the younger adult population (20-64 years old). Some of these results are shown in the Figure 1. It should be noted that the results shown in Figure 1 [16] exclude pedestrians using assistive devices for mobility.

The study found that lower design values for pedestrian walking speeds are desirable for older pedestrians when they cross a signalized intersection, as well as for older pedestrians with walkers or canes.

As a result of this work, TAC PCCG[14] modified its pedestrian walking speed as follows:

> *"Practitioners should apply these [pedestrian walking speed for the design pedestrian] values as follows:*
>
> - *Use 0.8 m/s walking speed in cases where at least 20 percent of pedestrians crossing the signalized intersection use assistive devices for mobility (possibly in the vicinity of hospitals or nursing homes). This walking speed applies to all types of crossings (whether the crossing is equipped with accessible pedestrian signals or not).*
> - *Use 0.9 m/s walking speed in cases where at least 20 percent of pedestrians crossing the signalized intersection are older pedestrians (65 years of age or older).*
> - *Use 1.0 m/s walking speed to accommodate the general population.*
> - *Practitioners need to use standard practice in their own jurisdictions, and engineering judgment to decide whether these walking speed values should be used to calculate only the clearance interval or the entire duration of the walk and clearance phases."*[14]

A Design Pedestrian may be defined as an average pedestrian whose walking speed is used for the design of a pedestrian facility.

3.4.2.2 Children as Pedestrians

TAC's PCCG[14] states that children may have problems with the ability to estimate available and required crossing gaps due to their limited search and attention capacity.

Children have difficulty judging speed, spatial relations, and distance as compared to adults. Their auditory and visual acuity, depth perception and proper scanning ability develop gradually and do not fully mature until at least age 10. Even children above this age are easily distracted and may not always behave as drivers expect[17]. Furthermore, according to ITE Handbook[13], their concept of safety is not well developed, their knowledge of safe crossing conditions and ability to properly judge traffic gaps is poor, they have limited understanding about traffic control devices, and have difficulty correctly perceiving the direction of sound and the speed of a vehicle.

TAC's PCCG[14] states that addressing the limitations of road users requires understanding that traffic control devices supplement the visual roadway information and assist in developing proper driver expectations. For example, the driver may fail to make the right decisions in the case of uncommon or unexpected situations, where driver expectation may be violated due to the road geometry, surrounding land use, or traffic characteristics along the way. In these situations, traffic control devices need to be implemented to advice, warn, and/or regulate operations [14].

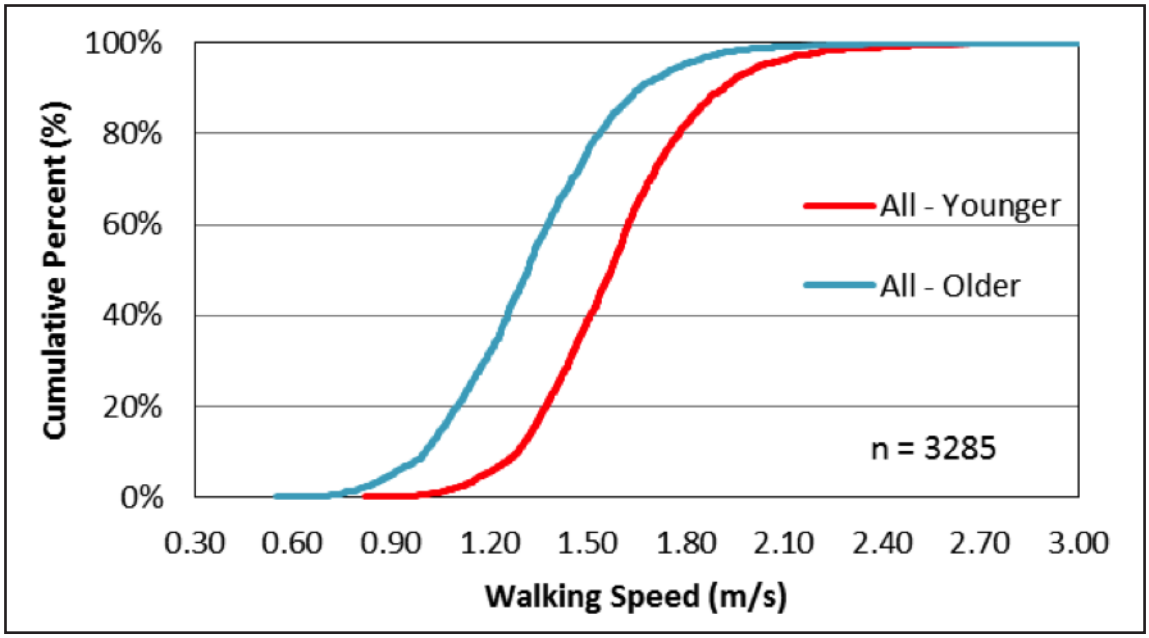


Figure 1: Pedestrian Walking Speed at Signalized Intersections in Canada by Age

4. Planning

4.1 Classification of Pedestrian Crossing Facilities

The appropriate selection of facility and treatment options for pedestrian crossings is governed by the existing or anticipated conditions and by the complexity of the surrounding environment. The complexity of the environment may encompass a range of influencing factors such as pedestrian and vehicle volumes and their level of interaction (exposure), vehicle speeds (type of exposure), the crossing distance (length of exposure), road users characteristics (age, ability, understanding, expectation and behaviour), and visibility conditions. In general, the more complex the condition, the more sophisticated the treatment measures that may be required.

According to the intent of HTA[1] , the classification of pedestrian crossings is based on the presence or absence of a traffic control device. Therefore, pedestrian crossing treatment systems in Ontario are either controlled or uncontrolled. In the most complex pedestrian crossing environments, where community linkages over major barriers such as freeways and railway lines are required, physically-separated facilities may be used.

4.1.1 Controlled Crossings

Under complex conditions, traffic control measures may be used to provide pedestrians added protection through the use of controlled crossings. At these crossings drivers are required to yield the right-of-way to pedestrians in specific conditions.

Controlled crossings, in order of increasing complexity, may include locations that are controlled by stop or yield signs, pedestrian crossovers (PXO), intersection pedestrian signals (IPS or half signals), mid-block pedestrian signals (MPS) or full traffic control signals. The use of school crossing guards is also considered to be a form of pedestrian control at designated crossings during school periods. The crossing guard ensures opportunities for children and other pedestrians to cross safely. School crossing guards are normally stationed at marked school crossings but may be stationed at locations that are controlled crossings.

The types of pedestrian crossing treatments used for controlled pedestrian crossing locations in order of increasing complexity follow a definite hierarchy as outlined in Section 4.2. Section 5 describes the methodology for selection of Controlled Pedestrian Crossing Treatments. Section 6 provides guidance on their design.

4.1.2 Uncontrolled Crossings

Uncontrolled crossings are locations where pedestrians cross without the aid of traffic control measures and a dedicated pedestrian right-of-way. Drivers are not required to yield the right-of-way to pedestrians. At these locations, pedestrians need to wait for safe gaps in traffic before attempting to cross on the roadway. At an uncontrolled location, the pedestrian must not enter the roadway if vehicles are not able to stop and drivers must make every effort to avoid a collision. This dual responsibility puts the onus on both road users for each other's safety as there is no prescribed right-of-way. As pedestrians are the more vulnerable road user, they must take extra care to ensure that all approaching drivers have seen them and have or will be able to stop safely, before considering entering the roadway.

At uncontrolled crossings, only signage (no pavement markings) and modification of the physical environment can be used in order to generate a balance between increased driver awareness of crossing activity and pedestrians' understanding of the rule of the road. Section 7 provides guidance on the design of uncontrolled pedestrian crossing facilities.

4.1.3 Physically-Separated Facilities

Physically-separated facilities are grade-separated crossings either in the form of an overpass or an underpass. They provide for the highest form of pedestrian protection by physically separating vehicular and pedestrian traffic. Grade separation may be considered if other forms of controlled

crossings are not appropriate or when there are insufficient gaps and obvious safety concerns with at-grade pedestrian crossings where sufficient property exists to build the structures. Section 8 provides more information on Physically-Separated Facilities.

4.2 Hierarchy of for Controlled Pedestrian Crossings Treatment Systems

A pedestrian crossing treatment system is defined as a combination of components which form a single strategy to facilitate the crossing of pedestrians. Components may include signs, signals and pavement markings as defined in OTM Books 5, 6, 11 and 12 and other elements, such as geometric features, auxiliary aids, and the use of school crossing guards.

The hierarchy of Pedestrian Crossing Treatment Systems for Controlled Pedestrian Crossings in relation to the complexity of the roadway environmental conditions is as follows:

- Traffic Signals
  - Full Traffic Signal
  - Intersection Pedestrian Signals (IPS)
  - Mid-block Pedestrian Signal (MPS)
- Pedestrian Crossovers (PXO)
  - PXO A
  - PXO B
  - PXO C
  - PXO D
- Stop Controlled or Yield Controlled Intersections
- Supervised School Crossing

Figure 2 demonstrates the hierarchy of pedestrian crossing treatments for controlled pedestrian crossings. Implementation requirements for the treatment systems are consistent with the current OTM Book guidelines and municipal policies, as demonstrated in Figure 2.

A brief description of each type of controlled treatment system is included in Table 5.

4.3 Overview of Treatment System Selection

The selection of the most appropriate type of pedestrian crossing treatment from the range of choices available in the hierarchy for a pedestrian crossing location requires an assessment of the complexity of the roadway environmental condition. A comprehensive study of the traffic conditions and the physical characteristics of a location under consideration should be undertaken to determine the type of treatment system that would be most appropriate for that location.

Similar to the warrants for traffic signals in OTM Book 12 – Traffic Signals, this manual provides a Decision Support Tool (DST) describing threshold conditions for assessing pedestrian crossing needs and selection of a Treatment System.

The decision to install a particular type of Treatment System should be based on sound engineering judgement. Warrants should not be used as a substitute for engineering judgement; however they promote uniformity in treatment selection throughout a jurisdiction and help traffic practitioners in making informed decisions. It is traffic practitioner's fundamental responsibility to exercise engineering judgement and experience on technical matters within the context of using the DST for assessing pedestrian crossing needs and selection of an appropriate Treatment System.

The DST provided in this manual is based on the seven guiding principles contained in the TAC PCCG: safety, delay, equity, expectancy, consistency, connectivity, and pragmatism[15] as described below:

- **Safety:** Safety is the principal objective in providing pedestrian crossing control and

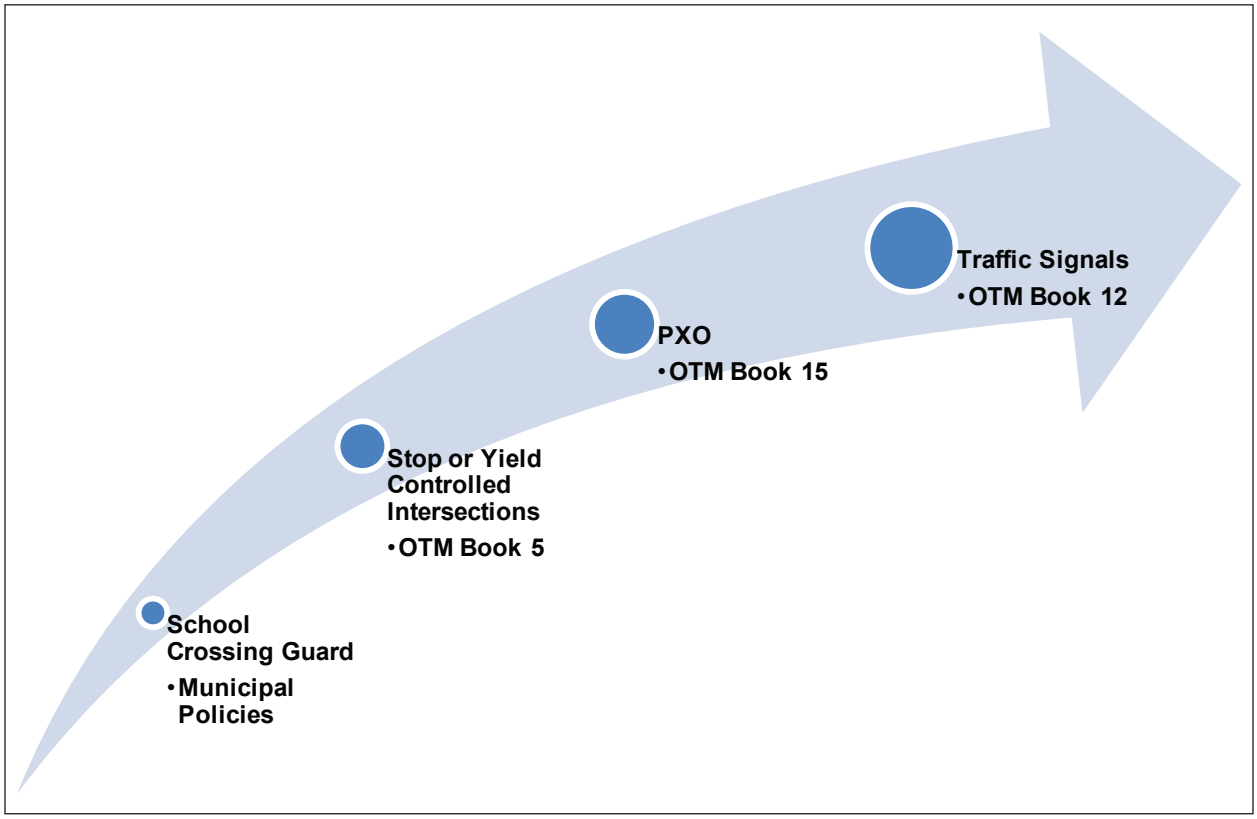


Figure 2: Hierarchy of Controlled Crossing Treatment Systems and Current Policies and Guidelines

other supporting facilities and devices. It is fundamental that the road system protect pedestrians and other vulnerable road users by achieving a high level of compliance from drivers, bicyclists and pedestrians, and by minimizing pedestrian exposure to vehicular traffic.

- **Delay:** Delay experienced by pedestrians attempting to cross the road should be managed. As pedestrian delay increases, the likelihood of pedestrians making risky or non-compliant crossings also increases. This reduces the efficiency and safety of the crossing for both pedestrians and vehicle occupants.
- **Equity:** The demographics of the pedestrian population as well as the mix of road users at different time periods should be considered, and crossing facilities and control devices should be designed accordingly. As the population changes, a "Design Pedestrian" should be considered to ensure the accessibility of all road users and not only those with good visual, mental, and physical capabilities (See Section 3.4).
- **Expectancy:** The presence of a pedestrian crossing treatment system should not violate driver expectancy, thereby increasing the likelihood of drivers responding to situations correctly and quickly.
- **Consistency:** This helps ensure that installations and devices are recognized, understood, and used effectively by all road users. The pedestrian crossing control devices or combinations of devices where single, simple treatments may be insufficient or

Table 5: Pedestrian Crossing Treatment Systems

Full traffic signals alternate the right-of-way between conflicting streams of vehicular traffic, or conflicting movements between vehicular traffic and pedestrians crossing a road for all approaches of an intersection by displaying instructions through light-emitted indications using standard colour and signal as regulated in the HTA. Traffic is alternately directed to stop and proceed through a sequence of indications in each cycle.
IPS are traffic control signal systems that are dedicated primarily to providing traffic gaps for pedestrian right-of-way installed as pedestrian signals at intersections.
MPS are traffic control signal systems that are dedicated primarily to providing traffic gaps for pedestrian right-of-way installed as pedestrian signals between intersections.
PXO A is distinctly defined by the use of regulatory and warning signs, flashing amber beacons, and pavement markings prescribed by Ontario Regulation 615 and illustrated in the layout. This treatment system uses internally illuminated overhead warning signs.
PXO B is distinctly defined by the prescribed use of regulatory and warning signs, rapid rectangular flashing beacons (RRFB) and pavement markings prescribed by Ontario Regulation 615 and illustrated in the layout. The system uses both the side mounted and over-head regulatory signs.
PXO C is distinctly defined by the prescribed use of regulatory and warning signs, RRFB and pavement markings prescribed by Ontario Regulation 615 and illustrated in the layout. The system uses only side mounted regulatory signs.
PXO D is distinctly defined by the prescribed use of regulatory and warning signs, and pavement markings prescribed by Ontario Regulation 615 and illustrated in the layout. The system uses only side mounted regulatory signs and does not require flashing beacons.
STOP controlled intersections using STOP / All-Way STOP signs as a form of traffic control to assign and regulate right-of-way at intersections with the potential for conflict. Vehicles approaching a STOP in advance of a crosswalk are required to stop at the stop bar, thereby, yielding to vehicular traffic and pedestrians whose arrival preceded their's before proceeding..
YIELD controlled intersections use YIELD signs as a form of traffic control to assign and regulate right-of-way at intersections with the potential for conflict. Vehicles approaching a YIELD sign in advance of a crosswalk on an intersection are required to slow down or stop when necessary to yield the right-of-way to pedestrians before entering the crosswalk.
Supervised school crossings are locations close to schools where school children have to cross en route between home and school. School crossings are supervised by school crossing guards during specified hours and during regular school periods.

unsafe should be designed according to the four traits of positive guidance: primacy (signs are placed according to the importance of their information, and in a way that presents the driver with information when it is essential); spreading (information is given in small amounts to reduce the information load on the driver); coding (color and shape coding of traffic signs); and redundancy (information is repeated).

- **Connectivity:** Facilitating connectivity between crosswalks and sidewalks and/or trail networks involves understanding and monitoring pedestrian desire lines, which evolve as a function of land use, the location of pedestrian generators and attractors, and proximity to existing crossing facilities. When alternatives to pedestrian desire lines are required due to other factors, these facilities should be simple, convenient, and clearly marked, and should effectively channel pedestrians so that they modify their natural choice with the shortest possible deviation.
- **Pragmatism:** The pragmatic selection of pedestrian crossing treatment systems involves consideration of costs, effectiveness of the device in local conditions, ease of installation and maintenance of the device, particularly in winter, when maintenance due to snow and ice can be challenging. The professional must realize that when a device is provided it should be functional year-round, unless it is intended to be used only temporarily.
- Application of these guiding principles will improve travel suitability and utility of walk trips. A connected, safe, and convenient network of pedestrian will increase walk trips which in turn contributes to more sustainable and healthier communities.
- In addition to these guiding principles, the development of the DST considered consistency with other OTM Books, as well as the latest research involving pedestrian crossing control.
- The DST includes two components: Preliminary Assessment and Pedestrian Crossing Selection. The preliminary assessment component identifies the pedestrian crossing needs and the pedestrian crossing selection component provides the means for selection of a particular type of treatment system.

5. Treatment System Selection for Controlled Crossings

Section 4.2 provides the hierarchy of Pedestrian Crossing Treatment Systems for Controlled Pedestrian Crossings.

To support an efficient deployment of the previously described hierarchy of treatment systems, this manual provides a DST based on the seven guiding principles as explained in Section 4.3. In addition to these guiding principles, the DST is consistent with other relevant OTM Books, as well as the latest safety research involving pedestrian crossing control.

The DST includes two components: (1) Preliminary Assessment and (2) Pedestrian Crossing Selection. The preliminary assessment is used to check whether a pedestrian crossing control is a candidate site and then the pedestrian crossing selection assist practitioners to choose a pedestrian crossing treatment system for the site.

5.1 Preliminary Assessment

Even before the preliminary assessment is undertaken it must be confirmed that the identified location has adequate sight distance for both motorists and pedestrians. Motorists must be able to see pedestrians in the waiting area adjacent to the crossing in sufficient time to perceive their intent to cross, react and brake to a stop comfortably. Similarly, pedestrians must be able to see oncoming traffic in both directions of travel so that they do not begin to cross when motorists have insufficient time to stop. These minimum stopping sight distances can be determined through standard guidance, such as the Geometric Design Standards for Ontario Highway.[27]

The main purpose of the preliminary assessment component of the DST for pedestrian crossing control is to identify whether a pedestrian crossing control measure of any type is warranted at a location.

Figure 3 illustrates the flow chart for performing the preliminary assessment to identify whether a site is a candidate for pedestrian crossing control.

The preliminary assessment involves the following steps:

- Check whether a traffic signal is warranted for pedestrians based on Justification 6 of OTM Book 12. Justification 6 of OTM Book 12 is also presented in Section 5.1.1. The types of traffic signals implemented include full traffic signal, IPS, and MPS.
- If a traffic signal is not warranted, the flow chart assists in checking whether a PXO is warranted for the site.

The rest of this subsection includes the details of the above noted steps.

5.1.1 Traffic Signal Assessment

As shown in Figure 3, checking for traffic signals is the first step in the preliminary assessment process. The pedestrian crossing treatment systems under traffic signals include full traffic signals, IPS, and MPS.

According to OTM Book 12-Justification 6, the installation of a pedestrian treatment is warranted if any one of the following criteria is satisfied:

- The subject site exceeds both the minimum pedestrian volume and the minimum pedestrian delay criteria for a period of 8-hour.

The pedestrian volume criterion is defined as the total 8-hour pedestrian volume crossing the main road at an intersection or mid-block location during the highest 8-hour of pedestrian traffic. Similarly, the pedestrian delay criterion is defined as the total 8-hour volume of pedestrians experiencing delays of ten seconds or more in crossing the road during the highest 8-hour of pedestrian traffic.

For pedestrian volume to be used in the above criteria, an adjusted pedestrian volume is applied to reflect a factored volume based on "equivalent adults" and the following definitions as described in OTM Book 12:

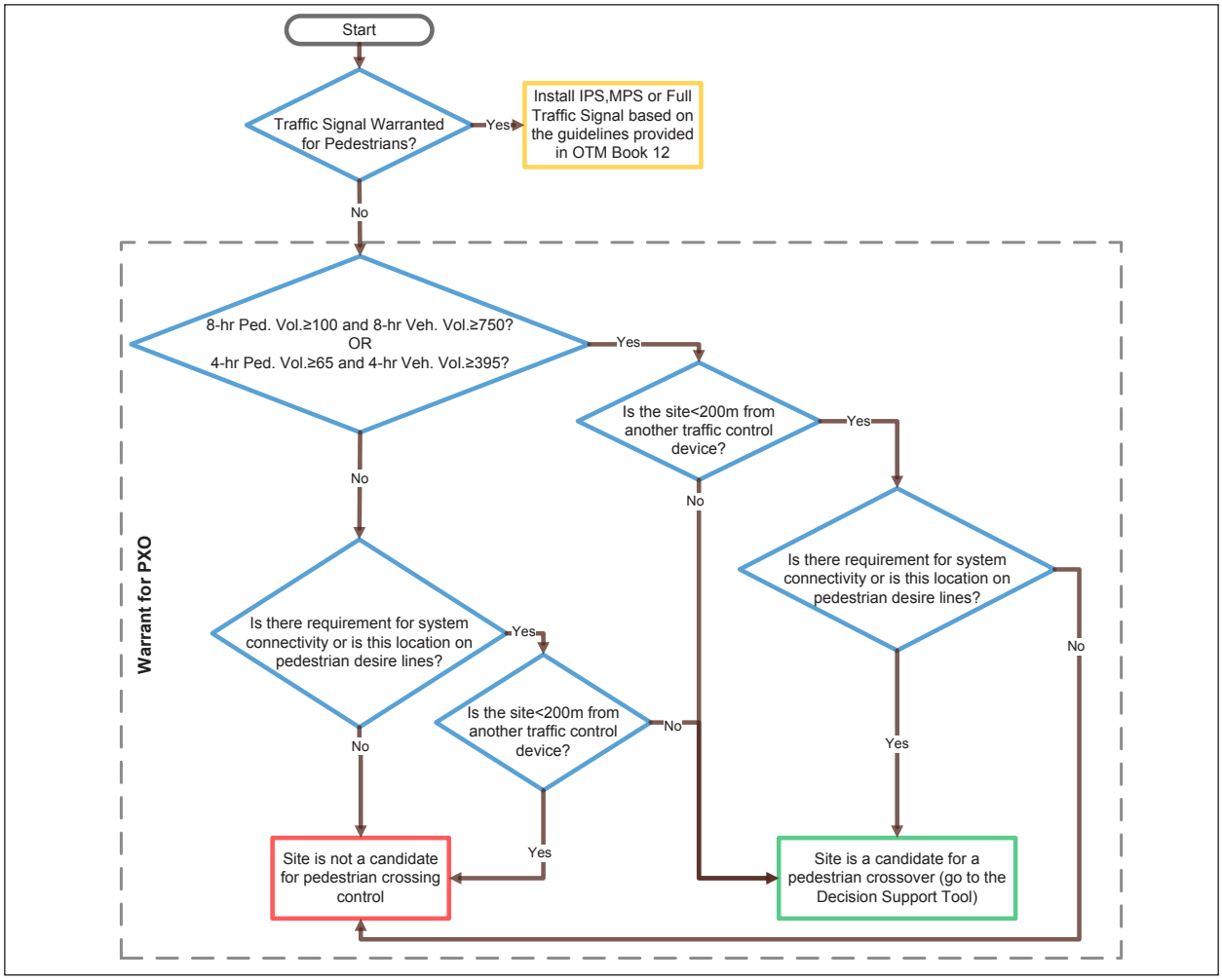


Figure 3: Decision Support Tool – Preliminary Assessment

- Unassisted – Adults and adolescents at or above the age of 12 are considered "unassisted" pedestrians.
- Assisted – Children under the age of 12, senior citizens, disabled pedestrians and other pedestrians requiring special consideration or assistance are considered "assisted" pedestrians. In cases where an adult is accompanying a pedestrian included in the "assisted" category, both individuals should be counted as "assisted" pedestrians to reflect their higher vulnerability. It should be recognized that the exact age of the pedestrian is not critical, but the observers will need to use their judgment to place each pedestrian into one of the two categories.

The factored pedestrian volume is calculated as follows:

Adjusted volume = Unassisted Pedestrian Volume + 2 x Assisted Pedestrian Volume

Figure 4 and Figure 5 show the graphs used to determine whether a pedestrian control treatment system is justified under the 8-hour criterion. In addition to 8-hour warrants, OTM Book 12-Justification 6 provides 4-hour warrants

for installation of pedestrian treatment for smaller communities. Smaller communities are defined as communities with population of less than 10,000.

Figure 6 and Figure 7 show the 4-hour pedestrian volume and pedestrian delay criteria for communities with population less than 10,000.

For further details on Justification 6 – Pedestrian Volume and Delay, refer to OTM Book 12.

5.1.2 Pedestrian Crossover Assessment

If a traffic signal (i.e. IPS, MPS, or full traffic signal) is not warranted at a site, the next step as shown in Figure 3 is to check whether a PXO is warranted. The preliminary assessment for PXOs is based on the following three factors:

Traffic volume: The research conducted by Zegeer et al[18], which analyzed pedestrian collisions at 2000 marked and unmarked crosswalks, found that there is a statistically significant relationship between pedestrian collision rate and traffic volume. Specifically, at locations with marked crosswalks, collision rates increase significantly as a function of traffic volume, for ADTs greater than approximately 9000 vehicles per day. This suggests the need to enhance the marked crosswalks at these locations with additional treatments to improve pedestrian safety. In addition, there is also a relationship between traffic volume and crossing opportunities, in which affects pedestrian delay. Therefore, by including traffic volume as a variable within the Pedestrian Crossover System preliminary assessment process, delay considerations are also integrated. This approach is consistent with the TAC's PCCG[14].

Crossing distance: The same research by Zegeer et al. (2005)[18] found that crossing distance has an impact on the likelihood of a pedestrian collision, particularly on roads with higher traffic volumes (i.e., the wider the crossing distance, the more difficult it is for pedestrians to safely cross the street). A particular concern with wider cross-sections is the multi-threat situations that are created by multilane roads. Collisions involving multiple threats typically occur when the driver and pedestrian fail to see each other because of the sight obstruction created by a vehicle that has already stopped for the pedestrian in another lane.

Pedestrian system connectivity: The provision of pedestrian system connectivity is important for proper pedestrian accommodation. As indicated in the guiding principles in Section 4.3, facilitating connectivity between crosswalks and sidewalks, and/or trail networks involves understanding and monitoring pedestrian desire lines, which evolve as a function of land use, the location of pedestrian generators and attractors, and proximity to existing crossing facilities. Providing proper connectivity between origins and destinations within a pedestrian network allow pedestrians for simple and convenient access to facilities with the shortest possible deviation.

Based on the above factors, the steps to check the requirement of a PXO are as follows:

1. Check minimum pedestrian and vehicular volume as the first step. If the total 8-hour pedestrian volume crossing the main road at an intersection or midblock location during the highest pedestrian traffic hours is greater than 100 "equivalent adult pedestrians" as defined in section 5.1.1 and the 8-hour vehicular volume during the same time period is greater than 750 vehicles, then check whether the distance of the site from the closest traffic control device is more than 200 m. If the distance is more than 200 m then the location is a candidate for a PXO. The 200 m minimum distance required from the site to the nearest traffic control device is consistent with Justification 6 of OTM Book 12 and the TAC's PCCG[14]. Otherwise, check for any justification based on connectivity requirements or pedestrian desired lines based on the engineering judgment. If the site cannot be justified for a pedestrian crossing control based on connectivity requirements or pedestrian desire lines, then the site is not a candidate for a pedestrian crossing control. As an alternative to the 8-hour pedestrian and vehicular volumes threshold, the flow chart

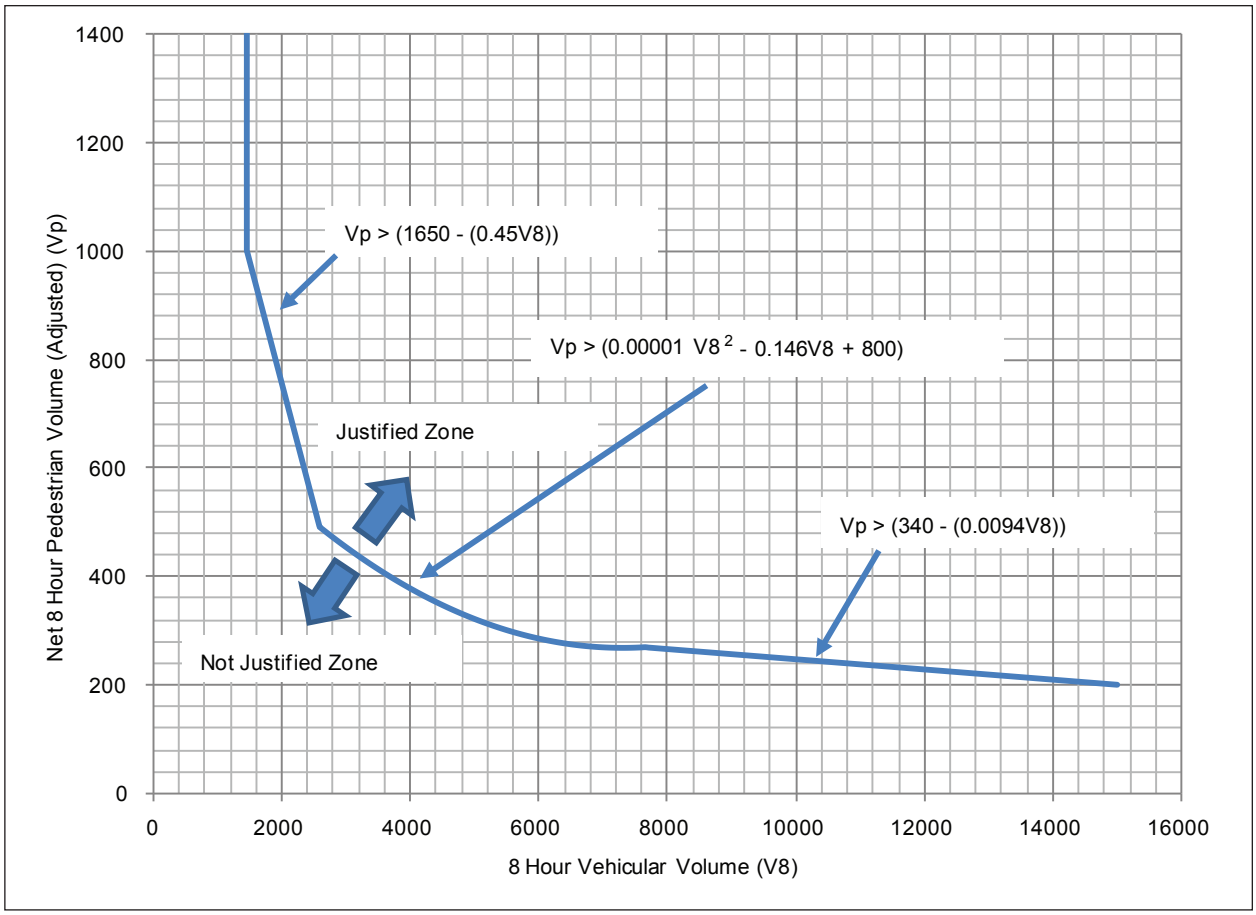


Figure 4: OTM Book 12 Justificayion 6 - Pedestrian Volume

shown in Figure 3 allows for the use of 4-hour pedestrian and vehicular volumes. If a road authority chooses to use 4-hour pedestrian and vehicular volumes, the minimum thresholds for the total 4-hour pedestrian volume crossing the main road at an intersection or a midblock location during the highest pedestrian traffic and the total vehicular volumes during the same periods are 65 equivalent adult and 395 vehicles respectively. It should be noted that equivalent adult pedestrian volume should be calculated based on Section 4 of OTM Book 12 – Traffic Signal.

2. If the minimum pedestrian and vehicular volume requirements are not met, assess whether this site provides system connectivity or is on a desired pedestrian line. If the site does not satisfy the system connectivity requirement or it is not on a pedestrian desire line, the site is not a candidate for a pedestrian crossing control. However, if a pedestrian crossing control can be justified based on system connectivity or pedestrian desire line requirements and the distance of the site to the nearest traffic control device is more than 200 m, then the site is a candidate for a pedestrian crossover. Otherwise, if the distance of the site to the closest traffic control device is less than 200 m, the site is not a candidate for a pedestrian crossing control.

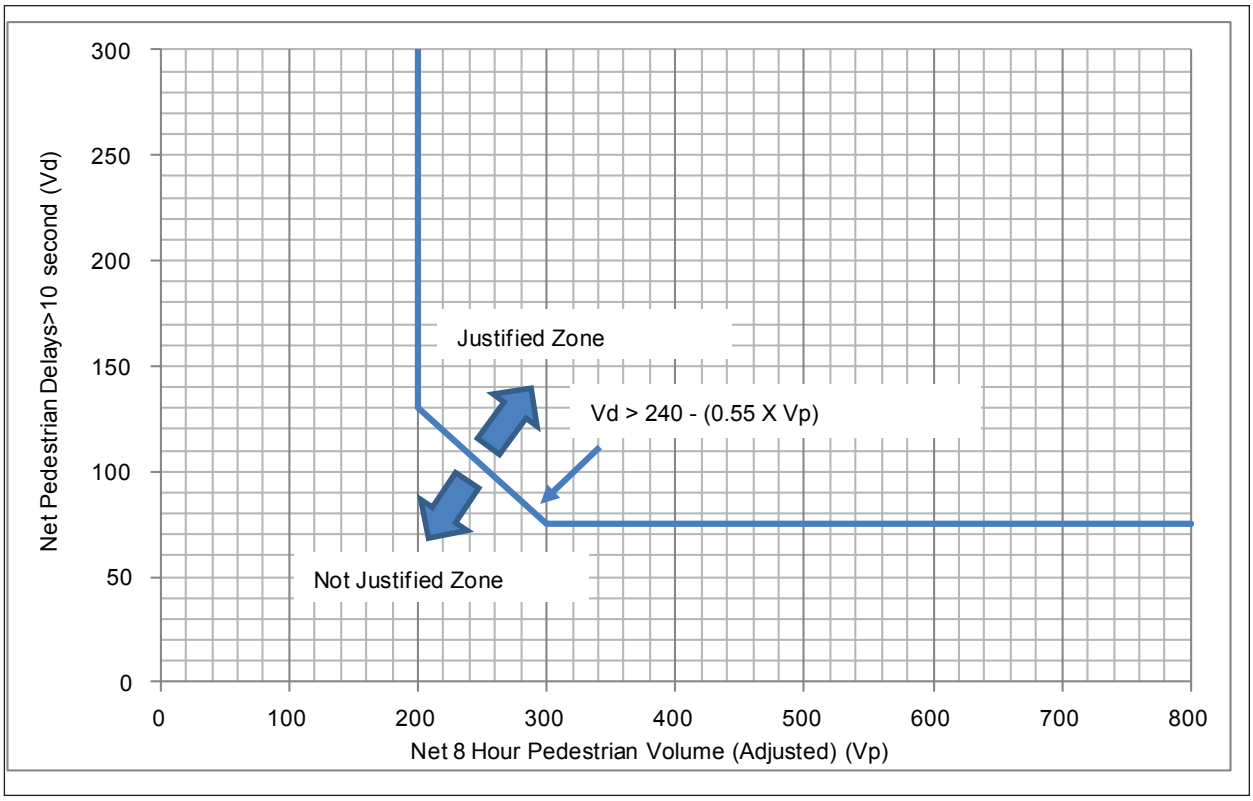


Figure 5: OTM Book 12 Justification 6 – Pedestrian Delay

The distance depends on a number of factors such as road type, traffic volume, expected queue length, pedestrian volume, and characteristics of pedestrians expected to use the facility. In the case of Ontario, this value has been set at 200 meters to avoid proliferation of traffic control devices in close proximity of each other. Having control devices in close proximity to each other can result in incorrect driver decisions which, in turn, may lead to collisions with pedestrians and other road users. Close proximity of various devices can also result in traffic flow disruptions and hence, low level of service along a corridor. This value of 200 meters is consistent with other OTM books limiting the distance between different traffic control devices (see Section 6.1).

5.1.3 Stop and Yield Controlled Intersections

Stop control intersections provide an opportunity for pedestrians to safely cross the major roads of intersections. If a two-way stop control intersection does not satisfy the minimum requirements for an IPS, full traffic signal or PXO as described in Section 5.1.1 and Section 5.1.2, warrants for all-way stop control must be checked.

Section 2 of OTM Book 5 – Regulatory Signs provides the warrant system for installation of all-way stop control at an intersection. The warrant system is based on minimum traffic volume of the major and minor road, and past collision history of the intersection.

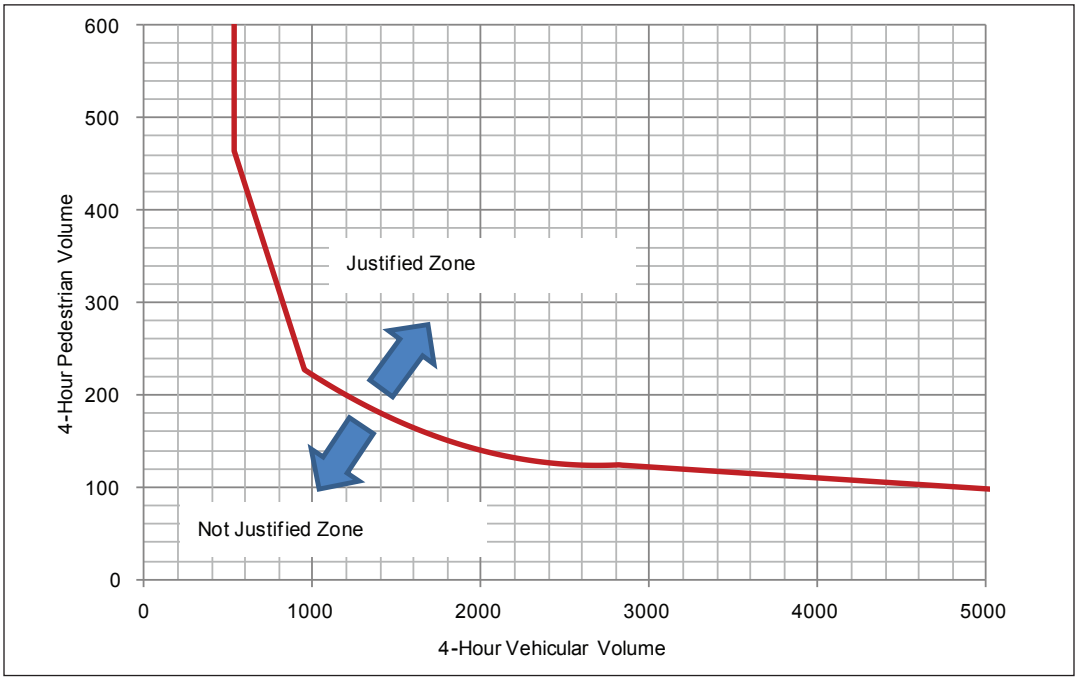


Figure 6: 4-Hour Pedestrian Volume Criterion for Communities of Population Less than 10,000

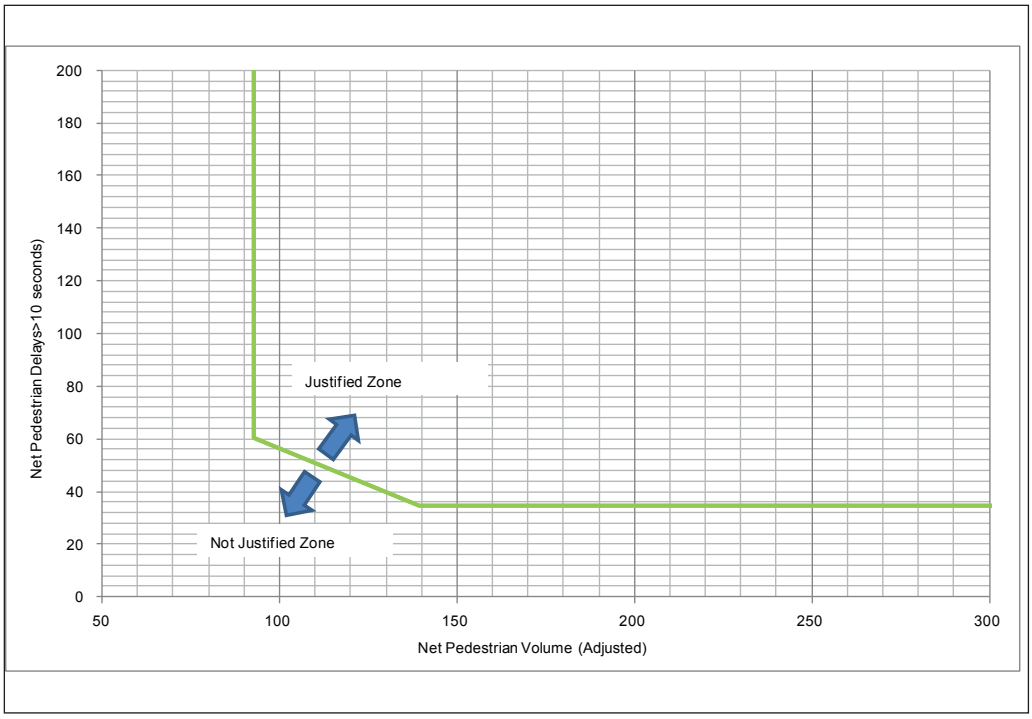


Figure 7: 4-Hour Pedestrian Delay Criterion for Communities of Population Less than 10,000

If an all-way stop control is not warranted, a yield control can be provided as an alternative, the guidelines for which are provided in OTM Book 5.

