



COLORADO
Department of Transportation



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Pedestrian Crossing Installation Guide

2021 Edition

ACKNOWLEDGEMENTS

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FHWA Manual on Uniform Traffic Control Devices (2009).

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CDOT Roadside Design Guide, Chapter 14 (2015).

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Colorado Revised Statutes, Article 42.

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Acronyms

AASHTO	American Association of State Highway Transportation Officials
ADA	Americans with Disabilities Act
ADT	Average Daily Traffic
CDOT	Colorado Department of Transportation
CFR	Code of Federal Regulations
CRS	Colorado Revised Statutes
FHWA	Federal Highway Administration
HCM	Highway Capacity Manual
ITE	Institute of Transportation Engineers
LED	Light Emitting Diode
MPH	Miles Per Hour
MPO	Metropolitan Planning Organization
MUTCD	Manual on Uniform Traffic Control Devices
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
PROWAG	Public Right of Way Accessible Guidelines
RRFB	Rectangular Rapid Flashing Beacon
SSD	Stopping Sight Distance
TEA-21	Transportation Equity Act for the 21 st Century
VPD	Vehicles Per Day

Definitions

ADT	The amount of vehicular traffic that crosses an imaginary line across a roadway in a 24-hour period. On a two-way street, ADT typically includes both directions of travel.
Crosswalk	Defined in the MUTCD as: that part of a roadway at an intersection included within the connections of 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 traversable roadway, and in the absence of a sidewalk on one side of the roadway, the part of a roadway included within the extension of the lateral lines of the sidewalk at right angles to the center line. any portion of a roadway at an intersection or elsewhere distinctly indicated as a pedestrian crossing by pavement marking lines on the surface, which might be supplemented by contrasting pavement texture, style, or color.
Controlled Crosswalk	A legal crosswalk across a roadway approach that is controlled by a stop sign or traffic signal, including pedestrian hybrid beacons.
Marked Crosswalk	A legal crosswalk that features traffic control markings.
Mid-block Crosswalk	A crosswalk location that is not at an intersection and features traffic control markings to indicate that it is a legal crosswalk.
Multiple Threat Crash	Occurs on roadways with two or more lanes in a single direction when one lane of traffic stops for a pedestrian and obscures the view of the crossing pedestrian to a motorist in the adjacent traveling lane.
Peak Hour	The hour of each day when traffic volumes are at their highest.
Pedestrian Hybrid Beacon	A traffic control device used to stop motorists and allow pedestrians to cross a roadway safely.
RRFB	A pedestrian-activated, high-intensity warning light that notifies drivers when a pedestrian is entering a crosswalk.
Road Diet	A low-cost strategy that reconfigures a roadway cross-section to better accommodate the needs of all users, increase mobility, reduce crashes, and improve the quality of life in communities.
School Crossing	Locations where ten (10) or more student pedestrians are crossing per hour.
SSD	The minimum distance required by a driver of a vehicle traveling at a given speed to bring the vehicle to a stop after an object on the roadway becomes visible.
Uncontrolled Crosswalk	A legal crosswalk across a roadway approach that is <u>not</u> controlled by a stop sign or traffic signal.
Unmarked Crosswalk	A legal crosswalk that <u>does not</u> feature any type of traffic control markings.
VPD	The amount of vehicular traffic that crosses an imaginary line across a roadway in a 24-hour period.

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Chapter 1. Introduction

1.1 Crosswalk Safety

Approximately 5,000 pedestrians are killed, and 70,000 pedestrians are injured in traffic crashes each year in the United States. Pedestrians account for roughly 14 percent of all fatal crashes. According to the NHTSA, a pedestrian is killed every 2 hours and injured every 8 minutes, on average. The elderly (age 60 and above) and young children (age 14 and below) are at higher risk and are more likely to be killed or injured in a pedestrian crash than any other group. While it is easy and common to blame drivers for the crashes, according to the published FHWA report, *A Review of Pedestrian Safety Research in the United States and Abroad* (2003), pedestrians are solely culpable in 43 percent of crashes and drivers in 35 percent of crashes.

To eliminate confusion over crosswalk safety, FHWA published the *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations* report in 2005. Data was collected at 2,000 sites; 1,622 were at uncontrolled intersections and 278 were at midblock crossings. Conclusions from this report indicate:

- On 2-lane roads, there was no significant difference in pedestrian crash rates between marked and unmarked sites;
- On multilane roads with an ADT of 12,000 vpd or less, there was no difference in pedestrian crash rates between marked and unmarked sites;
- On multilane roads with no raised median and an ADT greater than 12,000 vpd, marked crosswalks had a higher crash rate than unmarked crossings; and
- On multilane roads with an ADT greater than 15,000 vpd and raised medians, a significantly higher crash rate was associated with marked crosswalks as compared to unmarked.

It is also important to recognize that the speed of motorists has serious consequences when a pedestrian is involved. A pedestrian struck by a vehicle traveling at 40 mph has an 85 percent chance of being killed. Whereas, at 30 mph, the likelihood reduces to 45 percent.

Pedestrians using a crosswalk may have a false sense of security that all motorists will stop. Education, enforcement, and engineering are components that need to be employed to address this issue. As a step toward this effort, CDOT has developed this Pedestrian Crossing Guideline to address pedestrian crossing safety at controlled and uncontrolled crosswalks.

1.2 Mission

It is the mission of CDOT to provide the best multi modal transportation system for Colorado that most effectively and safely moves people, goods, and information. CDOT policy, state statute, and federal surface transportation regulations place a strong emphasis on creating a system for use by persons of all ages and abilities for safe and convenient access to jobs, services, schools, and recreation. The Chief Engineer Design Guidance expresses support for taking a flexible approach when designing and planning our state transportation system and helps identify resources to provide context sensitive solutions particularly related to bicycle and pedestrian accommodation.

1.3 Purpose

The purpose of the Pedestrian Crossing Guideline is to serve as a document that guides staff in determining where and how to improve pedestrian crosswalks on the State Highway system. These guidelines are intended to be used to consistently and transparently determine appropriate treatments for Pedestrian crossings, if any, while ensuring efficient function for all users. In addition, these guidelines provide the necessary references for clarifying the legal rights of pedestrian and drivers in crosswalk scenarios.

