

# City of Stockton

## Pedestrian Safety and Crosswalk Installation Guidelines (2020 Update)

October 2020

**Prepared for:** City of Stockton

OC17-0532

FEHR  PEERS

# Table of Contents

---

<b>Glossary .....</b>	<b>1</b>
<b>Introduction.....</b>	<b>4</b>
<b>Function of Crosswalks.....</b>	<b>5</b>
Why do cities mark crosswalks? .....	5
Steps in identifying candidate locations for crosswalks .....	5
<b>Crosswalk Safety Research .....</b>	<b>7</b>
FHWA Study Summary (2002) .....	8
FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations (2018) .....	8
<b>Crossing and Pedestrian Guidance.....</b>	<b>11</b>
Controlled Locations.....	11
Best Practices.....	11
Special Treatments.....	11
Uncontrolled Locations.....	15
When to Install Crosswalks at Uncontrolled Intersections .....	15
When to Install Crosswalks at Mid-Block Locations .....	15
Safety Considerations at Uncontrolled Locations.....	16
Special Treatments for Uncontrolled Locations .....	16
Trail Crossings.....	21
Choosing the Right Treatment for Crosswalks at Uncontrolled Locations.....	21
Compact Intersection Design.....	23
Sidewalks and Curb Ramps.....	25
Sidewalks.....	25
Curb Ramps.....	26
Development Review.....	26
Impact on the existing pedestrian system.....	26
Pedestrian travel patterns and access .....	26
Pedestrian circulation and access.....	26
Safety of Operations.....	27
Internal Pedestrian Circulation .....	27
Access to Transit .....	27
Developer Education Program .....	27

## List of Tables and Figures

---

Figure 1: Application of Pedestrian Crash Countermeasures by Roadway Feature .....	9
Figure 2: "Triple Four" Crosswalks .....	17
Figure 3: Cross Walk Placement Flow Chart for Uncontrolled Locations .....	22

# Glossary

**Actuated Signal:** A traffic signal where the amount of time for each phase is controlled by the direct or indirect actions of the user such as push buttons, or video, inductive loop or other type of detection devices.

**Advance Stop Line (ASL):** A stop line at an intersection or mid-block crossing placed before a marked crosswalk.

**Average Daily Traffic (ADT):** The total bi-directional volume of traffic passing through a given point during a 24-hour period.

**Approach:** This is the portion of an intersection leg used by incoming traffic.

**AASHTO:** American Association of State Highway and Transportation Officials.

**Bulbout:** Also known as a curb extension, which protrudes into the street at an intersection or mid-block crossing to reduce the crossing distance and exposure for pedestrians, and to reduce vehicular traffic speeds.

**Controlled Location:** Intersection or mid-block crossing location with a traffic signal or stop sign.

**Channelization:** This is the separation or regulation of conflicting traffic movements into definite paths of travel by use of pavement markings, raised islands or other suitable means to facilitate the safe and orderly conduct of vehicles and/or pedestrians.

**Crosswalk:** Portion of roadway where pedestrians are permitted to cross the street; may be marked or unmarked.

**CTCDC:** California Traffic Control Device Commission.

**Curb Radius:** The radius of the circle joining the intersecting street curbs at a corner.

**Curb Ramp:** A combined ramp and landing that accomplishes a change in level at a curb. This element provides street and sidewalk access to pedestrians using wheelchairs.

**Cycle Time:** Time, in seconds, required for one complete sequence of signal indications for all movements at a given intersection.

**Delay:** This is the lost time (compared to free flow conditions) for vehicles, pedestrians or bicyclists.

**Detectable Warning:** A surface specified in the *Americans with Disabilities Act Accessibility Guidelines*, comprised of raised, truncated domes, used to inform pedestrians who are visually impaired, of road and rail vehicle crossings in the area immediately ahead.

**85<sup>th</sup> Percentile Speed:** The average speed at which 85 percent of drivers on a particular roadway are traveling.

**Exclusive Pedestrian Phase:** Signal phase during which only pedestrians are permitted to cross an intersection and all vehicular signals display red.