According to HTA[1] , every driver approaching a stop sign at an intersection is required to yield right-of-way to pedestrians at the crosswalk (crosswalk defined in Section 6.2.1.1). For intersection locations, where a stop control is not warranted and a pedestrian control is required, a yield sign can be used as an alternative to the stop sign. A yield sign is often installed at intersections with right turn channels. OTM Book 5 provides guidelines for installations of a yield controlled intersection but does not provide any warrant for these types of intersections. It may be noted that right-turn channel locations must be individually assessed for an applicable pedestrian crossing treatment. A PXO may be applicable for a particular right-turn channel location.

5.1.4 Implementation of Supervised School Crossing

Designated school crossings are locations close to schools where school children have to cross enroute between home and school. The use of school crossing guards is considered to be a form of pedestrian control at designated crossings during school periods. The crossing guard provides opportunities for children and other pedestrians to cross in safety. School crossing guards are normally stationed at marked school crossings but may be stationed at locations that are controlled intersections (e.g. all-way stop controlled or yield-controlled intersections). According to HTA[1] Section 176 – School Crossings, school crossing guards may provide a designated right-of-for all persons as vehicles must yield to a crossing guard. It should be noted that a school crossing in the absence of stop signs, IPS, PXO, MPS or traffic control signals is considered a controlled crossing only when the crossing is being supervised by a school crossing guard. It should be specifically noted that the presence of school crossing signs and markings only in the absence of school crossing guards do not require drivers to yield the right-of-way to pedestrians.

The overall planning process for a school crossing guard includes determining the needs for a school crossing; defining the minimum thresholds required for implementing a supervised school crossing; and maintaining consistency in the location and operation of supervised school crossings. The Ontario Traffic Council (OTC) School Crossing Guard Guide[20] is an information document published in 2005 that provides various guiding principles for the consideration, implementation and maintenance of school crossings. The justification for school crossing guards is often determined by municipal by-laws.

5.2 Treatment System Selection

The preliminary assessment component of the DST described in Section 5.1 is used to identify which type of controlled pedestrian crossing treatment system is warranted at a site.

The second component of the DST is the guidance for pedestrian crossing treatment Selection to assist practitioners to identify which treatment system is applicable to the site based on traffic and geometric characteristics of the site.

Pedestrian Crossing Treatment systems provided in Section 4.2 are applicable to the application environments as specified in the Table 6.

The following sections provide the guidance to select the type of pedestrian crossing treatment for a specific pedestrian control crossing.

5.2.1 Traffic Signal Selection

The selection of a traffic signal as a pedestrian crossing treatment is based on OTM Book 12. Section 5.1.1 provides the guidance for checking the warrants for traffic signals (full traffic signal, IPS, or MPS) as a pedestrian crossing treatment.

Traffic control signals may be installed provided any of Justifications 1 to 6, are met and it is determined that conditions are satisfactory for the installation of traffic control signals. Where

Table 6: Treatment Systems by Application Environment

Type of Crossing	Treatment System	Mid-block	Intersection	Roundabout	Right-turn Channel
Traffic Signal	Full Signal		•		
	Intersection Pedestrian Signal		•		
	Mid-block Pedestrian Signal	•			
Pedestrian Crossover	PXO A	•	•		
	PXO B	•	•	•	
	PXO C	•	•	•	
	PXO D	•	•	•	•
Stop or Yield Control			•		•
Crossing Guard		•	•	•	•

traffic control signals are installed, provisions for pedestrian crossings must be considered.

IPS should be installed at intersections where traffic volume is low and a full traffic signal is not warranted based on Justification 1 through 5 of OTM Book 12. In this case, the justification of an IPS should be made on the basis of Justification 6 being fulfilled.

MPS must be restricted to roadways posted at less than 80 km/h. Justification for MPS should be based on the Justification 6 as indicated in OTM Book 12. In addition, where traffic signals are not warranted under Justification 6 but a PXO is warranted an MPS should be used if either the posted speed exceeds 60 km/hr or there are more than four lanes of traffic."

5.2.2 Pedestrian Crossover Selection

The selection of an appropriate PXO treatment (i.e. PXO A, PXO B, PXO C, and PXO D) is based on the Pedestrian Crossover Selection matrix provided in this section.

The Pedestrian Crossover Selection Matrix has been developed based on the following criteria:

Consistency with the HTA: According to HTA[1], the application of PXOs is limited to roads with a posted speed limit of 60 km/h or less.

Consistency with OTM Book 12: According to OTM Book 12:

- A PXO can be installed on roadways with a maximum of 4 lanes.
- Vehicular traffic volumes are collected during the 8 or 4 hours with the highest pedestrian volumes.
- A PXO must not be used where the road volume exceeds 35,000 AADT.
- PXOs should not be installed within 200 m of other signal-protected pedestrian crossings.

Consistency with the TAC PCCG: The TAC's PCCG[14] was developed based on the seminal research conducted by Zegeer[18] which focused on pedestrian safety. To ensure that the safety of pedestrians is paramount, the same variables and vehicular volume ranges are used in this matrix.

Compliance Rate: The compliance rate of drivers to the PXOs is a multivariate function. For example, the compliance rate decreases as the

posted speed limit increases for most pedestrian crossing control treatment systems. The findings of research by Turner et al[19] were considered in the development of the selection matrix to maximize compliance rates of drivers.

Conspicuity: It is important that the treatment systems are conspicuous to drivers. As a result, a more conspicuous treatment system utilizing overhead-mounted signs is recommended where there is a potential for blockage of ground mounted signs (e.g. multilane roads).

The selection matrix for PXO treatment systems is shown in Table 7.

Four variables are used to select a PXO for a site:

- 8-hour or 4-hour two-way vehicular volume of the roadway at the location of the crosswalk.
- Posted speed limit of the roadway.
- Total number of lanes for the entire roadway cross section.
- Presence of raised pedestrian refuge (i.e., refuge island or median).

To use Table 7, first the appropriate row associated with the vehicular volume of a site and the posted speed limit of the site is selected. It should be noted that either 8-hour or 4-hour vehicular volumes can be utilized.

Next the column representing the total number of lanes for the site is selected. The intersection of the row and the column will be one of the cells of the table. The content of the cell represent the suggested PXO type. The vehicular volume in Table 7 provides the option for practitioners to use 8-hour vehicular volume during the highest pedestrian volume or 4-hour vehicular volume during the highest pedestrian volumes.

For example, PXO D is suggested for a site with 8-hour vehicular volume of 3000 vehicles, posted speed limit of 50 km/h with 2 lanes. The hatched cells in this table show that a PXO is not recommended for sites with these traffic and geometric conditions. Generally a traffic signal is warranted for such conditions.

It should be noted that the Selection Matrix will be used irrespective of the type of the environment, such as one-way/two-way roadways, roundabouts, intersections, etc.

It may be noted that if the use of a PXO is desired based on the connectivity or desired lines only (i.e. pedestrian and vehicular volume conditions are not fulfilled), then Table 7 can still be used based on speed and geometry of the roadway (use top two rows of the matrix).

5.2.3 Stop Control Applications

Stop control (two-way or all-way) at an intersection provides a safe opportunity for pedestrians to cross the major roads of intersections. The selection of stop control must be based on guidelines provided in OTM Book 5 – Regulatory Signs. For consistency with OTM Book 5, the application and selection of all-way stop control for warranted intersections should be restricted to exclude the following circumstances:

Pedestrian crossing: where the protection of pedestrians, school children in particular, is a prime concern. This concern can usually be addressed by other means, such as crossing school guards.

Geometric characteristics:

- At intersections that are offset, poorly defined or geometrically substandard.
- Where traffic would be required to stop on grades.
- Where visibility of the sign is hampered by curves or grades, and insufficient safe stopping distance exists.
- At intersections that are not roundabouts having less than three, or more than four, approaches.

Table 7: Pedestrian Crossover Selection Matrix

Two-way Vehicular Volume			Speed Limit (km/h	Total Number of Lanes for the Roadway Cross Section[1]			
Time Period	Lower Bound	Upper Bound		1 or 2 Lanes	3 lanes	4 lanes w/raised refuge	4 lanes w/o raised refuge
8 Hour	750	2,250	≤50	PXO D	PXO C[3]	PXO D[2]	PXO B
4 Hour	395	1,185					
8 Hour	750	2,250	60	PXO C	PXO B	PXO C[2]	PXO B
4 Hour	395	1,185					
8 Hour	2,250	4,500	≤50	PXO D	PXO B	PXO D[2]	PXO B
4 Hour	1,185	2,370					
8 Hour	2,250	4,500	60	PXO C	PXO B	PXO C[2]	PXO B
4 Hour	1,185	2,370					
8 Hour	4,500	6,000	≤50	PXO C	PXO B	PXO C[2]	PXO B
4 Hour	2,370	3,155					
8 Hour	4,500	6,000	60	PXO B	PXO B	PXO C[2]	PXO B
4 Hour	2,370	3,155					
8 Hour	6,000	7,500	≤50	PXO B	PXO B	PXO C[2]	PXO A
4 Hour	3,155	3,950					
8 Hour	6,000	7,500	60	PXO B	PXO B		
4 Hour	3,155	3,950					
8 Hour	7,500	17,500	≤50	PXO B	PXO B		
4 Hour	3,950	9,215					
8 Hour	7,500	17,500	60	PXO B			
4 Hour	3,950	9,215					

[1]The total number of lanes is representative of crossing distance. The width of these lanes is assumed to be between 3.0 m and 3.75 m according to MTO Geometric Design Standards for Ontario Highways (Chapter D.2). A cross sectional feature (e.g. bike lane or on-street parking) that extends the average crossing distance beyond this range of lane widths may need to be considered as an additional lane in this table.

[2]Use of two side mounted signs per direction (one on the right side and on the median).

[3] Use PXO B for one-way streets.

- On multi-lane approaches where a parked or stopped vehicle on the right will obscure the stop sign.

Traffic Characteristics:

- On roads within urban areas having a posted speed limit in excess of 60 km/h;
- As a means of deterring the movement of through traffic in a residential area;
- Where any other traffic device controlling right-of-way is permanently in place within 250 m, with the exception of a YIELD sign;
- On truck or bus routes, except in an industrial area or where two such routes cross;
- On roads where progressive signal timing exists; and
- As a speed control device.

If a two-way stop control does not satisfy the minimum requirements for an IPS, full traffic signal or PXO as described in Section 5.2.1 and Section 5.2.2, warrants for all-way stop control must be checked. OTM Book 5 provides the warrant system for installation of all-way stop control at an intersection. The warrant is based on minimum traffic volume of the major road, minor road, and past collision history of the intersection.

5.2.4 Yield Control Applications

For pedestrian crossing treatments at intersections that are not warranted for traffic signals, stop controls, or pedestrian crossovers, the yield-control provides an alternative opportunity for pedestrians to make a safe and convenient crossing.

According to the HTA[1] , the vehicles approaching the yield sign shall slow down to a reasonable speed or stop if necessary and shall yield the right-of-way to traffic in the intersection or approaching on the intersecting highway so closely that it constitutes an immediate hazard and having so yielded may proceed with caution. If the yield sign is installed at the intersection before the crosswalk, vehicles must yield to pedestrians and other conflicting vehicles. A yield sign cannot be used to provide the right-of-way to pedestrians at roundabouts and right-turn channels installed at locations other than at intersections.

Applications for yield-controlled intersections are prescribed in the HTA[1], OTM Book 5 – Regulatory Signs, and the OTM Book 11 – Pavement, Hazard and Delineation Markings. In OTM Book 5 Section 3, installation conditions and location criteria for the consideration of yield-controlled intersections are prescribed.

5.2.5 Supervised School Crossing Applications

Scenarios in which a school crossing guard may be used (provided that the highway speed limit does not exceed 60 km/h) include:

- Mid-block locations with the required marked crossing and school crossing signs found often in front of, or adjacent to a school site. The crossing is uncontrolled when not supervised by the crossing guard.
- Conventional stop-controlled intersections (stop signs) on the side street only.
- All-way stop-controlled intersections.
- Intersection pedestrian signals and midblock signals.
- Pedestrian crossovers.
- Traffic control signals.

A school crossing must not be implemented on a roadway with a posted speed limit in excess of 60 km/h. Section 5.1.4 provides the guidelines for use of crossing guard as a pedestrian control treatment at designated crossings.

6. Pedestrian Crossing Facility Design: Controlled Crossings

6.1 General Considerations

Controlled crossings manage the interaction between pedestrians and vehicles, and present operational benefits to pedestrians by providing priority over vehicles either at all times or for allocated periods of time. This priority may provide a sense of security for pedestrians, encourage pedestrians to cross at the controlled location and limit the number of locations where pedestrian crossings occur.

The OTM guidelines that would automatically limit the distance between pedestrian crossings are as follows:

- According to OTM Book 12, the minimum distance between traffic signals for roads posted at 60 km/h or less is 215 m and for roads posted at 80 km/h is 350 m.
- According to OTM Book 12, PXOs should not be installed within 200 m of other signal-protected pedestrian crossings.
- According to OTM Book 5, all-way stop controls should not be used where any other traffic device controlling right-of-way is permanently in place within 250 m, with the exception of a Yield sign.

Adequate sight distance for all road users must be provided as a fundamental component of all controlled crossing design. Visibility of all signs and signals should be confirmed.

The pedestrian crossing treatment systems for controlled crossings are combinations of various components that may be required components, desired components or optional components.

The "required" components are those components, which are mandatory for the effective operation of a treatment system and also, those components that are legally required under the HTA[1] and its regulations or under the AODA[3].

The "desired" components are those components, which are not mandatory but have potential to improve the overall performance of the treatment system. The "desired" component suggests the recommended practices for application of legal requirements and interpretations in Ontario.

The "optional" components are those components which may be implemented based on the availability of the resources if there is a desire to further improve the conspicuity of the treatment system. In addition, optional components may also provide guidance for application of any legal requirements.

The detailed lists of components with respect to their usage as "required", "desired", or "optional" components for specific treatment system are provided in the table of components of each treatment system in Section 6.3.

The requirements with respect to the individual components are provided in the following sections.

6.2 Treatment System Components

One of the purposes of OTM books is to promote uniformity of treatment in the design, application and operation of traffic control devices and systems across Ontario. In order to maintain this uniformity, the design and application of each treatment system component must be consistent within all treatment systems and all types of pedestrian crossings. Wherever selected, the treatment system components must follow the guidelines provided in the following sections. The treatment system components are grouped together based on their application within various treatment systems.

6.2.1 Geometric Design Components

6.2.1.1 Crosswalk

According to the HTA[1], a "crosswalk" means,

a. that part of a highway at an intersection that is included within the connections of the lateral lines of the sidewalks on opposite sides of the highway, measured from the curbs or, in the absence of curbs, from the edges of the roadway, or

b. any portion of a roadway at an intersection or elsewhere distinctly indicated for pedestrian crossing by signs or by lines or other markings on the surface.

In Ontario, the HTA[1] defines crosswalks without distinction between controlled and uncontrolled crossing locations. In spite of this, the rules of the road are distinct as noted in Section 2.1.1. In the absence of stop/yield signs, pedestrian crossover, or half or full traffic control signals, pedestrians at an uncontrolled crossing location are required to wait for gaps in vehicular traffic before crossing.

Crosswalks must be marked for all types of controlled pedestrian crossing treatments to define and delineate the path for pedestrians to cross the roadway and to reduce the potential for conflicts with motor vehicles.

Careful consideration should be given to installing crosswalks at uncontrolled locations where vehicles would not otherwise stop. The presence of a marked pedestrian crossing may create a false sense of confidence on the part of pedestrians, particularly children, who may enter the crosswalk expecting that approaching drivers will see them and stop. A discrepancy may exist between pedestrians' expectations and the expectations of approaching drivers who may not expect to find a pedestrian crossing at an uncontrolled location. If a crosswalk at an uncontrolled location is deemed necessary, its safety may be enhanced by the addition of advance markings, warning signs and illumination.

The width of the crosswalk between the lines is usually determined by the widths of the connected sidewalks and the expected two-way pedestrian flows utilizing the crossing at the peak time. The crosswalk must be at least 2.5 m wide while widths of 3 m to 4 m are typical of urban areas with significant pedestrian activity. In general, the design of pedestrian crosswalk is based on the following principles (see OTM Book 11 and OTM Book 12):

- Crosswalks must line up with proposed or existing curb ramps and should also line up with proposed or existing sidewalks.
- The outer edge of the crosswalk must be at least 1.0 m from the edge of the stop line for traffic signal control and stop controlled pedestrian treatments. The stop line location can vary if necessary. For pedestrian crossing treatments with a yield to pedestrian line, the outer edge of the crosswalk must be a minimum 1.5 m from the yield line for two-lane roadways and a minimum 6.0 m from the yield line for multi-lane roadways.
- The inner edge of the crosswalk should be a minimum of 0.5 m from the through edge of pavement of the parallel roadway for roadways posted under 80 km/h and 1.0 to 1.5 m for roadways posted at 80 km/h and above.
- Where circumstances allow each crosswalk should reach the far curb without intersecting with the other crosswalk across the cross-street. This directs pedestrians to the far sidewalk to await a crossing of a second leg of the intersection instead of waiting near the curb in the travelled portion of the roadway.
- Where intersecting roadways are skewed (i.e., not close to 90 degrees) or the configuration of the lanes result in crosswalks that tend to intersect in the turning flare, it is better to have the inner edges of the crosswalk intersect at the curb than to carry each set of lines through each other.

- Where existing geometry is used for signal control pedestrian treatments, the crosswalk should be situated adjacent to existing poles in order to improve pedestrian signal head visibility and pushbutton accessibility.
- Crosswalks should not cross over the centre median where the median is not equipped with wheelchair ramps or at-grade depressions.
- Consideration should be given to snow covered roadways where crosswalk lines may not be visible. Wherever possible, the crosswalk lines should be within the most direct route from sidewalk to sidewalk.
- Crosswalks should be as short as possible without compromising other design factors.
- In case of traffic signal control pedestrian treatments, pedestrian signal heads should be positioned within the extension of the crosswalk if possible.
- Crosswalks should be laid out such that pedestrians (specifically a person with a mobility device) are not forced outside of the lines of the crosswalk due to the angle of the curb ramps.

The details of different types of crosswalk markings are included in Section 6.2.4. Figure 8 demonstrates a typical crosswalk layout with standard crosswalk markings and stop lines for a signalized intersection.

6.2.1.2 Curb Ramps

Curb ramps provide access for people using wheelchairs or scooters at crossings where there is an elevation change between the sidewalk and the street level crossing.

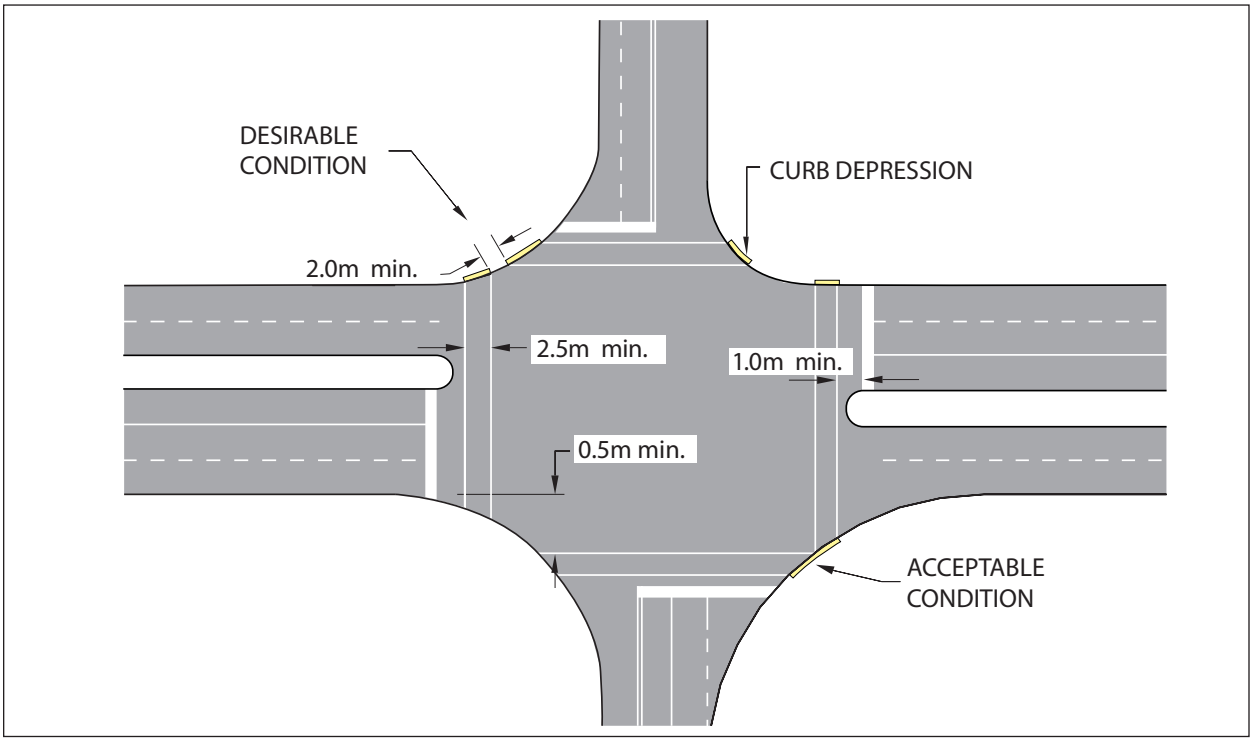


Figure 8: Typical Crosswalk Design with Standard Crosswalk Markings

Crosswalks and curb ramps must be laid out in a manner such that that the pedestrians (specifically with mobility devices) are not forced outside of the lines of the crosswalk due to the angle between curb ramps and the crosswalk. The location of curb ramps should be coordinated with crosswalks and sidewalks such that they are aligned.

Where traffic islands (refuge islands and medians) are provided within a pedestrian crossing, they must contain a level area for pedestrians to cross and must have curb ramps on both sides.

Specific requirements for curb ramps are provided in Section 2.3.3 – Designing for Accessibility.

6.2.1.3 Curb Extensions

Curb extensions "extend" the sidewalk or curb line to reduce the length of the crosswalk or define space allocated for curb side parking. Curb extensions reduce the distance pedestrians have to walk, hence pedestrians require smaller gaps to cross and pedestrian delays are likely to be shorter. Curb extensions can provide refuge for pedestrians, improve the sight distance and sight lines for both pedestrians and motorists and may also be considered as a traffic calming measure.[22]

Curb extensions are typically installed on local or collector streets with urban cross-sections. Curb extensions are most appropriate with on-street parking or where on-street parking is to be implemented. Where curb extensions are to be installed at intersections, consideration should be given to:

- Providing turning radii sufficient for commercial vehicles or transit vehicles to prevent them from mounting the curb and putting pedestrians at risk.
- The delineation and space requirements of bicycle lanes.
- Restricting parking in close proximity to the curb extension and parking within the boulevard on the curb extension to improve visibility of pedestrians and drivers.
- Local requirements for snow removal.

Delineation to provide visibility to motorists and maintenance crews.

6.2.1.4 Curb Depressions

Curb depressions improve accessibility for crossing activity for all pedestrians. They are typically provided in urban areas where pedestrian activity exists. Curb depressions are not intended to imply right-of-way, but rather improve accessibility and safety where pedestrian activity has been demonstrated, or is anticipated.

Specific requirements for depressed curbs are provided in Section 2.3.3 – Designing for Accessibility.

6.2.1.5 Raised Refuge Islands

Raised refuge islands are desirable components for pedestrian crossing treatment at many locations. Refuge islands are raised medians placed in the centre of the roadway at midblock locations or unsignalized intersections. Raised refuge islands may also be provided as median islands on wide streets signalized intersections, where the width may not permit pedestrians to cross the street on a single pedestrian signal indication. Refuge islands are intended to assist pedestrians in crossing wide streets by providing a safe "refuge" in the centre of the road, allowing pedestrians to cross one direction of traffic at a time. The presence of a refuge island reduces the time a pedestrian must wait for an adequate gap in the traffic stream and reduces the crossing distance (exposure to traffic) that they must face at one time. Where properly installed, pedestrian refuge islands are beneficial in delineating pedestrian activity, and encouraging pedestrians to cross at more desirable crossing locations. Pedestrian refuge islands are particularly suitable near pedestrian generators such as hospitals, schools, malls, etc., and may form part of a larger streetscaping plan.

The design of pedestrian refuge islands may vary in terms of size, shape, approach end

treatment, etc., and may also form part of a larger streetscaping design solution. Stopping sight distance must be sufficient to accommodate the design speed for vehicles approaching the pedestrian refuge islands. If landscaping is present on the island or median, it should not obstruct the pedestrian pathway, the visibility of the pedestrian and motorists to each other, or the motorist's sight distance at the intersection.

Design requirements for pedestrian refuge islands are provided in TAC's Geometric Design Guide for Canadian Roads.[12]

The road environment should be designed such that there is sufficient information for drivers and pedestrians to make timely and rational decisions. Pedestrian refuge islands should be equipped with signs to allow drivers to identify the hazard of the island and the presence of the pedestrian crossing. The signs should include the standard size Keep Right sign (Rb-25), (or the oversize Keep Right sign (Rb-125)), and the Object Marker sign (Wa-33L). The use of Pedestrian Ahead sign (Wc-7) and Pedestrian Yield to Traffic sign (Wc-28) should also be considered. For further information on the application of these signs, see OTM Book 5 – Regulatory Signs and OTM Book 6 – Warning Signs.

Pavement markings must be used to guide approaching traffic away from fixed obstructions within the road way. Pavement markings should be continuous and off-set from refuge islands to provide positive guidance and separation from the hazard that the island represents. A painted refuge is not a substitute to a raised refuge. For further information on pavement markings, see OTM Book 11 – Pavement, Hazard and Delineation.

Access to the refuge island should be designed to be functional and safe for all pedestrians and must follow the guidelines provided in Section 2.3 - Accessibility. The island or median should be large enough to enable a wheelchair to wait on a level landing or a cut-through design should be provided. The cut-through width should be the same as the complete width of the crosswalk. A level area on the refuge island must be provided for pedestrians to cross and the island must have curb ramps on both sides according to the requirements provided in Section 6.2.1.2 – Curb Ramps.

Wherever practical, raised refuge islands should be supplemented with appropriate barricades to channelize pedestrians so that they can view oncoming traffic. The specifications for pedestrian barricades are available in Ontario Provincial Standard Drawings (OPSD).

6.2.1.6 Raised Crosswalk

A raised crosswalk is a marked pedestrian crossing point at an intersection or mid-block location constructed at a higher elevation than the adjacent roadway.[20] The raised surface improves drivers' awareness of the potential for pedestrian activity and has a traffic calming effect as one of its effects is to reduce speed. Raised crosswalk applications should be considered within the context of the road authority's traffic calming policies and practices.

6.2.2 Signs

Regulatory and warning signing for pedestrians and drivers may serve to assist, restrict and prohibit selected vehicular or pedestrian movements to reduce noted potential conflicts. The regulatory signs must be provided, wherever conditions are met according to OTM Book 5 – Regulatory Signs and Ontario Regulation 615[2] with all amendments. Where right-of-way to pedestrians is being assigned at new locations through the provision of a PXO, an introductory period is required to safely carry out the transition. The complete procedure with required regulatory signs is also included in Ontario Regulation 615[2].

Warning signs are intended to provide advance notice to road users about unexpected and potentially dangerous conditions on or near the road. The conditions to which warnings signs apply typically require that road users exercise caution, and may require drivers to slow down in order to travel safely in the presence of a hazard. The installation conditions and location criteria

for warning signs is provided in OTM Book 6 – Warning Signs.

Ontario Regulation 615[2] specifies the mandatory warning and regulatory signs for PXOs. As such, the signs for PXOs must be provided according to the Ontario Regulation 615[2] together with all amendments. It may be noted that the complete information on signs for PXOs was not available in respective OTM Books (Book 5 and Book 6) on the date of publishing of this manual.

The listings of required, desired and optional signs for different treatment system components are provided in respective table of components in Section 6.3.

6.2.3 Signals

The components under this category include the following:

6.2.3.1 Pedestrian Control Indicators

Pedestrian control indicators are symbols of "don't walk" and "walk" displays provided in controlled sequence to regulate intervals for pedestrian crossings. The shape, size, design, background, colour, mounting height, and guidelines for installation and layout of pedestrian control indications as prescribed by HTA Regulation 626[21] are provided in OTM Book 12.

The sequencing of pedestrian indicators is as follows:

- **Walking Pedestrian** ("Walk") shall be displayed only when the corresponding through movement green indications are displayed or during an all-red period if special pedestrian phasing is used (such as leading pedestrian intervals or exclusive pedestrian phases). The Walking Pedestrian indication does not necessarily have to be displayed with the green at actuated intersections (where a pushbutton actuation is used) as this allows for the use of less vehicular green time during cycles when no pedestrians are waiting to cross. The walking pedestrian symbol must not be displayed at any time during which the orange hand ("Don't Walk") or flashing orange hand (Flashing Don't Walk), also known as the Pedestrian Clearance Interval, is displayed.
- **Flashing Hand** ("Flashing Don't Walk", FDW) should be displayed after every Walking Pedestrian indication as this is a clearance interval required to warn pedestrians of an upcoming solid hand outline indication. Most agencies terminate the flashing hand at the beginning of the amber but it is permissible to continue the FDW through the amber or all-red clearance intervals as this may provide additional information or reassurance to crossing pedestrians.
- **Solid Hand Outline** ("Don't Walk") shall be displayed with any conflicting phases. This indication may also be displayed during the amber and all-red displays.

The guidelines for calculation of pedestrian timing at traffic signals and pedestrian actuation are detailed in OTM Book 12 – Traffic Signals.

In addition to the required components when pedestrian signal indicators are provided, additional optional components are available, as follows.

6.2.3.2 Accessible Pedestrian Signals

The detailed information on APS is included in Section 2.3 – Accessibility.

6.2.3.3 Pedestrian Actuation

Actuated signals make use of detection to respond to vehicle and pedestrian actuation.

When the minimum vehicle green interval is less than the minimum pedestrian crossing time plus the pedestrian clearance time (for vehicles at intersections with traffic actuated controls), and a pedestrian actuation is detected, the green vehicle time may be extended.

An exception to this may occur at intersections with very few pedestrians. In this case, pedestrian pushbuttons may be used to change and extend

the normal traffic signal indication, provided that a signal head exists on the same side of the road facing the actuating pushbutton.

In most operations, the pedestrian pushbutton actuation is accepted as a call during all times except when the Walking Pedestrian indication is underway.

Signal indications for vehicles may include the following components in addition to, or instead of, traditional red/amber/green signal heads.

6.2.3.4 Pedestrian Pushbuttons

Pedestrian pushbuttons must be used at pedestrian actuated traffic signals. Pedestrian pushbutton should be located according to the guidelines provided in Section 2.3 – Accessibility.

6.2.3.5 Countdown Pedestrian Signals

Pedestrian countdown signals (PCS) may supplement the regular Walk and Flashing Don't Walk indicators with a numeric countdown of the number of seconds remaining in the Flashing Don't Walk indications. PCS are optional devices that can be provided at locations where pedestrian signals are installed. The additional information from the PCS devices enhances the pedestrians' understanding of the remaining time to cross. Pedestrian countdown signals are often effective devices at locations that have a high percentage of seniors, children, and other mobility-challenged pedestrians, at locations with a history of high pedestrian-motor vehicle conflicts, and those locations that generate high pedestrian and/or motor vehicle traffic.

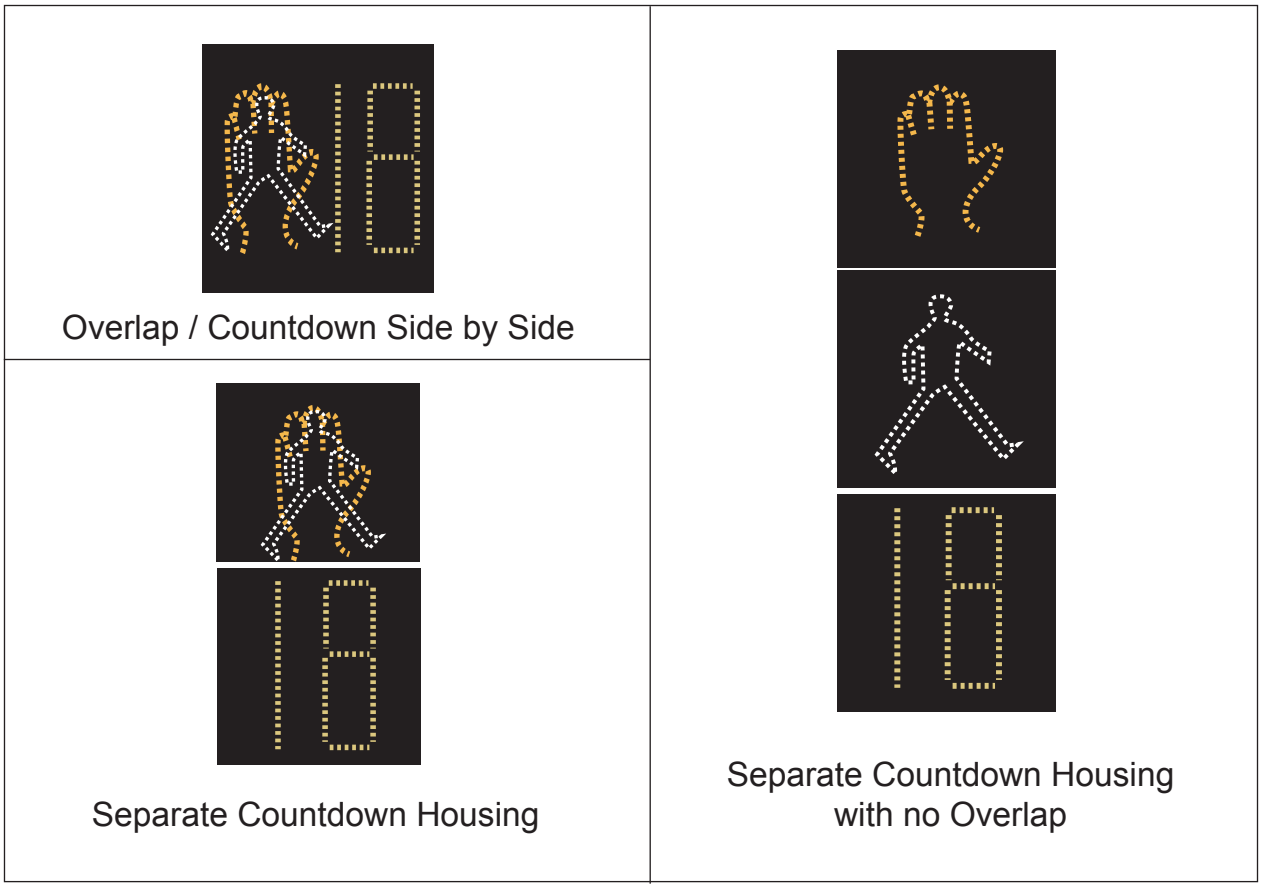


Figure 9: Pedestrian Countdown Timers Display Configuration

The standard elements of PCS consist of:

- Numeric countdown display visible to pedestrians entering a crosswalk.
- "Separate Countdown Housing" configuration, "Overlap / Countdown Side by Side" configuration or "Separate Countdown Housing with no Overlap" configuration. See Figure 9.
- Standard application of the "WALK" symbol and "DON'T WALK" symbol indicators.
- Optional PCS information sign, which may be installed adjacent to the pedestrian pushbuttons to inform pedestrians of the use of the Pedestrian Countdown Signal.

The recommended practice for pedestrian countdown equipment is to initiate the countdown display at the beginning of the flashing DON'T WALK interval (in which case the numeric display remains blank during the walk indication).

6.2.3.6 Exclusive Pedestrian Phase

An exclusive pedestrian phase is a portion of a traffic signal cycle that is dedicated to one or more pedestrian movements while displaying red on all traffic signal indications for vehicles. Figure 10 illustrates one example of exclusive pedestrian phasing.

Exclusive pedestrian phases are normally required only where the volumes of crossing pedestrians are extremely high (such as downtown locations or central business districts) and where safety is impaired by the use of normal pedestrian display intervals parallel to the (vehicle) signal head.

Exclusive pedestrian phases can reduce the risks associated with turning traffic as all vehicular movements are stopped during the pedestrian phase. In some locations turn restrictions are implemented.

Implementing exclusive pedestrian phases requires phasing and timing adjustments to the traffic signals. Adequate signage is also required to ensure restriction of right-turns-on-red and to ensure that pedestrians understand when and where they are permitted to cross. The decision to implement an exclusive pedestrian phase as part of a pedestrian solution must be weighed against its impact to the overall traffic operations. Prior to implementing an exclusive pedestrian phase, careful considerations must be given to:

- The impact of longer cycle lengths (due to the extended walk or pedestrian clearance intervals) on traffic operations. This includes impacts on intersection capacity and network traffic signal coordination.
- Increased pedestrian delays due to prolonged cycle length.
- Potential for increased pedestrian violations during the "don't walk" interval.

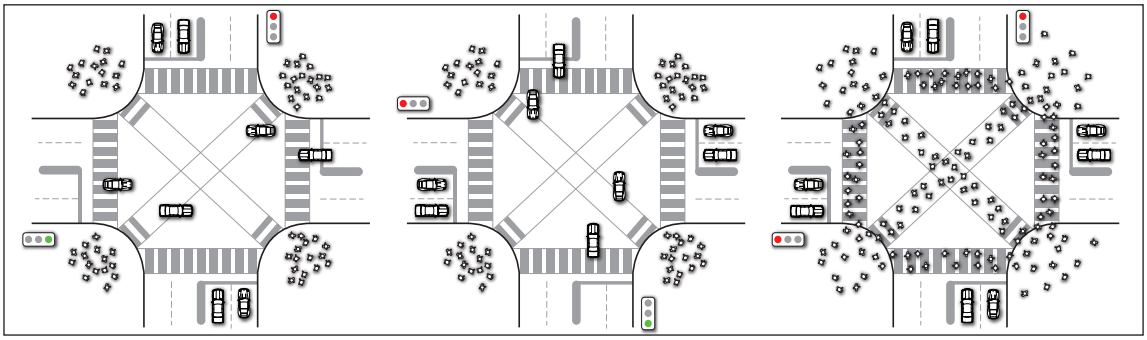


Figure 10: Exclusive Pedestrian Phase

- An understanding from road users of the operation of exclusive pedestrian phases (potential for driver confusion and motor vehicle-pedestrian conflicts) and the need for education campaigns to raise road users' awareness.
- The level of motor vehicle-pedestrian conflicts and the anticipated level of conflicts with the exclusive pedestrian phase.
- Pedestrians with a disability and their ability to navigate the crossings, especially for the visually impaired. Clear signage and appropriate audible cues must be provided for the visually impaired.

For additional information, see OTM Book 12 – Traffic Signals.

6.2.3.7 Leading Pedestrian Interval

A leading pedestrian interval is another form of an exclusive pedestrian phase. One form of application includes a walk indication (generally around 4 to 6 seconds in duration) provided in advance of the corresponding vehicle green indication to give pedestrians a head start on turning traffic. The lead-time allows pedestrians to establish themselves in the crosswalk and reduce conflicts. For additional information, see OTM Book 12 – Traffic Signals.

6.2.3.8 Auxiliary Signal Head

Auxiliary Signal Heads may be considered for IPS and MPS applications on the near side of the approaches with setback stopbars. A signal head installed in addition to the primary and secondary signal heads for the purposes of aiding in signal visibility is termed as "auxiliary" signal head. Auxiliary Signal Heads may be mounted on one or both sides as may be necessary.

Auxiliary signal heads shall display the same indications, at the same times, as the primary and secondary heads. According to MUTCD[9] Canada an auxiliary near-side signal head should be considered where the primary signal head is more than 45 m from the stop line. Near-side auxiliary signal heads should be located as near as possible to the stop line.

MUTCD[9] Canada provides the following conditions that may require the use of auxiliary signal heads:

a. Approach widths in excess of three through lanes,

b. Intersecting street width in excess of 25 m,

c. Driver uncertainty as to proper location to stop,

d. High percentage of large vehicles which tend to block a driver's view of signal heads in their normal location,

e. Approach geometry that makes it impossible to ensure continuous visibility of the signal heads, or

f. Accommodation of right or left-turn signal phasing.

6.2.3.9 Flashing Amber Beacons

Flashing Amber Beacons are mandatory components for PXO A. Four pedestrian-actuated beacons, circular in shape, mounted in pairs, back to back (two per directions) must be installed in conjunction with the OVERHEAD X signs. The beacons must be flashed at a rate of 50 to 60 on and off flashes per minute, with the duration of the on and off flashes being approximately equal. For more information on the specifications and operation of the flashing beacons, see OTM Book 12 - Traffic Signals.

Pedestrian actuation of the flashing amber beacons must be by pushbuttons. The actuation must not be delayed.

Pedestrian-actuated beacons must flash for a minimum period of time, calculated as follows:

Minimum flashing time = (crossing distance / walking rate) + 5 seconds

The walking rate should be in the range of 1 m/s to 1.25 m/s, but a lower rate may be used where local conditions or pedestrian characteristics demand.

6.2.3.10 Rapid Rectangular Flashing Beacons with Tell Tale

Rapid Rectangular Flashing Beacons (RRFBs) are pedestrian-activated, high-intensity flashing beacons that warn drivers of the presence of a pedestrian in the crosswalk. RRFBs consist of two rectangular yellow indications with two tell-tale end indicators to let pedestrian know that the beacon is flashing.

RRFBs are required components for PXO Types B and C. Wherever required for an applicable PXO, an RRFB must be used for each direction of travel (see installation layouts of PXO B and C). An RRFB shall not be used for crosswalks approaches controlled by YIELD signs, STOP signs, or traffic control signals. An RRFB shall not be installed independent of the crossing signs for the approach the RRFB faces. The RRFB shall be installed on the same support as the associated PEDESTRIAN CROSSING sign.