Chapter 2. Statutes, Policies, Resources

2.1 Federal Statutes

TEA-21 Section 1202. Bicycle transportation and pedestrian walkways

- (a) In General - Bicyclists and pedestrians shall be given due consideration in the comprehensive transportation plans developed by each metropolitan planning organization and State in accordance with sections 134 and 135, respectively. Bicycle transportation facilities and pedestrian walkways shall be considered, where appropriate, in conjunction with all new construction and reconstruction of transportation facilities, except where bicycle and pedestrian use are not permitted.

Safety Considerations – Transportation plans and projects shall provide due consideration for safety and contiguous routes for bicyclists and pedestrians. Safety considerations shall include the installation, where appropriate, and maintenance of audible traffic signals and audible signs at street crossings.

FHWA Guidance, Policy: Mainstreaming Nonmotorized Transportation (February 1999)

Even where circumstances are exceptional and bicycle use and walking are either prohibited or made incompatible, States, MPOs, and local governments must still ensure that bicycles and pedestrian access along the corridor served by the new or improved facility is not made more difficult or impossible.

Title 23, USC Section 135. Statewide and nonmetropolitan transportation planning

- (a) (3) The process for developing the statewide plan and the transportation improvement program shall provide for consideration for all modes of transportation...

Title 23, USC Section 217. Bicycle transportation and pedestrian walkways

- (g) (1) In General – Bicyclists and pedestrians shall be given due consideration in the comprehensive transportation plans developed by each metropolitan planning organization and State in accordance with sections 134 and 135, respectively. Bicycle transportation facilities and pedestrian walkways shall be considered, where appropriate, in conjunction with all new construction and reconstruction of transportation facilities, except where bicycle and pedestrian use are not permitted.
- (2) Safety Considerations – Transportation plans and projects shall provide due consideration for safety and contiguous routes for bicyclists and pedestrians. Safety considerations shall include the installation, where appropriate, and maintenance of audible traffic signals and audible signs at street crossings.

2.2 Colorado Statutes

The CRS contains pedestrians' rights and responsibilities when crossing the street, either in a marked or unmarked crosswalk or outside of the crosswalk. Key elements of the CRS as pertaining to this guidance includes:

Section 42-1-102. Definitions

- (21) "Crosswalk" means that portion of a roadway ordinarily included within the prolongation or connection of the lateral lines of sidewalks at intersections or any portion of a roadway distinctly indicated for pedestrian crossing by lines or other marking on the surface.

Section 42-4-801. Pedestrian obedience to traffic control devices and traffic regulations.

- (1) A pedestrian shall obey the instructions of any official traffic control device specifically applicable to the pedestrian, unless otherwise directed by a police officer.
- (2) Pedestrians shall be subject to traffic and pedestrian-control signals as provided in sections 42-4-604 and 42-4-802 (5).

- (3) At all other places, pedestrians shall be accorded the privileges and shall be subjected to the restrictions stated in this title.

Section 42-4-802. Pedestrians’ right-of-way in crosswalks.

- (1) When traffic control signals are not in place or not in operation, the driver of a vehicle shall yield the right-of-way, slowing down or stopping if need be to so yield, to a pedestrian crossing the roadway within a crosswalk when the pedestrian is upon the half of the roadway upon which the vehicle is traveling or when the pedestrian is approaching so closely from the opposite half of the roadway as to be in danger.
- (3) No pedestrian shall suddenly leave a curb or other place of safety and ride a bicycle, ride an electrical assisted bicycle, walk, or run into the path of a moving vehicle that is so close as to constitute an immediate hazard.
- (5) Whenever special pedestrian-control signals exhibiting “Walk” or “Don’t Walk” word or symbol indications are in place, as declared in the traffic control manual adopted by the department of transportation, such signals shall indicate and require as follows:
 - (a) “Walk” (steady): While the “Walk” indication is steadily illuminated, pedestrians facing such signal may proceed across the roadway in the direction of the signal indication and shall be given the right-of-way by the drivers of all vehicles.
 - (b) “Don’t Walk” (steady): While the “Don’t Walk” indication is steadily illuminated; no pedestrian shall enter the roadway in the direction of the signal indication.
 - (c) “Don’t Walk” (flashing): Whenever the “Don’t Walk” indication is flashing, no pedestrian shall start to cross the roadway in the direction of such signal indication, but any pedestrian who has partly completed crossing during the “Walk” indication shall proceed to the sidewalk or to a safety island, and all drivers of vehicles shall yield to any such pedestrian.

Section 42-4-803. Crossing at other than crosswalks.

- (1) Every pedestrian crossing a roadway at any point other than within a marked crosswalk or within an unmarked crosswalk at an intersection shall yield the right-of-way to all vehicles upon the roadway.
- (2) Any pedestrian crossing a roadway at a point where a pedestrian tunnel or overhead pedestrian crossing has been provided shall yield the right-of-way to all vehicles upon the roadway.
- (3) Between adjacent intersections at which traffic control signals are in operation, pedestrians shall not cross at any place except in a marked crosswalk.
- (4) No pedestrian shall cross a roadway intersection diagonally unless authorized by traffic control devices; and, when authorized to cross diagonally, pedestrians shall cross only in accordance with the official traffic control device pertaining to such crossing movements.

Section 42-4-1903. School buses – stops – signs – passing.

- (1) (a) The driver of a motor vehicle upon any highway, road, or street, upon meeting or overtaking from either direction any school bus that has stopped, shall stop the vehicle at least twenty feet before reaching the school bus if visual signal lights as specified in subsection (2) of this section have been actuated on the school bus. The driver shall not proceed until the visual signal lights are no longer being actuated. The driver of a motor vehicle shall stop when a school bus that is not required to be equipped with visual signal lights by subsection (2) of this section stops to receive or discharge school children.
- (2) (a) (II) Display eight visual signal lights meeting the requirements of 49 CFR 571.108 or its successor regulation

2.3 CDOT Policies and Procedures

The Transportation Commission supports CDOT in elevating the needs of bicyclists and pedestrians in planning, design, and operation of transportation facilities. CDOT has implemented Policy Directives 1602.0

and 605.0, and Procedural Directives 1602.1 and 605.1 to increase the safety and mobility of bicyclists and pedestrians along the state highway system.