**FHWA:** Federal Highway Administration.

**Green Time:** This is the length of a green indication for a particular traffic movement.

**Island:** A defined area between traffic lanes for control of vehicle movements and/or for pedestrian refuge.

**Level of Service (LOS):** This is a measure of the mobility characteristics of transportation facility. Level of service for vehicles is determined by the delay or the volume/capacity ratio. Pedestrian and bicycle level of service can be quantitative or qualitative, using measures such as connectivity, comfort, accessibility and convenience.

**Median:** Portion of a divided highway or roadway separating the traveled ways for traffic moving in opposite directions. This may consist of a paved surface, unpaved surface, or raised island that can also serve as a refuge for pedestrians and other non-motorized roadway users.

**Mid-block Crossing:** A crossing point positioned between intersections rather than at an intersection.

**MUTCD:** The Manual for Uniform Traffic Control Devices, a compilation of national standards for all traffic control devices.

**Pedestrian:** A person who travels on foot or who uses assistive devices, such as a wheelchair, for mobility.

**Pedestrian Hybrid Beacon (PHB):** A type of beacon used to warn and control traffic at an unsignalized location, to assist pedestrians in crossing a street or highway at a marked crosswalk. Also referred to as a High-Intensity Activated Crosswalk Beacon (HAWK).

**Rapid Rectangular Flashing Beacon (RRFB):** A pedestrian-actuated crossing device that provides a high-visibility strobe-like warning to drivers when pedestrians are in a crosswalk.

**Refuge Island:** A median island that is designed to allow pedestrians to cross a street safely.

**Safe Routes to Schools:** An approach that promotes walking and bicycling to school through strategies such as infrastructure improvements, safety education, and incentives.

**Safe Routes for Seniors:** An approach that targets improving the safety and desirability of walking and bicycling for older adults.

**Scramble Phase:** Pedestrians are permitted to cross in all directions at an intersection including diagonally, during an exclusive pedestrian signal phase.

**Sight Distance (SD):** The length of roadway visible to the driver, bicyclist or pedestrian with an unobstructed line of sight.

**Signal Cycle:** One complete sequence of signal indications for all movements at a given intersection.

**Signal Progression:** Progressive movement of traffic (without stopping) at a planned speed, through signalized locations.

**Signage or Markings:** Regulatory signs and roadway markings, such as STOP or YIELD.

**SJRTD:** San Joaquin Regional Transit District.

**Stopping Sight Distance:** The distance traveled by a vehicle from the instant a driver of a vehicle sights an object necessitating a stop to where the vehicle is fully stopped, including the time needed to recognize the situation and apply the brakes.

**Turning Radius:** The minimum path of a turning vehicle at a corner. See also "curb radius."

**Traffic Calming Device:** A physical or visual measure used to divert or slow traffic.

**Uncontrolled Location:** Intersection or mid-block crossing without a traffic signal or stop sign.

**Volume:** The number of vehicles, bicyclists, or pedestrians passing a given point during a specified period.

**Warrants:** Warrants are intended to provide guidance to the transportation professional in evaluating potential safety and operational benefits of installing improvements based on 'average' or 'normal' conditions. Warrants are not a substitute for engineering judgment. The fact that a warrant is met is not conclusive justification for the installations. Reliance exclusively on warrants may fail to provide adequate facilities for pedestrians, especially those with disabilities.

# Introduction

The City of Stockton is developing a Neighborhood Traffic Management Program (NTMP) to develop a process for implementing “traffic calming” measures to address safety concerns, traffic problems and quality-of-life issues related to speeding on neighborhood streets. Additionally, the City is also revising its street design standards to reduce the need to implement traffic calming measures in the future.

This document complements the NTMP and Street Design Standards by providing guidelines for improving pedestrian safety and enhancing pedestrian circulation. A comprehensive pedestrian safety strategy contains a five-pronged approach of engineering, enforcement, encouragement, education, and evaluation. This document focuses on engineering elements, such as pedestrian crossing treatments and intersection design.