An RRFB shall consist of two rapidly and alternately rectangular yellow indications having LED-array based pulsing light sources, and shall be designed in accordance with the following operational requirements:

a. Each RRFB shall consist of two rectangular-shaped yellow indications with two tell-tale end indicators, each with LED-array based light source. Each RRFB indication shall be minimum of 125 wide by 50mm high

b. The two RRFB indications shall be aligned horizontally, with the longer dimension horizontal and with a minimum space between the two indications of 175 mm, measured from inside edge of one indication to inside edge of the other indication.

c. When activated, the two yellow indications in each RRFB shall flash in a rapidly alternating "wig-wag" flashing sequence (left light on, then right light on) with a duty cycle of 800 milliseconds (ms). The left LED flashes two times in a slow volley each time it is energized (125 ms on and 75 ms off per flash). This is followed by the right LED, which flashes four times in a rapid volley when energized (25 ms on and 25 ms off per flash) and then has a longer flash for 200 ms. The effect is known as a "stutter flash effect".

d. The flash rate of each individual yellow indication, as applied over the full on-off sequence of a flashing period of the indication, shall not be between 5 and 30 flashes per second, to avoid frequencies that might cause seizures.

RRFBs must be activated manually by pushbuttons. Time lapse between the activation and start of flashing should be less than 1 second and in no case more than 3 seconds. There is generally no time lapse between the first pedestrian activation and the next one. If a pedestrian pushes the button midway through a flashing cycle then the beacons will reset their duration and flash for another cycle.

RRFBs must flash for a minimum period of time, calculated as follows:

Minimum flashing time = (crossing distance / walking rate) + 5 seconds

The walking rate should be in the range of 1 m/s to 1.25 m/s, but a lower rate may be used where local conditions or pedestrian characteristics demand.

6.2.4 Pavement Markings

The guidelines related to design, installation, and application of pavement markings are provided in OTM Book 11 – Markings and Delineation. Additionally, Ontario Regulation 615 provides information regarding requirements for pavement markings utilized with PXOs.

The components under this category include the following:

6.2.4.1 Stop Line

A stop line (also known as stop bar) must be used for controlled intersections (traffic signal control and stop control intersections) to indicate the point at which a vehicle must stop in compliance with the traffic control. A stop line must be solid white retro reflective line between 30 cm and 60 cm wide. The stop line must extend across the approach lanes from the right pavement edge to the directional dividing line or median, or, in the case of one-way streets, to the left pavement edge. Stop lines are normally placed parallel to the edge of the crossing roadway, but may be positioned at an angle to the edges of crossing roadways when these roadways are of different widths.

At intersections where a pedestrian crosswalk is located, the separation between the crosswalk line and the stop line must be at least 1 m. Stop lines should be parallel to crosswalk lines. For additional information on stop line, see OTM Book 11 – Pavement, Hazard and Delineation Markings.

6.2.4.2 Advanced Stop Bar

In some instances at signalized intersections or signalized mid-block crossings, the vehicle stop line can be moved further back from the crosswalk to improve visibility or to accommodate the path of turning vehicles.

In other instances, such as MPS or IPS crossings, it is a requirement that sufficient separation be provided between the vehicle stop line and the crosswalk. The driver's vertical vision is limited by the top of the windshield, resulting in a need for overhead signal heads to be placed at least 15 metres from the stop bar. Therefore, the crosswalk must be maintained such that the minimum separation between crosswalk and vehicle stop bar at IPS is 15 metres and at MPS is 12 metres (15 metres recommended practice). The purpose is to provide the appropriate viewing angle for the traffic signal indications of drivers approaching the crossing in the absence of visual cues of crossroads.

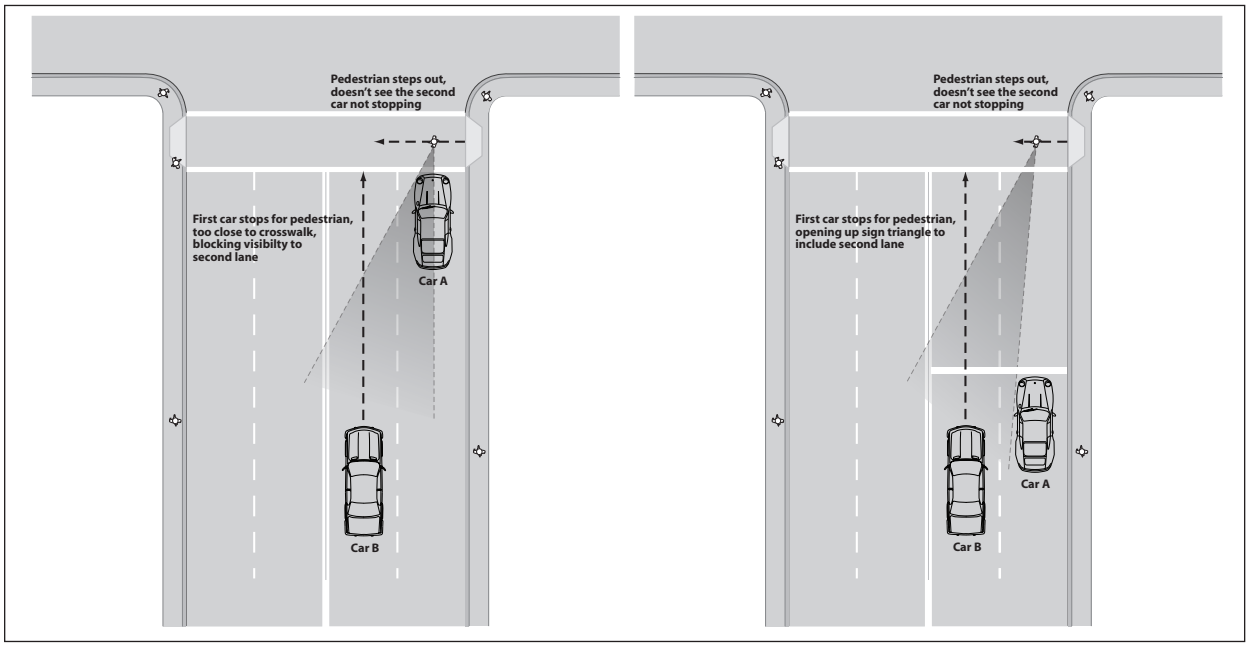


Figure 11: Pedestrian Visibility with Advanced Stop Bar

In addition, on multilane approaches an advanced stop bar allows pedestrians to see vehicles in the median lane without visibility being blocked by vehicles stopped in the curb lane. Figure 11 demonstrates the pedestrian visibility with Advanced Stop bar.

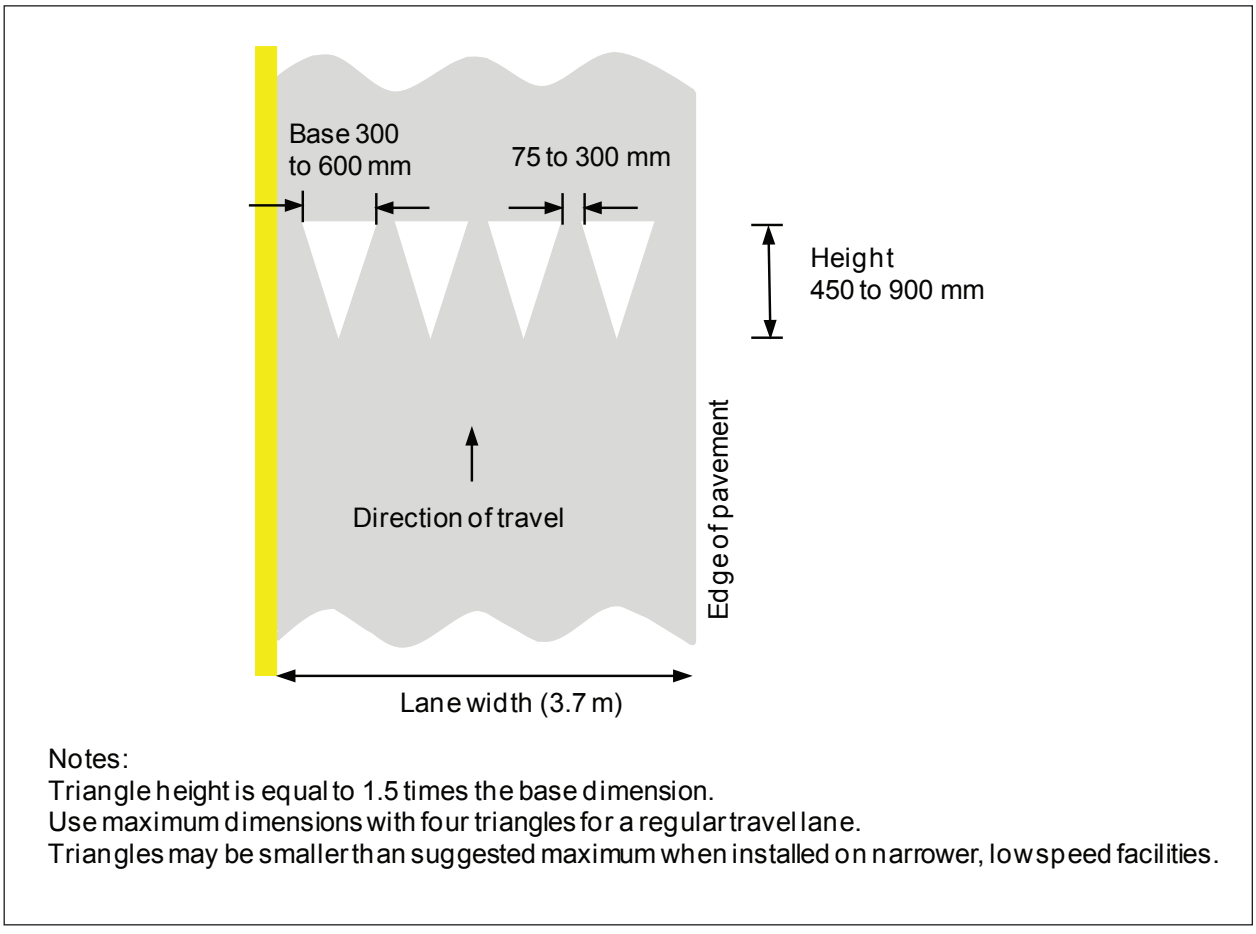
6.2.4.3 Yield to Pedestrian Line

A yield to pedestrian line is used to indicate the point at which a vehicle approaching a crosswalk must yield to pedestrians in the crosswalk. A yield to pedestrian line is a mandatory component for PXO B, C, and D, and is a desirable component for PXO A.

The pavement markings for yield to pedestrian line consist of retro reflective white triangles of size 300 to 600 mm base and 450 to 900 mm height with a clear spacing of 75 to 300 mm marked as shown in Figure 12.[14] The apex of the triangle faces the direction of travel.

The yield to pedestrian line must be used a minimum 6.0 m in advance of the crosswalks in the direction of travel, which is consistent with TAC PCCG.[14]

This pavement marking must not be used for locations with traffic signal or stop control. A stop bar should be used for these applications.



Notes:
Triangle height is equal to 1.5 times the base dimension.
Use maximum dimensions with four triangles for a regular travel lane.
Triangles may be smaller than suggested maximum when installed on narrower, low speed facilities.

Figure 12: Specifications for Yield to Pedestrian Line

6.2.4.4 Standard Crosswalk Markings

Crosswalk markings define and delineate the path of pedestrians to cross the roadway. Standard crosswalk markings must be provided at all signal control and stop controlled pedestrian crossing treatments.

Crosswalk lines must be solid white parallel retro reflective lines 10 cm to 20 cm wide, extending entirely across the pavement (see OTM Book 11 for details). Under special circumstances, such as where vehicle stop lines are not provided or where motor vehicle speeds exceed 60 km/hr, the width of the crosswalk lines may be widened to 60 cm. The downstream edge of the crosswalk should be inset at least 60 cm from the projected nearside curb line of the cross street.

The width of the crosswalk between the lines is usually determined by the widths of the connected sidewalks and the expected two-way pedestrian flows utilizing the crossing during peak times. The crosswalk must be at least 2.5 m wide. Widths of 3 m to 4 m are typical of urban areas with higher levels of pedestrian activity.

Obstacles such as curbs and raised islands should remain outside the crosswalk lines in consideration of persons with walking impairments and persons using wheelchairs, walkers, and strollers. The traveled part of the crosswalk must be aligned with curb ramps on both sides of the roadway as well as cut-outs on raised islands.

Pavement markings for pedestrian crosswalks for signalized and stop controlled intersections are prescribed in OTM Book 11 – Pavement, Hazard and Delineation Markings.

6.2.4.5 Ladder Crosswalk Markings

Ladder crosswalk markings are enhanced pavement markings that incorporate longitudinal stripes to enhance the delineation of pedestrian crosswalks Ladder style crosswalks are a combination of zebra pavement markings aligned perpendicular to the pedestrian direction of travel together with standard parallel crosswalk lines. The contrast of the markings provides enhanced visibility of the crosswalk and thereby increases drivers' awareness of potential conflicts. Figure 13 demonstrates typical ladder crosswalk markings.

The typical configuration of zebra crosswalk markings consists of 0.6 metre wide white block markings spaced at 0.6 metres. Marking products may include traditional pavement marking paint or durable applications such as thermoplastic or cold plastic.

Ladder crosswalk markings are a mandatory component for PXO B, C, and D. These PXOs are provided with a yield to pedestrian line. The outer edge of the ladder crosswalks must be minimum 1.5 m from the yield to pedestrian line for two-lane roadways and minimum 6.0 m from the yield to pedestrian line for multi-lane roadways.

Ladder crosswalks may also be considered as an optional component for other pedestrian control treatments. Care should be taken to avoid excessive use of ladder crosswalks in order to retain their effectiveness in gaining the particular attention of motorists to the potential presence of pedestrians. High potential for vehicle-pedestrian conflict or a collision history which may reflect a high incidence of pedestrian collisions may indicate the need to consider ladder crosswalks at locations other than PXO B, C or D.

6.2.4.6 School Crosswalk Markings

Children are normally not as alert as adult pedestrians to the dangers of the roadway. The use of a school crosswalk and appropriate signage help to warn drivers that extra caution is required since children may be present.

Crosswalk markings for supervised school crosswalks, except those at pedestrian crossovers (discussed above) or signalized intersections must conform to OTM Book 11 – Pavement, Hazard and Delineation Markings. It may be noted that OTM Book 11 prescribes different types of pavement markings for rural and urban school crosswalks (see OTM Book 11 for layouts).

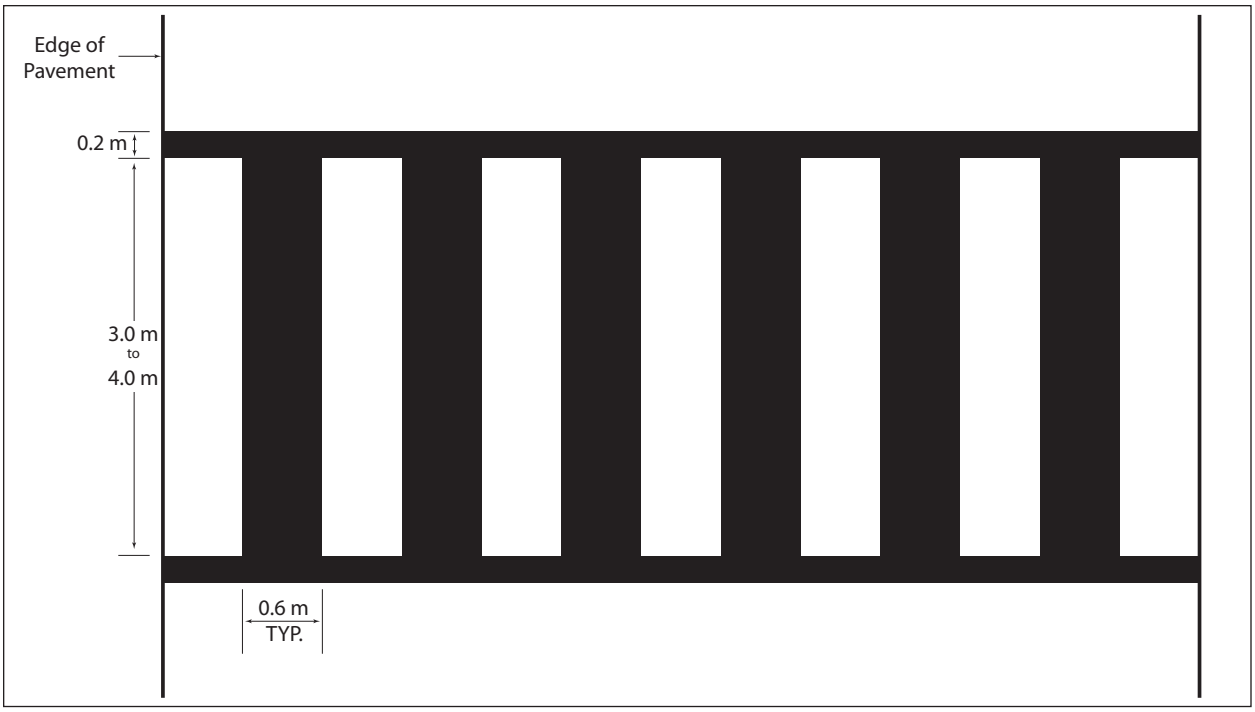


Figure 13: Pavement Markings for Ladder Crosswalk

6.2.4.7 Typical Pavement Markings for Pedestrian Crossover Type A

Ontario Regulation 615[2] has defined the typical pavement markings for pedestrian crossovers with standard dimensions (see details in OTM Book 11 – Pavement, Hazard and Delineation Markings). It may be noted that prior to publication of the current OTM Book 15, there was only one type of pedestrian crossover defined by the regulations. Currently, there are four types of PXOs (PXO A, B, C, and D). The pavement markings defined in regulations for pedestrian crossovers prior to this publication are applicable to current PXO A only.

For pavement markings of other PXOs, see the corresponding sections of this manual.

6.2.4.8 Textured or Coloured Crosswalk

A textured or coloured crosswalk is a crosswalk incorporating a textured and/or patterned surface that is designed to contrast with the adjacent roadway.[22] Similar to ladder crosswalk markings, textured or coloured crosswalks are applied to increase the conspicuity of a pedestrian crossing and increase drivers' awareness of potential conflicts. When drivers can see the crosswalk better, they are more likely to respect the crosswalk as pedestrian space.

One of the effects of textured crosswalks is also to reduce speed. A coloured crosswalk may be defined through admixtures in the asphalt or concrete or the use of concrete within an asphalt roadway. Alternatively, a textured crosswalk may consist of interlocking paving stones or coloured reinforced stamped concrete and asphalt.[24] In all cases, parallel standard crosswalk lines are still needed to delineate the outside edges of the crosswalk if the location is a controlled crossing.

For the implementation of textured crosswalks, consideration should be given to potential for traction and/or stability problems for seniors, the disabled, wheelchairs, bicycles and motorcycles

if there are rough or pronounced grooves parallel to the direction of travel. The use of textured materials should be designed to maintain visibility at night and over a long period of time. However, not all textured or coloured crosswalks have the same level of visibility to motorists.

6.2.5 School Crossing Guard

School crossings are supervised by school crossing guards during specified hours and during regular school periods. The role of the crossing guards is to direct and supervise the movement of persons (as set out in the HTA[1]) across a highway by creating necessary gaps in vehicular traffic to provide safe passage at designated school crossing locations.

According to the HTA[1], a school crossing guard means a person sixteen years of age or older who is directing the movement of persons across a highway and who is employed by a municipality or employed by a corporation under contract with a municipality to provide the services of a school crossing guard.

6.2.6 Illumination

Roadway illumination is an important component which provides an adequate visual environment for road users to safely use the road system during hours of darkness. Studies have proved that roadway lighting substantially decreases night-time collisions, particularly fatalities. The number of pedestrian fatalities is approximately one quarter of all roadway-related fatalities; hence lighting of pedestrian facilities is of utmost importance.[31]

The design of all pedestrian crossing treatments (controlled or uncontrolled) must provide adequate lighting to enhance the safety of pedestrians. The guidelines related to planning and design of roadway lighting including lighting of pedestrian crosswalks at intersections, roundabouts and mid-blocks are provided in the TAC Guide for the Design of Roadway Lighting (Roadway Lighting Guide)[31]. The Guide also includes the warranting criteria for each application of roadway lighting.

Illumination for Intersections

If an intersection is signalized, it must be fully illuminated. For unsignalized intersections the need for illumination (full illumination, partial illumination, or no illumination) should be determined using warrants provided in TAC's Roadway Lighting Guide[31]. The warrants are based on the following criteria:

- Traffic Volumes (particularly on the cross street)
- The presence of crosswalks
- Nighttime collisions that may be attributed to the lack of illumination
- The extent of raised medians

The intersection lighting requirements are in terms of minimum average maintained horizontal illuminance levels for full or partial intersection lighting based on road classification and pedestrian volumes. For pedestrian crosswalks at intersections vertical illuminance values must be considered to improve pedestrian visibility. The maintained average vertical levels of illuminance must meet or exceed the maintained average horizontal design levels for the intersection. For complete design procedure for intersection illumination, including warrant analysis, horizontal and vertical illuminance calculations, equipment selection, and pole layout, see TAC's Roadway Lighting Guide[31].

6.2.6.1 Illumination for Roundabouts

Roundabouts in urban areas must be illuminated. Roundabouts in rural areas should be illuminated in most cases and must be illuminated, when one or more of the entry roads are illuminated, heavy night time traffic volumes exist, cyclists and pedestrians are present, complex or unexpected geometric layout exists or distracting architectural elements (such as statues, water features, sculptures or other objects in the centre island) may reduce driver visibility.

Illuminance requirements for roundabouts and roundabout pedestrian crosswalks are similar to intersections. For complete design procedure for roundabout illumination, including warrant analysis, horizontal and vertical illuminance calculations, equipment selection, and pole layout, see TAC's Roadway Lighting Guide[31] for more information.

6.2.6.2 Illumination for Mid-block Crosswalks

A mid-block crosswalk may pose additional challenges for drivers than a crosswalk at an intersection. Hence the mid-block pedestrian crosswalks (controlled and uncontrolled) with nighttime pedestrian traffic must be adequately illuminated regardless of the roadway is illuminated or not.

The illumination requirements for mid-block crossings installed with traffic signals are the same as for signalized intersections.

If the roadway approaching the crosswalk is lighted, the horizontal luminance levels of the roadway must meet or exceed the recommended levels defined in TAC's Roadway Lighting Guide[31]. The vertical illuminance levels of crosswalks at a height of 1.5 m must be 20 lux for areas with low pedestrian conflicts (less than 11 pedestrians per hour), 30 lux for areas with medium pedestrian conflict (11 to 99 pedestrians per hour) and 30 lux for areas with high pedestrian conflict (100 or more pedestrians per hour). To meet the vertical illuminance levels, poles must be placed in advance of the mid-block crosswalk. Exact placement will depend on variables such as luminaire optics, lamp wattage and mounting height. For complete design procedure for mid-block crosswalks, including horizontal roadway luminance and vertical illuminance calculations, equipment selections, and pole layout, refer to TAC's Roadway Lighting Guide[31].

6.3 Treatment System Design

6.3.1 Traffic Signals

The function of a traffic control signal is to alternate the right-of-way between conflicting streams of vehicular traffic, or conflicting movements between vehicular traffic and pedestrians crossing a road, safely and efficiently. Traffic control signals assign right-of-way to road users by displaying instructions through light-emitted indications using standard colour and signal as regulated in HTA[1] . Traffic is alternately directed to stop and proceed through a sequence of indications in each cycle. In this process, dedicated time is allotted to specific movements of traffic, or to modes of traffic that include motor vehicles, transit vehicles, pedestrians and cyclists. Where traffic control signals are installed, provisions for pedestrian crossings must be considered.

6.3.1.1 Full Traffic Signal

Description

Full traffic signals alternate the right-of-way between conflicting streams of vehicular traffic, or conflicting movements between vehicular traffic and pedestrians crossing a road for all approaches of an intersection. The selection criteria for full traffic signals as pedestrian crossing treatments are provided in Sections 5.1.1 and 5.2.1.

Table of Components

Table 8 provides the components of full traffic signal as a pedestrian control treatment. The details of individual components are provided in Section 6.2.

Application Environments

The application environments for Full Traffic Signals as pedestrian crossing treatments are all applicable signalized intersections with one way and two-way streets.

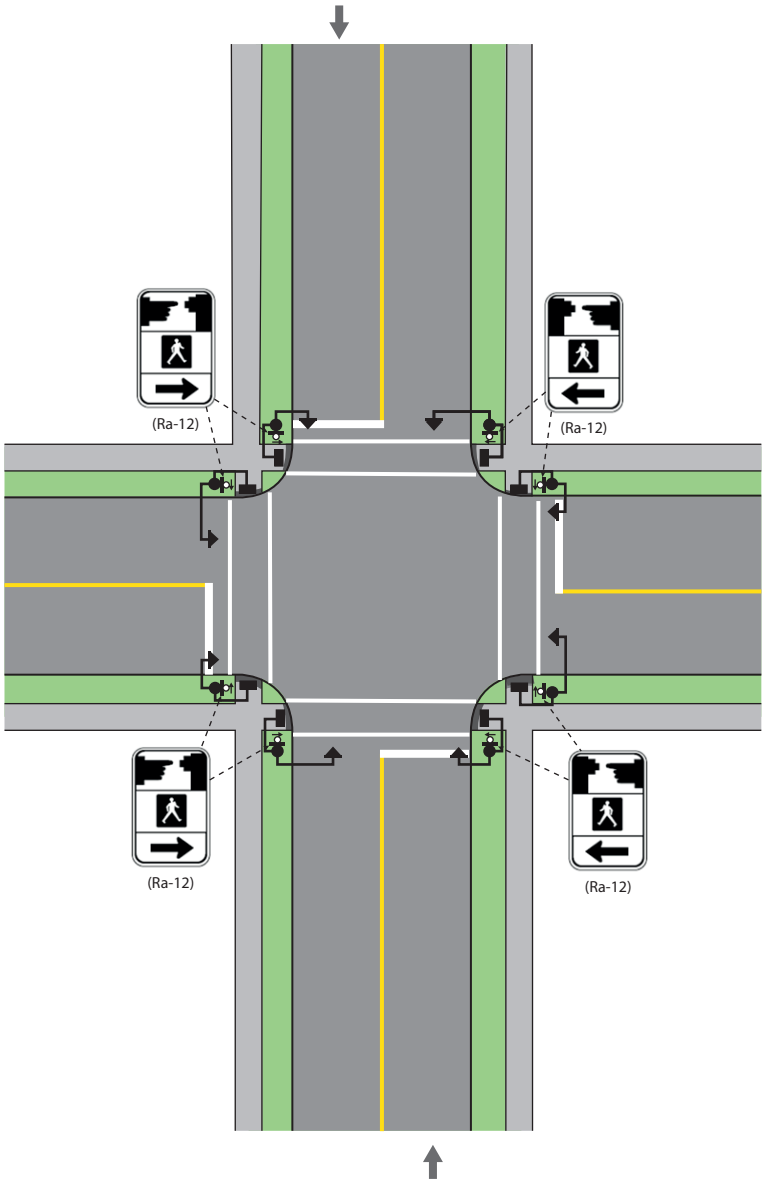
Typical Installation Layouts

Figure 14 to Figure 15 illustrate installation details for Full Traffic Signals as pedestrian crossing treatments for two-way and one-way movements. It is practitioner's responsibility to select an appropriate layout for a location based on the selection criteria provided in this manual.

It may be noted that OTM Book 12 – Traffic Signals provides numerous examples of layout practices for traffic signals.

Table 8: Components for Full Traffic Signal as a Pedestrian Crossing Treatment

Required Components	Desirable Components	Optional Components
• Traffic Signal Heads as required • Approach Markings (Stop Line, No-Passing zone, and required Turn Lanes markings) • Crosswalk Markings • Parking and other sight obstructions prohibition within at least 30 m of crossings • Stopping prohibition for a minimum of 15 m on each approach to the crossing, and 10 m following the crossing • Pedestrian Control Indications with AODA compliant Pedestrian Signal Pushbuttons and Pedestrian Pushbutton Symbol Sign (Ra-120), if pedestrian actuated.	• Raised refuge island (for road cross-sections with more than two lanes and two-directional traffic) with mandatory: • Pavement markings on approaches to obstructions • Keep Right Sign (Rb-25, Rb-125) • Object Marker Sign (Wa-33L) • Stopping prohibition for a minimum of 30 m on each approach to the crossing, and 15 m following the crossing	• School Crossing Guard • Pedestrian Count Down Signals • Pedestrian Countdown Signal Information Sign • Exclusive Pedestrian Phasing • Leading Pedestrian Interval • Auxiliary Signal Heads • Ladder Crosswalk • Textured Crosswalk • Raised Crosswalk • Cross on Walk Signal Only Sign (RA-7) • No Right Turn on Red sign (Rb-79) • Pedestrian Must Push Button to Receive Walk Signal (Ra-13) • Advanced Stop Bar at Crosswalk with mandatory Stop Here on Red Signal Sign (Rb-78) • Safety elements including Barricades, Pedestrian Fencing, Gates, Walls, Bollards, and Barriers



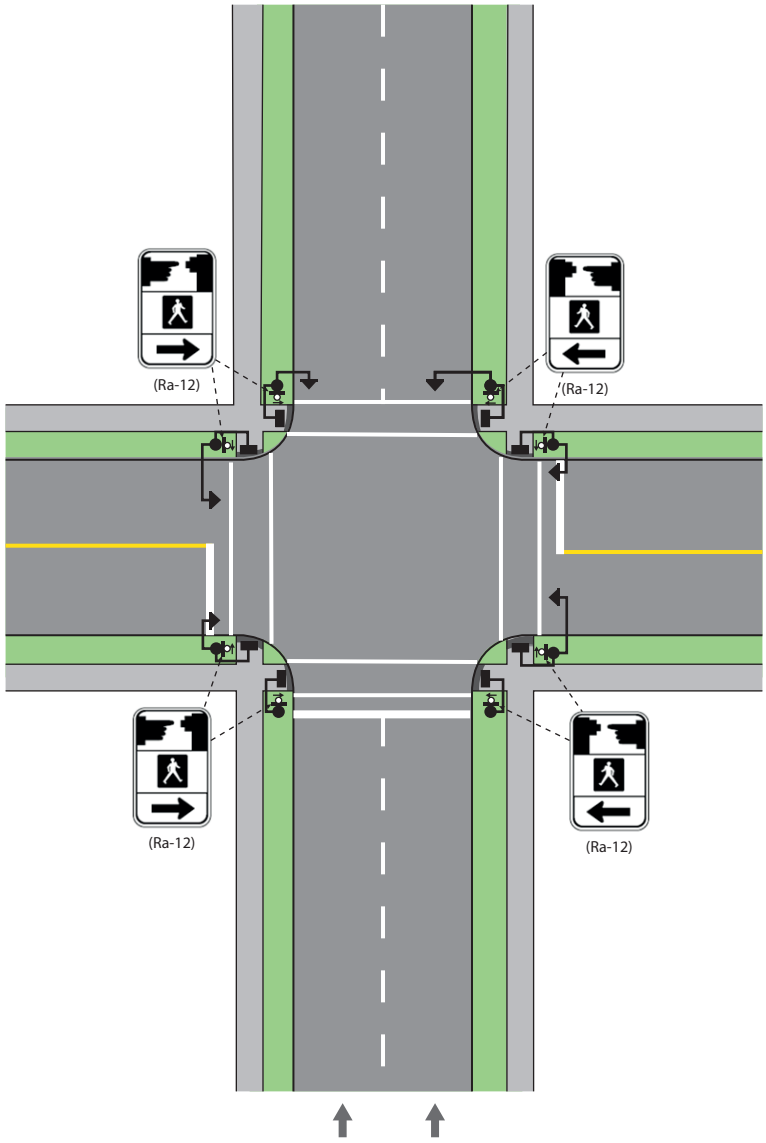
General notes:

- Accessible as per AODA
- Required illumination of pedestrian crosswalk and waiting area to be provided
- Provide approach markings and crosswalk layouts according to OTM Book 11
- For layouts of traffic signals, location of pedestrian heads and poles, and relevant dimensions, refer to OTM Book 12

○ Pushbutton

N.T.S.

Figure 14: Pedestrian Treatment at Full Traffic Signal (2-lane, 2-way)



General notes:

- Accessible as per AODA
- Required illumination of pedestrian crosswalk and waiting area to be provided
- Provide approach markings and crosswalk layouts according to OTM Book 11
- For layouts of traffic signals, location of pedestrian heads and poles, and relevant dimensions, refer to OTM Book 12

○ Pushbutton

N.T.S.

Figure 15: Pedestrian Treatment at Full Traffic Signal (2-lane, 1-way)

6.3.1.2 Intersection and Mid-block Pedestrian Signals (IPS and MPS)

Description

Traffic control signal systems that are dedicated primarily to providing traffic gaps for pedestrian right-of-way may be installed as pedestrian signals either at intersections (Intersection Pedestrian Signals) or between intersections (Midblock Pedestrian Signals). The control of pedestrian signals is by pedestrian actuated two phase operation; pedestrian signal indications are used for crossing the main street and regular traffic control signals on main roadway approaches. Both control types require that main road traffic be fully signalized, while for IPS crossings, the side road must be controlled with stop signs, as illustrated in typical installation layouts. For IPS installations side street traffic is stop controlled but may cross or turn during the pedestrian phase if not in conflict with a pedestrian.

For IPS, typical three-section signal heads are used for the main road and pedestrian signal with pushbuttons are required for crossing. Signal heads may be mounted on the same poles, either back to back or independently. It is possible to install crossing on the opposite side of the side road or to install dual crossings, one on each side (see OTM Book 12 for details).

Both IPS and MPS require that a standard crosswalk be marked in accordance with practice for traffic signals. An IPS requires the near side stop line to be set back a minimum of 15 m from the crosswalk. For a MPS, the stop lines must set back a minimum of 12 m from crosswalk (see details on advanced stop bar in Section 6.2.4).

The selection criteria for IPS and MPS as pedestrian crossing treatments are provided in Sections 5.1.1 and 5.2.1.

Table of Components

Table 9 provides the components of IPS and MPS as pedestrian control treatments. The details of individual components are provided in Section 6.2.

Application Environments

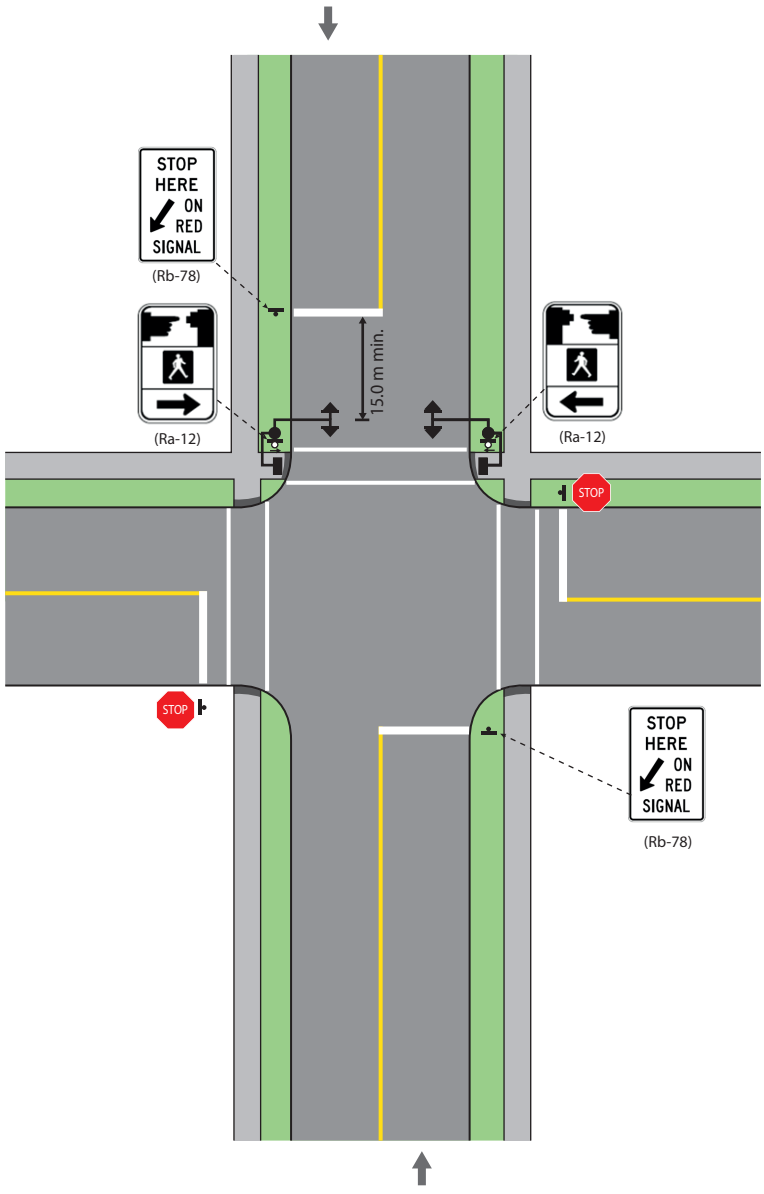
The application environments for IPS and MPS as pedestrian crossing treatments are all applicable intersections and mid-block locations respectively, with one way and two-way streets. MPS installations must be restricted to roadways posted at less than 80 km/h.

Typical Installation Layouts

Figure 16 to Figure 19 illustrates installation details for IPS and MPS as pedestrian crossing treatments for two-way and one-way movements. It is practitioner's responsibility to select an appropriate layout for a location based on the selection criteria provided in this manual.

Table 9: Components for Intersection and Mid-block Pedestrian Signals

Required Components	Desirable Components	Optional Components
• Traffic Signal Heads as required • Approach Markings (Stop Line, No-Passing zone, and required Turn Lanes markings) • Crosswalk Markings • Advanced Stop Bar at Crosswalk with mandatory Stop Here on Red Signal Sign (Rb-78) • Stop Here On Red sign (Rb-78) on the near side of an IPS with vehicle and pedestrian heads installed on the far side • Pedestrian Control Indications with AODA compliant Pedestrian Signal Pushbuttons and Pedestrian Pushbutton Symbol Sign (Ra-12) • Parking and other sight obstructions prohibition within at least 30 m of crossings • Stopping prohibition for a minimum of 15 m on each approach to the crossing, and 10 m following the crossing • Stop sign (Ra-1) on the cross street for IPS	• Raised refuge island (for road cross-sections with more than two lanes and two-directional traffic) with mandatory: • Pavement markings on approaches to obstructions • Keep Right Sign (Rb-25, Rb-125) • Object Marker Sign (Wa-33L) • Stopping prohibition for a minimum of 30 m on each approach to the crossing, and 15 m following the crossing	• School Crossing Guard • Pedestrian Count Down Signals • Pedestrian Countdown Signal Information Sign • Auxiliary Signal Heads • Type 12 Signal Head (300 mm red / amber / green lens) • Ladder Crosswalk Markings • Textured Crosswalk • Raised Crosswalk • Cross on Walk Signal Only Sign (RA-7) • Cross Other Side Sign (Ra-9) • Do Not Cross Here Sign (Ra-9a) • No Right Turn on Red sign (Rb-79) • Pedestrian Must Push Button to Receive Walk Signal (Ra-13) • Safety elements including Barricades, Pedestrian Fencing, Gates, Walls, Bollards, and Barriers



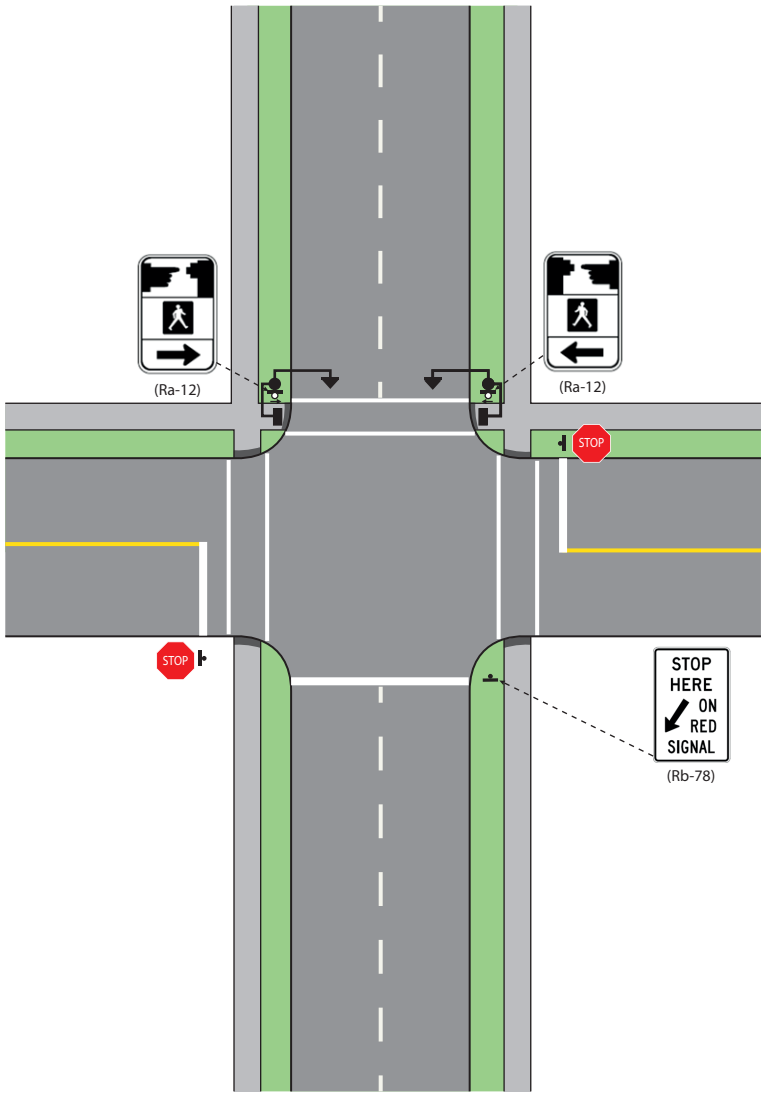
General notes:

- Accessible as per AODA
- Required illumination of pedestrian crosswalk and waiting area to be provided
- Provide approach markings and crosswalk layouts according to OTM Book 11
- For layouts of traffic signals, location of pedestrian heads and poles, and relevant dimensions, refer to OTM Book 12

○ Pushbutton

N.T.S.