CDOT Policy Directive 1602.0 'Elevating Bicycle and Pedestrian Opportunities in Colorado'

<https://www.codot.gov/admin/programs/bikeped/documents/1602-0-policy-bike-pedestrian>

CDOT Procedural Directive 1602.1 'Elevating Bicycle and Pedestrian Opportunities in Colorado'

<https://www.codot.gov/admin/programs/bikeped/documents/1602-1-2013-bicycle-and-pedestrian-policy>

CDOT Policy Directive 605.0 'Comprehensive Accessibility for Persons with Disabilities'

https://www.codot.gov/business/civilrights/ada/assets/605-0-pd-comprehensive-accessibility-for-persons-with-disabilities_2018.pdf

CDOT Procedural Directive 605.1 'ADA Accessibility Requirements in CDOT Transportation Projects'

<https://www.codot.gov/business/civilrights/ada/assets/0605-1.pdf>

2.4 Additional Resources

In addition to these guidelines, CDOT encourages the use of the following resources when planning or designing pedestrian improvements to Colorado's transportation network.

2015 CDOT Roadway Design Guide, Chapter 14

https://www.codot.gov/admin/business/designsupport/bulletins_manuals/roadway-design-guide/ch14

2016 CDOT Bicycle & Pedestrian Best Practices Compliant Curb Ramps

<https://www.codot.gov/programs/bikeped/bicycle-pedestrian-best-practices>

2019 CDOT Miscellaneous Standard Plan M-608-1 'Curb Ramps'

<https://www.codot.gov/business/designsupport/2019-and-2012-m-standards/2019-m-standards-plans/2019-m-standards-plan-sheets/m-608-1-curb-ramps/m-608-1-curb-ramps>

2019 CDOT Miscellaneous Standard Plan M-609-1 'Curb, Gutters, and Sidewalks'

<https://www.codot.gov/business/designsupport/2019-and-2012-m-standards/2019-m-standards-plans/2019-m-standards-plan-sheets/m-609-1-curb-gutters-and-sidewalks/m-609-1-curb-gutters-and-sidewalks>

2019 CDOT Safety Standard Plan S-614-45 'Pedestrian Push Button Post Assembly Details'

<https://www.codot.gov/safety/traffic-safety/assets/s-standard-plans/2019/s-614-45/s-614-45.pdf>

2020 CDOT Lighting Design Guidelines

<https://www.codot.gov/safety/traffic-safety/assets/documents/cdot-lighting-design-guideline-2020.pdf>

2009 Manual on Uniform Traffic Control Devices (MUTCD)

<https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/mutcd2009r1r2edition.pdf>

2017 FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations

https://safety.fhwa.dot.gov/ped_bike/step/docs/STEP_Guide_for_Improving_Ped_Safety_at_Unsig_Loc_3-2018_07_17-508compliant.pdf

2016 FHWA Small Town and Rural Multimodal Networks Guide

https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/small_towns/fhwahep17024_lg.pdf

2011 AASHTO A Policy on Geometric Design of Highway & Streets (Green Book)

Purchase at:

<https://store.transportation.org/item/collectiondetail/180>

2004 AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities

Purchase at:

<https://store.transportation.org/Item/CollectionDetail?ID=131>

2007 Mitigation Strategies for Design Exceptions

<https://safety.fhwa.dot.gov/geometric/pubs/mitigationstrategies/>

2014 NCHRP 783: Evaluation of the 13 Controlling Criteria for Geometric Design

<http://www.trb.org/Publications/Blurbs/171358.aspx>

FHWA Interim Approvals

https://mutcd.fhwa.dot.gov/res-interim_approvals.htm

National Association of City Transportation Officials (NACTO) Urban Street Design Guide

<https://nacto.org/publication/urban-street-design-guide/>

2010 ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach

<https://www.ite.org/pub/?id=E1CFF43C-2354-D714-51D9-D82B39D4DBAD>

2005 Safety Effects of Marked versus Unmarked Crosswalks at Uncontrolled Locations

<https://www.fhwa.dot.gov/publications/research/safety/04100/04100.pdf>

Chapter 3. Pedestrian Crossing Installation Request

The pedestrian crossing installation request process is intended to provide consistency on State Highways when considering the installation of crosswalks and other enhancements. Experience has shown that poorly placed crosswalks may decrease safety for pedestrians. An engineering evaluation must be completed to determine if a candidate location is suitable for a crosswalk. The process for evaluation is as follows:

1. A city, county, law enforcement, and or school district should complete and return the Pedestrian Crossing Installation Request form (see **Appendix A**) to the CDOT Traffic Engineering Region that has jurisdiction over the candidate crossing location(s). All citizens must work with their local agency representative to submit a request.
2. CDOT Traffic Engineering will evaluate the candidate location(s) and will provide pedestrian crossing treatment recommendations based on the engineering evaluation.

Chapter 4. Pedestrian Crossing Evaluation

The evaluation of locations for potential crossing treatments should include three basic steps: 1. Identify and describe the pedestrian crossing location, 2. Observe the traffic and operations at the pedestrian crossing location, and 3. Determine the appropriate crossing treatment. The Crossing Location Evaluation Worksheet in Appendix B can be used to help guide you through these basic steps.

4.1 Identifying and Describing the Crossing Location

Most crosswalk identification and descriptions may be completed in the office using resources, such as, the CDOT Division of Transportation Development databases, Google Earth, and Google Maps. However, there may be a need for field visits to collect additional data and verify the data collected from the office. The following should be considered when identifying and describing a candidate location.

4.1.1 Pedestrian Crossing Location

Provide the location of the pedestrian crossing (i.e., State highway and milepost, cross street, street address, intersection path or trail, etc.). It is also important to record the following location attributes.

- a. The distance(s) to the nearest marked and/or protected crosswalk(s).

There are spacing requirements for specific crossing treatments. The Pedestrian Crossing Evaluation Flowchart (**Figure C3 and Figure C4 of Appendix C**) requires that a new uncontrolled mid-block crossing be at least 300 feet from the nearest marked and/or protected crosswalk. This spacing requirement may be waived if the evaluated crossing serves as a multi-use path, the pedestrian volumes exceed twice the minimum threshold, or at the discretion of an engineer.

- b. The posted speed limit at the pedestrian crossing.

Record the posted speed limit at the pedestrian cross. The posted speed limit will determine the type of pedestrian treatment as outlined in Table C1. Criteria for Pedestrian Crossing Treatments at Uncontrolled locations in **Appendix C**.

- c. Vehicular stopping sight distances on all approaches.

Measure the SSD of all vehicular approaches and make note of any obstructions that may be removed to improve the SSD.

- d. Pedestrian generators.

Determine if the pedestrian crossing connects at both ends of a multi-use path and make note of all nearby businesses, schools, or transits that may generate foot traffic. Also, determine if there are special events that occur in the area that may increase foot traffic.

4.1.2 Roadway Configuration

It is important to determine the roadway configuration to determine the appropriate crossing treatment(s) that are outlined in Table C1. Criteria for Pedestrian Crossing Treatments at Uncontrolled locations in **Appendix C**.

4.1.3 Existing Treatments

Identify the existing traffic control (if any) and any existing pedestrian crossing treatment (signage, markings, or physical structures), street lighting, and curb ramps.

4.2 Observing Traffic and Operations at the Crossing Location

Traffic and operations observations are split into three major categories: pedestrian volumes, vehicular volumes, and vehicle queueing.

4.2.1 Pedestrian Volumes

The Institute of Transportation Engineers recommends that certain conditions may not warrant the installation of marked crosswalks, such as when the pedestrian hourly peak pedestrian volume is below 25 pedestrians per peak 4 hours. The driver compliance significantly decreases when the pedestrian volume is very low. The following minimum volumes should be considered:

- 20 pedestrians¹ per hour in any one hour,
- 18 pedestrians¹ per hour in any two hours,
- 15 pedestrians¹ per hour in any three hours, or
- 10 school-aged pedestrians traveling to or from school in any one hour.

Therefore, it is important to collect pedestrian crossing volumes during the peak hours of use at the candidate crossing location. This will typically involve collection during AM, mid-day, and PM peak hours and whenever possible, collected during the warm-weather months and during fair weather conditions to represent peak crossing activity.

- a. All pedestrian volumes should include and differentiate between pedestrians and bicyclists.
- b. Note the number of young, elderly, and/or disabled pedestrians.
- c. If the candidate crossing location is anticipated to be used as a school crossing location, the volume of student pedestrians should be counted separately. The counts for school pedestrian volumes should be scheduled on school days when classes are in session.
- d. Note all nearby businesses that may generate pedestrian traffic.
- e. It is recommended that count schedules should coincide with events that may generate pedestrian traffic.

Pedestrian traffic could fluctuate from day-to-day. Therefore, it may be necessary to collect up to three days of pedestrian crossing volumes to determine if crossing treatment is warranted. Daily collection should be as follows:

Day 1: If minimum pedestrian volumes are met, no further pedestrian data is required. If the minimum pedestrian volumes are not met, but at least 50% of the minimum pedestrian volumes are observed, proceed to a second day of data collection.

Day 2: If minimum pedestrian volumes are met, no further pedestrian data is required. If the minimum pedestrian volumes are not met, but at least 50% of the minimum pedestrian volumes are observed, proceed to a third day of data collection.

Day 3: If minimum pedestrian volumes are not met, a marked crossing may not be warranted.

4.2.2 Vehicular Volumes

Collect hourly and average daily traffic volumes for vehicle traffic along the major roadway at the crossing location. A one-day sample with hourly volumes collected during the same hour as the pedestrian crossing volumes should be adequate.

CDOT acknowledges that there may be limited availability of resources to implement pedestrian crossing treatments and therefore, pedestrian crossing treatments should generally not be installed at locations where the average daily traffic volumes are less than 1,500 vehicles per day. Exceptions may be made at school crossings where the peak hour vehicle exceeds 10 percent of the average daily traffic or at the discretion of an engineer.

4.2.3 Vehicle Queuing

Note the presence of vehicle queues extending from nearby signals or intersections into the candidate crossing locations.

¹ Young, elderly, and disabled pedestrians should count as two-times (2x) towards the pedestrian volume.

Vehicle queues can lead to potential safety impacts at the crossing and create the potential for “multiple threat” crashes. If the vehicle queuing in one lane is much shorter than the queuing in the adjacent lane, a motorist would commonly assume that the stopped traffic in the adjacent lane is due to queuing, which may be the case. However, if the vehicle stopped for a pedestrian, instead of a queue, this increases the chances that a pedestrian may step in front of a vehicle that is approaching too fast to stop. Therefore, it is important to be aware of the formations of vehicle queues across pedestrian crossings, especially those resulting in differing queue lengths in adjacent lanes.

4.3 Determining the Appropriate Crossing Treatment

Using the data collected in section 4.1 and 4.2, determine the appropriate crossing treatment (if any) by utilizing Figure C2. Pedestrian Crossing Evaluation Flowchart and Table C1. Criteria for Pedestrian Crossing Treatments at Uncontrolled locations in **Appendix C**. The following should be considered when determining the appropriate crossing treatment.

4.3.1 Pedestrian Median Refuge

A pedestrian median refuge increases pedestrian safety by allowing pedestrians to cross fewer traffic lanes at a time, allowing pedestrians to assess conflicts separately, and by providing a refuge where slower pedestrians can wait for a gap in traffic.

A pedestrian median refuge should include a raised median or island in street crossing paths and should be either a cut through level with the street or have curb ramps with a level area at least 1.2 meters (~4 feet) long between the curb ramps. A painted center median or painted turn lane should never be considered as a pedestrian refuge.

Additional considerations for pedestrian refuges are as follows:

- A raised median nose at an intersection may be considered a pedestrian refuge if the median is at least 4 feet wide and the left turn volume is less than 20 vehicles per hour.
- A raised median at a mid-block pedestrian crossing may be considered a refuge if the median is at least 6 feet wide and includes curb ramps or a walkway at grade through the median.
- For multi-use path crossing locations, a 10-foot median refuge width is desirable.
- Since a cut through path is adjacent to traffic without a barrier, it must have a detachable warning surface, such as “truncated domes”.
- The use of free right turns can create conflicts between vehicles traveling at higher speeds and pedestrians/bicyclists. This problem is not entirely mitigated using “pork chop” channelizing islands.