Figure 16: Intersection Pedestrian Signal Pedestrian Crossing Treatment (2-lane, 2-way)



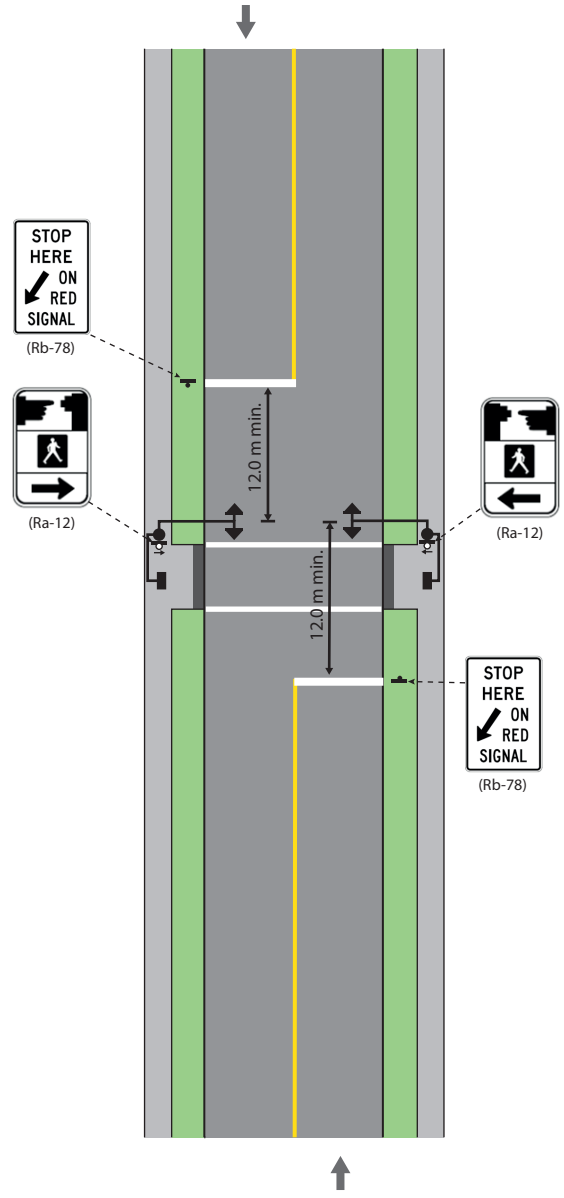
General notes:

- Accessible as per AODA
- Required illumination of pedestrian crosswalk and waiting area to be provided
- Provide approach markings and crosswalk layouts according to OTM Book 11
- For layouts of traffic signals, location of pedestrian heads and poles, and relevant dimensions, refer to OTM Book 12

○ Pushbutton

N.T.S.

Figure 17: Intersection Pedestrian Signal Pedestrian Crossing Treatment (2-lane, 1-way)

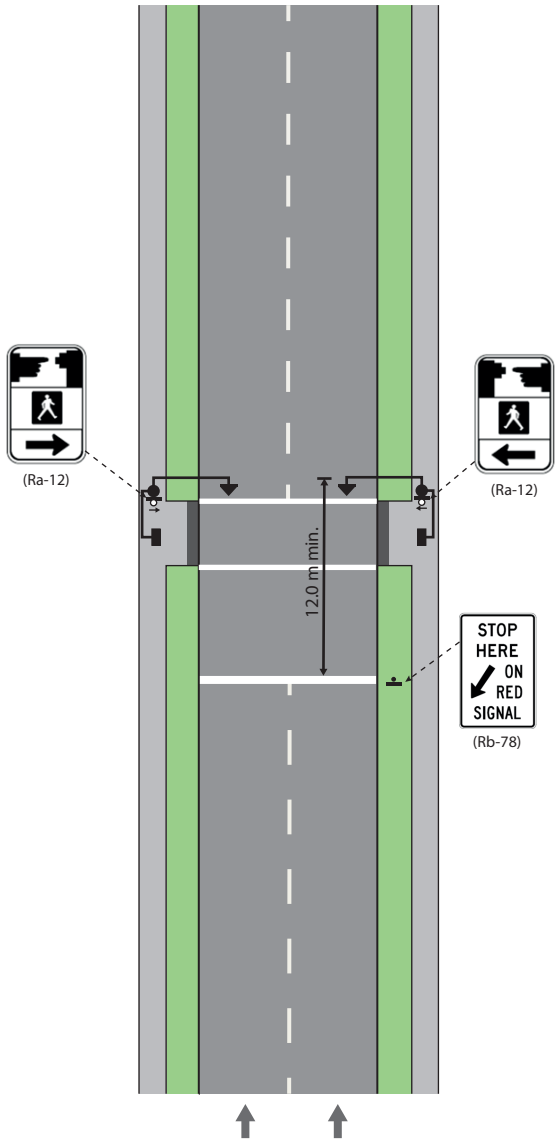


General notes:

- Accessible as per AODA
- Required illumination of pedestrian crosswalk and waiting area to be provided
- Provide approach markings and crosswalk layouts according to OTM Book 11
- For layouts of traffic signals, location of pedestrian heads and poles, and relevant dimensions, refer to OTM Book 12

N.T.S.

Figure 18: Mid-block Pedestrian Signal Pedestrian Crossing Treatment (2-lane, 2-way)



General notes:

- Accessible as per AODA
- Required illumination of pedestrian crosswalk and waiting area to be provided
- Provide approach markings and crosswalk layouts according to OTM Book 11
- For layouts of traffic signals, location of pedestrian heads and poles, and relevant dimensions, refer to OTM Book 12

N.T.S.

Figure 19: Mid-block Pedestrian Signal Pedestrian Crossing Treatment (2-lane, 1-way)

6.3.2 Pedestrian Crossovers

PXOs provide pedestrians with protected crossing opportunities by requiring motorists to yield to pedestrians within the crosswalk.

PXOs are "any portion of a roadway, designated by by-law of a municipality, at an intersection or elsewhere, distinctly indicated for pedestrian crossing by signs on the highway and lines or other markings on the surface of the roadway as prescribed by the HTA regulations."[21] The presence of a pedestrian in the crosswalk in the motorist's half of the roadway requires the motorist to yield the right-of-way.

There are four types of PXOs (PXO A to PXO D) as described in the following sections.

The selection criteria for PXOs as pedestrian crossing treatments are provided in Sections 5.2.2.

6.3.2.1 PXO A

Description

Type A pedestrian crossovers are distinctly defined by the prescribed use of regulatory and warning signs, flashing amber beacons, and pavement marking as listed in Table 10 and illustrated in installation layouts shown from Figure 20 to Figure 21. It is practitioner's responsibility to select an appropriate layout for a location based on the selection criteria provided in this manual.

Table of Components

Table 10 provides the components of a PXO A. The details of individual components are provided in Section 6.2.

Application Environments

The applicable application environments for PXO A are as follows, subject to the selection criteria provided in Section 5.2.2.

- Mid-block: up to 4 lanes total cross-section, 2-way
- Mid-block: up to 3 lanes total cross-section, 1-way
- Intersection: up to 4 lanes total cross-section, 2-way
- Intersection: up to 3 lanes total cross-section, 1-way

Typical Installation Layouts

Figure 20 to Figure 21 illustrate installation details for PXO A for intersection and mid-block environments. It is practitioner's responsibility to select an appropriate layout for a location based on the selection criteria provided in this manual. The location of the poles should be in advance of the pavement markings (near side) where practical. The location of the poles shown in the layout is for illustration purposes only. Jurisdictions may choose to install poles after the pedestrian crossing pavement marking (far side). However, this practice must be consistent throughout the jurisdiction.

Table 10: Components of Type A Pedestrian Crossover

Required Components	Desirable Components	Optional Components
• Typical Pedestrian Crossover Markings for Type A PXO, including double parallel markings, no passing zone, and "X" markings (see Section 6.2.4) • Two ground-mounted PEDESTRIAN X (Crossover) signs (Ra-4) together with their STOP FOR PEDESTRIANS (Ra-4t) tabs, mounted back-to-back installed on each side of the road for a two-way road • A NO PASSING HERE TO CROSSING (Ra-10) sign located on the right side of the roadway facing the traffic in each direction at a point approximately 30 m upstream of the crossing location for a two-way road • Double-sided, internally illuminated OVERHEAD X signs (Wc-20 or Wc-120). For location and installation guidelines, refer to OTM Book 6 • Pedestrian-Actuated flashing amber beacons (two per direction) installed in conjunction with the OVERHEAD X signs with Pedestrian Pushbuttons and a PEDESTRIAN PUSHBUTTON (Ra-11) sign • Parking and other sight obstructions prohibition within at least 30 m of crossings	• Flashing amber beacon tell-tale for pedestrian notification • AODA compliant pedestrian pushbuttons	• School Crossing Guard • Ladder Crosswalk Markings • Textured Crosswalk Markings • Raised Crosswalk • Safety elements including Barricades, Pedestrian Fencing, Gates, Walls, Bollards, and Barriers

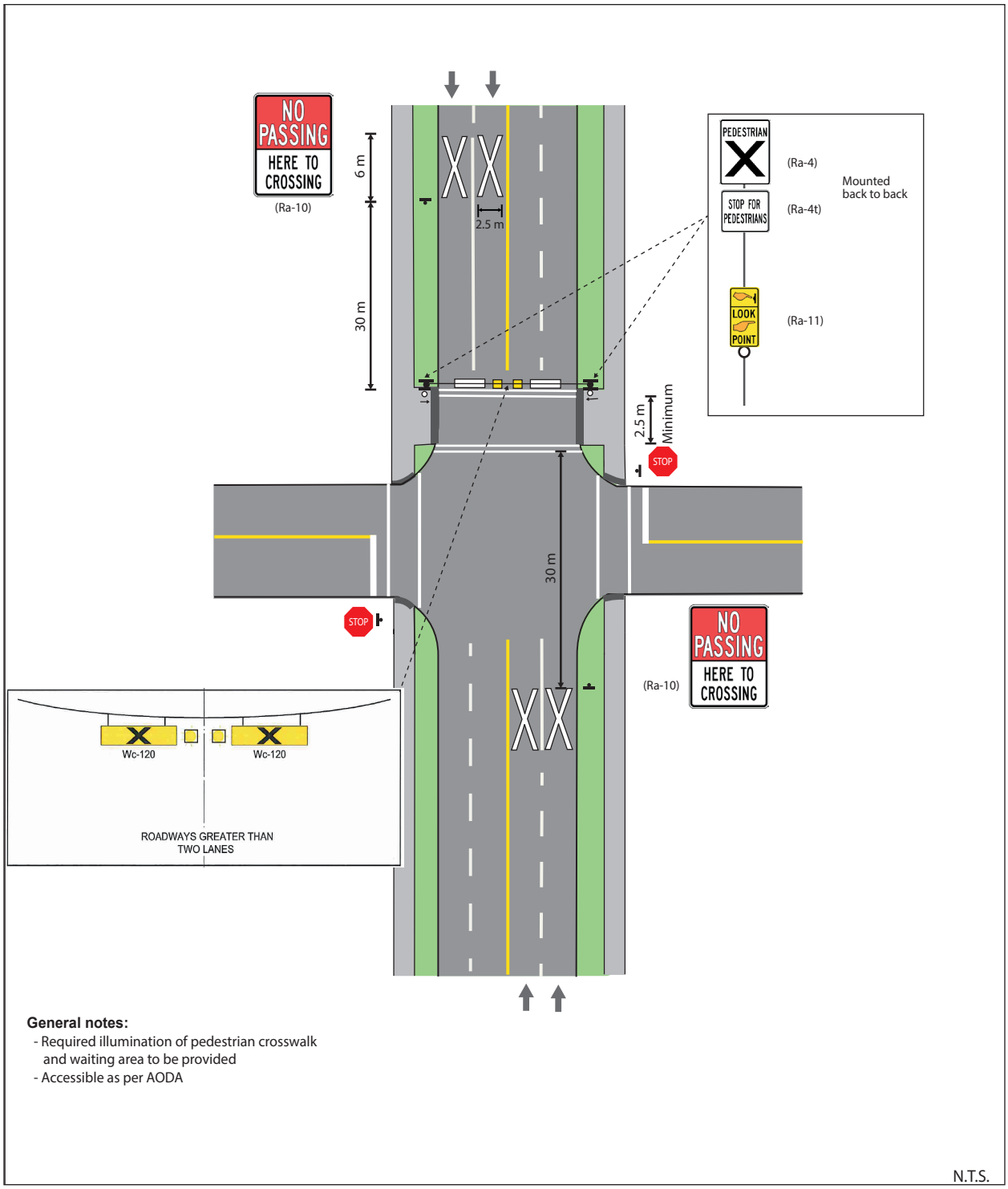


Figure 20: Pedestrian Crossover Type A – Intersection (2-way)

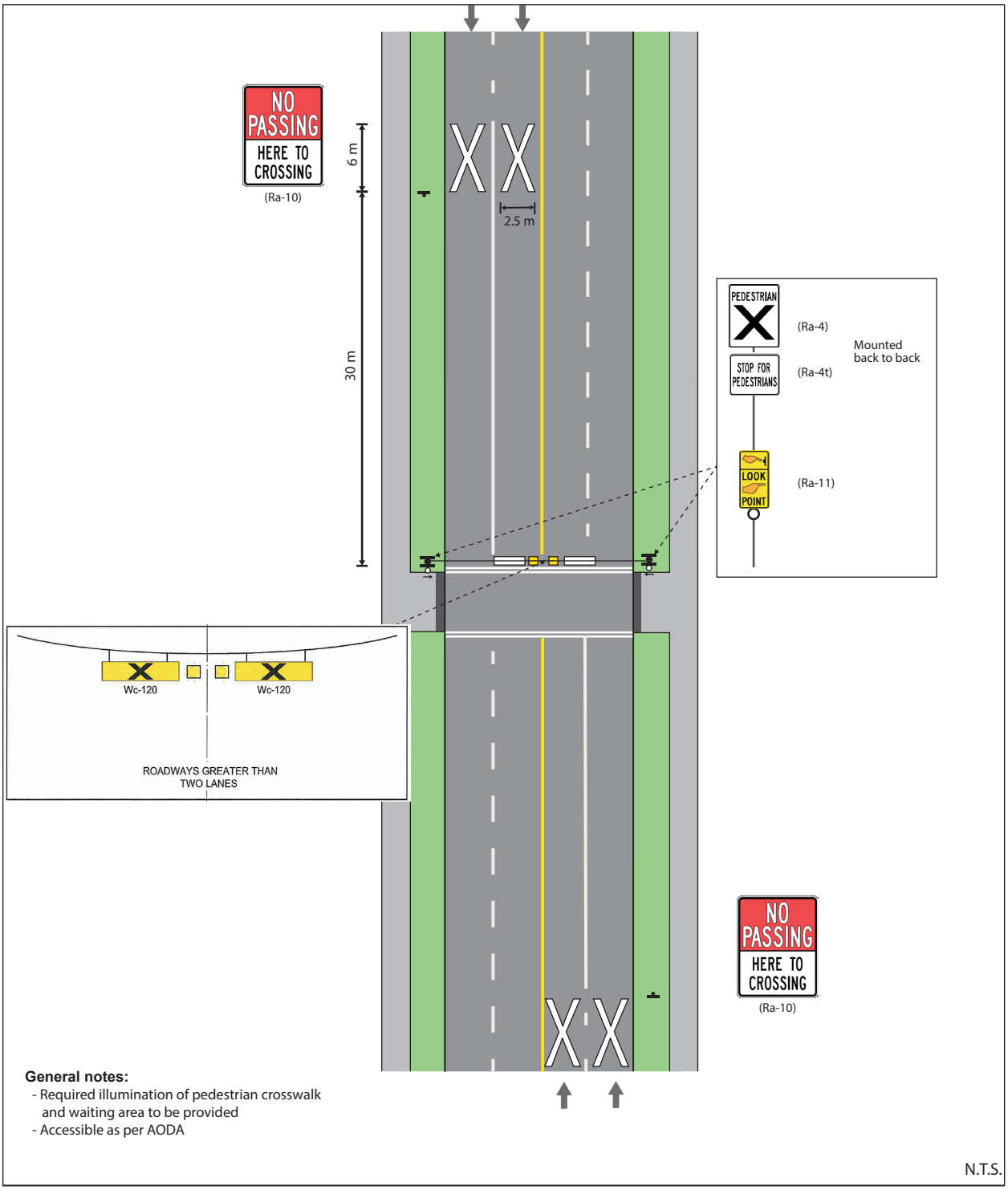


Figure 21: Pedestrian Crossover Type A – Mid-block (4-lane, 2-way)

6.3.2.2 PXO B

Description

Type B pedestrian crossovers are distinctly defined by the prescribed use of regulatory and warning signs, rapid rectangular flashing beacons and pavement marking as listed in Table 11 and illustrated in installation layouts from Figure 22 to Figure 30.

Table of Components

Table 11 provides the components of a PXO B. The details of individual components are provided in Section 6.2.

Application Environment

The applicable application environments for PXO B are as follows, subject to the selection criteria provided in Section 5.2.2.

- Mid-block: up to 4 lanes total cross-section, 2-way
- Mid-block: up to 3 lanes total cross-section, 1-way
- Intersection: up to 4 lanes total cross-section, 2-way
- Intersection: up to 3 lanes total cross-section, 1-way
- Single-Lane Roundabout
- Double-Lane Roundabout

Typical Installation Layout

Figure 22 to Figure 30 illustrate installation details for PXO B for various applicable environments. It is practitioner's responsibility to select an appropriate layout for a location based on the selection criteria provided in this manual. The location of the poles should be in advance of the pavement markings (near side) where practical. The location of the poles shown in the layout is for illustration purposes only. Jurisdictions may choose to install poles after the pedestrian crossing pavement marking (far side). However, this practice must be consistent throughout the jurisdiction.

Table 11: Components of Type B Pedestrian Crossover

Required Components	Desirable Components	Optional Components
• Side-mounted signs TAC (Ra-4) on both sides of the road for both directions, mounted back to back • One over-head mounted sign TAC (RA-4) for each direction of travel • Ladder Crosswalk Markings • Yield to Pedestrians line markings at 6.0 m from crosswalk • Actuated Double Sided Rectangle Rapid Flashing Beacon with Tell Tale and Pedestrian Pushbutton for pedestrians mounted above each set of side-mounted TAC (Ra-4) installed at the pedestrian crossover • Advanced Pedestrian Crossover Ahead sign (Wb-X) at 50.0 m upstream of the crosswalk • Passing restrictions on single lane approaches • Stopping prohibition for a minimum of 15 m on each approach to the crossing, and 10 m following the crossing • Lane change prohibition on multiple lane approaches using solid white lines • No Passing Here to Crossing sign (Ra-10) for multi-lane approaches	• Stopping prohibition for a minimum of 30 m on each approach to the crossing, and 15 m following the crossing • AODA compliant Pedestrian Pushbuttons	• School Crossing Guard • Textures Crosswalk Markings • Raised Crosswalk • Pedestrian Pushbutton (Ra-11) sign • Safety elements including Barricades, Pedestrian Fencing, Gates, Walls, Bollards, and Barriers

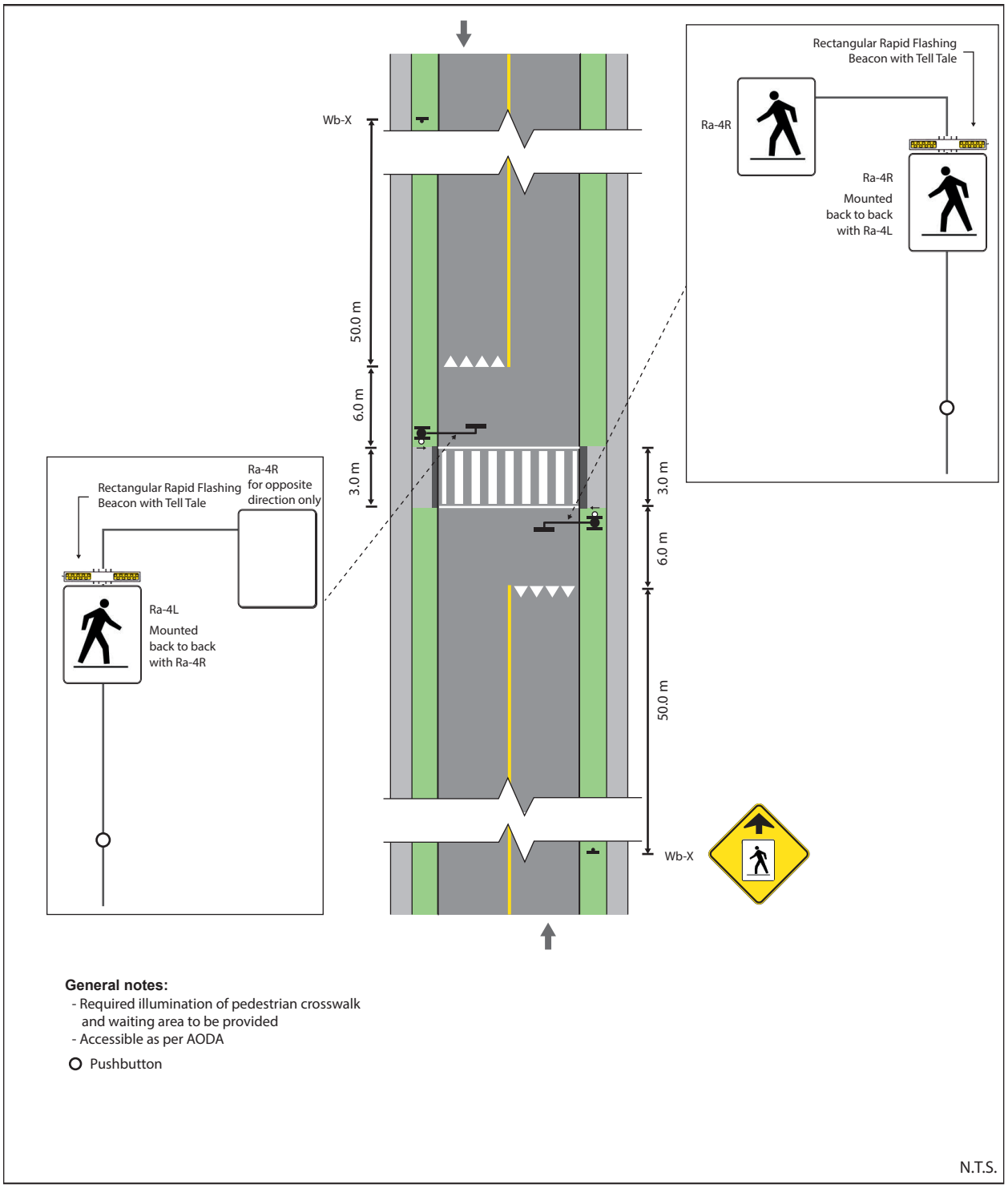


Figure 22: Pedestrian Crossover Type B – Mid-block (2-lane, 2-way)

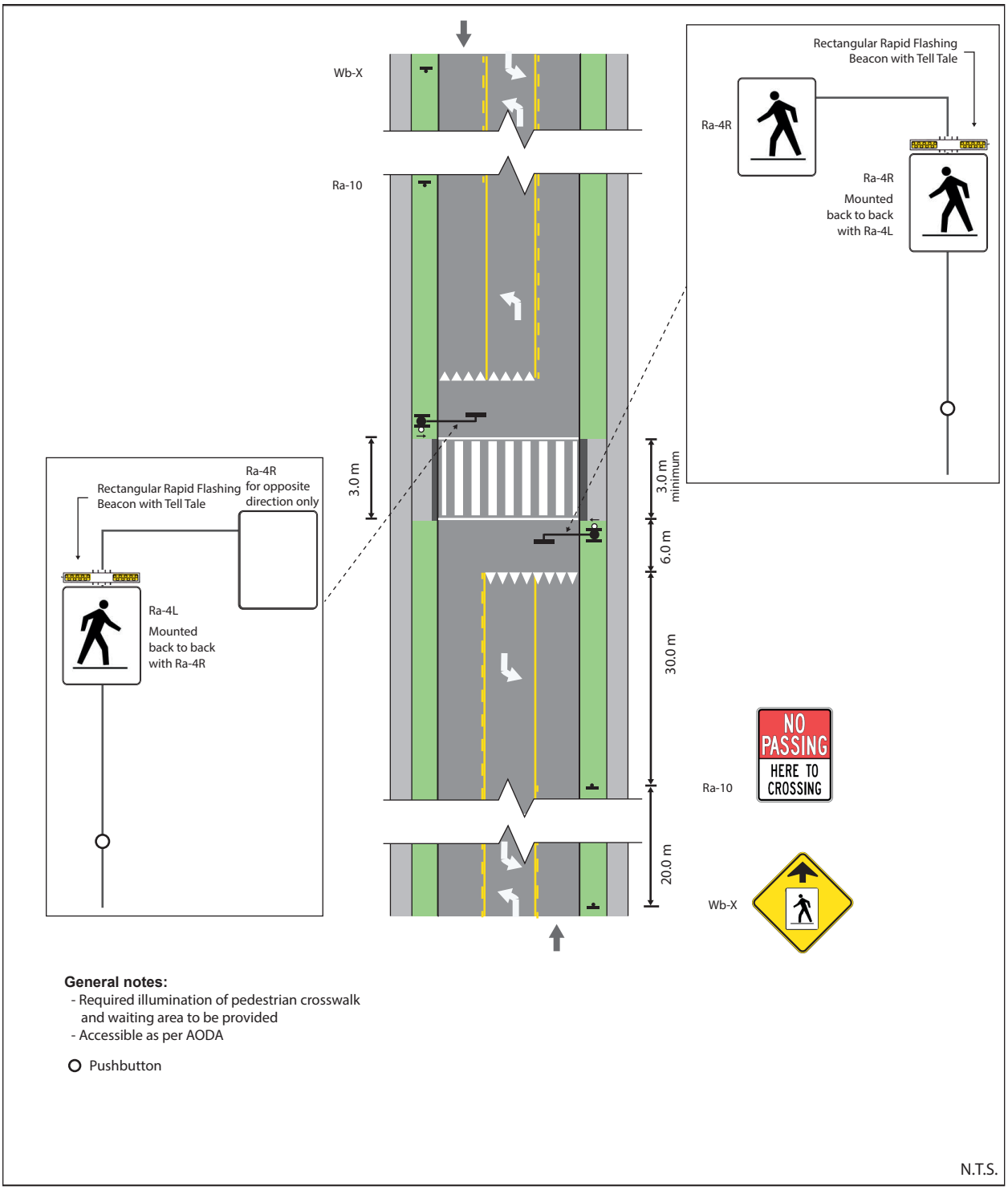


Figure 23: Pedestrian Crossover Type B – Mid-block (3-lane with centre 2-way left-turn lane)

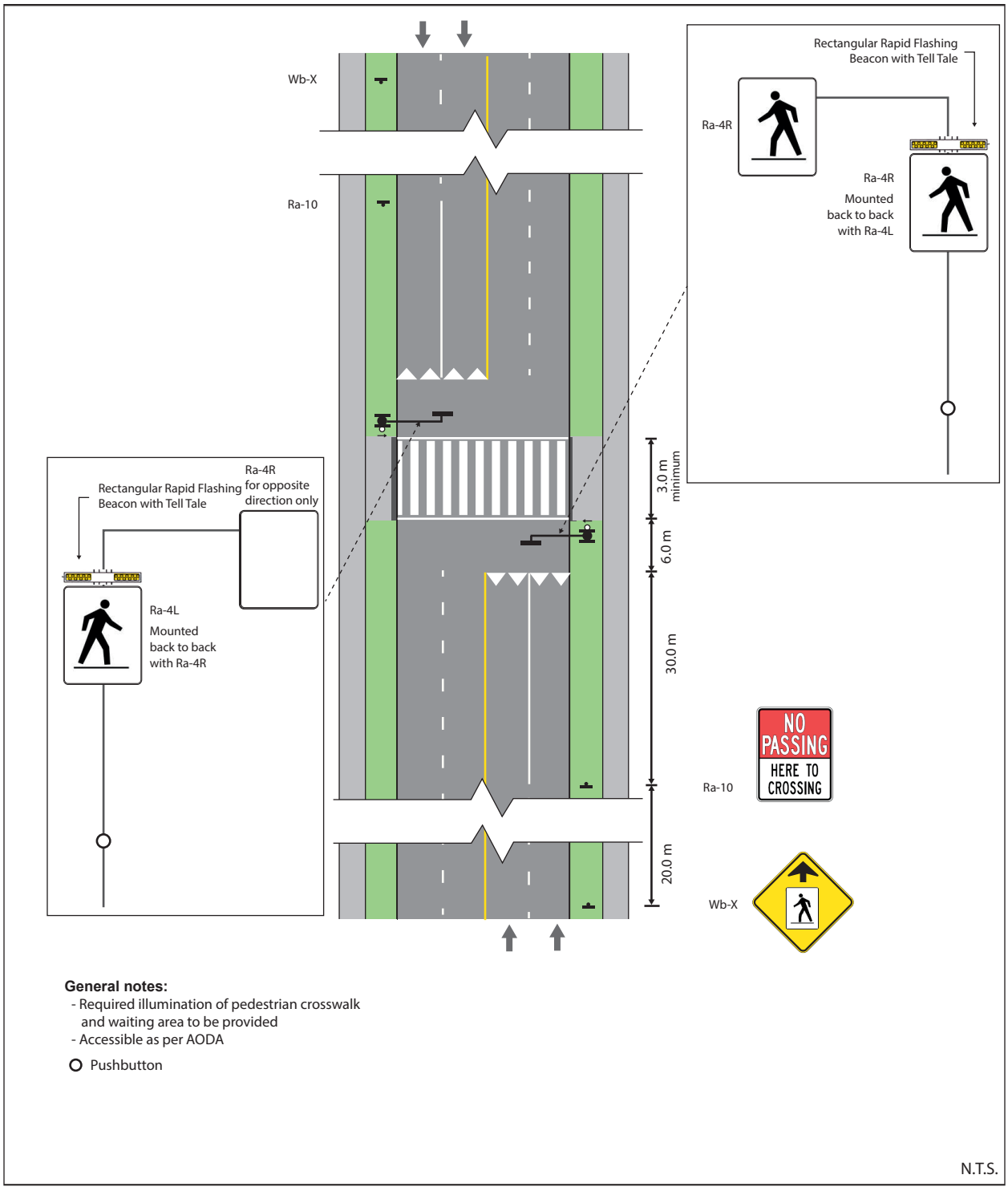


Figure 24: Pedestrian Crossover Type B – Mid-block (4-lane, 2-way)

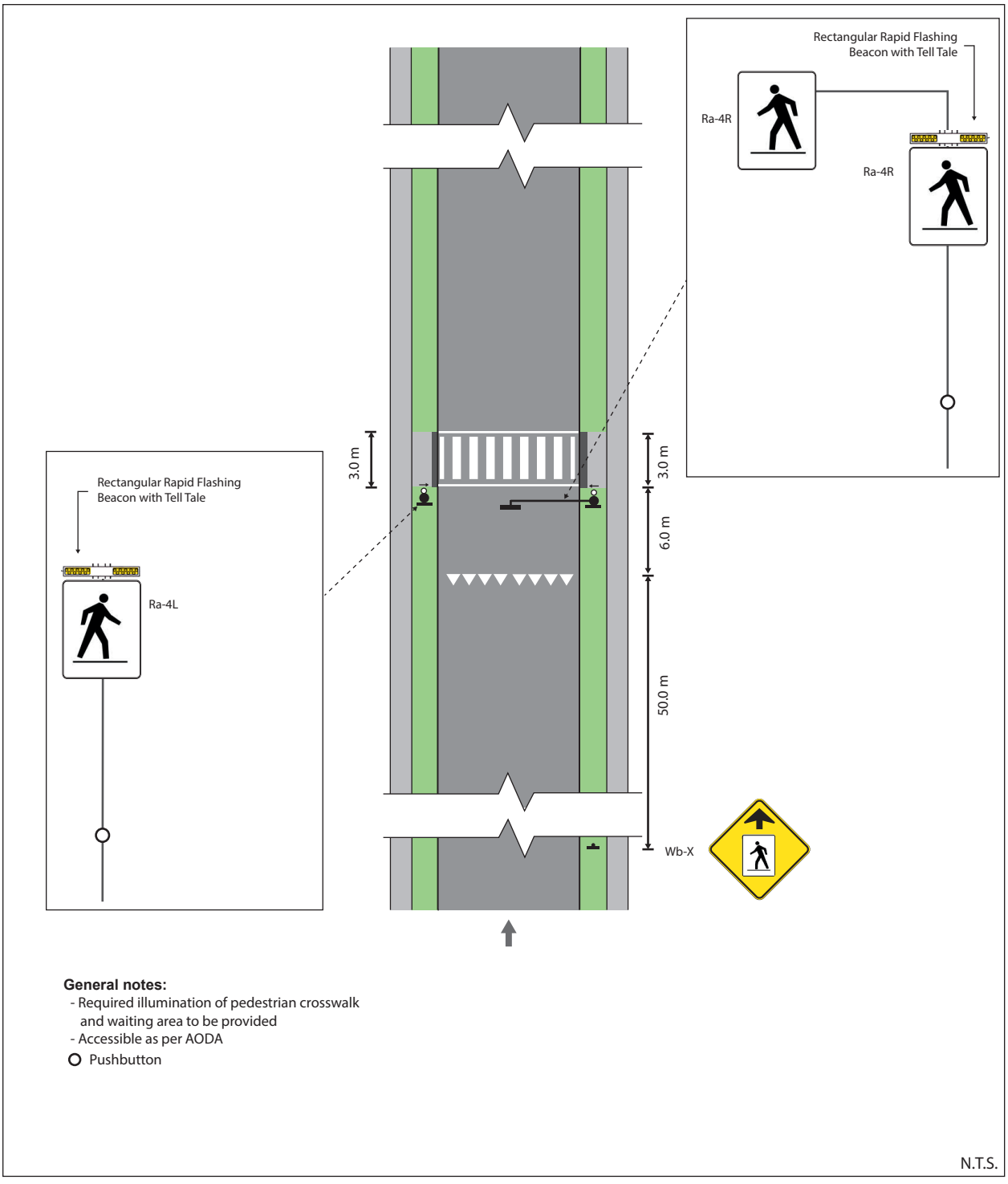


Figure 25: Pedestrian Crossover Type B – Mid-block (1-lane, 1-way)

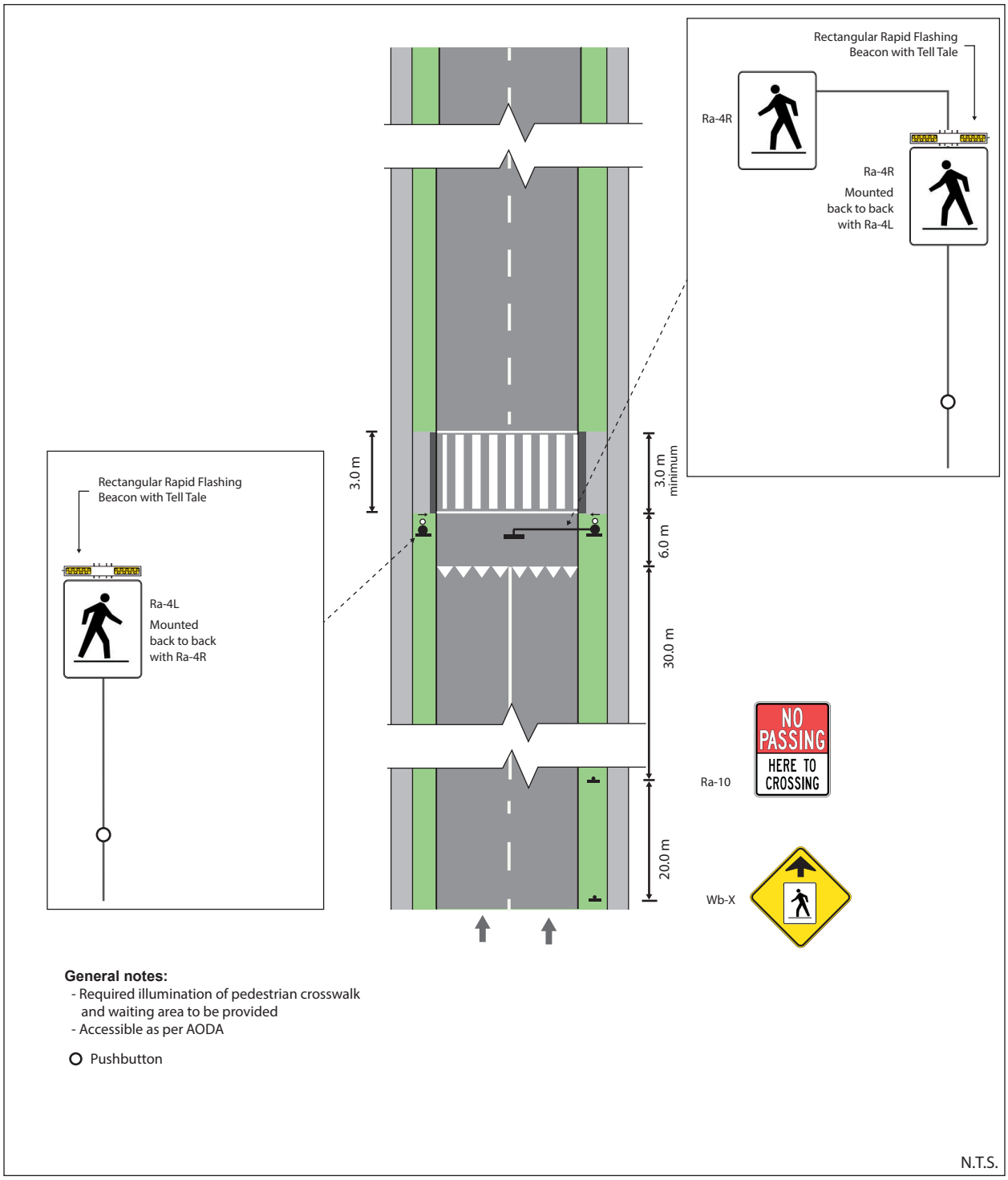


Figure 26: Pedestrian Crossover Type B – Mid-block (2-lane, 1-way)

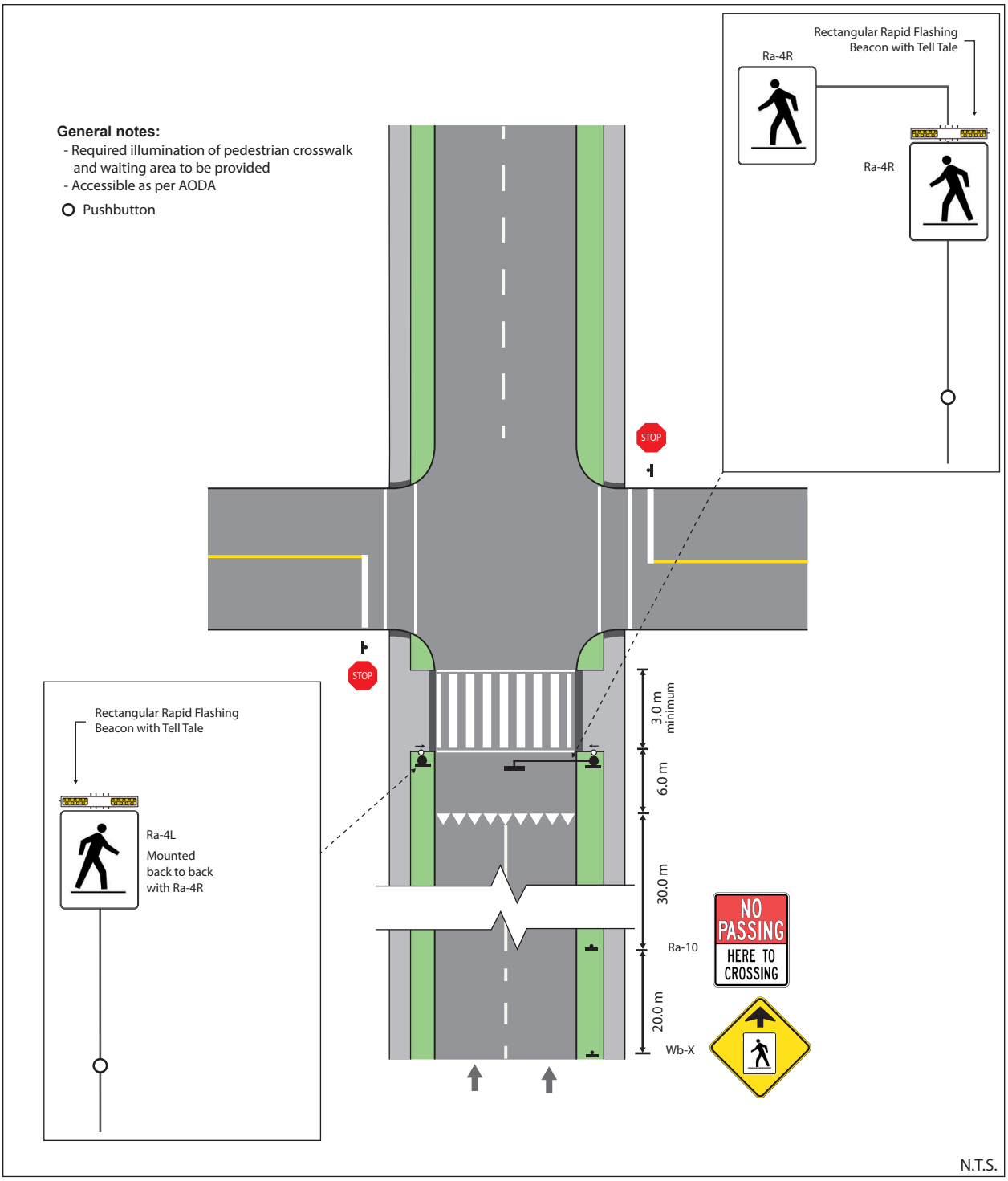


Figure 27: Pedestrian Crossover Type B – Intersection (1 –way)