4.3.2 Rectangular Rapid Flashing Beacons

RRFB are user-actuated amber LEDs that supplement warning signs at unsignalized intersections or mid-block crosswalks. RRFBs are used to assist pedestrians in crossing a roadway by warning traffic. This treatment may be considered at locations that do not meet a warrant for a pedestrian hybrid beacon and the pedestrian volumes exceeds the minimum volumes as follows:

- 20 pedestrians² per hour in any one hour,
- 18 pedestrians² per hour in any two hours,
- 15 pedestrians² per hour in any three hours, or
- 10 school aged pedestrians traveling to or from school in any one hour.

4.3.3 Pedestrian Hybrid Beacons

Pedestrian hybrid beacons, also known as HAWK Beacons, are addressed in Chapter 4F of the 2009 MUTCD. Pedestrian hybrid beacons are used at unsignalized locations to assist pedestrians in crossing a roadway by warning and controlling traffic. This treatment may be considered at locations that do not meet

² Young, elderly, and disabled pedestrians should count as two-times (2x) towards the pedestrian volume.

a warrant for a traffic signal and the vehicle volumes on the major road exceeds the curve in Figure C1. Guidelines for the Installation of Pedestrian Hybrid Beacons or Figure C2. Guidelines for the Installation of Pedestrian Hybrid Beacons on High-Speed Roadways in **Appendix C**.

4.3.4 Pedestrian Traffic Signals

Signal protection at crosswalks is addressed in Chapter 4C of the 2009 MUTCD. Generally, a warrant for a traffic control signal is based on the pedestrian needs according to the following criteria:

- Signalized intersections with substantial pedestrian volumes (100 or more for each of any 4 hours, or 190 or more during any 1 hour).
- There are less than 60 gaps per hour in the major street traffic stream or adequate length for pedestrians to cross.
- The nearest traffic signal along the major street is greater than 300 feet (roughly 100 meters) away.
- Traffic gaps do not provide sufficient time to cross the street or cross to or from a median (when present).
- Where blocks are long and controlled intersections spaced far apart, mid-block marked crosswalks may be appropriate.

4.3.5 Traffic Operations

The installation of RRFBs, pedestrian hybrid beacons, and pedestrian traffic signals may have a significant impact on the operations of a corridor. Vehicle and pedestrian crossing volumes, type of pedestrian populations (college or elementary students, elderly, mixed), and spacing to adjacent signalized intersections should all be considered when selecting a crossing treatment and how it will operate. Pedestrian hybrid beacons and pedestrian traffic signals should coordinate with the signal progression of the corridor.

4.3.6 Unmarked Pedestrian Crossing Facilitation

There may be locations where pedestrians regularly cross the roadway but fall short of the signed and marked pedestrian crossing treatments as defined. In some cases, subject to engineering judgment, it may be appropriate to install unmarked pedestrian crossing facilitations that include curb ramps and/or a raised median refuge. These treatments will only be considered if the location is more than 300 feet from the nearest signed, marked, and/or protected pedestrian crossing, and it is believed that there is little potential to redirect pedestrians to a more defined crossing location.

4.3.7 School Crossings

A school crossing should follow the warrant guide of at least five (5) school children crossing per hour. In addition, all engineering design criteria must be met, which includes:

- The crossing needs to be within 600 feet of a school, or
- Be an official school route as assigned by the school.

The school or district should implement a school crossing guard program as the first. If additional school crossing treatments are warranted, a school zone study should be completed.

4.3.8 Transit Stops

According to the ITE Design and Safety Pedestrian Facilities, two percent of pedestrian crashes in urban areas and three percent of crashes in rural areas are a result of the location of the transit stop on the near side of the intersection. Like “multiple threat” crashes as discussed with vehicle queuing, pedestrians crossing in front of a bus may step into traffic in the adjacent lane that is traveling too fast to stop. For crossing mitigations near transit stops, work with the local transit agency to determine the feasibility of moving the transit stop to the far side of the intersection. If it is not feasible to move the transit stop, consider installing a bus pull out or locate the transit stop 30 feet from the intersection or an existing crossing location

4.3.9 Pedestrian Crossing at Roundabouts

A roundabout, compared to a traditional intersection, typically provides a safer crossing for pedestrians due to the geometric features that allow for a shorter crossing distance, slower vehicular design speeds, fewer vehicular turning movements, and pedestrian refuge in the splitter island when needed. However, it should be noted that roundabout designs remove audible cues that typically exist at traditional intersections making it difficult for the visually impaired to navigate the crossing of a roundabout leg.

Signing at a roundabout is similar to a traditional intersection. Signs should be placed where they have a maximum visibility for motorists, but also located in an area that will not obstruct the view of pedestrians or bicyclists within the crosswalk. Pedestrian Crossing (W11-2) warning signs with diagonal downward pointing arrow (W16-7p) plaques should be used at pedestrian crossings within a roundabout at both entries and exits.

In addition to signing, crosswalks should be located at least 20 feet from the yield point on the entrance and exit of a roundabout. In accordance with the MUTCD, pedestrian crosswalks shall not be marked to or from the central island of a roundabout.

4.3.10 Crosswalk Lighting

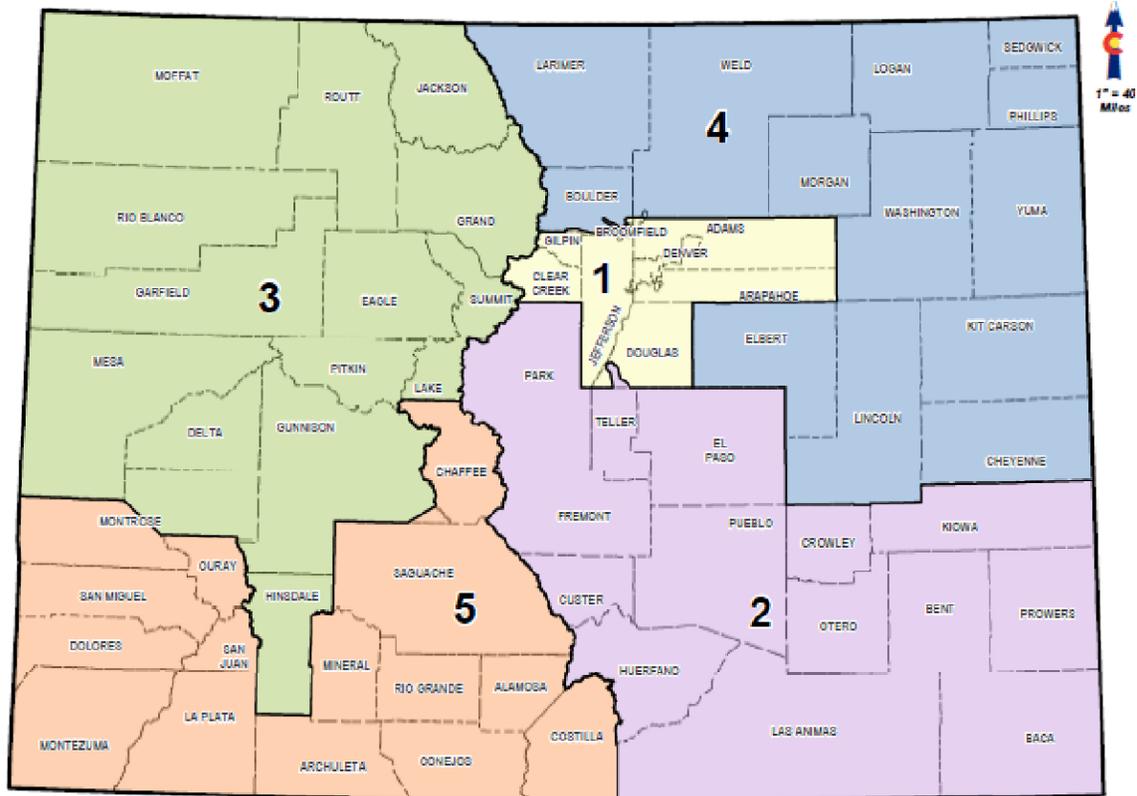
For crosswalk lighting best practices, refer to section 2.2.9 of the 2020 CDOT Lighting Design Guidelines.

Appendix A. Pedestrian Crossing Installation Form

Pedestrian Crossing Installation Request Form

Please complete the Pedestrian Crossing Installation Request form in blue or black ink and return to the corresponding CDOT Regional Traffic Office for evaluation.

Figure A1. CDOT Regional Boundary Map



Region 1 Traffic Engineering

2829 W. Howard Pl., 2nd Floor
 Denver, CO 80204
 (303) 365-7318

Region 2 Traffic Engineering

5615 Wills Blvd
 Pueblo, CO 81008
 (719) 546-5411

Region 3 Traffic Engineering

2328 G Road
 Grand Jct., CO 81505
 (970) 683-6275

Region 4 Traffic Engineering

10601 10th Street
 Greeley, CO 80634
 (970) 350-2121

Region 5 Traffic Engineering

3803 N. Main Ave 100
 Durango, CO 81301
 (970) 385-1449

Description of Proposed Crossing Location		Official School Crossing ³
State Highway & Milepost:	Cross Streets (if applicable):	Crossing Location: At Intersection Mid-Block
Nearest Marked and/or Protected Crossing:		Distance to Proposed Crossing:
Pedestrian Traffic Volumes		
<u>AM Pedestrian Counts</u>	<u>Mid-Day Pedestrian Counts</u>	<u>PM Pedestrian Counts</u>
Peak Hour: Pedestrian Volume:	Peak Hour: Pedestrian Volume:	Peak Hour: Pedestrian Volume:
Please provide the names of businesses and/or other traffic generators at or near the proposed crossing location.		
Pedestrian Crash History		
Crash Reports Attached Please provide a brief description of the pedestrian crash history at this location.		
Additional Information		
Please provide a brief explanation of why the crosswalk is needed.		
Contact Information		
Name of Person Requesting:	Phone Number:	Email:
Street Address:	State:	Zip:

³ An official school crossing must be designated by the school.

Appendix B. Pedestrian Crossing Evaluation Worksheet

Location Description			
State Highway & Milepost:		Major Street:	
		Crossing Location: At Intersection Mid-Block Roundabout	
Existing Traffic Control: Stop Sign Traffic Signal Uncontrolled		Existing Crossing Treatments (if any):	
Official School Crossing: Yes No		Speed Limit:	
Official School Crossing:		Nearby Pedestrian Generators (schools, transit stops, commercial businesses, etc.):	
Roadway Configuration: 2-Lane 3-Lane w/ Striped Median 3-Lane w/ Raised Median 4-Lane 5-Lane w/ Striped Median 5-Lane w/ Raised Median 6-Lane Other: _____		Crossing Distance by Direction: Total Distance: _____ Dist. to Median: _____ N E S W Other _____ Dist. to Median: _____ N E S W Other _____	
Stopping Sight Distance (uncontrolled locations only): _____		Is the SSD \geq 8x the speed limit? Yes No	
		If no, are improvements to SSD feasible? Yes No	

Traffic Volumes and Operations

Time of Day:	AM	MID-DAY	PM	OTHER
Start and End Time:	to	to	to	to
Day of Week:				
No. of Transit Boardings (if applicable):				
No. of Young, Elderly, and Disabled Peds (YED):				
No. of Bicyclists:				
No. of Non YED Pedestrians:				
Total Pedestrians (adjusted for 2x YED):				
Major Street Vehicle Volume (Daily): _____	vehicles/day			

Nearest Intersection (Direction #1)

Cross Street Name: _____

Located _____ feet to the N E S W of the crossing location. Signalized? Yes No

Time of Day:	AM	MID-DAY	PM	OTHER
How many times per hour did the downstream vehicle queue back up into the pedestrian crossing?				
If multiple lanes per direction, are queue lengths approximately equal?	Yes No	Yes No	Yes No	Yes No
If no, which lane is longer (inside, outside, middle) and by how much?				

Nearest Intersection (Direction #2)

Cross Street Name: _____

Located _____ feet to the N E S W of the crossing location. Signalized? Yes No

Time of Day:	AM	MID-DAY	PM	OTHER
How many times per hour did the downstream vehicle queue back up into the pedestrian crossing?				
If multiple lanes per direction, are queue lengths approximately equal?	Yes No	Yes No	Yes No	Yes No
If no, which lane is longer (inside, outside, middle) and by how much?				