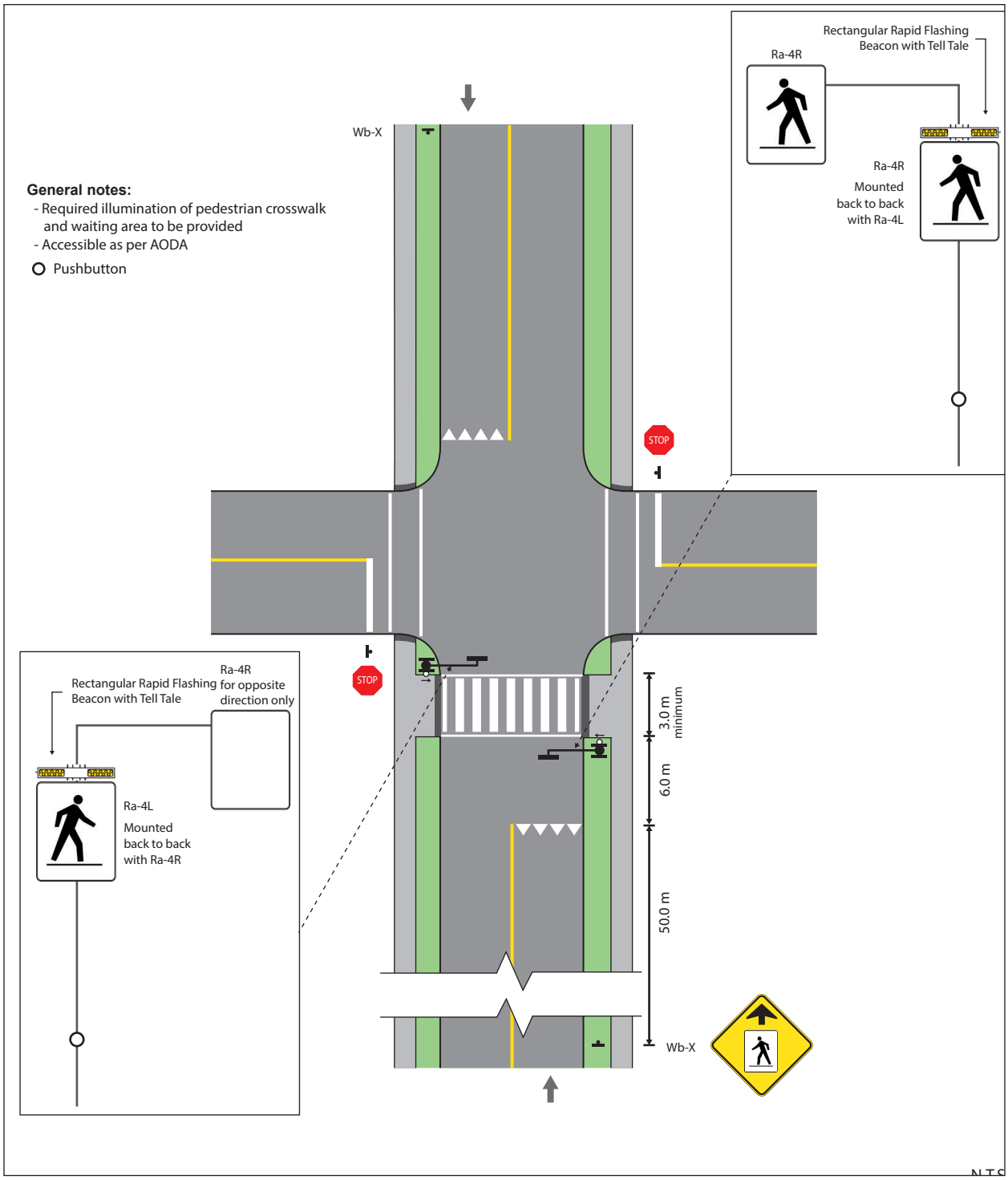


Figure 28: Pedestrian Crossover Type B – Intersection (2-way)

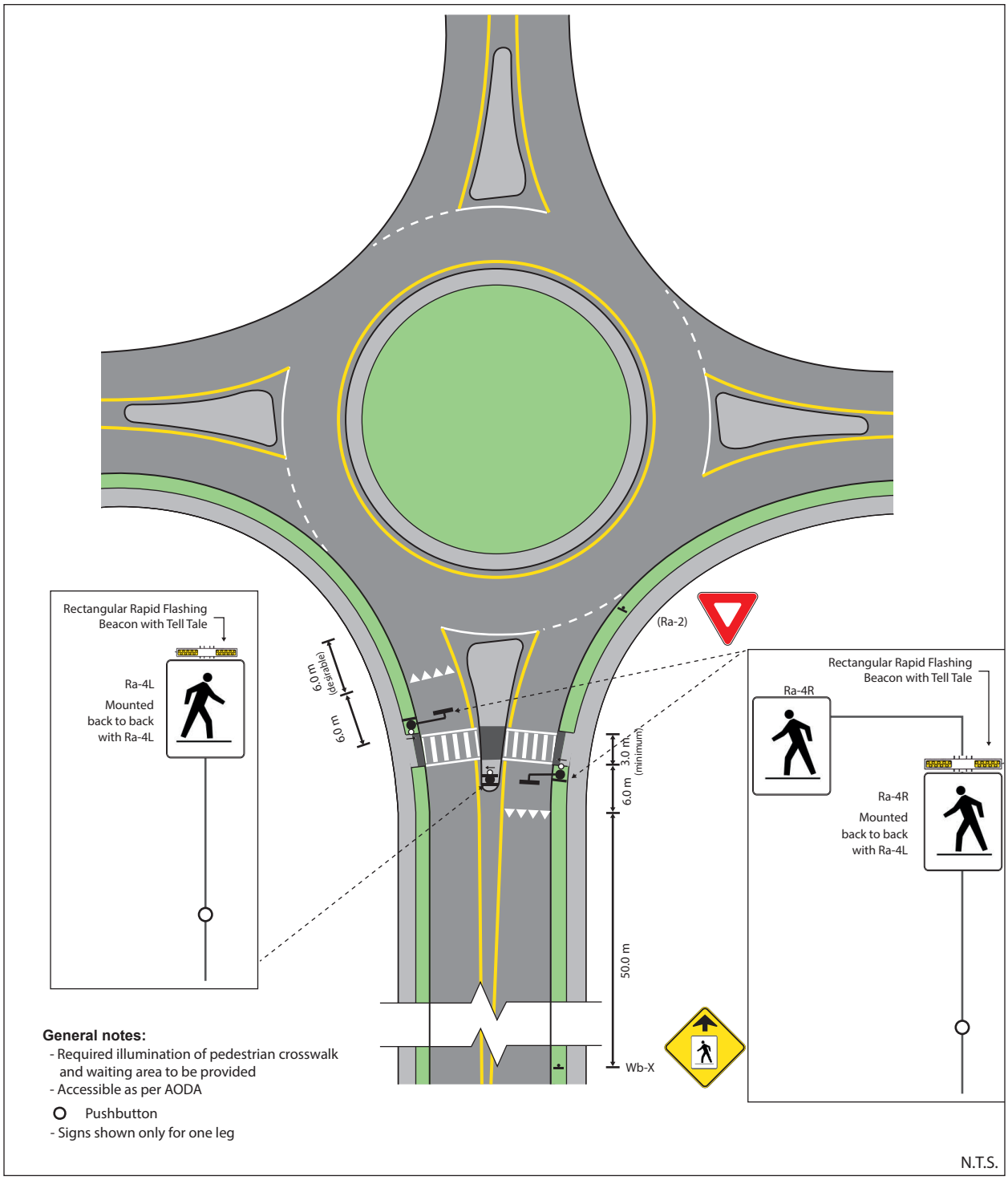


Figure 29: Pedestrian Crossover Type B – Single-Lane Roundabout

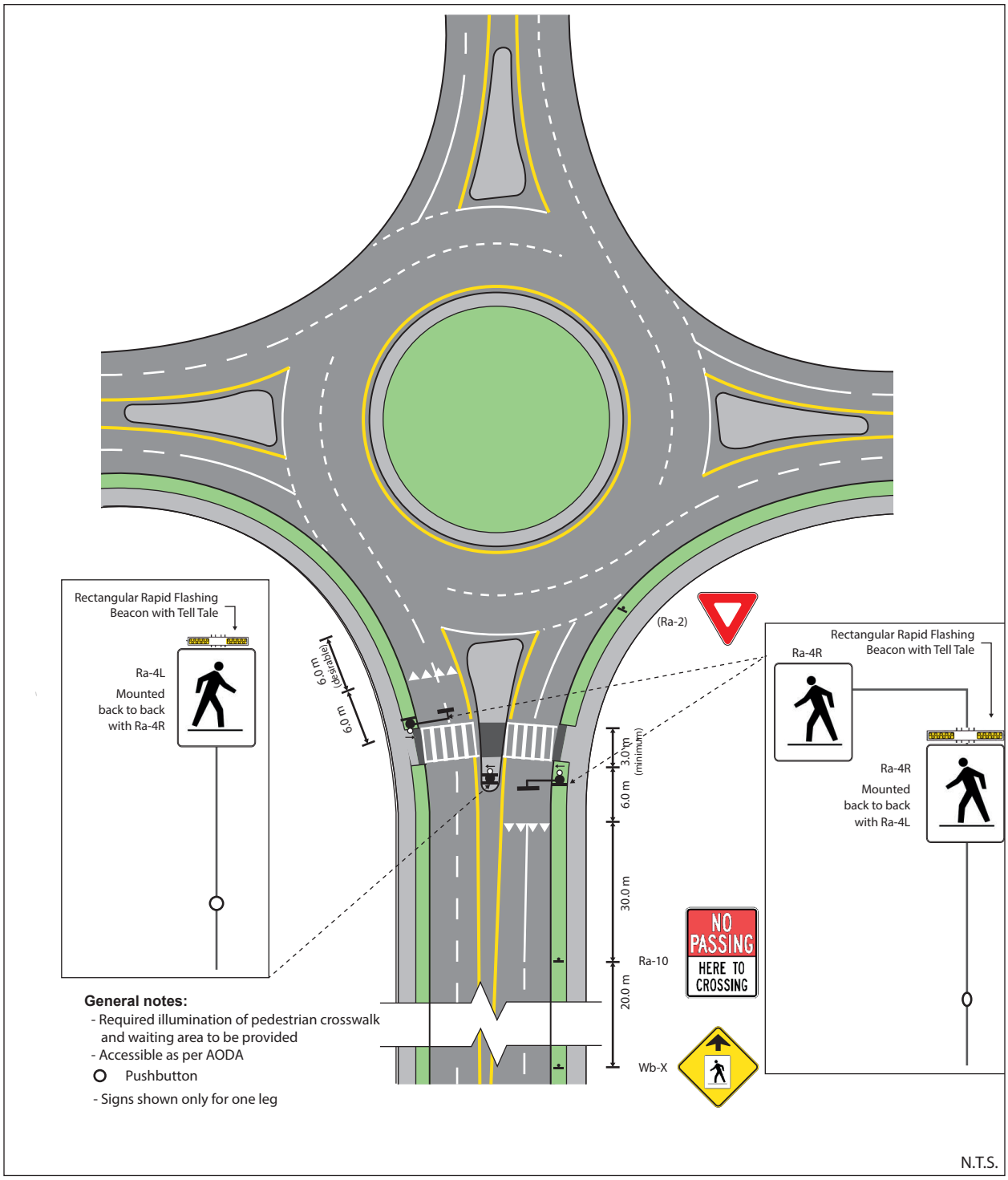


Figure 30: Pedestrian Crossover Type B – Double-Lane Roundabout

6.3.2.3 PXO C

Description

Type C pedestrian crossovers are distinctly defined by the prescribed use of regulatory and warning signs, rapid rectangular flashing beacons and pavement marking as listed in Table 12 and illustrated in installation layouts from Figure 31 to Figure 39.

Table of Components

Table 12 provides the components of a PXO C. The details of individual components are provided in Section 6.2.

Application Environment

The applicable application environments for PXO C are as follows, subject to the selection criteria provided in Section 5.2.2.

- Mid-block : up to 3 lanes total cross-section, 2-way
- Mid-block: 4-lane, 2-way with raised refuge only
- Mid-block: up to 2 lanes total cross-section, 1-way
- Intersection: up to 3 lanes total cross-section, 2-way
- Intersection: 4-lane, 2-way with raised refuge only
- Intersection: up to 2 lanes total cross-section, 1-way
- Single-Lane Roundabout
- Double-Lane Roundabout

Typical Installation Layout

Figure 31 to Figure 39 illustrates installation details for PXO Cs as pedestrian crossing treatments for various applicable environments. It is practitioner's responsibility to select an appropriate layout for a location based on the selection criteria provided in this manual. The location of the poles should be in advance of the pavement markings (near side) where practical. The location of the poles shown in the layout is for illustration purposes only. Jurisdictions may choose to install poles after the pedestrian crossing pavement marking (far side). However, this practice must be consistent throughout the jurisdiction.

Table 12: Components of Type C Pedestrian Crossover

Required Components	Desirable Components	Optional Components
• Side-mounted signs TAC (Ra-4) on both sides of the road for both directions, mounted back to back, when there is no raised refuge • Two side mounted signs TAC (Ra-4) for each direction, one on the right side and the other on the median mounted back to back with another TAC (Ra-4) sign for pedestrian crossovers for four lane roadways with raised median refuge • Ladder Crosswalk Markings • Yield to Pedestrians line markings at 6.0 m from crosswalk • Actuated Double Sided Rectangle Rapid Flashing Beacon with Tell Tale and Pedestrian Pushbutton for pedestrians mounted above each set of (Ra-4) installed at the pedestrian crossover • Advanced Pedestrian Crossover Ahead sign (Wb-X) at 50.0 m upstream of the crosswalk • Passing restrictions on single lane approaches • Stopping prohibition for a minimum of 15 m on each approach to the crossing, and 10 m following the crossing • Lane change prohibition on multiple lane approaches using solid white lines • No Passing Here to Crossing sign (Ra-10) for multi-lane approaches	• Raised refuge island with mandatory: • Pavement markings on approaches to obstructions • Keep Right sign (Rb-25, Rb-125) • Object Marker Sign (Wa-33L) • Stopping prohibition for a minimum of 30 m on each approach to the crossing, and 15 m following the crossing • AODA compliant Pedestrian Pushbuttons • Barricades for pedestrian crossovers for four lane roadways with raised median refuge • Staggered design for crossings with raised refuge island	• School Crossing Guard • Textures Crosswalk Markings • Raised Crosswalk • Pedestrian Pushbutton (Ra-11) sign • Safety elements including Barricades, Pedestrian Fencing, Gates, Walls, Bollards, and Barriers when raised refuge not present

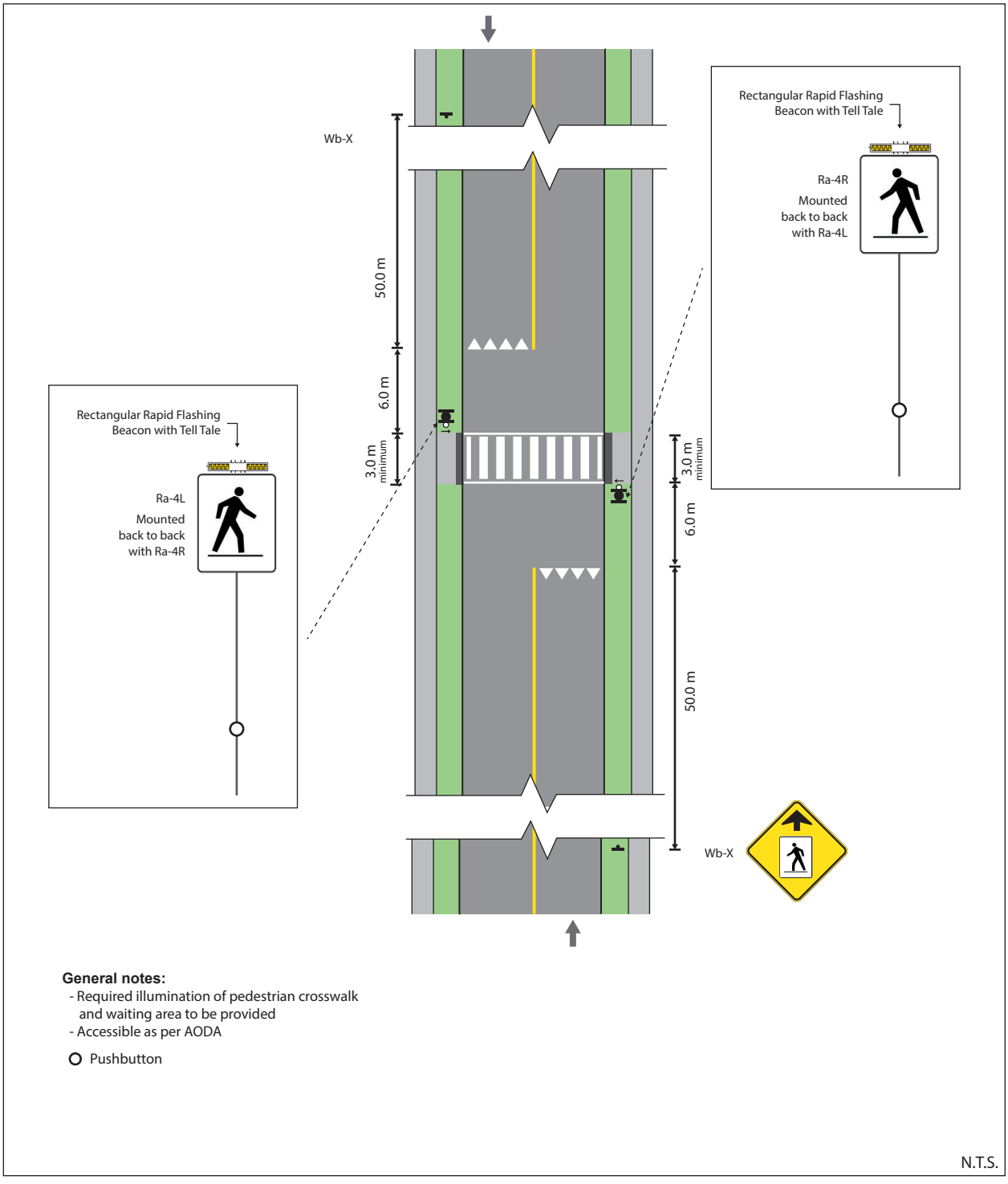


Figure 31: Pedestrian Crossover Type C – Mid-block (2-lane, 2-way)

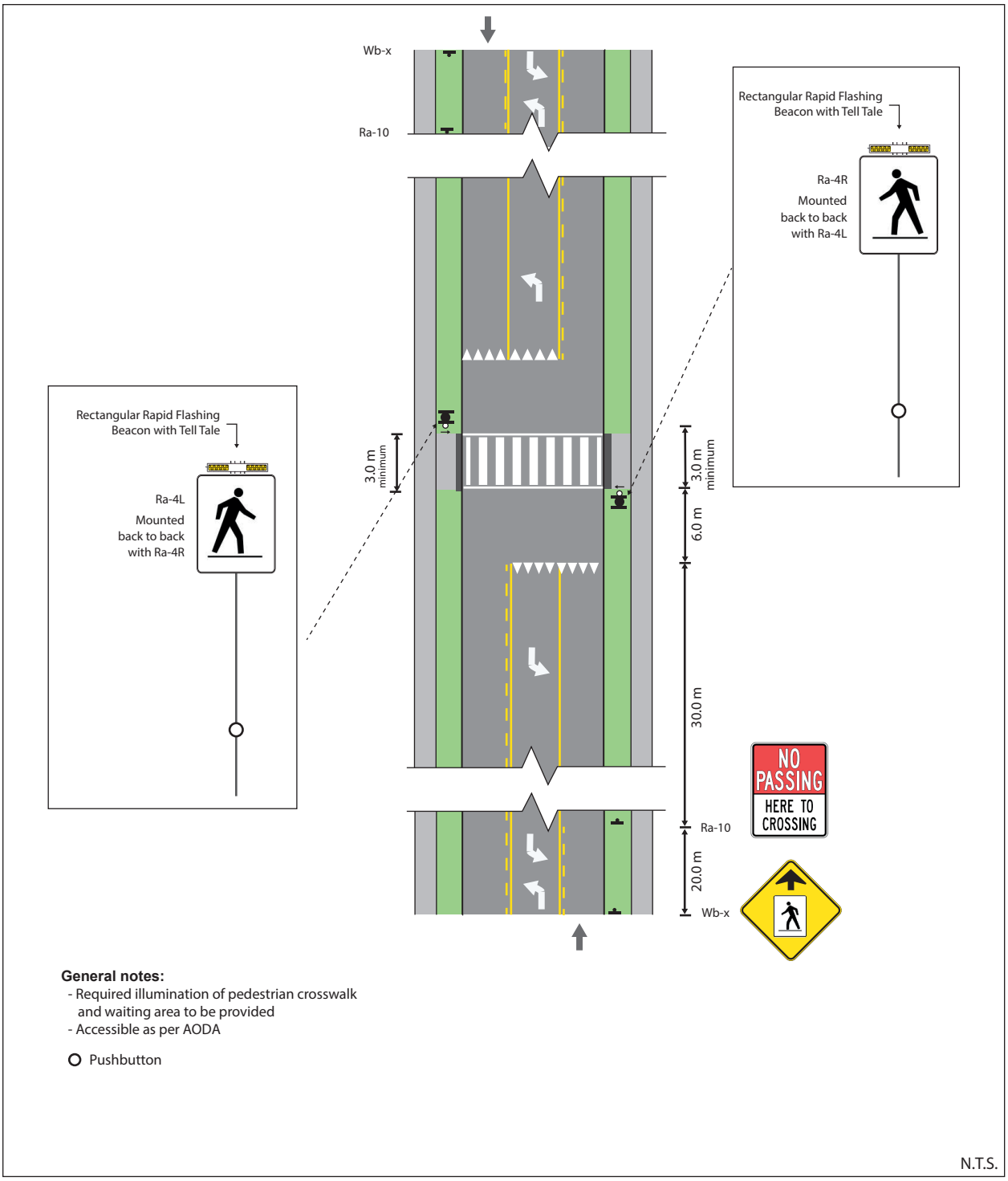


Figure 32: Pedestrian Crossover Type C – Mid-block (3-lane with centre 2-way left-turn lane)

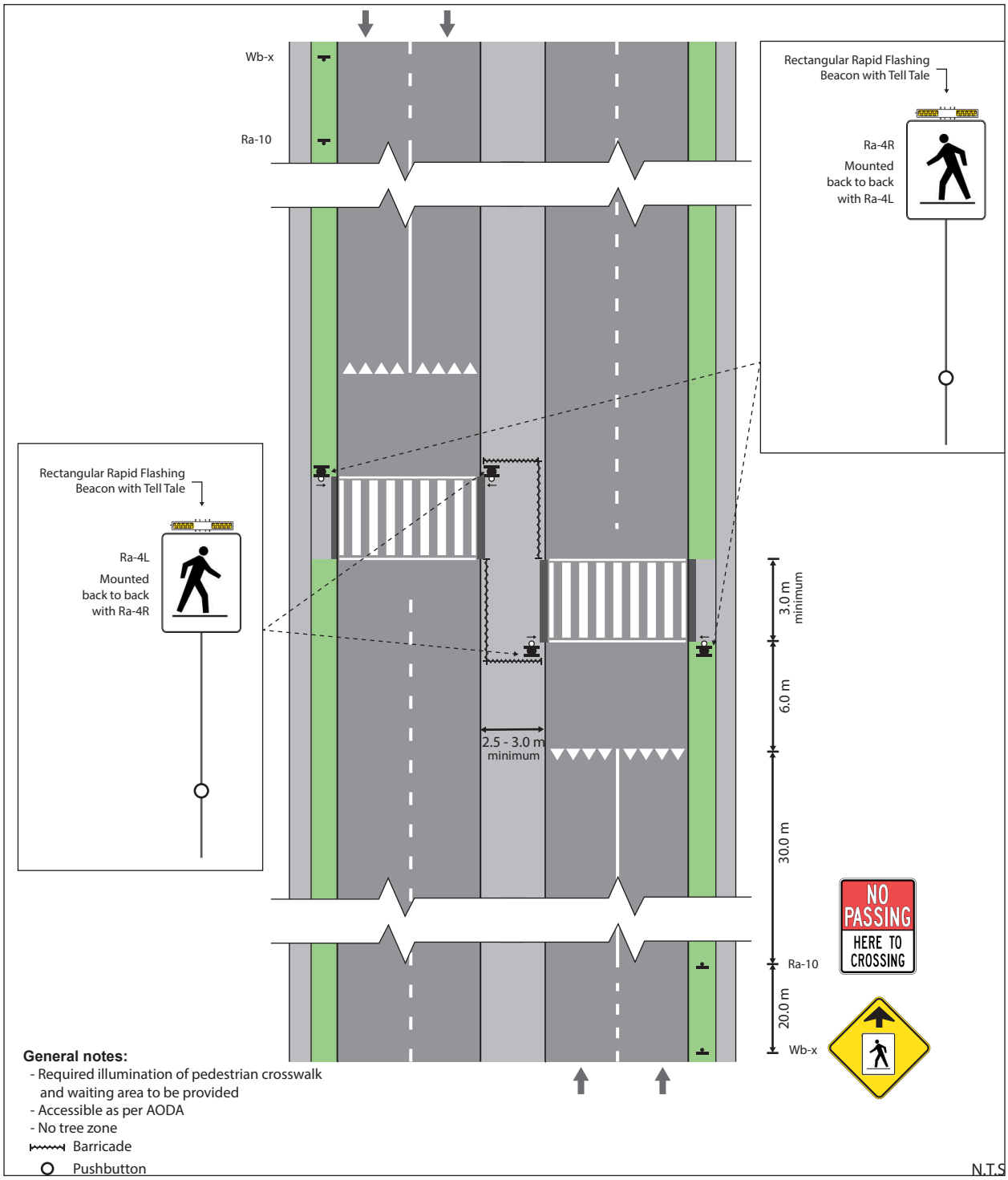


Figure 33: Pedestrian Crossover Type C – Mid-block (4-lane, 2-way with raised refuge)

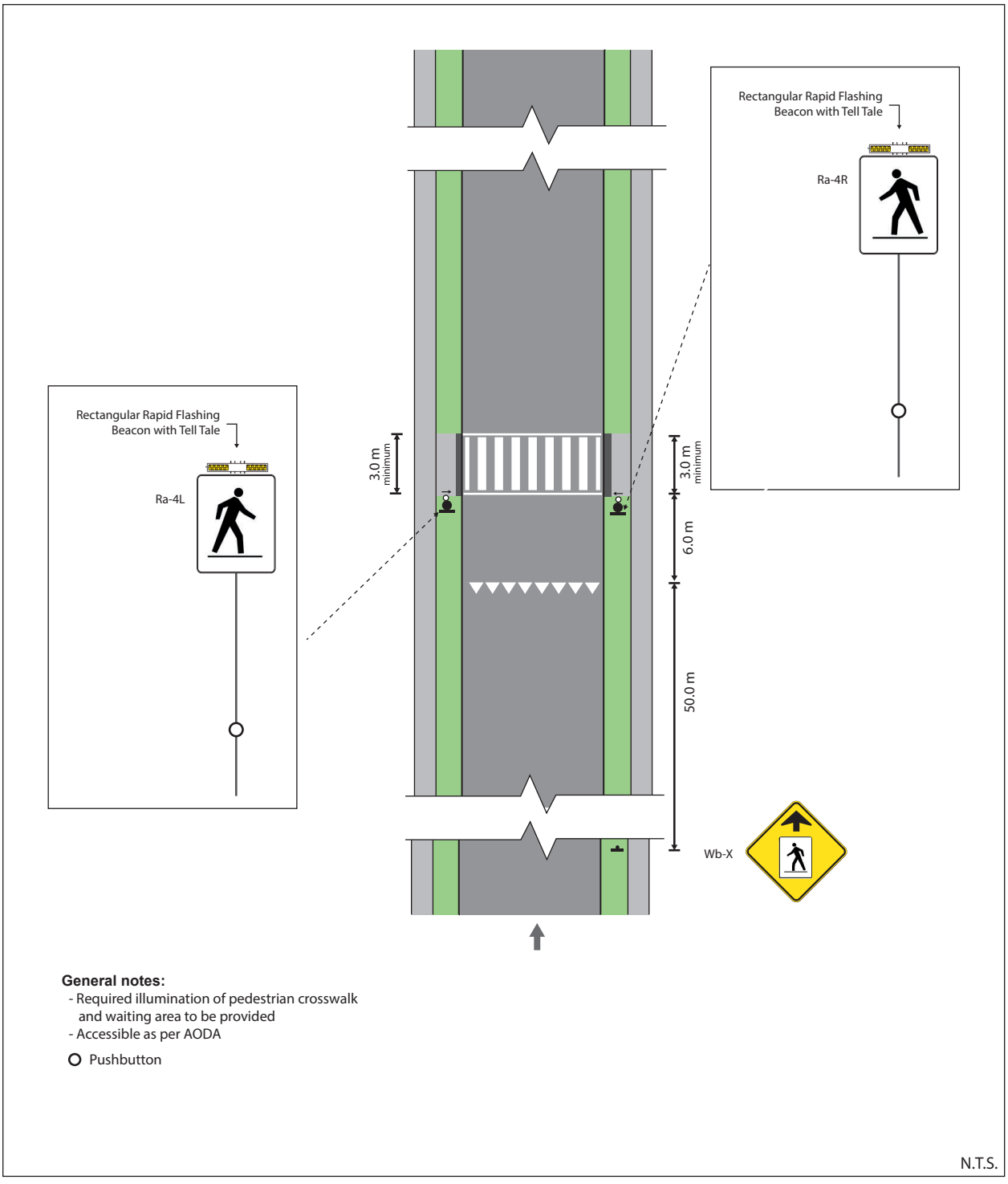


Figure 34: Pedestrian Crossover Type C – Mid-block (1-lane, 1-way)

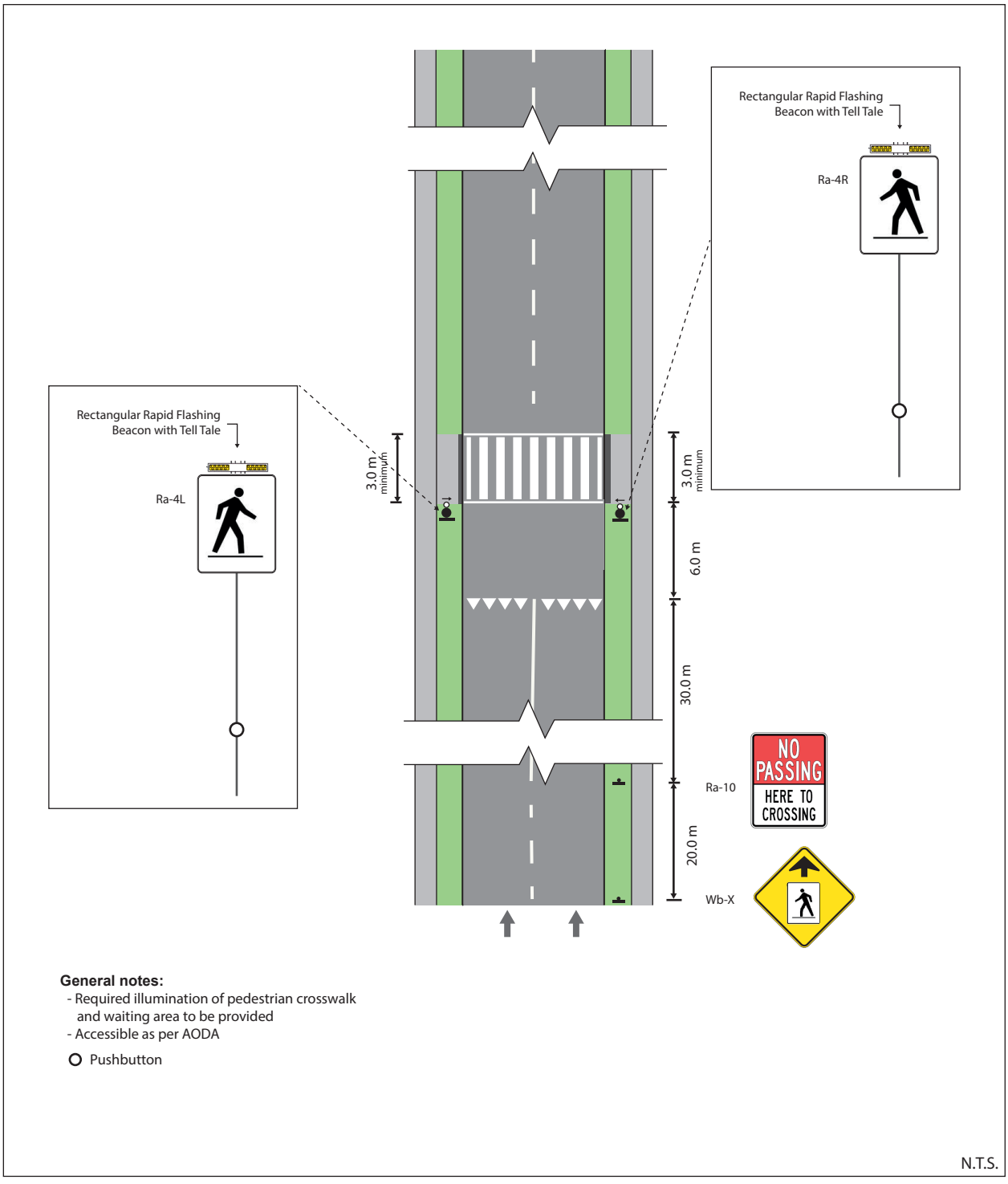


Figure 35: Pedestrian Crossover Type C – Mid-block (2-lane, 1-way)

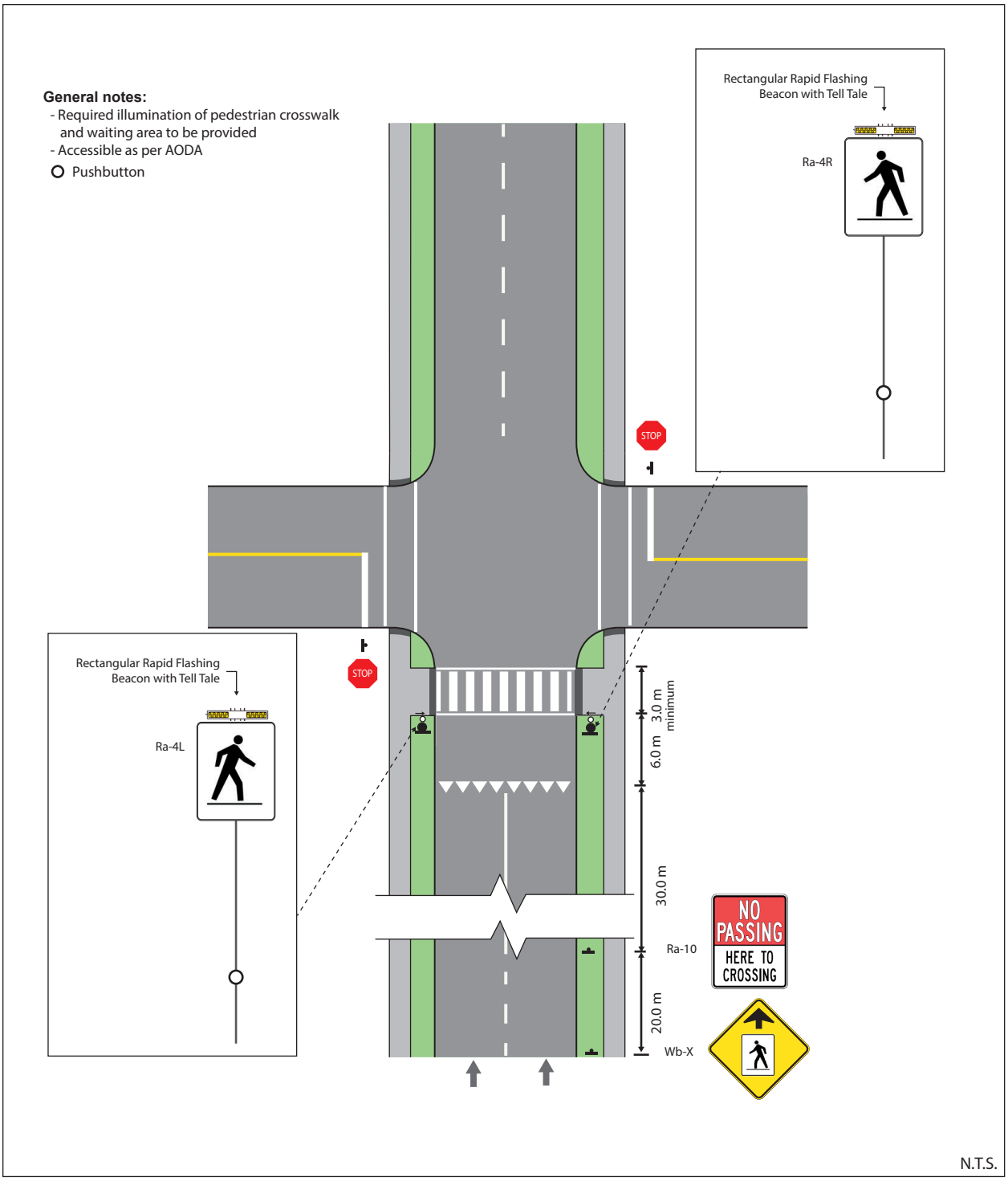


Figure 36: Pedestrian Crossover Type C – Intersection (1-way)

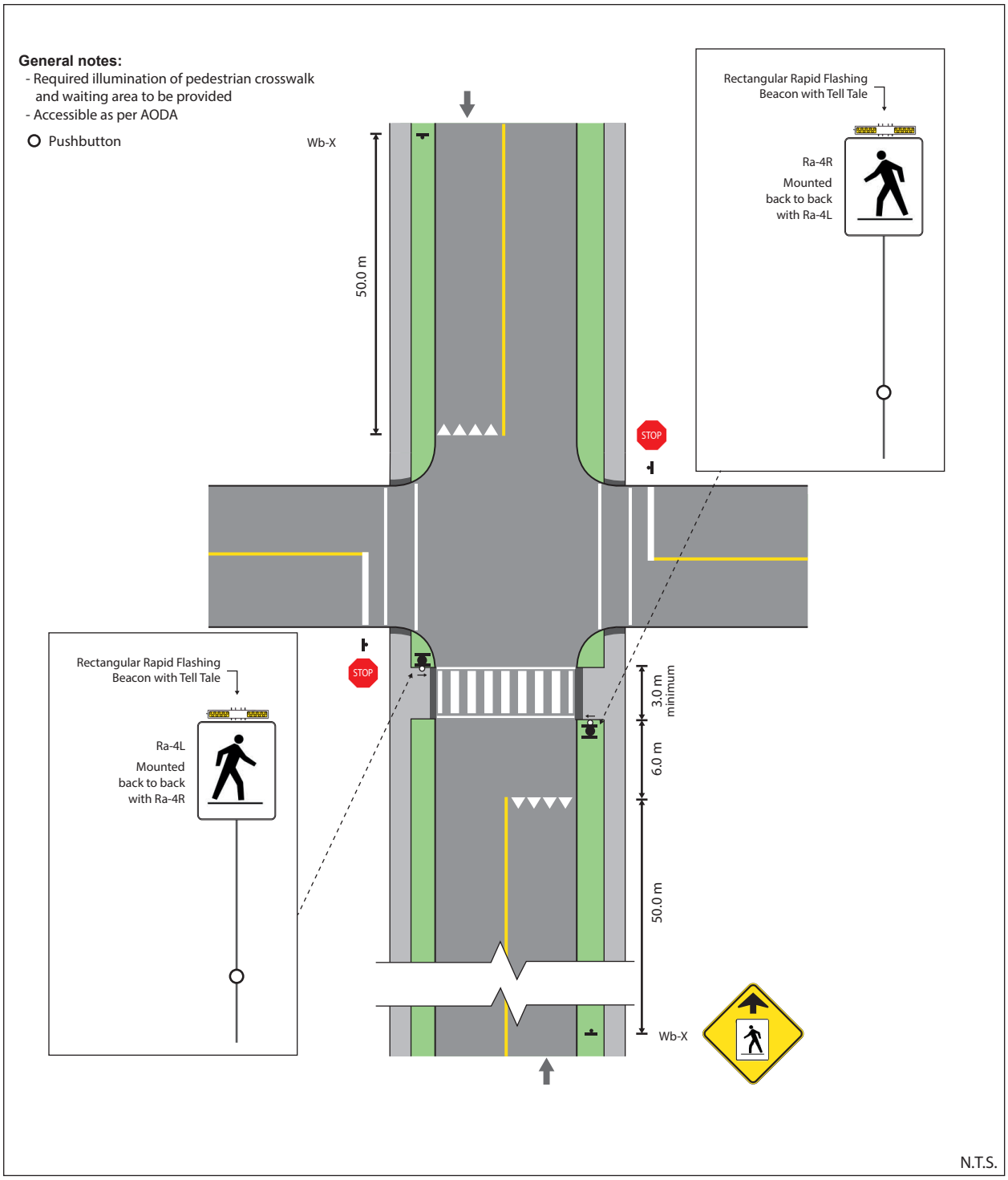


Figure 37: Pedestrian Crossover Type C – Intersection (2-way)

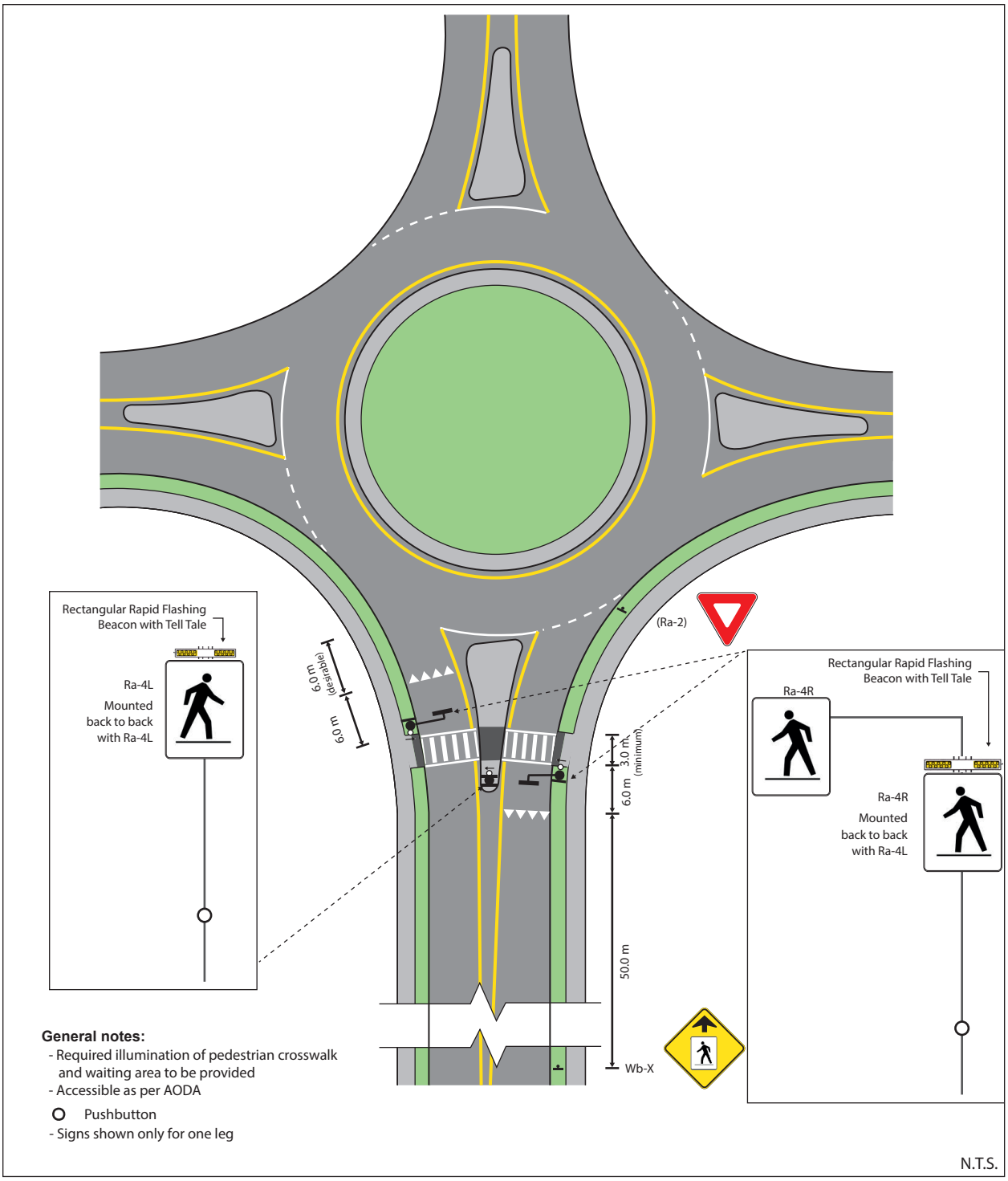


Figure 38: Pedestrian Crossover Type C – Single-Lane Roundabout

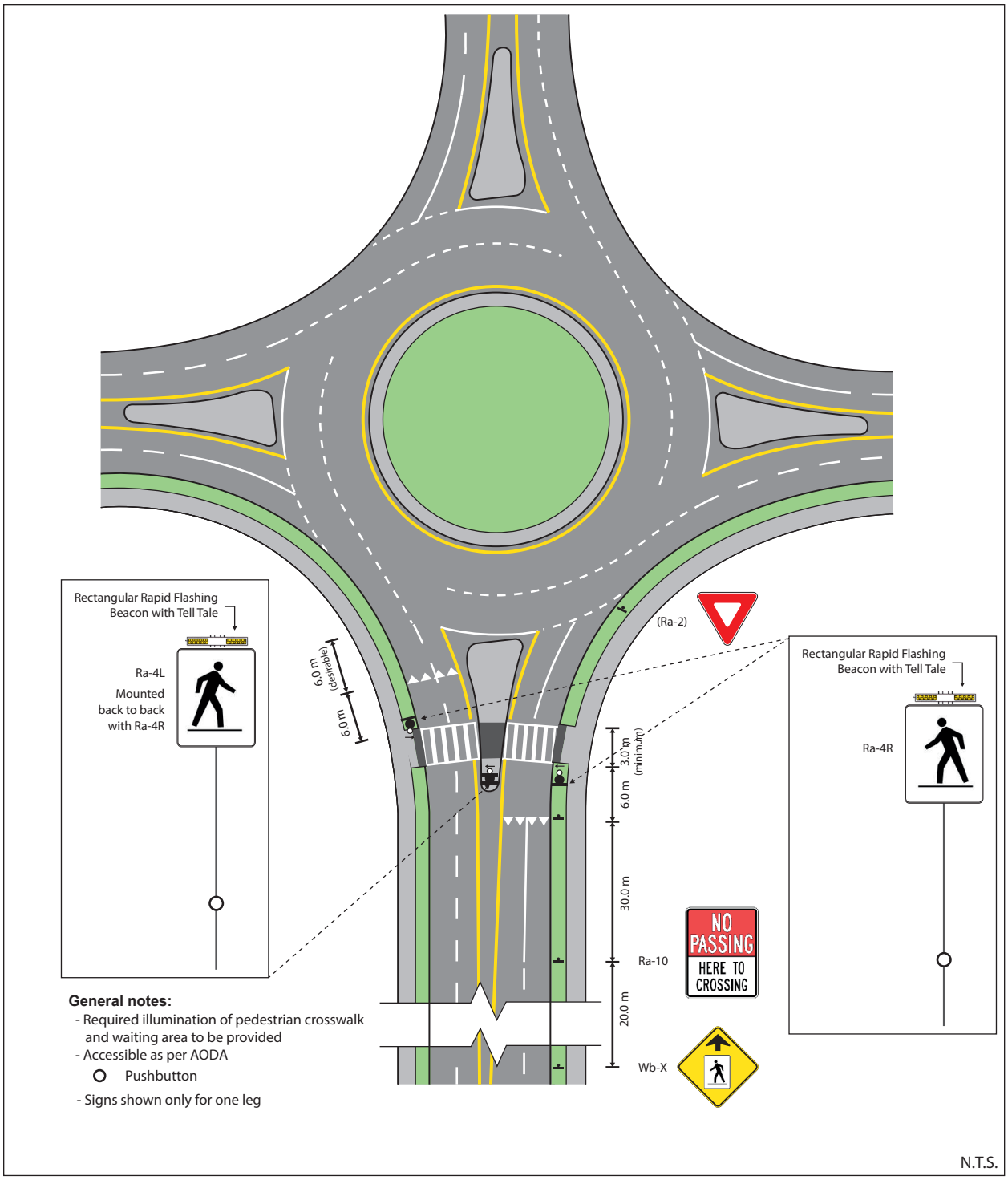


Figure 39: Pedestrian Crossover Type C – Double-Lane Roundabout

6.3.2.4 PXO D

Description

Type D pedestrian crossovers are distinctly defined by the prescribed use of regulatory and warning signs, and pavement marking as listed in Table 13 and illustrated in installation layouts from Figure 40 to Figure 48.