Appendix C. Figure and Tables

Figure C1. Guidelines for the Installation of Pedestrian Hybrid Beacons on Low-Speed Roadways

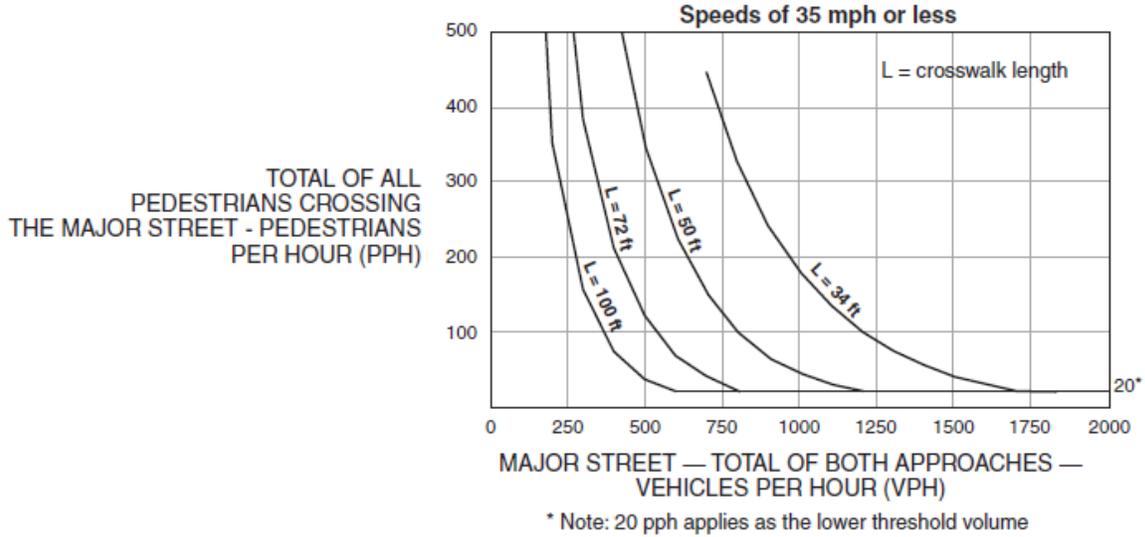


Figure C2. Guidelines for the installation of Pedestrian Hybrid Beacons on High-Speed Roadways

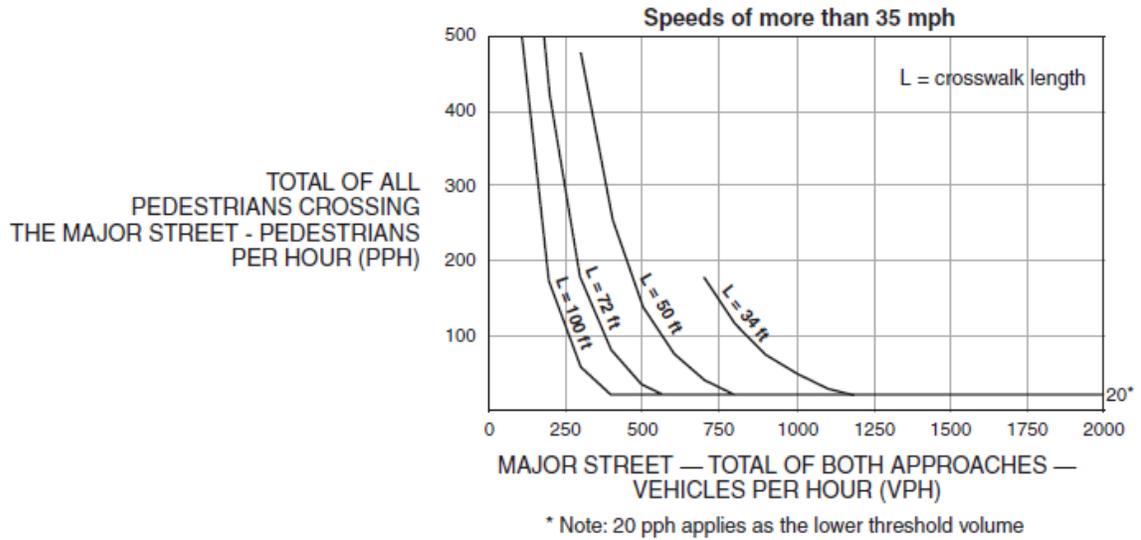
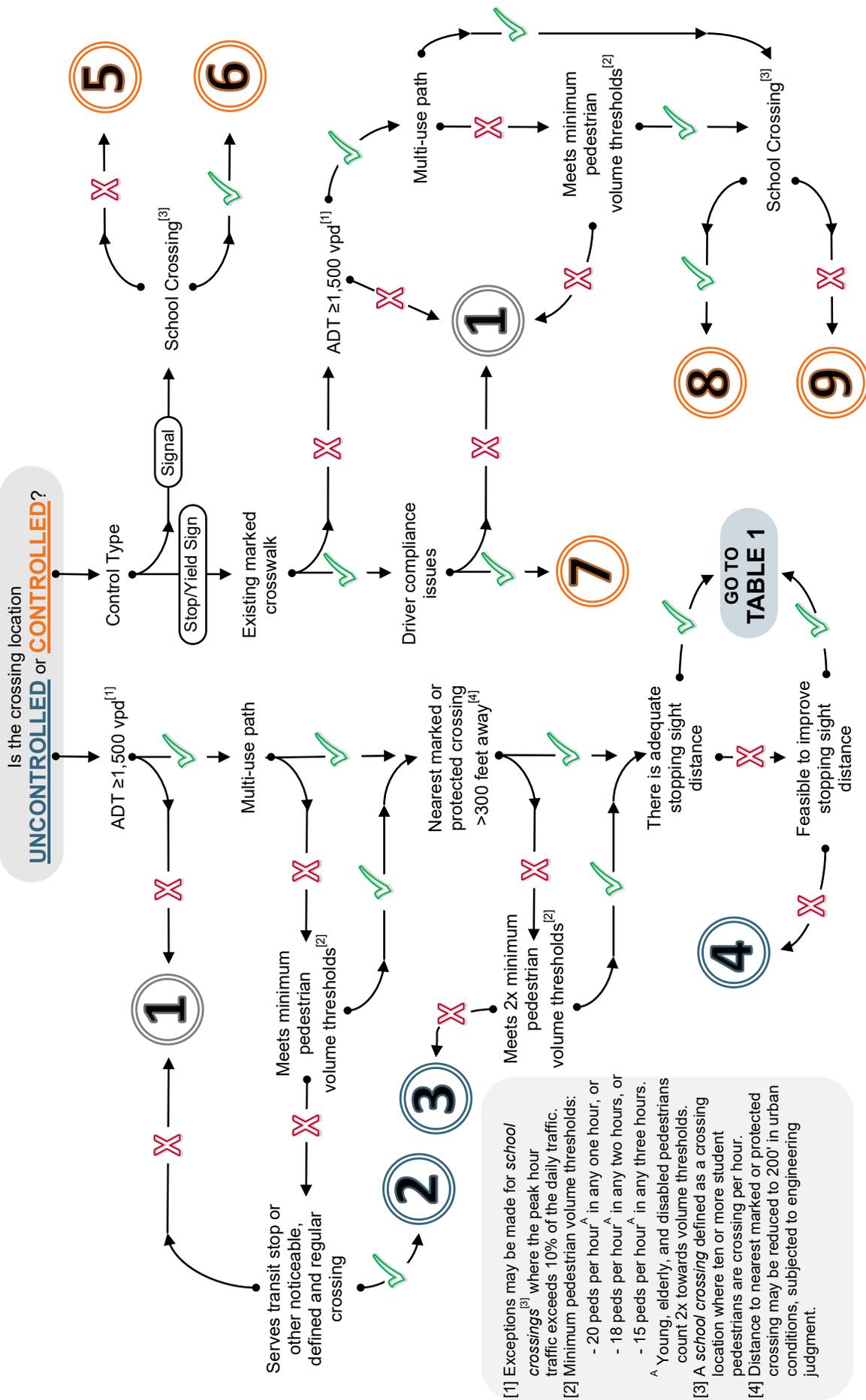