Table of Components

Table 13 provides the components of a Type D PXO. The details of individual components are provided in Section 6.2.

Application Environment

The applicable application environments for PXO D are as follows, subject to the selection criteria provided in Section 5.2.2.

- Mid-block : 2-lane, 2-way
- Mid-block: 4-lane, 2-way with raised refuge only
- Mid-block: up to 2 lanes total cross-section, 1-way
- Intersection: 2-lane, 2-way
- Intersection: 4-lane, 2-way with raised refuge only
- Intersection: up to 2 lanes total cross-section, 1-way
- Single-Lane Roundabout
- Double-Lane Roundabout
- Right-turn Channelization

Typical Installation Layout

Figure 40 to Figure 48 illustrates installation details for PXO D for various applicable environments. It is practitioner's responsibility to select an appropriate layout for a location based on the selection criteria provided in this manual. The location of the poles should be in advance of the pavement markings (near side) where practical. The location of the poles shown in the layout is for illustration purposes only. Jurisdictions may choose to install poles after the pedestrian crossing pavement marking (far side). However, this practice must be consistent throughout the jurisdiction.

Table 13: Components of Type D Pedestrian Crossover

Required Components	Desirable Components	Optional Components
• Side-mounted signs TAC (Ra-4) on both sides of the road for both directions, mounted back to back, when there is no raised refuge • Two Side mounted signs TAC (Ra-4) for each direction, one on the right side and the other on the median mounted back to back with another TAC (Ra-4) sign for pedestrian crossovers for four lane roadways with raised median refuge • Ladder Crosswalk Markings • Yield to Pedestrians line markings at 6.0 m from crosswalk • Advanced Pedestrian Crossover Ahead sign (Wb-X) at 50.0 m upstream of the crosswalk • Stopping prohibition for a minimum of 15 m on each approach to the crossing, and 10 m following the crossing • Lane change prohibition on multi-lane approaches using solid white lines • No Passing Here to Crossing sign (Ra-10) for multi-lane approaches	• Raised refuge islands and Centre Medians with mandatory: • Pavement markings on approaches to obstructions • Keep Right sign (Rb-25, Rb-125) • Object Marker Sign (Wa-33L) • Stopping prohibition for a minimum of 30 m on each approach to the crossing, and 15 m following the crossing • Passing restrictions on single lane approaches using solid yellow centreline • Barricades for pedestrian crossovers for four lane roadways with raised median refuge • Staggered design for crossings with raised refuge island	• School Crossing Guard • Textures Crosswalk Markings • Raised Crosswalk • Safety elements including Barricades, Pedestrian Fencing, Gates, Walls, Bollards, and Barriers for applications without raised refuge

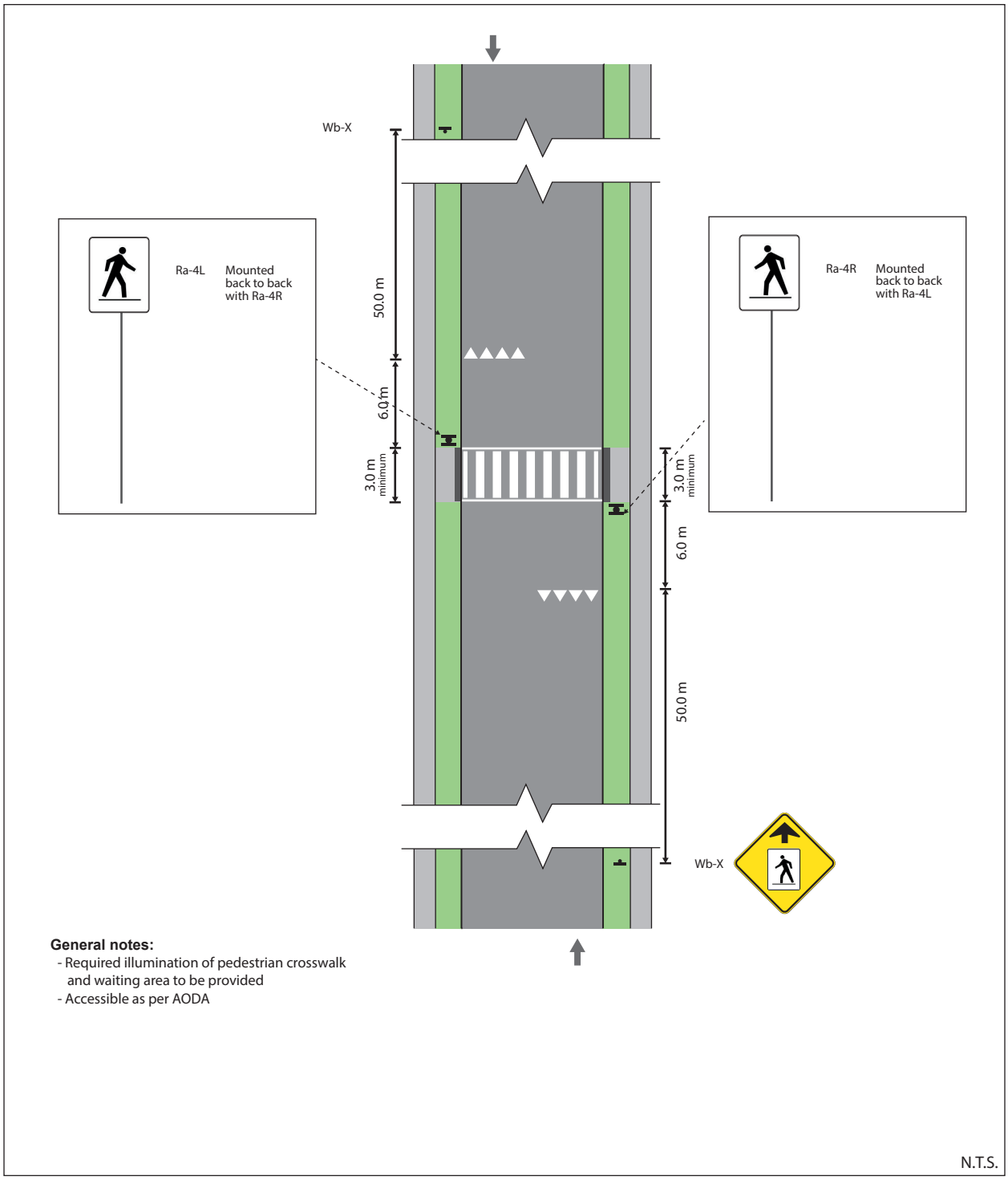


Figure 40: Pedestrian Crossover Type D – Mid-block (2-lane, 2-way)

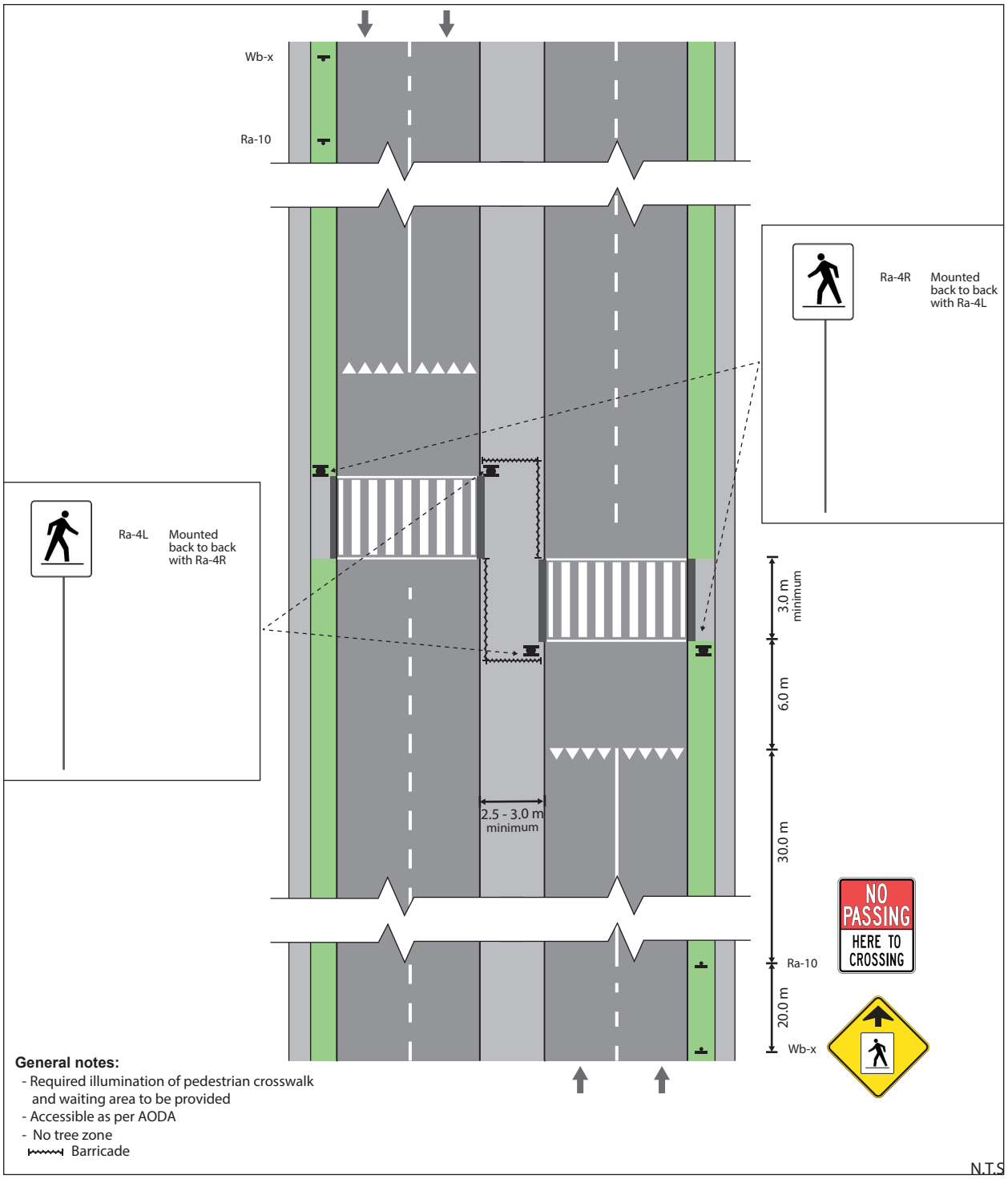


Figure 41: Pedestrian Crossover Type D – Mid-block (4-lane, 2-way with raised refuge)

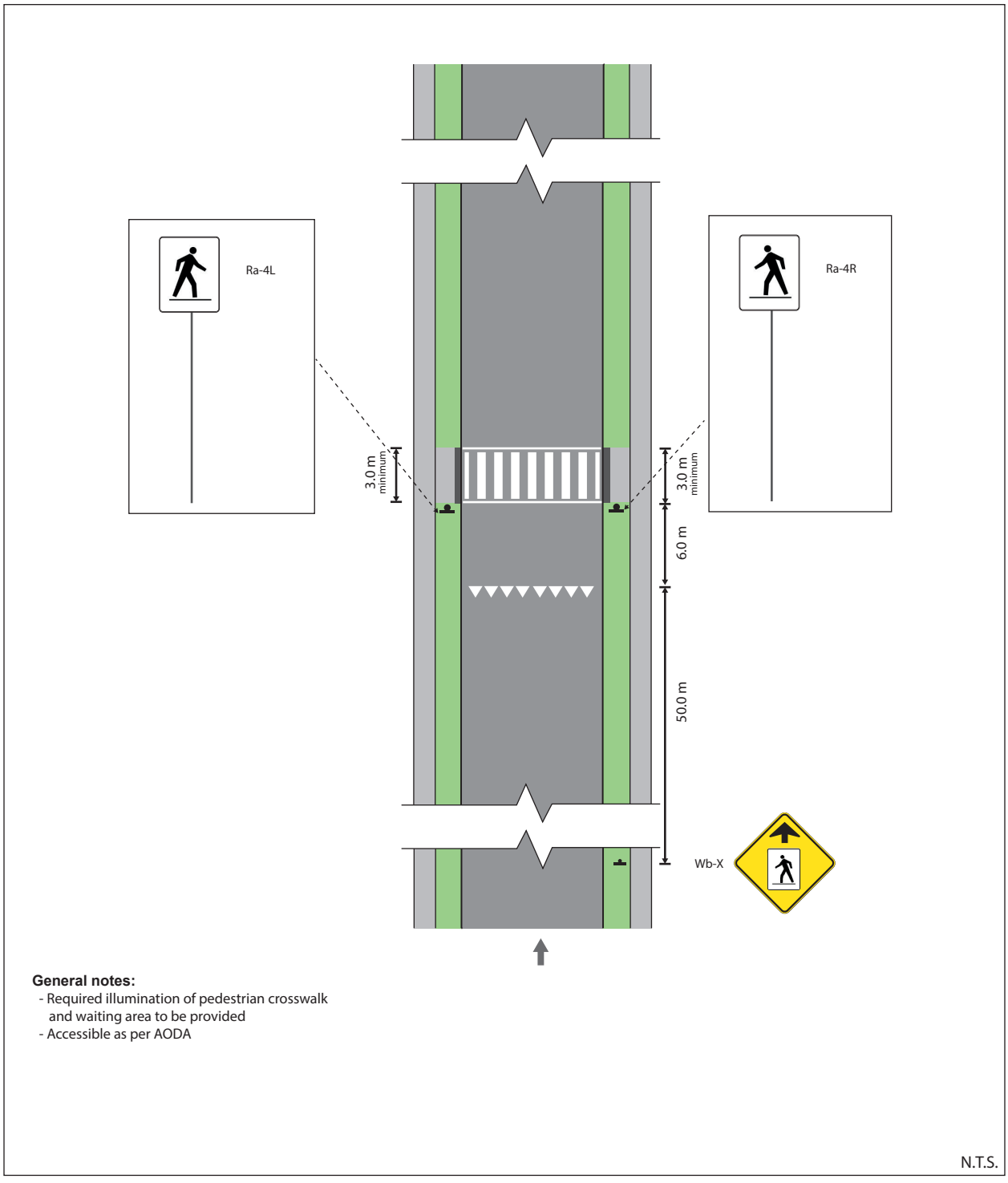


Figure 42: Pedestrian Crossover Type D – Mid-block (1-lane, 1-way)

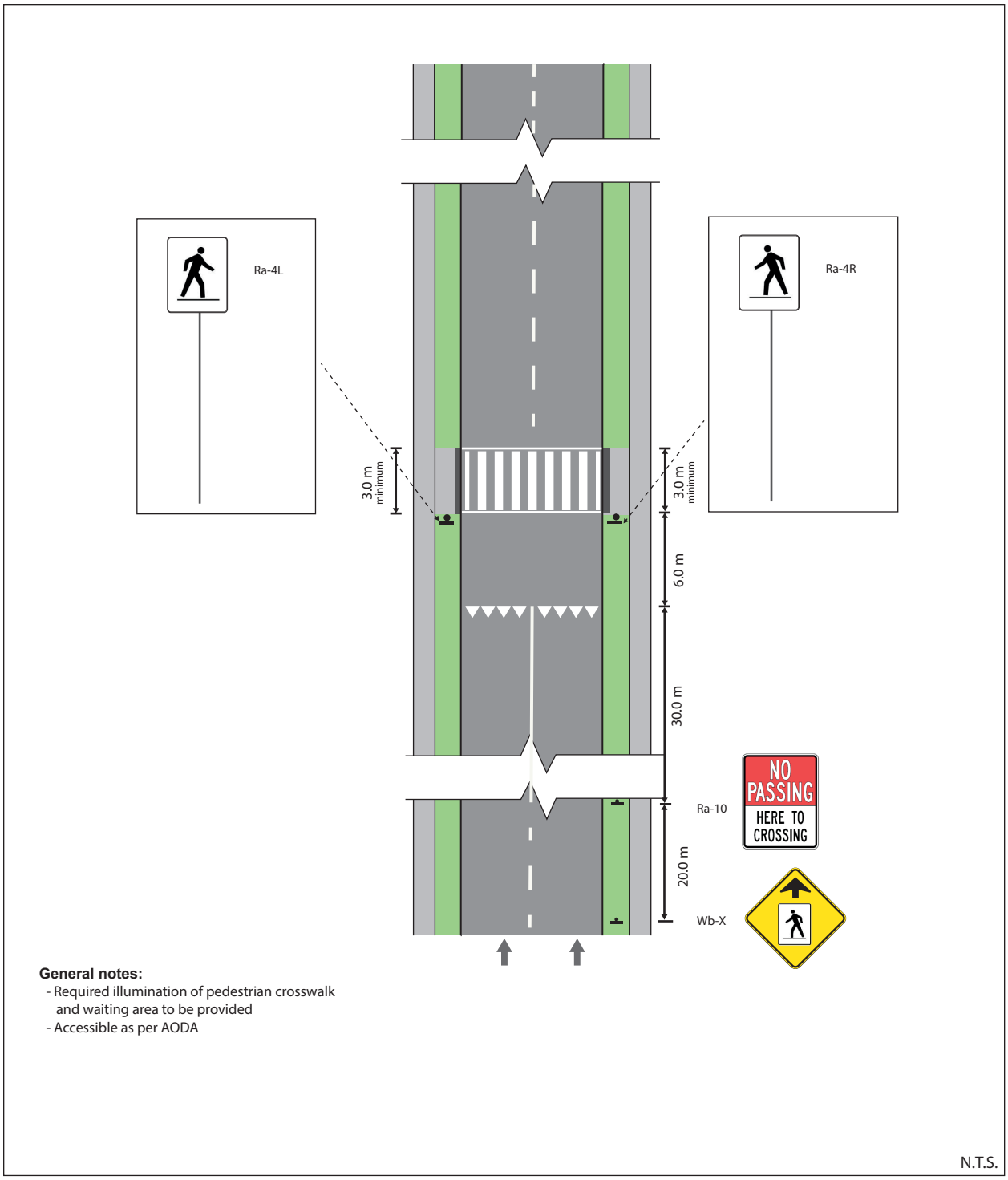


Figure 43: Pedestrian Crossover Type D – Mid-block (2-lane, 1-way)

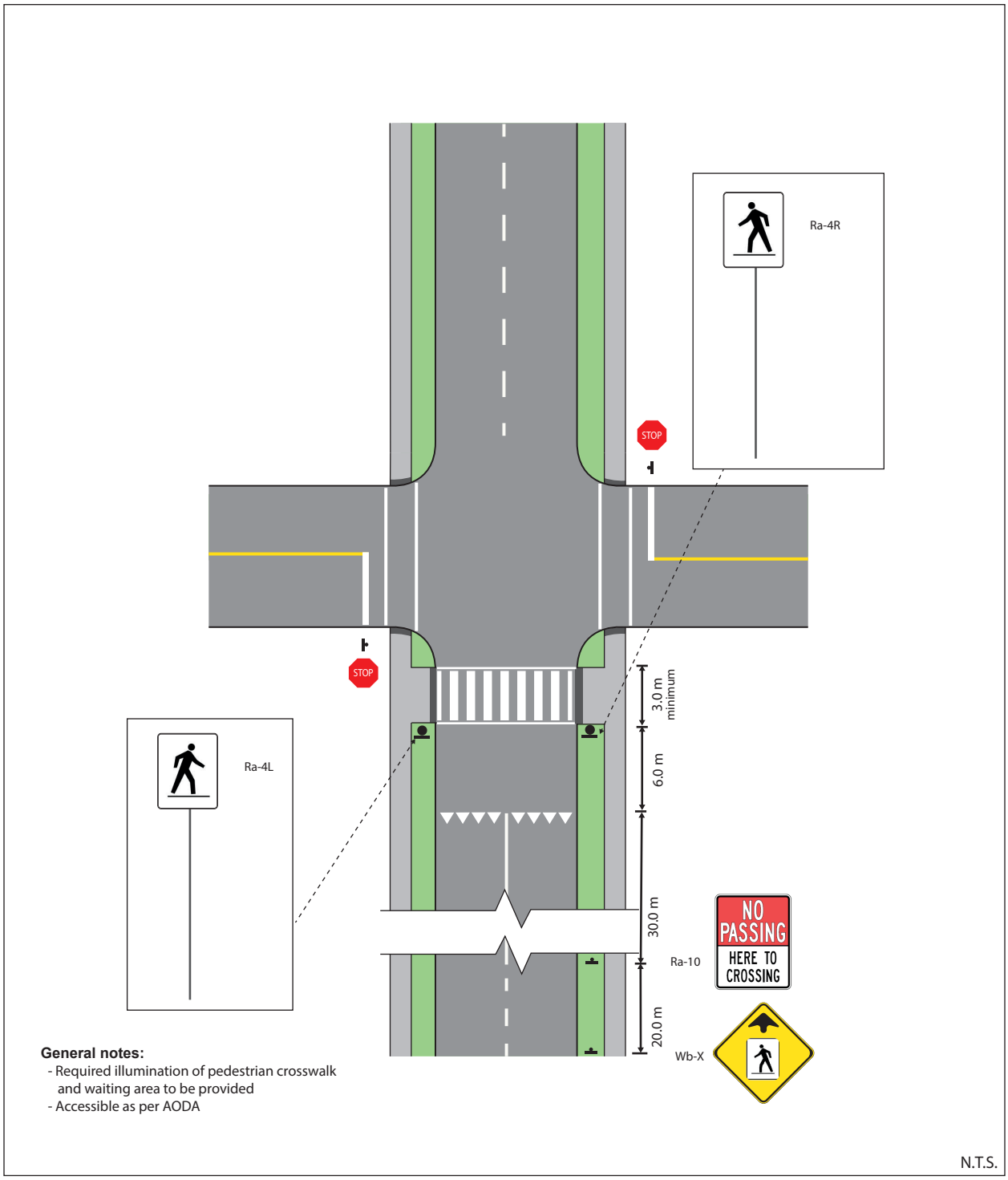


Figure 44: Pedestrian Crossover Type D – Intersection (1-way)

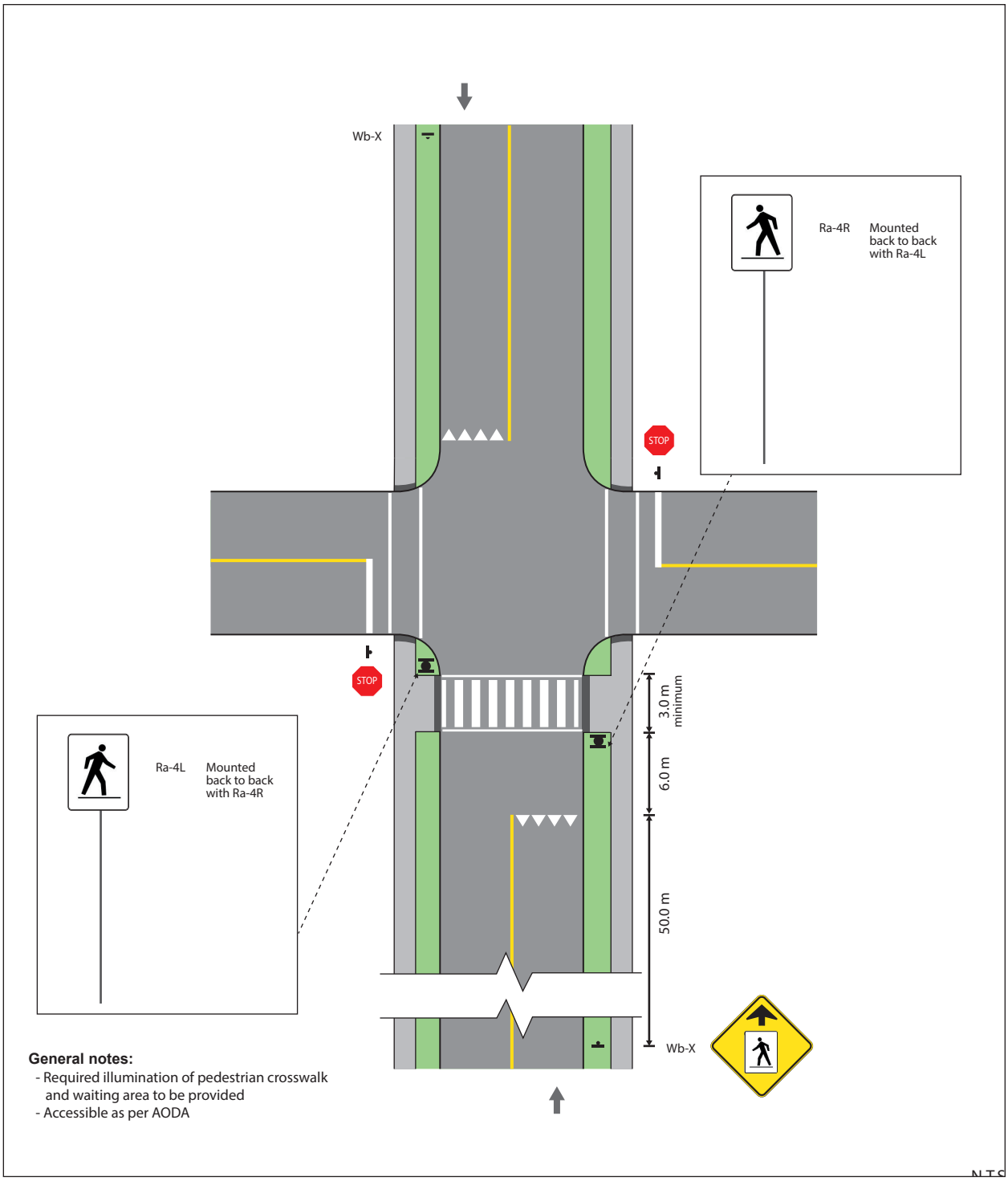


Figure 45: Pedestrian Crossover Type D – Intersection (2-way)

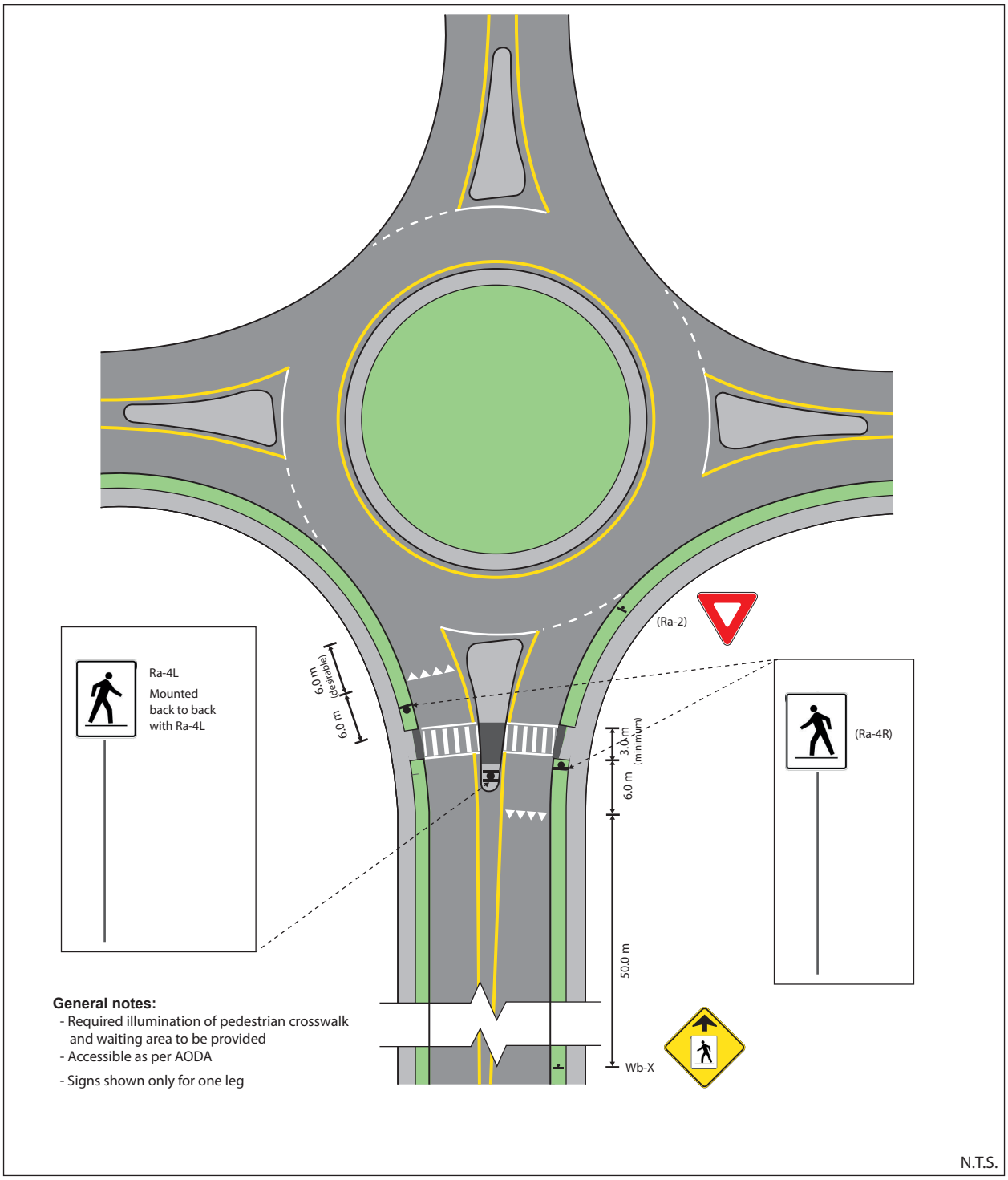


Figure 46: Pedestrian Crossover Type D – Single-Lane Roundabout

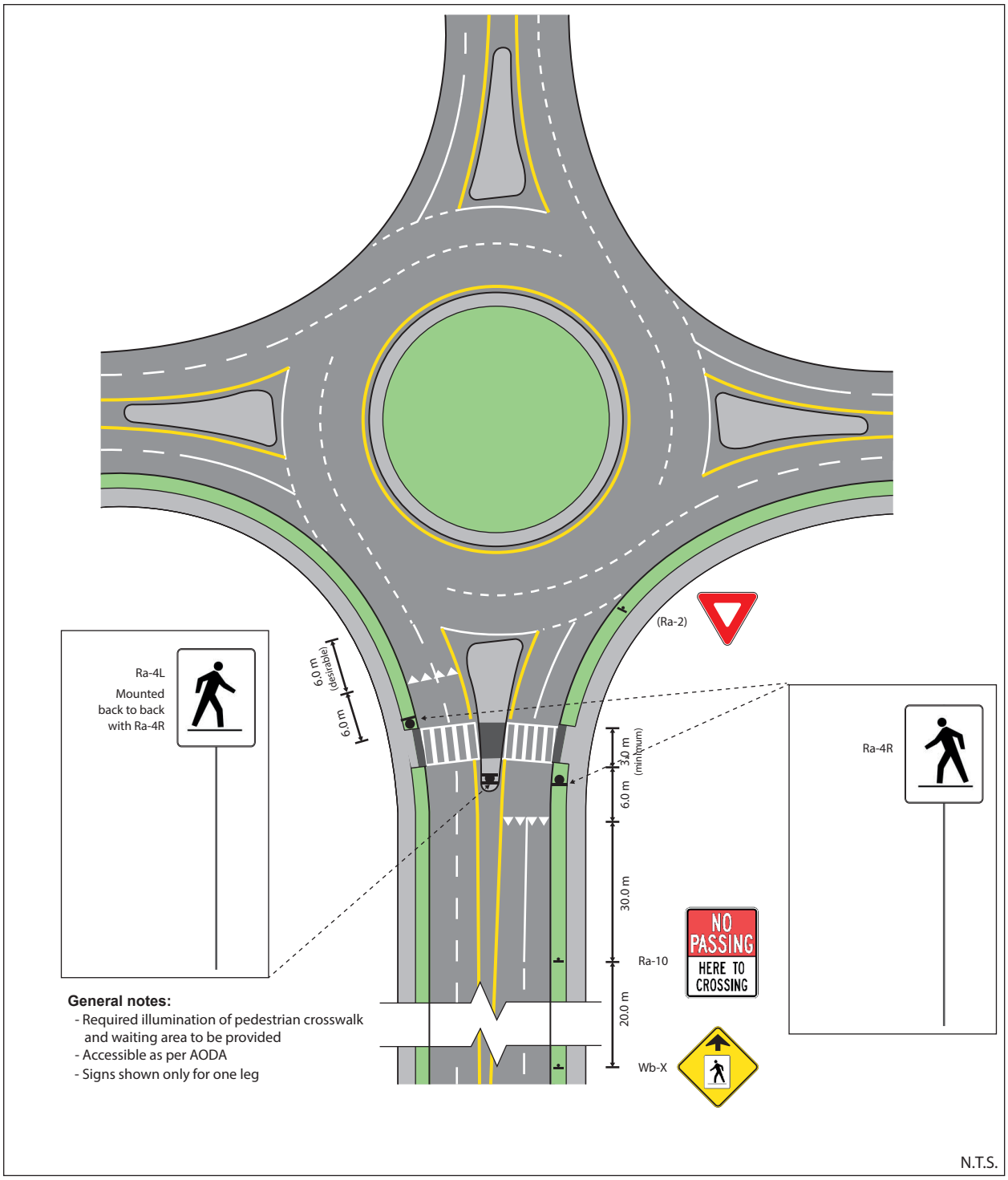


Figure 47: Pedestrian Crossover Type D – Double-Lane Roundabout

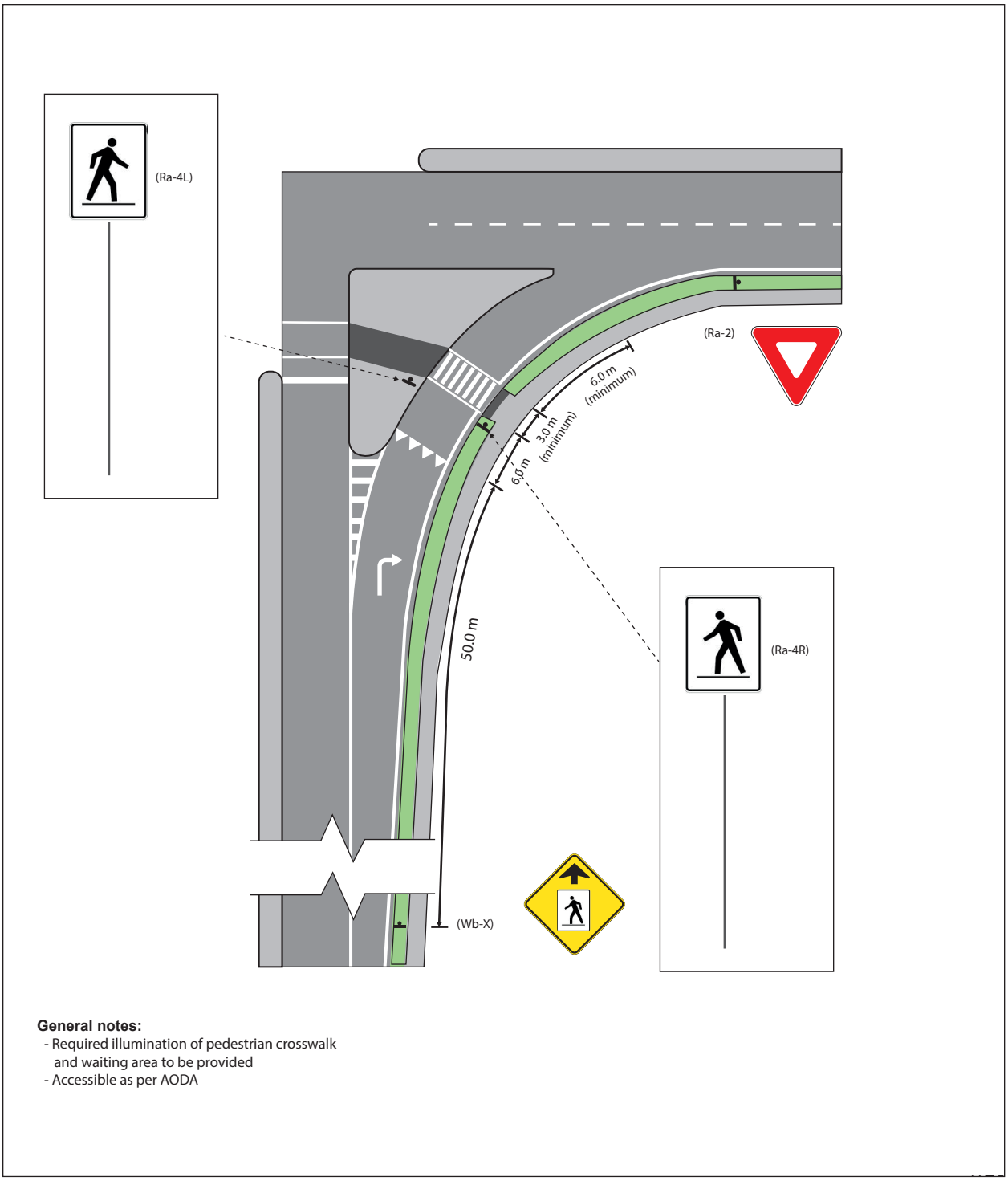


Figure 48: Pedestrian Crossover Type D – Right-turn Channel

6.3.3 Stop Controlled Intersections and Yield Controlled Intersections

Description

STOP and YIELD signs are erected as a form of traffic control to assign and regulate right-of-way at intersections with the potential for conflict.

Vehicles approaching a STOP in advance of a crosswalk are required to stop at the stop bar if present or before the sidewalk, and if neither the stop bar nor sidewalk is present then prior to entering the intersecting roadway, thereby, yielding to vehicular traffic and pedestrians before proceeding.

Vehicles approaching a YIELD sign in advance of a crosswalk are required to slow down or stop when necessary to yield the right-of-way to pedestrians before entering the crosswalk (marked or otherwise)

The purpose of the STOP sign is to clearly assign right-of-way between vehicles approaching an intersection from different directions when traffic signals are not warranted or not yet installed. The STOP sign requires the driver to stop the vehicle before entering the intersection, yield to any traffic in or approaching an intersection, and then proceed when safe to do so.[2] Under such circumstances, especially where there is crosswalk, the driver of the vehicle is required to yield to pedestrians crossing on the minor street approach of a one-way or two-way stop-controlled intersection, or on any approach of an all-way stop-controlled intersection.