Figure C3. Pedestrian Crossing Evaluation Flowchart



[1] Exceptions may be made for school crossings^[3] where the peak hour traffic exceeds 10% of the daily traffic.
 [2] Minimum pedestrian volume thresholds:
 - 20 peds per hour^A in any one hour, or
 - 18 peds per hour^A in any two hours, or
 - 15 peds per hour^A in any three hours.
^A Young, elderly, and disabled pedestrians count 2x towards volume thresholds.
 [3] A school crossing defined as a crossing location where ten or more student pedestrians are crossing per hour.
 [4] Distance to nearest marked or protected crossing may be reduced to 200' in urban conditions, subjected to engineering judgment.

- 1** No action is recommended at this time.
- 2** Consider installing an unmarked pedestrian crossing facilitation.
- 3** Direct pedestrians to the nearest marked or protected crossing.
- 4** Direct pedestrians to the nearest marked or protected crossing, OR consider installing a pedestrian hybrid beacon, traffic signal, or grade-separated crossing.
- 5** Install a marked crosswalk.
- 6** Install a marked crosswalk with a school crossing sign (S1-1) on a mast arm.
- 7** Consider neck downs, median refuge, or additional signs to increase drive awareness of pedestrians.
- 8** Install marked crosswalk with school pedestrian crossing sign (S1-1) and down arrow (16-7p) at the crosswalk plus an advanced (S1-1) signs.
- 9** Install marked crosswalk with W1 1-2 advanced pedestrian signs.

Table C1. Criteria for Pedestrian Treatments at Uncontrolled Locations

The criteria for pedestrian crossing treatments at uncontrolled locations is intended as a general minimum. Engineering judgment should be used on a case-by-case basis. The prevailing speed may be used if it is significantly different than the posted speed.

Roadway Configuration	Roadway ADT and Posted Speed (mph)															
	1,500 – 9,000 vpd				9,001 – 12,000 vpd				12,001 – 15,000 vpd				> 15,000 vpd			
	≤30	35	40	≥45	≤30	35	40	≥45	≤30	35	40	≥45	≤30	35	40	≥45
2 lanes, one-way street	A	B	C	E	A	B	C	E	B	B	C	E	B	C	C	E
2 lanes, two-way street with no median	A	B	C	E	A	B	C	E	B	B	C	E	B	C	C	E
3 lanes with raised median	A	B	D	E	A	C	D	E	B	D	D	E	C	D	D	E
3 lanes without raised median	C	C	D	E	C	C	D	E	C	C	D	E	C	D	D	E
4 lanes with raised median	A	B	C	E	A	B	C	E	B	B	C	E	B	C	C	E
4 lanes, two-way street without raised median	A	D	D	E	B	D	D	E	B	D	D	E	D	D	D	E
5 lanes with raised median	A	B	D	E	B	C	D	E	B	C	D	E	C	C	D	E
5 lanes without raised median	D	D	D	E	D	D	D	E	D	D	D	E	D	D	D	E
6 lanes with or without raised median	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F

Treatment Descriptions:

- A. Install marked crosswalk with enhanced roadside signs.
Install a marked crosswalk with a standard W11-2 with a W16-7p plaque mounted on the side of the roadway at the crosswalk location and a standard W11-2 advanced pedestrian warning sign. Use S1-1 signs for school crossing locations. An optional R1-6 may be used in addition.
- B. Install marked crosswalk with enhanced roadside and in-roadway signs.
- C. Install marked crosswalk with enhanced signs and geometric improvements to increase pedestrian visibility and reduce exposure.
- D. Install marked crosswalk with enhanced signs, pedestrian activated RRFBs, and geometric improvements to increase visibility pedestrian and reduce exposure.
- E. Do not install marked crosswalk at uncontrolled crossing. Determine if speed limit can effectively be reduced to 40 mph by making geometric or other infrastructure changes (i.e., bulb out, median refuge, etc.). If so, utilize criteria D above. If this is not possible, if pedestrian volume meets warrants, consider a pedestrian hybrid beacon, pedestrian traffic signal, or grade separated crossing.
- F. Do not install marked crosswalk at uncontrolled crossings with three (3) or more through lanes per direction or where the speed limit is greater or equal to 45 mph and/or there is not a median refuge on a 5-lane crossing. Consider pedestrian hybrid beacon, pedestrian traffic signal, or separated crossing.



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