The purpose of a YIELD sign is to regulate right-of-way control. Vehicles approaching the sign must yield the right-of-way at the intersection to any oncoming traffic on the priority road, and stop if necessary.[1] As such, vehicular traffic is required to yield to pedestrian crossing on the approach, especially where there is a crosswalk.

Applications for STOP and YIELD signs are prescribed in HTA[1], OTM Book 5 – Regulatory Signs and the OTM Book 11 – Pavement, Hazard and Delineation Markings.

Crosswalks should be marked at all intersections where there is substantial conflict between motor vehicle and pedestrian movements (see OTM Book 11 – Pavement, Hazard and Delineation Markings for additional information). The selection criteria for stop controlled and yield controlled intersections as pedestrian crossing treatments is provided in Sections 5.1.3 and 5.2.3.

Table of Components

Table 14 provides the components of stopped controlled or Yield Controlled intersections as pedestrian control treatments. The details of individual components are provided in Section 6.2.

Application Environments

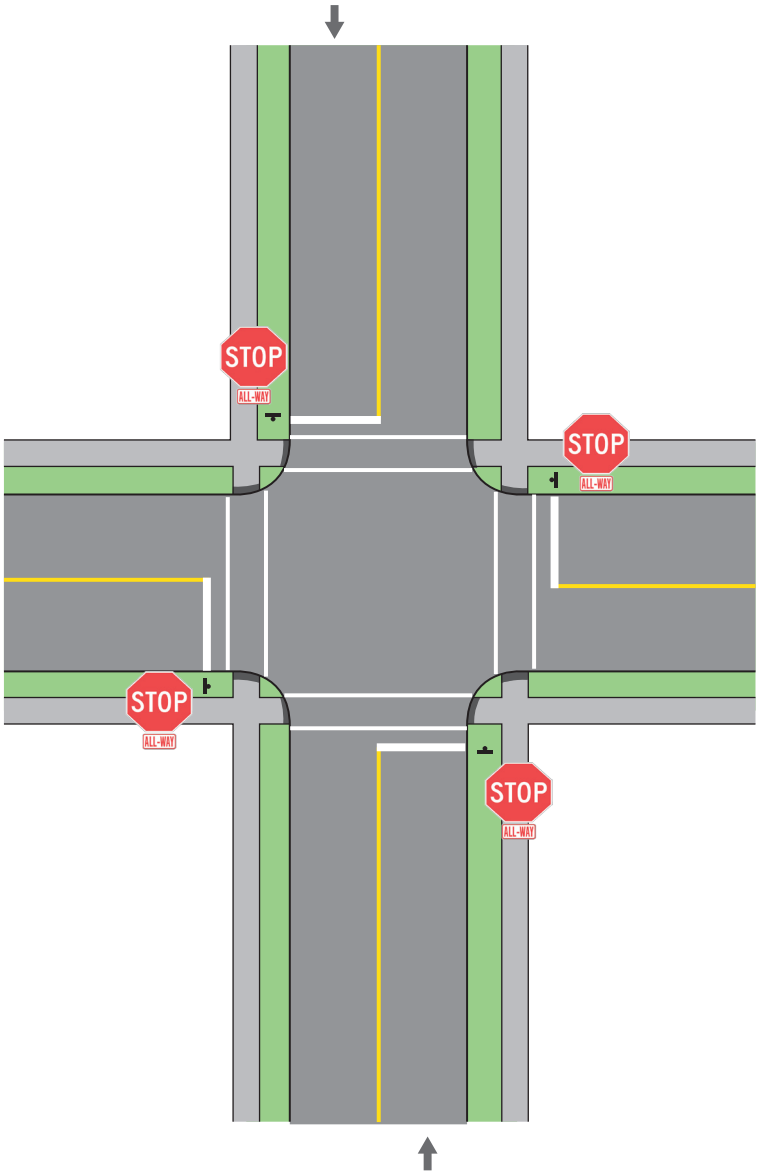
Stop controlled and Yield Controlled Pedestrian treatments are used for applicable intersections. In OTM Book 5 – Regulatory Signs, the installation conditions and location criteria for the consideration of Stop-controlled and YIELD-controlled intersections are prescribed. Applicable numerical warrants for STOP signs are also included. The stop control can be used for intersections with one-way and two-way streets. The use of yield control as a pedestrian treatment is only applicable for right-turn channels at intersections. The yield control must not be used to provide right-of-way to pedestrians at roundabouts and right-turn-channels and other non-intersection locations. According to OTM Book 5, the Yield sign must be installed on the right side of the roadway, facing traffic, no closer than 1.5 m and no further than 15 m from the edge of the intersecting roadway, unless it is clearly not practicable to locate the yield sign closer to the intersection.

Table 14: Components for Stop controlled or Yield Controlled Pedestrian Crossing Treatment

Required Components	Desirable Components	Optional Components
• Approach Markings (Stop Line, No-Passing zone, and required Turn Lanes) (Note: Stop Line not provided for yield control) • Crosswalk Markings • Channelized traffic island for intersections with right-turn channels with mandatory: • Pavement markings on approaches to obstructions • Object Marker Sign (Wa-33L)		• School Crossing Guard • Textured Crosswalk • Raised Crosswalk • Parking and other sight obstructions prohibition within at least 30 m of crossings • Stopping prohibition for a minimum of 15 m on each approach to the crossing, and 10 m following the crossing • Safety elements including Barricades, Pedestrian Fencing, Gates, Walls, Bollards, and Barriers

Typical Installation Layouts

Figure 49 to Figure 50 illustrates installation details for Stop Controlled and Yield Controlled intersection as a pedestrian crossing treatment. It is practitioner's responsibility to select an appropriate layout for a location based on the selection criteria provided in this manual. OTM Book 5 also provides layouts for some typical locations for STOP sign.

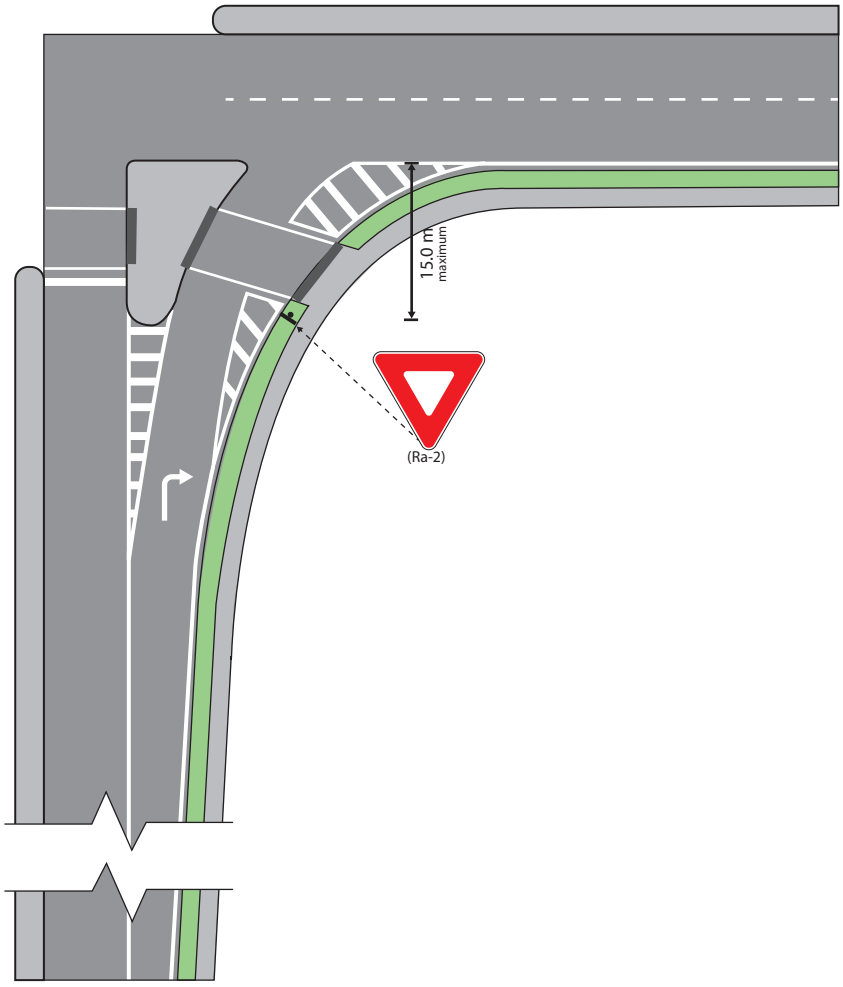


General notes:

- Accessible as per AODA
- Required illumination of pedestrian crosswalk and waiting area to be provided
- Provide approach markings and crosswalk layouts according to OTM Book 11
- Minimum 1.0 m setback of stop bar from marked crosswalk

N.T.S.

Figure 49: Stop Controlled Intersections as Pedestrian Crossing Treatment



General notes:

- Accessible as per AODA
- Provide approach markings and crosswalk layouts according to OTM Book 11

N.T.S.

Figure 50: Yield Controlled Intersections as Pedestrian Crossing Treatment

6.3.4 Supervised School Crossing

Description

Designated school crossings are locations close to schools where school children have to cross en route between home and school. School crossings are supervised by school patrollers or adult crossing guards during specified hours and during regular school periods.

School crossing guard may be stationed at all types of controlled crossings and marked school crosswalks (see School Crosswalk Markings in Section 6.2.4). Practitioners should note that marked school crossing locations (in the absence of a traffic control) without the presence of an adult crossing guard are considered an uncontrolled crossing as they create a false sense of security on the part of pedestrians, particularly children, who may enter the crossing expecting that approaching drivers will see them and stop.

The role of the crossing guards is to direct and supervise the movement of persons across a highway by creating necessary gaps in vehicular traffic to provide safe passage at designated school crossing locations. School crossing guards must display a mandatory stop sign as specified in Ontario Regulation 615 Section 11[2] to direct the vehicular traffic to stop. Elementary school aged children generally have not yet developed good judgment related to traffic and in making sound decisions for safe crossings. School crossings and the use of adult crossing guards are intended to provide protection and enhanced safety for children where there is sufficient potential for conflict with motor vehicles.

When a stop sign is displayed by a school crossing guard, the driver of any vehicle or street car approaching the stop sign shall stop before reaching the crossing. At all other times when a school crossing guard is not present, the school crossing, in the absence of any other traffic control, is considered an uncontrolled crossing.

Scenarios in which a school crossing guard may be stationed are included in Section 5.2.5.

The specific legislation related to school crossings and the operation of school crossing guards is found in HTA 176 – School crossings[1] and includes the following definitions:

- A school crossing guard means a person sixteen years of age or older who is directing the movement of persons across a highway and who is employed by a municipality or employed by a corporation under contract with a municipality to provide the services of a school crossing guard.
- School crossing guard about to direct persons across a highway with a speed limit not in excess of 60 km/h shall, prior to entering the roadway, display a school crossing stop sign in an upright position so that it is visible to vehicular traffic approaching each direction.
- Where a school crossing stop sign is displayed, the driver of any vehicle or streetcar approaching the stop sign shall stop before reaching the crossing.

Ontario Regulation 615 Section 11[23] includes the specifications for school crossing stop sign, which states that a school crossing stop sign shall be octagonal in shape, not less than 30 cm in height and not less than 30 cm in width. Each face of a school crossing stop sign shall bear the word "STOP". The sign may include one red flashing light above or below the word "STOP."

The Ontario Traffic Council (OTC) School Crossing Guard Guide[20] is an information document published in 2005 that provides various guiding principles for the consideration, implementation and maintenance of school crossings. The document outlines:

- The specific legislation related to school crossings and specifications for a school crossing stop sign as stated above.
- Recommendations on use of supplementary equipment including safety vest, armbands, gloves, mitts and a raincoat.

- Guiding principles to follow in the recruitment, training and administration of school crossing guards.
- Recommended process that may be followed by road authorities and practitioners considering a school crossing guard and recommended warrant criteria to be considered as part of the process.
- Recommendations with respect to "school crossing" sign placement, crosswalk dimensions, parking and stopping controls as well as passing and "lane change" restrictions are provided. (These guidelines build on the information contained in the Ontario Traffic Manual series, in particular, OTM Book 5 – Regulatory Signs, OTM Book 6 – Warning Signs and OTM Book 11 – Pavement, Hazard and Delineation Markings).

Table of Components

Table 15 provides the components of a designated supervised school crossing. The details of individual components are provided in Section 6.2.

Application Environment

School crossing guards may be stationed at otherwise uncontrolled mid-block / intersections locations with required marked school crosswalks and school crossing signs within the school area where school children have to cross en route between home and school.

School crossing guards may also be stationed at all controlled crossings in conjunction with other pedestrian treatment systems. However, in this case the school crossing guard will be treated as an additional component of the base treatment system.

Typical Installation Layout

Figure 51 to Figure 52 illustrates installation details for school crossings with designated crossing guards at uncontrolled locations with marked school crosswalks (rural and urban areas).

Table 15: Components of School Crossing Guard

Required Components	Desirable Components	Optional Components

• Crossing Guard
• School Crosswalk Markings for supervised crossing according to OTM Book 11 (different requirements for urban and rural locations)
• School Crossing Sign (Wc-2, Wc-102)
• School Crossing Tab Sign (Wc-2t, Wc-102t)
• School Crossing Ahead Sign (Wc-2A, Wc-102A)
• Crossing Ahead Tab sign (Wc-2At, Wc-102At)
• No Parking (Rb-51) sign within 30 m of crossings
	• Refuge Islands and Centre Medians with mandatory:
	  • Pavement markings on approaches to obstructions
	  • Keep Right Sign (Rb-25, Rb-125)
	  • Object Marker Sign (Wa-33L)
	• School Zone Maximum Speed Sign (Rb-6)
	• School Zone Maximum Speed When Flashing Sign (Rb-6A)
		• Raised Crosswalk
		• Advance Stop Bar
		• Safety elements including Barricades, Pedestrian Fencing, Gates, Walls, Bollards, and Barriers

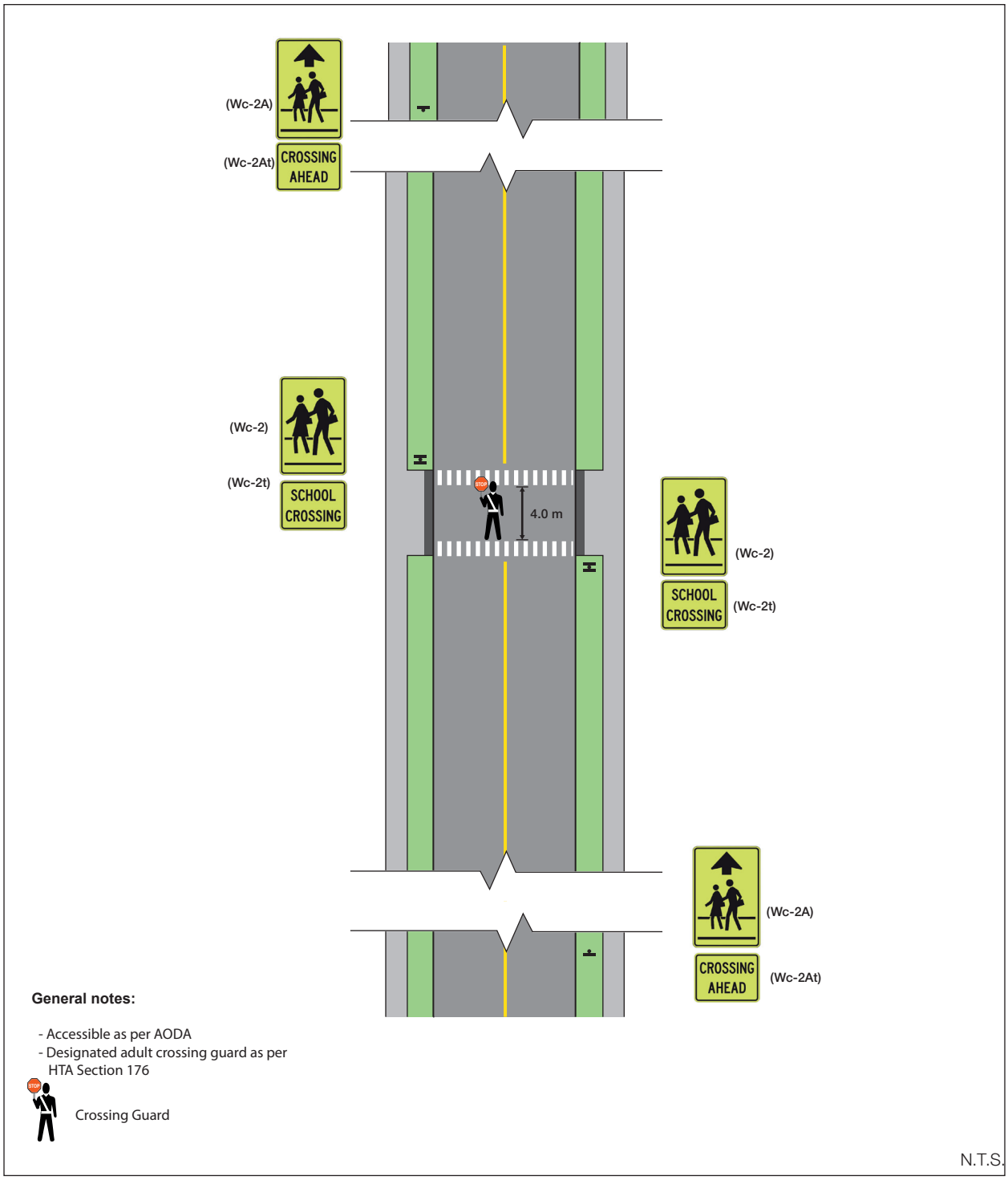


Figure 51: School Crossing with Designated Crossing Guard (Rural Areas)

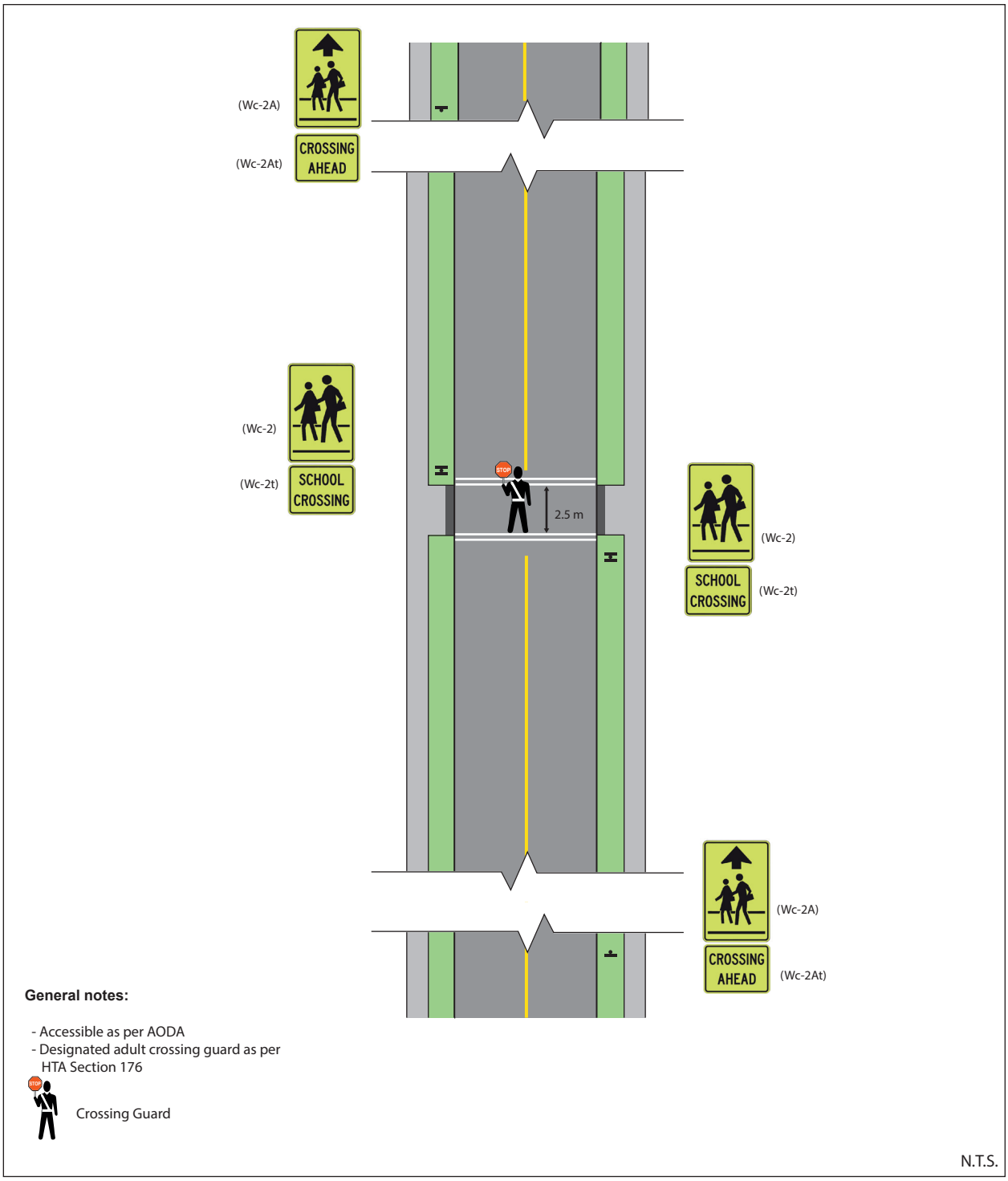


Figure 52: School Crossing with Designated Crossing Guard (Urban Areas)

6.3.5 Specific Environments

6.3.5.1 Roundabouts

Roundabouts are circular intersections that are used as an alternative form of traffic control to signalized or stop-controlled intersections. Similar to other forms of traffic controls, roundabouts should be designed to accommodate pedestrians where there is a reasonable possibility of pedestrian activity. A properly designed roundabout places a high priority on encouraging speed reduction, which then reduces crash severity, including crashes with pedestrians, and improves gap opportunity for crossings.[31] A roundabout also reduces the number of conflict points in comparison to a regular intersection.

For further information, practitioners are recommended to refer to the TAC Synthesis of North American Roundabout Practice[29], December 2008 and the FHWA Roundabout: an Informational Guide, 2000[29].

Accommodating pedestrians at a roundabout requires sidewalk connections to the pedestrian crossing, signing, curb ramps, and refuge areas on the splitter islands. The general guiding principles are as follows:

- Pedestrian crossings are provided around the perimeter of the roundabout on the approaches set back from the yield line. Pedestrian access to the central island is strongly discouraged.
- Pedestrian crossing at roundabouts should be located one vehicle length (desirable 6.0 m), or a multiple thereof, back from the yield line. This length is given in the FHWA guide as 7.5 m, although many jurisdictions are now using a shorter 6.0 m distance to better reflect the length of most passenger cars.[27], [28]

The setback distance is intended to separate vehicle-vehicle and vehicle-pedestrian conflict points such that it allows for the second entering driver to devote full attention to crossing pedestrians while waiting for the driver ahead to enter the circulatory roadway.

Note. Crossing locations for pedestrians is a balance between safety and convenience. Pedestrians want crossing locations as close to the intersection as possible to minimize deviation from the straight path. At the same time, a setback is necessary to provide drivers exiting the circulatory roadway time for decision-making.[28]

- There are two approaches to aligning pedestrian crossings at roundabouts. Agencies may choose pedestrian crossings in a straight continuous alignment across the entire roundabout approach. The benefit of a straight alignment is a more easily understood configuration for visually impaired pedestrians. The alternative design is to angle the pedestrian crossing perpendicular to the direction of traffic so that a visually impaired pedestrian, who departs perpendicular to the curb, will stay within the crossing and have a shorter crossing distance. This manual recommends the second approach.
- A splitter island is a raised or painted area on an approach to a roundabout that is used to separate entering from exiting traffic. It also deflects and slows entering traffic, and provides storage space for pedestrians crossing the road in two stages (thus functioning as a refuge island). These splitter island refuge areas should be wide enough to accommodate a person pushing a stroller or walking a bicycle (with a child trailer attached) or at least 1.8 m. The island or median should be large enough to enable a wheelchair to wait on a level landing or a cut-through design should be provided. The cut-through width should be the same as the complete width of the crosswalk.

Pedestrian Crossing Treatment

In Ontario, there is no formal pedestrian right-of-way at roundabouts unless accompanied by a traffic control measure. In the absence of a traffic control, roundabouts are considered as uncontrolled crossings, in which case the pedestrian signs for uncontrolled crossings would apply. It may be noted that a normal yield sign

cannot be used at roundabouts to provide right-of-way to pedestrians. For pedestrian signs of uncontrolled crossings, refer to Section 7 and Table 16.

All roundabouts locations must be assessed first for controlled pedestrian crossing treatments based on the methodology provided in Section 5. If warranted, controlled pedestrian crossings at roundabouts must be provided. It may be noted that roundabouts may be applicable for PXO B, C, or D type of pedestrian crossing treatments based on the selection criteria provided in Section 5. The typical installation layouts for roundabouts are included in the corresponding sections of PXOs.

6.3.5.2 Right Turn Channels

Channelized right-turn lanes are implemented to increase intersection efficiency from the motor vehicle perspective and reduce unnecessary delay and idling emissions where high right-turn vehicular traffic volume exists. Channelization is achieved using an island, which also reduces the crossing distance and pedestrian intervals required for the remainder of the crossing. The island also removes the turning traffic from the intersection and offers a pedestrian refuge area. At signalized intersections, it provides a place to install traffic controls such as a traffic signal pole. Some right-turn channels are also used to reduce excessive pavement areas caused by skewed and flared intersection configurations.

The general approaches to pedestrian crossing treatments at right-turn channels are as follows:

- Where the right-turn channel is free flow (i.e., where there is no formal yield to pedestrians), pedestrians crossing to the island must wait for safe gaps in traffic because a protected pedestrian crossing is not provided. For free flow uncontrolled channelized right-turn lanes, crosswalk markings must not be applied on the channelization curve. Pedestrian Yield to Traffic (Wc-28) sign should be installed if field observations have indicated that pedestrians frequently cross at a location without waiting for the appropriate gaps and/or where drivers may not expect pedestrians.
- Not all right-turn channels are free flow. At right-turn channels at intersections where a YIELD sign or a STOP sign is posted in advance of a crosswalk, drivers are required to yield the right-of-way to pedestrians as specified in the HTA[1]. In this case, the pedestrian crossing treatment is considered as in stop or yield controlled intersections (see Section 6.3.3).

  In some instances, the right-turn channel at a signalized intersection may be controlled by the traffic signal itself. In other instances, the right-turn channel at an intersection may be controlled by a yield control requiring right-turning vehicles to yield to pedestrians in addition to cross-street traffic.
- Some right-turn channels may be warranted for a PXO based on the minimum pedestrian and vehicular volume criteria provided in Section 5.1.2.

A road authority must assess the requirement of a controlled or uncontrolled pedestrian crossing on every right turn channel location based on the guidelines provided in this manual. If a right-turn channel is not integrated as part of a traffic signal, it must be assessed for the applicability of a type of controlled pedestrian crossing treatment in the lower hierarchy than traffic signals.

Assessment of a right-turn channel for a PXO has to be conducted using the same pedestrian and vehicular volume criteria provided in Section 5.1.2 and Table 7. However, a right-turn channel can only be provided with a PXO D, even if a PXO higher in hierarchy than a PXO D (PXO B or PXO C) is warranted. A typical installation layout for a right turn channel with a PXO D is included in Section 6.3.3.4 (See Figure 48).

If a PXO is warranted using the pedestrian and volume criteria provided in Section 5.1.2 and Table 7 for a right-turn channel location on a roadway with a posted speed greater than 60

km/h, appropriate type of traffic control signal pedestrian crossing treatment should be provided by considering one of the following: integrate as part of a fully signalized intersection, IPS, or MPS. Recall from Section 5.2.1, where traffic signals are not warranted under Justification 6 but a PXO is warranted an MPS should be used if either the posted speed exceeds 60 km/hr or there are more than four lanes of traffic. MPS must be restricted to roadways posted at less than 80 km/h.

The right-turn channel locations that are not warranted for a PXO and still require a pedestrian crossing treatment should be considered for a yield control. It may be noted that wherever required, a YIELD sign must be installed on the right side of the roadway, facing traffic, no closer than 1.5 m and no further than 15 m from the edge of the intersecting roadway, unless it is clearly not practicable to locate the YIELD sign closer to the intersection.

Right-turn channels for streets with posted speeds of higher than 60 km/h must be considered as uncontrolled crossings in the absence of a traffic signal and a Pedestrian Yield to Traffic (Wc-28) sign should be installed if field observations have indicated that pedestrians frequently cross those locations.

Design Considerations

The design of a right-turn channel should take into consideration different geometric elements. The elements to consider generally include:

Curb Radii — The lower the design speed, the shorter the curve radius and the narrower the lane width requirements for the channelized lane; while the lower the design speed, the shorter the curve radius and the wider the lane width requirements for the channelized lane.

Angle of entry — The angle of entry of right-turn channels are controlled by the combinations of curve radius and/or spiral lengths. Right-turn channel with a low adjacent road entry angle allow vehicles to accelerate and merge into the receiving adjacent lane more quickly than right-turn channels with a higher angle of entry.

Traditionally, right-turn channels were designed having a low adjacent road entry angles and having higher free flow speeds. A more recent approach better suited for urban areas is known as urban "Smart Channels" (see Figure 48). Urban Smart Channels are designed to increase the adjacent road entry angle, such that the turning speed can be reduced to be more consistent with yield conditions (as it may require a full stop) and the reduced viewing angle can improve drivers' visibility of pedestrians, thereby improving the pedestrian safety.

Size of Island — The area of a triangular island should be preferably 10 m^2 (some agencies prefer 15 m^2) however the acceptable minimum standards are[27]:

- 4.5 m^2 for urban intersections
- 7.0 m^2 for rural intersections

The lengths of the sides of an island excluding rounding at the corners should be as follows:

- 3.5 m preferably and 3.0 m minimum for urban intersections
- 4.5 m preferably and 3.75 m minimum for rural intersections

Placement of Control Signs and Crosswalk
Alternative approaches are available for the placement of traffic control signs at channelized right-turn lanes. The placement of the YIELD or STOP sign in advance of the crossing point will create a controlled crossing as discussed above. Another approach available is implementing a PXO, subject to the criteria provided in Section 5.

6.3.5.3 Railway Crossings

The regulatory framework for railway safety and security is administered by Transport Canada under the Railway Safety Act, whereby the construction or modifications of a grade crossing requires the authorization by the Canadian Transportation Agency. While the need for such a crossing is typically established by the public road authority, the design and protection requirements must meet

the Transport Canada standards. No proposed road crossing may depart from the standards set out in the Regulations except in accordance with an approval of the Minister of Transport granted under the provisions of Section 10 of the Railway Safety Act.[24] The respective roles and responsibilities overseeing railway crossings are summarized as follows:

Railway Company – The responsibilities of the railway company that owns or operates over the line of a railway at the grade crossing includes the following:

- The part of the road surface of the grade crossing that lies within the rail right-of-way
- Sightlines along the railway right of way
- Drainage along the railway right of way
- Railway crossing signs
- Grade crossing warning systems

Road authority - The road authority that has the legal authority to open and maintain the road that passes across the line of a railway is responsible for:

- The road approaches and those parts of the surface of the road up to the ends of the railway ties, including the elevation of the road in relation to the railway track
- Sightlines along the road right of way
- Drainage along the road right of way
- Traffic control devices on road approaches and stop signs at grade crossings, including devices that interconnect with grade crossing warning systems
- Lighting devices to illuminate trains, engines and other railway equipment occupying grade crossings to ensure that they are clearly visible to pedestrians and drivers of vehicles
- The removal of snow from the road for the safe passage of vehicles, bicycles, pedestrians and persons using assistive devices over the grade crossing

While these lists reflect the legal responsibilities of each agency, the general practice in Ontario has been that the Railway company maintains the crossing surface above the rail ties (usually plates or a vulcanized rubber mat) while the Road authority maintains the asphalt leading to the crossing surface above the ties.

In determining the solution most suited to a particular crossing location, a number of factors should be considered, including[25]:

Pedestrian traffic:

- When the grade crossing is close to pedestrian attractors (schools, seniors centre, transit stops and commuter stations, parks and places of interest, shopping centres, major employers, public parking lots, sports facilities or fairgrounds and residential areas)
- When the grade crossing forms a part of the safe walkway path to school
- Forms part of the access to a commuter station
- Is regularly used by persons using an assistive device
- Has a high level of pedestrian activity

Site Condition:

- Number and type of railway tracks in the grade crossing: main tracks, sidings, service track, etc.
- Volume of train traffic and associated speed
- Use of train whistle at the grade crossing
- Type of grade crossing warning system
- Presence or absence of any sign, signal or marking dedicated to pedestrians
- Location of the sidewalks or pedestrian pathways in relation to the warning signal

- Discontinuity between the sidewalks or pedestrian pathways and the crosswalk across the rail line
- Visibility of the warning system and along the railway line, from the sidewalks or pedestrian pathways leading to the grade crossing

Other factual information:

- Collision history
- Frequency of inclement weather

Guidance and detailed information relating to railway crossing at-grade is provided on Transport Canada's website[26], the Geometric Design Standards for Ontario Highway (MTO 1999)[27] and the Geometric Design Guide for Canadian Roads (TAC 1999)[12]. These references provide guiding principles and design standards for the treatment of pedestrian crossings over railway lines, including the following:

a. Crossing Surfaces must be smooth, continuous and slip resistant. Smooth surfaces will allow the driver to cross the tracks while devoting more attention to the presence of other vehicles, trains and pedestrians rather than concentrating on the best path by which to negotiate the crossing. This is applicable to pedestrian traffic as well.

   Crossing surfaces should be clearly delineated such that pedestrians know where to cross, as well as how far they must stop from the railway. Pedestrians are expected to locate themselves 5 m from the nearest rail, or 2 m in advance of a stop sign, railway crossing sign, warning signals, or gate arm, where they exist.[27] Sidewalk, pedestrian path and crosswalk travelled surfaces should be delineated within 8 m of the nearest rail with a continuous solid white line on both edges of the travelled surface. Using materials of different textures and colors will further aid pedestrians in locating crossings.

b. The minimum width of the grade crossing surface must be 8 metres for vehicular use, and another 1.5 metres for pedestrian traffic. If the distance between the vehicle and pedestrian crossovers is greater than or equal to 1 metre the two surfaces may be separated. Crossing surfaces should extend 0.5 metres beyond the edge of the travelled roadway, pathway, sidewalk or trail.

c. Passive and active devices may be used to assist pedestrians at crossings and can be used individually or in tandem, depending on site specific attributes such as pedestrian volumes, frequency of trains, speed of trains, complexity of crossing geometry, sight distance, multiple tracks, etc. Passive devices include fencing, swing gates, barriers, pavement markings, and fixed message signs. Active devices include flashers, audible active control devices, automated pedestrian gates, pedestrian signals, variable message signs and blank-out signs.

Active devices are more effective at reducing risk than passive devices, but are generally more costly to construct and operate.

For detailed information with respect to the design standard and specifications, it is recommended that practitioners refer to TAC's RTD 10 Road/ Railway Grade Crossings - Technical Standards and Inspection, Testing and Maintenance Requirements (DRAFT).[28]

Wherever feasible, grade-separated crossings of railway lines are preferred.

6.3.5.4 Temporary Conditions

OTM Book 7 – Temporary Conditions was developed to provide guidance for traffic control during construction, maintenance and utility work on public roadways in Ontario. Section 2.6.2 Pedestrian Safety Considerations of the manual recommends the provision of a safe, delineated travel path that ensures:

- Pedestrians are guided to through and from work sites in a clear and positive manner.

- The characteristics of the existing sidewalk (s) or footpath (s) are replicated as nearly as practicable.
- Pedestrian movements are inhibited as little as practical.
- Exposure to potential hazards is minimized.
- Pedestrians are not led into direct conflicts with work site vehicles, equipment, or operations.
- Pedestrians are not led into direct conflicts with mainline traffic that is moving through or around the work site.

The impact on pedestrians must be addressed in all temporary traffic control layouts where pedestrians are, or may be present. Pedestrian safety must be given special consideration, particularly when the work encroaches upon a sidewalk.

The components for pedestrian crossing treatments in temporary work zones may include Pedestrian Directional Sign (TC-40), Sidewalk Closed Tab (TC-41t), Temporary Traffic Signals, Traffic Control Persons with Traffic Control (TC 22) signs in addition to pedestrian barricades, barrels, construction markers, and / or fencing (see OTM Book 7 for details). Book 7 – Temporary Conditions provides the guidelines for the design traffic control devices for pedestrian safety in a work zone.

7. Pedestrian Crossing Facility Design: Uncontrolled Crossings

Uncontrolled pedestrian crossings are locations where pedestrian crossing activity takes place without traffic control measures to require drivers to yield the right of way to pedestrians at the crossing. At uncontrolled crossings, drivers are not required to yield right-of-way to pedestrians and pedestrians must wait for a safe gap sufficient to fully cross the roadway or for vehicles to stop before crossing. Consequently, uncontrolled crossings are to be discouraged especially where there is a higher likelihood of conflicts given the lack of formal right-of-way designation for pedestrians.

Controlled pedestrian crossing treatments must be assessed and implemented first based on the methodology provided in Section 5. Wherever possible, pedestrians are to be encouraged to use controlled crossing locations.

Under certain circumstances, pedestrian crossing activities may occur at locations where traffic control measures are not warranted (due to low vehicular and/or pedestrian traffic volume or physical constraints) and alternative controlled crossings are not conveniently available. Accommodating pedestrians at these locations must then be evaluated carefully for alternative treatment options. It is desirable to focus pedestrians to crossing points where sight distance is greatest and unanticipated conflicts are lowest. Pedestrian treatments in the form of signage and modifications of the physical environment, for example curb extensions, raised medians, speed tables, etc. may be provided at these uncontrolled crossing locations to aid road users.

7.1 Justification for Uncontrolled Crossings

The decision to provide pedestrian treatments to enhance uncontrolled crossings is a balance between increased driver awareness of crossing activity and pedestrians' understanding of the rules of the road. The presence of enhanced pedestrian features at uncontrolled crossings may create a false sense of confidence on the part of pedestrians, particularly children, who may enter the crossing expecting that approaching drivers will see them and stop.

The basis for justification requires engineering judgment in all cases and careful consideration of the overall roadway environment within the local context. These considerations are further described below.

- **Suitability and Consideration for Controlled Crossing** — Pedestrians should be encouraged to cross at controlled crosswalk locations in most situations. The use of controlled crossings should therefore be considered first as a potential treatment option. Where conditions do not support the use of a controlled crossing, the needs of pedestrians must be evaluated based on other considerations as follows.
- **Motorists' and Pedestrians' Behaviour** — Careful consideration should be given to prevalent behaviour and understanding of drivers and pedestrians at crossings. Road users may exhibit different levels of caution, and behave and react differently at different crossing locations. This can in part be due to their familiarity or unfamiliarity with the crossings, or their age and physical ability. This may also be a function of the surrounding environment to which pedestrians are reacting. The implementation of pedestrian treatments to enhance an uncontrolled crossing should only be considered if there is a high level of caution anticipated to be exhibited by both drivers and pedestrians

- **Vehicle Volumes and Speed (Exposure)** — As vehicle volumes and speeds on the roadway increase the exposure and risk to pedestrians, the disadvantages of uncontrolled crossings would eventually outweigh the benefits. Therefore, enhancements at uncontrolled crossings are not recommended at high exposure locations. As a guideline, uncontrolled crossings must not be considered under the following conditions:
  - The speed limit is 60 km/h or more.
  - The pedestrian and traffic volumes exceed the warrant thresholds for controlled crossing treatments (See Section 5).
  - The roadway is more than two through lanes in each direction or more than three through lanes if it is one-way.
  - The road classification is higher than a collector road, that is, major collector and arterial.
- **Geometry** – Adequate sight distance for both the motorist and pedestrian must be available according to Geometric Design Standards for Ontario Highway[27]. This includes examination of any sight-distance restrictions imposed by objects, such as on-street parking, street furniture, landscaping, buildings, etc. Night-time visibility and illumination requirements must also be assessed where uncontrolled crossings are located. There is an inherent limitation in drivers' or pedestrians' ability to detect objects, especially under low visibility conditions.

Enhancements of uncontrolled crossings should not be considered if sight-distance restrictions cannot be removed.

- **Spacing of Crossing Opportunities** — The frequency of crossings should be considered so that they can be provided at the appropriate spacing in relation to the following:
- Presence of nearby controlled crossings — Uncontrolled crossings should be avoided if in close proximity to controlled crossings. Pedestrians should be encouraged to cross at controlled crosswalks in most situations. It is recommended that a minimum of 100 metres separation from the nearest controlled crossing be maintained.
  - **The Type of road environment** — In pedestrian districts and main street pedestrian design areas where there is a high level of pedestrian activity, it may be desirable to maintain frequent crossing opportunities. In contrast, along areas or strips with low density and dispersed activity generators, which may consist of commercial, civic or residential activities, where roads have been designed for high vehicular volume and speed, frequent crossing opportunities may not be feasible as the conditions will likely warrant higher level of pedestrian controls.

The distance between which crossing opportunities are provided should be established by the road authority according to the local conditions. Where possible, pedestrians should be directed to a controlled crossing point by incorporating design features that attract and encourage pedestrians to use it. For example, the proper application of curb extension can provide pedestrians with a vantage point to look for gaps in traffic and from which a pedestrian would feel more comfortable crossing.

7.2 General Design

Given that pedestrians do not have any additional protection over vehicles at uncontrolled crossings, the decision to implement pedestrian treatments at uncontrolled crossing points should consider the need of warning signs and geometric elements that help to:

- Simplify crossings for pedestrians.
- Heighten and maximize the level of road users' awareness of the environment and road hazard.

- Inform, clarify and reinforce the rules of the road.

The warning signs and geometric design elements are shown in table of components.

Marked crosswalks with painted pavement markings are not recommended at uncontrolled crossings as they create a false sense of security on the part of pedestrians, particularly children, who may enter the crossing expecting that approaching drivers will see them and stop. The only exception is a school crossing (see Section 3.2.7) since it acts as a controlled crossing when the adult school crossing guard is present.

Table of Components

Table 16 provides the components of pedestrian treatments at uncontrolled crossings. The details of individual components are provided in Section 6.2.

Typical Installation Layout

Figure 53 to Figure 54 illustrates installation details for a typical uncontrolled crossing.

Table 16: Components for Pedestrian Treatment at Uncontrolled Crossing

Required Components	Desirable Components	Optional Components

• Pedestrian Ahead (Wc-7) or Playground Ahead (Wc-3) or Trail Crossing (Wc-32) Advanced Warning Signs for Drivers
• Pedestrians Yield to Traffic (Wc-28) Warning Signs for Pedestrians
• No Parking (Rb-51 sign within 30 m of crossings
	• Refuge Islands and Centre Medians with mandatory:
	  • Pavement markings on approaches to obstructions
	  • Keep Right Sign (Rb-25, Rb-125)
	  • Object Marker Sign (Wa-33L)
	• Raised Crosswalk
	• Curb Extensions
	• Curb Depressions
		• School Crosswalk Markings for supervised crossing according to OTM Book 11 (different requirements for urban and rural locations)
		• Crossing Guard
		• School Crossing Sign (Wc-2, Wc-102)
		• School Crossing Tab Sign (Wc-2t, Wc-102t)
		• School Crossing Ahead Sign (Wc-2A, Wc-102A)
		• Crossing Ahead Tab sign (Wc-2At, Wc-102At)
		• School Zone Maximum Speed Sign (Rb-6)
		• School Zone Maximum Speed When Flashing Sign (Rb-6A)

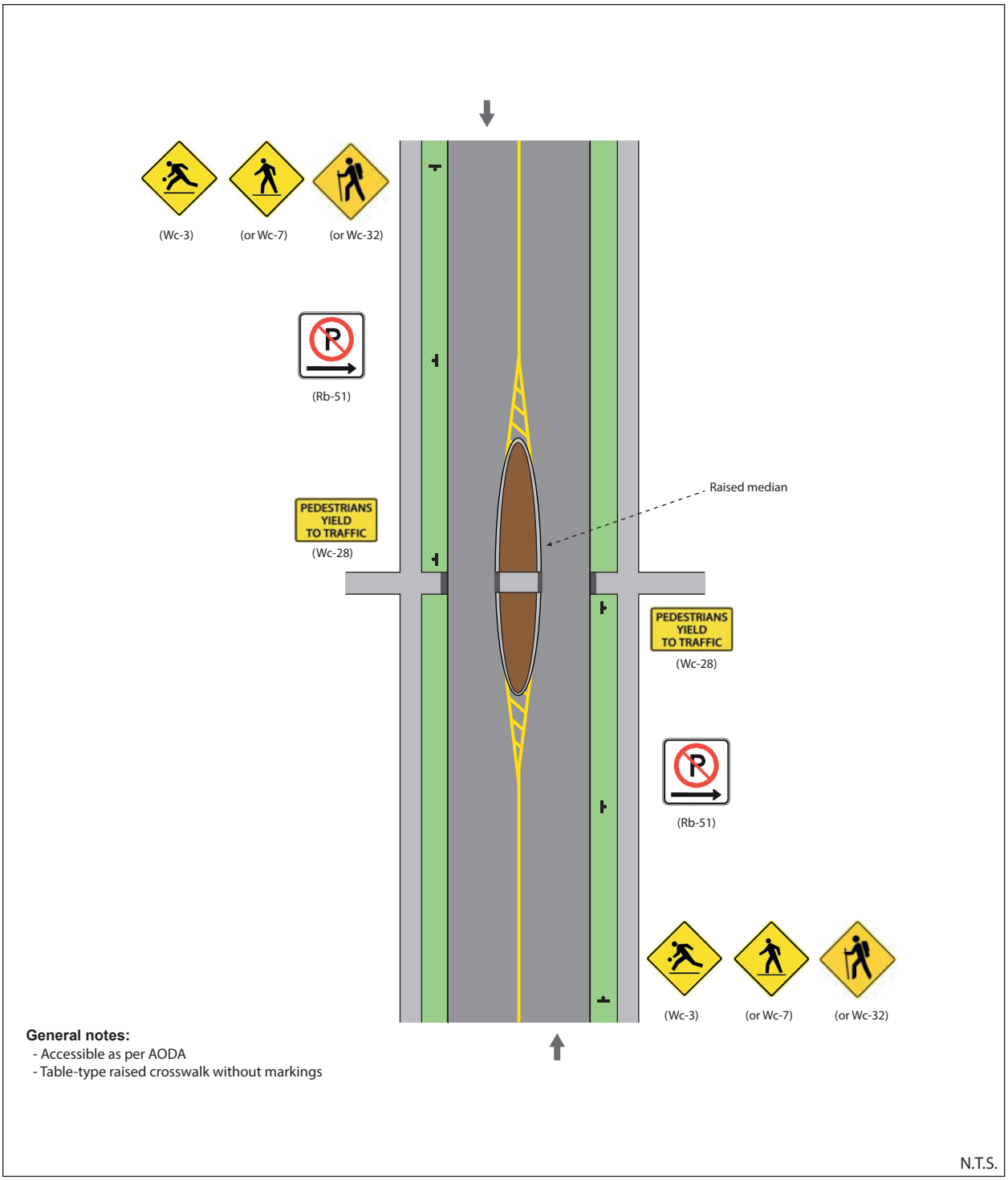


Figure 53: Typical Uncontrolled Pedestrian Crossing with Raised Median

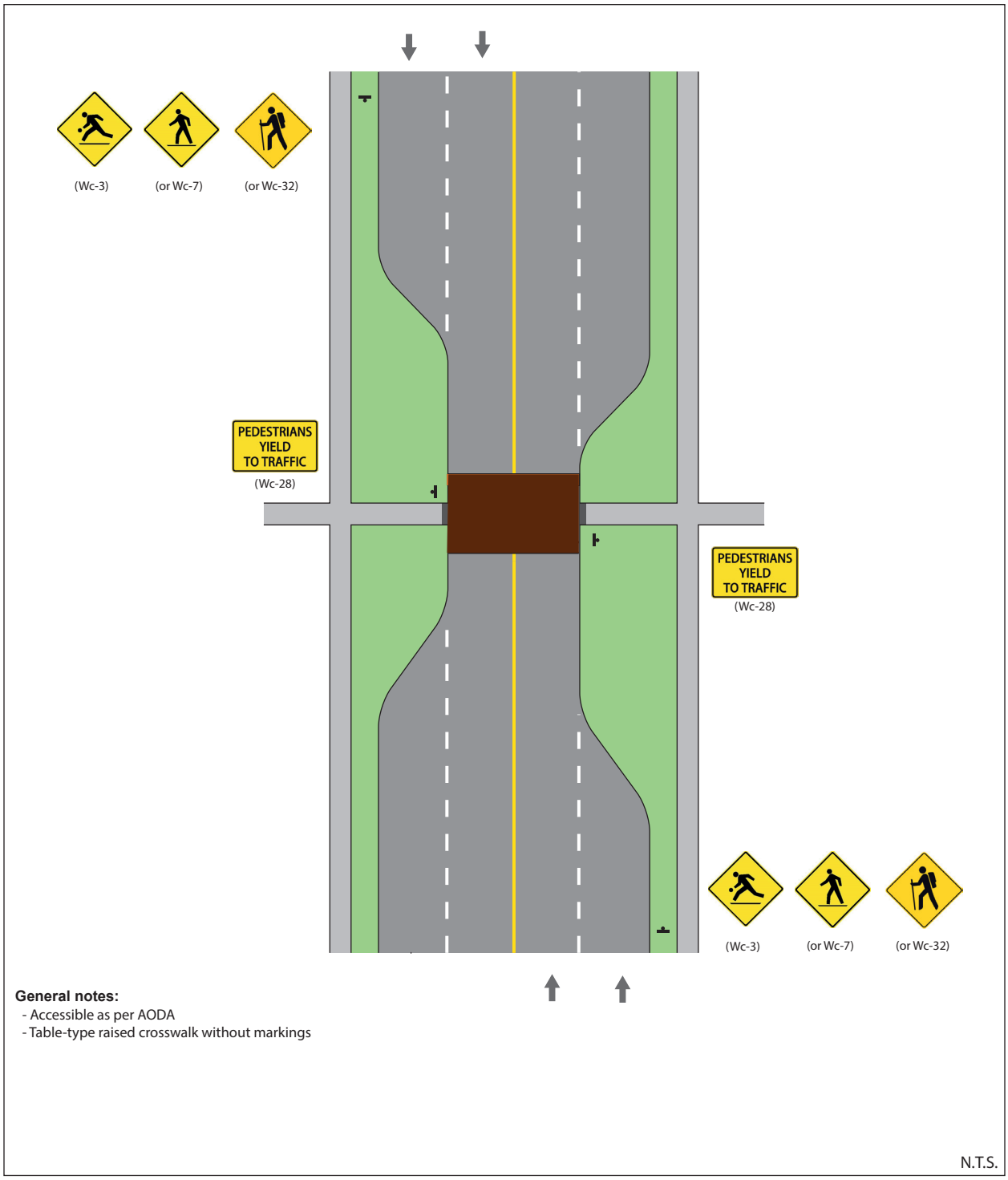


Figure 54: Typical Uncontrolled Pedestrian Crossing with Raised Crosswalk

8. Pedestrian Crossing Facility Design: Grade-Separated Facilities

8.1 General

Grade separated crossings in the form of a pedestrian overpass or underpass (tunnel) provides physical separation between vehicles and pedestrians, thereby removing any interaction and conflicts between different types of road users. The complete separation of vehicular and pedestrian traffic allows for a higher degree of safety compared to at-grade alternatives for high-exposure locations. While the installation of grade separated pedestrian crossings (GSPC) may be required due to the complexity of the crossing environment, GSPC may also be necessary to connect and maintain community linkages over major barriers such as freeways and railway lines where at-grade alternatives are not feasible.

The overall costs of GSPC are significantly higher than at-grade crossing alternatives due to the increased complexity through the planning, design and construction stages. The cost effectiveness of GSPC will depend on the usage of the crossing and related reduced exposure of pedestrians to motor vehicle conflicts and collisions. Pedestrians tend to follow the path of least resistance (shortest and most convenient path), and when faced with the need to use stairs or a steep grade to walk up to an overpass (or down to an underpass), the extra effort could dissuade pedestrians into choosing a more direct at grade route across the road.

From a traffic operations perspective, the effectiveness of grade separated crossings can be measured by the degree to which the facilities can:

- Reduce the risk of motor vehicle-pedestrian conflicts where exposure between motor vehicles and pedestrians is high (i.e., high pedestrian volume and/or high motor vehicle volume and/or high vehicle speeds).
- Increase the convenience of pedestrian routes by significantly reducing the pedestrian travel distance between origins and destinations.

In addition to traffic operations, there are a multitude of factors that impact the overall feasibility for the installation of GSPC. Considerations of these factors include environmental, traffic, structural, economic and social. The process for the consideration of GSPC will likely require public agencies to carry out a comprehensive feasibility study or environmental assessment study to fully identify and determine the needs.

8.2 Feasibility Study

Requests for GSPC may come from different sources and can be driven by the public, community or private sector projects. Policies may be developed as a means to more formally process GSPC requests and to prioritize needs and resources. The process invariably would include the following:

Needs Assessment - The needs for GSPC may initially be assessed using a numeric warrant as a screening tool to determine if further assessments may be required to address such crossing needs. A numeric warrant may include:

a) An exposure-based criteria that measures the level of interaction and conflict of a crossing (i.e., the vehicular and pedestrian traffic must exceed a minimum threshold such as that of a controlled crossing).

a. A directness ratio that measures the crossing opportunities.

b. Condition-based criteria (e.g., crossing of major barriers such as freeways and railway links).

c. Consideration of alternative at-grade measures to accommodate the crossing needs.

d. Safety records if it is an existing facility.

Feasibility Assessment - If it is determined that there is a need for GSPC based on the needs assessment, a further step is to conduct a comprehensive assessment to evaluate the feasibility of a new structure based on impacts to different stakeholders. In assessing whether a grade separated crossing is appropriate at a particular location, consideration should be given to the anticipated benefits (in recognition of use of the crossing) relative to the cost. This benefit and cost assessment would have considerations to the following:

a. Impact on natural environmental.

b. Impact on cultural environment (built heritage, archaeological).

c. Transportation impact (likely utilization, accessibility, convenience of linkage, safety, potential benefits to other modes of transportation, official plan policies).

d. Land-use and social-economic impacts (adjacent land-owners impact, community linkages, walkability).

e. Engineering feasibility (availability of land, existing constraints, and acceptable grades).

f. Economics (capital costs and operating / maintenance costs, funding source)

Public consultation will be a critical element in the decision-making process.

Figure 55 provides an overview of the process.

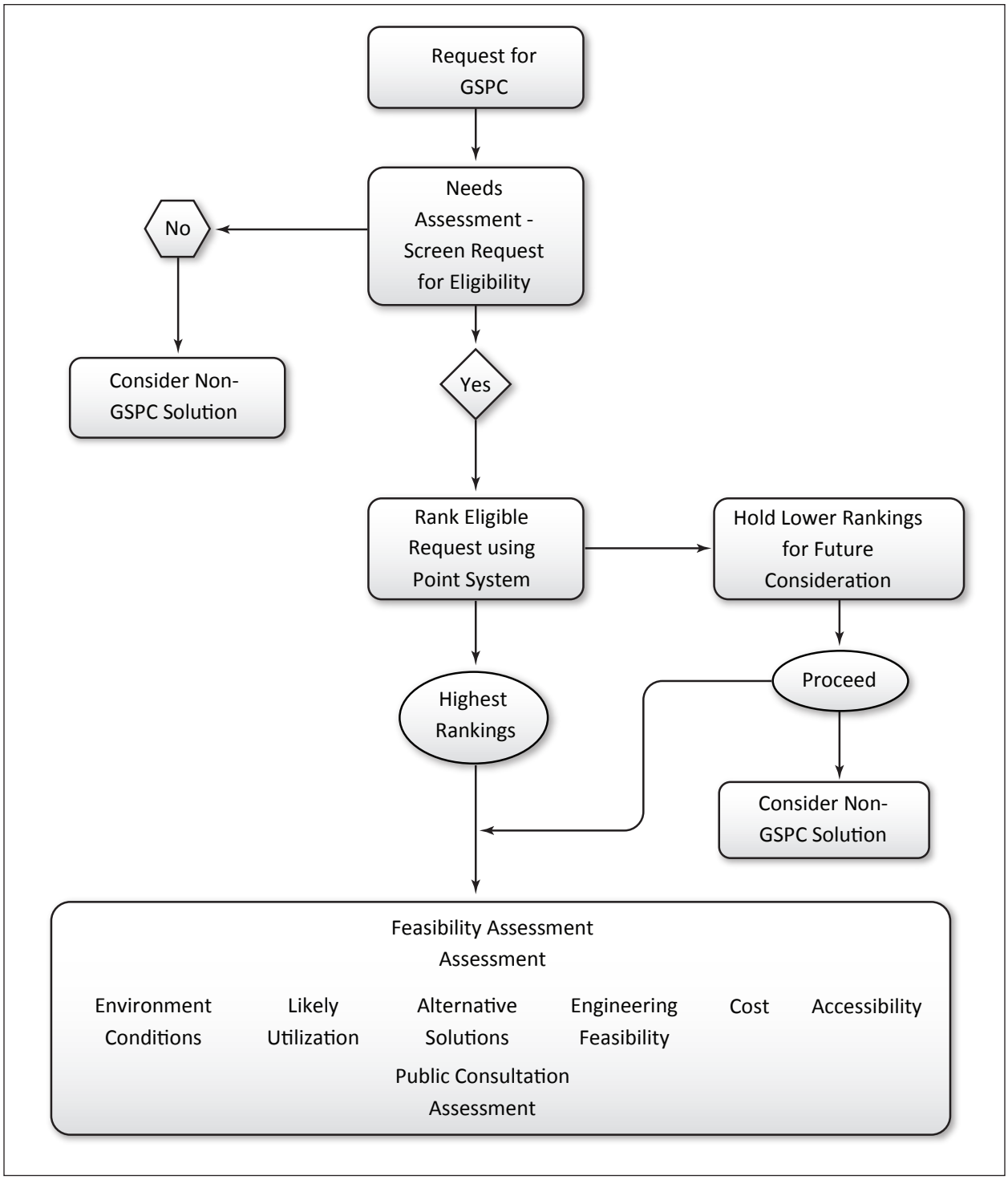


Figure 55: Grade Separated Pedestrian Crossing Accessibility

9. Glossary / Definitions

Accident

See Collision.

Actuation

The operation of a detector in registering the presence or passage of a vehicle or pedestrian is defined as actuation.

Accessibility

Provisions made to facilities to address the range of capabilities of the individual users. This is achieved through the elimination of physical and information barriers that preclude the use of the facility.

AODA

In Ontario, the Accessibility for Ontarians with Disabilities Act, 2005 (AODA) sets out legal requirements for the purpose of improving accessibility standards for Ontarians with physical or mental disabilities.

Accessible Pedestrian Signal (APS)

Auxiliary devices that supplement traffic control signals to aid pedestrians with vision losses (and those with both visual and hearing impairments) in their road crossing. Information is communicated in non-visual format such as audible tones, verbal messages, and/or vibrotactile indications to provide cues at both ends of a crossing when activated.

Approach Speed

The maximum safe speed that can be maintained over a short section of highway immediately in advance of a potentially hazardous location, taking into account pavement and shoulder width, horizontal and vertical alignment, sight distance, and other controlling factors. The approach speed does not necessarily coincide with the design speed.

Arterial Road

A road, used primarily for through traffic rather than for access to adjacent land, that is characterized by high vehicular capacity and continuity of movement is an Arterial Road. Intersections are spaced relatively far apart and are frequently signalized. See also Collector Road and Local Road.

At-grade Intersection

An intersection of two roadways where there is no vertical separation between the two roadways at their point of intersection.

Audible Pedestrian Signal

See Accessible Pedestrian Signal.

Average Maintained Horizontal Illuminance

The average level of horizontal illuminance on the roadway pavement when the output of the lamp and luminaire is diminished by the light loss factors expressed in lumens per square metre (lux) for the pavement area.

Bicycle

A vehicle having only two tandem wheels, propelled solely by human power, upon which typically one or two persons may travel. The Highway Traffic Act definition of bicycle includes tricycles and unicycles, power assisted bicycles (electric) and excludes motor-assisted bicycles.

Bicycle Lane

A portion of a roadway which has been designated by striping, signing and pavement markings for the preferential or exclusive use of bicyclists is termed as a Bicycle Lane.

Bicycle Path

A bikeway physically separated from the motorized vehicular traffic by an open space or barrier and either within the highway right-of-way or within an independent right-of-way.

Bus

Any motor vehicle designed, constructed and/or used in the transportation of ten or more seated passengers.

Collector Road

A road for which vehicle movement and access are of equal importance is termed as a Collector Road. Direct access to adjacent properties may be permitted in some cases, typically in lower-density residential areas. Intersections are spaced at varying intervals and are typically only signalized where the collector road intersects an arterial road or in some cases another collector road. See Arterial Road and Local Road.

Collision

An incident resulting in property damage, personal injury or death and involving the loss of control and/or the striking of one or more vehicles with another vehicle, a person, an animal or an inanimate object.

Commercial Motor Vehicle

A motor vehicle having a permanently attached truck or delivery body, including fire apparatus, buses, and truck tractors and trailers (combination units) used for hauling purposes on the highways, that may require a Commercial Vehicle Operating Registration (CVOR).

Community

A community is a group of individuals with a common interest. A community is often defined by neighbourhood boundaries, but may also include individuals who live outside the neighbourhood, but who work or operate businesses in the neighbourhood, or whose children attend school in the neighbourhood.

Conflict

A Collision or near-collision which requires evasive action on the part of one or more persons may be termed as a conflict. Conflicts can occur between two motorists, between a motorist and cyclist, between a motorist and pedestrian, and between a cyclist and pedestrian.

Controlled Intersection

An intersection where traffic approaching from any or all directions is regulated by some form of traffic control device is defined as a controlled intersection.

Controlled Crossing

A location that is controlled by stop or yield signs, pedestrian crossovers (PXO), intersection pedestrian signal (IPS or half signals), mid-block pedestrian signal (MPS), or full traffic control signals. At controlled crossings, vehicles must yield to pedestrians within or closely approaching the driver's half of the roadway.

Crossover

See Pedestrian Crossover.

Crosswalk

See Pedestrian Crosswalk.

Curb

A vertical or sloping construction element along the edge of a pavement or shoulder forming part of a gutter, strengthening or protecting the edge, and clearly defining the edge to vehicle operators. The surface of the curb facing the general direction of the pavement is called the "face".

Curb Depression

Curb depressions improve accessibility for crossing activity for all pedestrians. They are typically provided in urban areas where pedestrian activity exists. Curb depressions are not intended to imply right-of-way, but rather improve accessibility and safety where pedestrian activity has been demonstrated.

Curb Extension

An extension of the sidewalk or curb line to reduce the width of the travelled portion of the roadway and often protrude into the space allocated for curb side parking is termed as curb extension. Curb extensions provide refuge for pedestrians, and can improve sight distance and sight lines for both pedestrians and motorists, and may also be considered as a traffic calming measure.

Curb Ramps

A ramp to transition between the change in elevation between the sidewalk and the street level crossing is defined as a curb ramp.

Curve

A horizontal or vertical deviation in the roadway is defined as a curve. A horizontal curve appears as a bend in the roadway, requiring drivers to turn the steering wheel. A vertical curve appears either as a "crest" or a "sag" to provide for a change in gradient on the profile of the roadway.

Cycle

When referring to a traffic signal, cycle describes one complete sequence of signal indications.

See Bicycle.

Cyclist

A person riding a bicycle is a cyclist.

Delineation

One, or a combination of several types of devices (excluding Guide Signs) that regulate, warn, or provide tracking information and guidance to drivers.

Design Speed

A speed selected for the purposes of design and correlation of those features of a highway, such as curvature, superelevation, and sight distance, upon which the safe operation of vehicles is dependant.

Device (Traffic Calming)

A physical feature of the roadway, constructed for the purpose of affecting the movement of motor vehicles, bicycles and/or pedestrians.

Device (Traffic Control)

See Traffic Control Device.

Driver

A person who operates a vehicle on a highway is a driver.

Driveway

A private road giving access from a public way to a building or property on abutting grounds is a driveway.

Edge Markings

Permanent high-colour markings with surface texture used to further enhance pedestrian delineation at crossings and distinguish the main pedestrian crossing path of travel from the vehicular route/roadway.

Exclusive Pedestrian Phase

An interval of a traffic signal cycle that is dedicated to one or more pedestrian movements while displaying red on all traffic signal indications for vehicles.

Expectancy

Used in traffic engineering to describe a driver's anticipation of upcoming road design and traffic control conditions. Driver expectancy is usually affected by previous experience and the consistency and continuity of traffic control devices encountered. Violation of driver expectancy should be avoided whenever possible.

Exposure

Degree or level of interaction between pedestrians and vehicles is termed as exposure.

Expressway

A divided arterial highway for through traffic with full or partial control of access and generally with grade separations at major intersections is defined as an expressway.

Flow

Movement of traffic:

Interrupted

Non-continuous movement of traffic

Uninterrupted

Continuous movement of traffic

Freeway

An expressway with full control of access and interchanges in place of At-grade Intersections is defined as a freeway. This term includes Toll Highways built to a freeway configuration.

Geometry

When referring to roadway design, geometry refers to the physical characteristics and dimensions of parts of the roadway.

Grade Separation

The vertical separation of two or more intersecting roadways or a roadway and another transportation mode, e.g., railroad, thus permitting traffic on all roads to cross traffic on all other roads without interference.

Guideline

A recommended (but usually not required) practice, method or value for a specific design feature or operating practice is a guideline.

Highway

Highway is a general term denoting a public way for purposes of vehicular and pedestrian travel, including the entire area within the right-of-way. This includes King's Highways, regional and county roads, rural roads, municipal roads and streets.

Highway Traffic Act (HTA)

The term is used for Ontario Highway Traffic Act.

Human Factors

The term is used for consideration of human physical, perceptual and mental limitations in engineering design, so as to optimize the relationship between people and things. The objective is to reduce error and increase user comfort.

Illuminance

The illuminance is the measure of the light (lumens) falling on a surface. The unit of illuminance is lumens per square metre, commonly known as "lux". For horizontal surfaces, the illuminance is termed as horizontal illuminance and for vertical surfaces; the illumination is termed as vertical illuminance.

Installation

The term is used for the process or act of placing, erecting, and/or connecting a traffic control device

or system into its functional position and state of operational readiness.

Intersection

The area embraced by the prolongation of lateral curb lines or, if none, of the rights-of-way of two or more highways that join one another at an angle, whether or not one highway crosses the other.

Intersection Approach

That part of an intersection leg used by traffic approaching the intersection.

Intersection Channelization

Raised or painted islands at an intersection that prevent specific movement(s) from being made or provide better definition of large uncontrolled areas of pavement.

Intersection Pedestrian Signal (IPS)

Traffic control signal implemented for dedicated pedestrian crossings at intersections. The control of the pedestrian signals is by pedestrian actuated two phase operation with only pedestrian signal indications used for crossing the main street and regular traffic control signals on main roadway approaches. The main road traffic must be fully signalized, while the side road must be controlled with stop signs.

Junction

See Intersection.

Jurisdiction

The term is used for legal or other authority with responsibility and control for specific actions within a defined area.

Kilometre

A measure of distance equal to 1000 m or 0.622 miles is kilometre and is abbreviated as km.

Ladder Crosswalk Markings

Pavement markings that incorporate longitudinal stripe markings to enhance the delineation of pedestrian crosswalks are defined as ladder crosswalk markings. A ladder style crosswalk is a combination of zebra pavement markings aligned perpendicular to the standard parallel crosswalk lines. The contrast of the markings provides enhanced conspicuity of the crosswalk and thereby increases the awareness of drivers to potential conflicts.

Lane

A defined width of road intended to accommodate a single line of moving vehicles.

Leading Pedestrian Interval

Leading pedestrian interval is a form of an exclusive pedestrian phase where a walk indication (generally around 4 to 6 seconds in duration) is provided in advance of the corresponding vehicle green indications to give pedestrians a head start on parallel or turning traffic.

Legal Authority

The authority provided, by legislation and regulation, to a jurisdiction or enforcement body for the actions it takes.

Local Road

The term is used for a street or road primarily for access to residence, business or other abutting property.

Lumens

The radiant energy generated by a lamp in the form of light is referred to as luminous flux and is measured in lumens. The lumen output of a lamp is the total amount of light emitted in all directions.

Luminance

The luminous flux in a light ray, emanating from a surface or falling on a surface, in a given direction,

per unit of projected area of the surface as viewed from that direction, per unit of solid angle. (Reflective light.)

m

Abbreviation for metre.

Maintenance

The term is used for upkeep of highways, traffic control devices, other transportation facilities, property and/or equipment.

May

The term "may" Indicates a permissive condition. No requirement for design or application is intended. However, mandatory requirements apply to some specific options if and when they are selected.

Median

That portion of a divided highway separating the travelled ways for traffic in opposite directions is defined as a median.

Median Barrier

A raised island, wall or structure located on the Centreline of a roadway through an intersection or along a road that prevents left turns or straight through movements from being made to and from a side street or private/commercial driveway.

Median Island

A zone or physical island constructed in the centre of a roadway to separate opposing directions of traffic. In the context of traffic calming, it may be used to reduce the overall width of the travel lanes.

Median Strip

An expanse of hard surface material separating opposing lanes on a highway is defined as the median strip. The hard surface is flush or nearly flush with the adjacent lanes.

Midblock

Segment of the roadway between two intersections is termed as midblock.

Midblock Pedestrian Signal (MPS)

Traffic control signal implemented for dedicated pedestrian crossings at midblocks. The control of the pedestrian signals is by pedestrian actuated two phase operation with only pedestrian signal indications used for crossing the main street and regular traffic control signals on main roadway approaches. The main road traffic must be fully signalized.

Ministry

The Ministry of Transportation, Ontario.

Minor Road

The lesser of two roads at an intersection.

Motor Vehicle

Includes an automobile, motorcycle, motor-assisted bicycle (moped), and any other vehicle propelled or driven other than with muscular power, but does not include a streetcar, or other vehicles designed to operate on rails, power assisted bicycles or a motorized snow vehicle, traction engine, farm tractor and implements of husbandry or road-building machine.

Motorist

See Driver.

MTO

The Ministry of Transportation Ontario.

Multi-use Path

Any off-road dedicated facility for non-motorized traffic such as bicycles, pedestrians and in-line skaters.

Must

The term "must" indicates a mandatory condition. Where certain requirements in the design or application of the device are described with the "must" stipulation, it is mandatory that these requirements be met when an installation is made.

MUTCD

The Manual of Uniform Traffic Control Devices for Ontario, 1995.

MUTCDC

The Manual of Uniform Traffic Control Devices for Canada, 1991 as amended in 2008.

MUTCD-US

The U.S. Manual of Uniform Traffic Control Devices, 1988.

Neighbourhood

A cohesive urban area defined by geographic features, the road network or socio-economic characteristics. With respect to traffic calming, neighbourhood boundaries are often defined by the arterial roadway network, which typically presents a significant barrier to travel and interaction.

Object Marker

A traffic sign mounted temporarily or permanently on an obstruction, within or adjacent to the roadway, to make the obstruction as highly visible as possible.

On-street Parking

The term is used for the use of vehicle parking on the roadway surface or on the adjacent shoulder.

Overhead Sign

A Traffic Sign mounted above the roadway, usually with 4.5 m to 5.3 m of vertical clearance and preferably located over the lane or lanes to which the sign applies.

Oversize Sign

A Traffic Sign with greater proportional dimensions than the minimum dimensions specified in this Manual. Such signs are generally required on higher speed highways, or on other highways in special cases.

Parking

The term is used for the stationary storage or leaving of a vehicle unoccupied or unattended.

Pavement Marking

A coloured marking applied to the pavement to provide drivers with roadway alignment information.

Pedestrian

Any person who is not in or upon a vehicle, motorized or otherwise propelled, or a person in a non-motorized wheelchair, or person in a motorized wheelchair that cannot travel at over 10 kph or a person pushing a bicycle or motorized or non-motorized wheelchair.

Pedestrian Aids

Used to supplement pedestrian crossings to enhance the level of safety and/or security Examples include pedestrian countdown signals, exclusive pedestrian phase, leading pedestrian interval, audible / accessible pedestrian signals, pedestrian delineation, advanced stop bar and signage.

Pedestrian Countdown Signals (PCS)

Supplementary devices that provide a numeric countdown display of the number of seconds remaining in the Flashing Don't Walk interval of a

pedestrian phase. PCS are optional devices that can be provided at locations where pedestrian signals are installed.

Pedestrian Crossover

Any portion of a Roadway, designated by by-law of a municipality, at an intersection or elsewhere, distinctly indicated for pedestrian crossing by signs on the highway and lines or other markings on the surface of the roadway as prescribed by the regulation and the Highway Traffic Act, with associated signs Ra-4, Ra-4t, Ra-10 and Ra-11.

Pedestrian Crosswalk

Any portion of the roadway, at an intersection or elsewhere, distinctly indicated for pedestrian crossing by appropriate pavement markings and/or signs, or by the projections of the lateral lines of the sidewalk on opposite sides of the road. See also Ladder Crosswalk Marking and Textured / Coloured Crosswalk

Pedestrian Delineation

A defined pedestrian crossing as indicated by edge markings, painted pavement markings, surface treatments, etc. With the exception of school crossings, marked crosswalks are not recommended at uncontrolled intersections.

Pedestrian Facility

The term is used for a facility where pedestrians are controlled and protected from other road users.

Pedestrian Fencing

Pedestrian fencing includes physical barriers (including fencing, gates, walls, bollards, etc.) that are implemented to discourage pedestrian crossing at non-designated locations and help direct pedestrians to crosswalks.

Pedestrian Signal (Traffic Signal)

A Traffic Signal head or indication showing either a white walking pedestrian on a black background (when pedestrians are permitted to cross) or an orange hand on a black background (when pedestrians are not permitted to cross, if continuous, or are not permitted to start crossing, if flashing).

Permissive

Refers to areas where a driver is permitted to travel (e.g., a truck route).

Phase (Traffic Signal)

The term is used for a part of a cycle where one or more traffic movements receive a green indication at the same time. Phase time is the time required from the start to the finish of the phase including Amber and All-red Interval times.

Posted Speed

A section upon which the maximum speed is indicated by the Regulatory Signs or where signs are not present designated as per Section 128 of the Highway Traffic Act.

Posted Speed Zone

A section of highway upon which the maximum speed is indicated by appropriate Regulatory Signs or where signs are not present, designated as per Section 128 of the Highway Traffic Act.

Prescribed Sign

The Highway Traffic Act, Section 182 (R.S.O. 1990), provides for the regulation of various signs, their type and location on the roadway. The criteria and specifications for application, dimensions, location and orientation are prescribed and illustrated under Regulations 615, 608, 581, 599 (R.R.O 1990) and are indicated as such in this Manual. Signs erected in accordance with the Regulations, and pursuant to the Highway Traffic Act, are enforceable under various provisions of the Act. Enforcement is permitted under the particular section under

the authority of which a prescribed sign may be erected to indicate a traffic regulation, or Highway Traffic Act Section 182 (R.S.O. 1990), which requires obedience to prescribed signs.

Railroad

All forms of non-highway ground transportation that runs on rails or electro-magnetic guide ways, including:

Commuter or short haul rail passenger service in a metropolitan or suburban area; and

High speed ground transportation systems that connect metropolitan areas, without regard to whether they use new technologies not associated with traditional railroads.

Railroad Crossing

A location where one or more railroad tracks cross a public highway, road, street, or private roadway, and include sidewalks and pathways at or associated with the crossing.

Raised Crosswalk

A Pedestrian Crosswalk at an intersection or mid-block, constructed to the same elevation as adjacent curbs and sidewalks.

Ramp

A ramp is an interconnecting roadway of a traffic interchange, or any connection between highways at different levels or between parallel highways, on which the vehicles may enter or leave a designated roadway.

Refuge Island

An island provided in a street for the safety of pedestrians, either as a Median Island on a wide street, where the width may not permit pedestrians to cross the street on a single Pedestrian Signal indication, or as a loading island for transit, such as Streetcars.

Regulation

A prescribed rule, supported by legislation, such as any regulation made under the Highway Traffic Act or municipal bylaw. Regulations provide the legal basis for enforcement.

Regulatory Sign

A traffic sign advising drivers of action they should or must do (or not do), under a given set of circumstances. Disregard of a regulatory sign would usually constitute an offence.

Restrictive

Refers to areas where, or times when, a driver is not permitted to travel.

Retro-reflective Material

A type of material applied in either strips or sheets which reflects illumination back to its source.

Right-of-way

Allocation of right of movement to a road user, in preference over other road users;

The width of the road allowance from the property line on one side to the property line on the opposite side of the roadway is also known as right-of-way.

Right-of-way Rule

Although these may vary in specific localities, in Ontario a vehicle approaching an uncontrolled intersection at the same time as another vehicle must yield to a vehicle approaching to its right.

Right Turn Channel

Right Turn Channel is an intersection design that isolates and directs the right-turn movement on an approach through the use of medians and splitter islands. Right-turn channels at signalized intersections are implemented to increase intersection efficiency and reduce unnecessary

delay and idling emissions where high right-turn vehicular traffic volume exists.

Right Turn on Red

The term is used for right-turning movement permitted on a red signal indication after coming to a stop and ensuring that a right turn can be made safely. Right Turn on Red is allowed by the Highway Traffic Act, but subject to site-specific local by-laws and posted regulatory signs restricting turns on red signals.

Road

See Highway.

Road Authority

The term is used for a body (Municipal, Provincial or private) that has legal jurisdiction over a roadway.

Roadway

The part of the highway that is improved, designed or ordinarily used for vehicular traffic, but does not include the shoulder, and, where a highway includes two or more separate roadways, the term "roadway" refers to any one roadway separately and not to all of the roadways collectively.

Roundabout

A raised circular island located in the centre of an intersection, which requires vehicles to travel through the intersection in a counter-clockwise direction around the island. Roundabouts are typically used on arterial and collector roads, and are distinguished by YIELD signs and raised Median Islands on all approaches, and in some cases, gradual widening of the entry approach to two or more lanes.

Running Slope

Running slope of a depressed curb is the slope provided along its length to achieve the depression.

Rural Area

An area outside of the limits of any incorporated or unincorporated city, town, village, or any other designated residential or commercial area.

School Crossing

Designated school crossings are locations close to schools where school children have to cross en route between home and school. School crossings are supervised by school patrollers or adult crossing guards whose role is to direct and supervise the movement of persons (as defined in the Highway Traffic Act) across a highway by creating necessary gaps in vehicular traffic.

School Area, School Zones and School Crossing Signs

The signs form a group of signs, both Regulatory and Warning, used to control vehicles and protect pedestrians wherever students and pedestrians are likely to be present and conflict with vehicles may occur.

Shall

The term "shall" means the same as "must".

Should

The term "should" Indicates an advisory condition. Where the work "should" is used, the action is advised; recommended but not mandatory. This term is meant to suggest good practice in most situations but also to recognize that in some situations, for good reasons, the recommended action cannot or need not be followed.

Sidewalk

Sidewalk is that portion of a road, adjacent to the travelled roadway, which has been improved for the use of pedestrians.

Sight Distance

The distance visible to the driver of a passenger vehicle, measured along the normal travel path of

a roadway, to the roadway surface or to a specified height above the roadway, when the view is unobstructed by traffic.

Sign

A Traffic Control Device mounted on a fixed or portable support which conveys a specific message by means of symbols or words, and is officially erected for the purpose of regulating, warning, or guiding traffic.

Signal Indication (Traffic Signal)

The term is used for illumination of one or more lenses in a signal head which conveys a message to traffic approaching the signal from one direction.

Signalized Control

The use of a traffic signal control device to control traffic on a road section or intersection is termed as signalized control.

Speed Limit

The maximum vehicular speed allowed within any given posted or unposted Speed Zone.

Splitter Island

A raised or painted area on an approach used to separate traffic entering from exiting. Splitter islands are implemented at roundabouts, or to form channelized lanes at intersections, or to provide storage space for pedestrians crossing the road in two stages (functioning as a refuge island).

Standard

A rule, principle, pattern or measure, which practice or theory has shown to be appropriate for a given set of conditions, and applicable, as the case may be, to planning, design, traffic control devices, operations or maintenance.

Stop Bar

A Pavement Marking placed laterally across the approach half of a travelled roadway at the site of a STOP or YIELD sign, Traffic Signal, or Pedestrian Crosswalk. The line indicates the point beyond which the foremost part of a vehicle must not protrude, should the vehicle be required to stop. Stop bar is also called a Stop Line.

Stop Line

The term is also used for Stop Bar.

Stopping (where prohibited)

The halting of a vehicle, even temporarily, whether occupied or not, except where necessary to avoid conflict with other vehicles, or in compliance with the directions of a police officer or Traffic Control Signal.

Stopping Sight Distance

The distance required by a driver of a vehicle, travelling at a given speed, to bring the vehicle to a stop after an object on the roadway becomes visible. It includes the distance travelled during the Perception-reaction Time and the vehicle braking distance.

Street

The term is used for an Urban Highway.

Surface

The surface is the top of the pavement material, Substrate, or Sign Sheeting.

Tab Sign

A tab is a sign smaller than the primary sign with which it is associated, and mounted below it. There are two types of tab signs:

Supplementary Tab Sign — contains additional, related information

Educational Tab Sign — conveys the meaning of symbols during their introductory period

Textured / Coloured Crosswalk

The terms are used crosswalk that incorporates a textured and / or patterned surface which contrasts with the adjacent roadway. They are applied to better define a pedestrian crossing and increase the awareness of drivers to potential conflicts.

Timing

When referring to traffic signals, timing describes the amount of time allotted to each Phase within each signal cycle.

Traffic Accident

See Collision.

Traffic Calming

The combination of mainly physical measures that reduce vehicle speeds and the negative effects of motor vehicle use, alter driver behavior and improve conditions for non-motorized street users.

Traffic Calming Measure

A physical device, design or other action which affects the movement of motor vehicles, bicycles, and/or pedestrians is termed as a traffic calming measure.

Traffic Control Device

Any sign, signal, marking, or device placed upon, over or adjacent to a roadway by a public authority or official having jurisdiction, for the purpose of regulating, warning, guiding or informing road users.

Traffic Control Person

A Traffic Control Person is a person, duly trained and thereby authorized, to direct traffic at a work zone, through the use of a "Stop" and "Slow" paddle. Each traffic control person may only control one direction of travel.

Traffic Control Signal (Traffic Signal)

Any power-operated Traffic Control Device, whether manually, electrically or mechanically operated, by which traffic is alternately directed to stop and permitted to proceed. Traffic Signal:

When used in general discussion, a traffic signal is a complete installation including signal heads, wiring, controller, poles and other appurtenances.

When used specifically, the terms refer to the signal head which conveys a message to the observer.

That part of a traffic control signal system that consists of one set of no less than three coloured lenses, red, amber and green, mounted on a frame and commonly referred to as a signal head.

Traffic Island

A raised or painted island designed to separate streams of vehicular traffic.

Traffic Sign

A traffic sign is a device (other than Delineators and Traffic Control Signals) which may be erected beside or above a roadway for the purpose of regulating, warning or guiding traffic.

Truck

A truck is a commercial vehicle exceeding a specified weight or length as defined by the Highway Traffic Act, municipal by-law, or toll agency.

Turn Lane

A lane designed to facilitate vehicular turn movements from the through roadway.

Uncontrolled Intersection

An uncontrolled intersection is the one which does not have traffic control devices on any of the approaches.

Uniformity

Consistency in the design and application of traffic control devices and operations.

Uncontrolled Pedestrian Crossings

A pedestrian crossing location (marked or unmarked) where there are no traffic control devices to assist pedestrians in crossing.

Urban Area

An indefinite area of land used primarily for residential, commercial, and/or industrial purposes, usually associated with a given area size, population, and density.

Vehicle

Includes a motor vehicle, trailer, traction engine, farm tractor, road-building machine, bicycle, and any vehicle drawn, propelled or driven by any kind of power, including muscular power, but does not include a motorized snow vehicle or streetcar.

Volume

The number of vehicles or pedestrians that pass over a given section of a lane or a roadway or make a particular movement during a specific time period (such as one hour or 24 hours) is termed as volume.

Walkability

A measure of the level of integration of pedestrian facilities and accommodation, which consist of sidewalks, trails, crossings, and the ease in which pedestrians can move through the network enjoyably and safely.

Warning Sign

A sign that indicates conditions on or adjacent to a highway or street that is actually or potentially hazardous to traffic operations.

Warrant

A criterion or set of criteria by which justification for a given type of Traffic Control Device or other application is determined is defined as a warrant.

Yield

To yield means to cede the right-of-way.

Zebra Crossing

A zebra crossing is a type of pedestrian consisting of alternating dark and light stripes on the road surface.

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