This document describes best practices related to numerous pedestrian treatments, including: pedestrian signals, pedestrian refuge islands, compact intersections, sidewalks, and crosswalks. It includes information about signalized and unsignalized locations, intersection design, and innovative treatments for at-grade crossings. It also includes recommendations for evaluating pedestrian safety as part of the development review process. This document is intended to serve as a reference guide for staff, citizens, and developers when determining the best engineering solutions to pedestrian safety concerns, particularly with regard to the location and design of crosswalks, pedestrian signals, and other elements of pedestrian safety.

Development of pedestrian safety guidelines will guide the City and developers in making decisions about where basic crosswalks (two stripes) can be marked; where crosswalks with special treatments, such as high visibility crosswalks, flashing beacons and other special features, should be employed; and, where crosswalks will not be marked due to safety concerns resulting from volume, speed or sight distance issues.

The City currently has a policy of prohibiting new crosswalks at uncontrolled locations (intersections and mid-block locations without a signal or stop sign), unless approved by City Council action. At controlled intersections, the City’s current policy is to install crosswalks where there is a demonstrated need.

The Pedestrian Safety and Crosswalk Installation Guidelines establish criteria for considering crosswalks at unsignalized or mid-block locations. The guidelines also recommend that crosswalks be installed at all approaches to controlled intersections unless safety or signal-phasing concerns suggest otherwise.

# Function of Crosswalks

Well-marked pedestrian crossings accomplish dual goals. They prepare drivers for the likelihood of encountering a pedestrian, and they create an atmosphere of walkability and accessibility for pedestrians. In California, it is legal for pedestrians to cross any street, except at unmarked locations between immediately adjacent signalized crossings or where crossing is expressly prohibited. Marked crossings reinforce the location and legitimacy of a crossing.

## Why do cities mark crosswalks?

Crosswalk Function:

- Creating reasonable expectations where pedestrians may cross a roadway
- Predictability of pedestrian actions, movement, and crossing locations
- Channelization of pedestrians to designated crossing locations

Advantages of marked crosswalks:

- Help pedestrians find their way across complex intersections
- Designate the shortest path
- Direct pedestrians to locations of best sight distance

Disadvantages of marked crosswalks:

- May create a "false sense of security" for pedestrians
- At uncontrolled locations on multi-lane streets with higher traffic volumes, may result in a greater number of pedestrian collisions if additional enhancements are not provided
- Maintenance is costly

## Steps in identifying candidate locations for crosswalks

The first step in identifying candidate crosswalk locations is to identify the places people would like to walk (pedestrian desire lines) which are affected by local land uses (homes, schools, parks, commercial establishments, etc.) and the location of transit stops. This information forms a basis for identifying pedestrian crossing improvement areas and prioritizing such improvements, thereby creating a convenient, connective and continuous walking environment.

The second step is identifying where it is safest for people to cross. Of all road users, pedestrians have the highest risk because they are the least protected. National statistics indicate that pedestrians represent 14 percent of all traffic incident fatalities while walking accounts for only three percent of

total travel trips. Pedestrian collisions occur most often when a pedestrian is attempting to cross the street at an intersection or mid-block location<sup>1</sup>.

Several major studies of pedestrian collision rates at marked and unmarked crosswalks have been conducted. In 2002, the Federal Highway Administration (FHWA) published a comprehensive report on the relative safety of marked and unmarked crossings. This document presents a variety of special treatment options to mitigate safety, visibility or operational concerns at specific locations. This was followed in 2018 by the publication of a guide to countermeasures for pedestrian safety at uncontrolled crossings. The flowchart in **Figure 3** outlines the steps in identifying candidate locations for crosswalks based on the findings of the 2018 FHWA report described on p. 8.

---

<sup>1</sup> *Pedestrian Crash Types, A 1990's Information Guide*, FHWA; This paper analyzed 5,076 pedestrian crashes that occurred during the early 1990's. Crashes were evenly selected from small, medium, and large communities within six states: California, Florida, Maryland, Minnesota, North Carolina, and Utah.

# Crosswalk Safety Research

A study by the City of San Diego in 1970 found that a higher rate of collisions involving pedestrians occurred at uncontrolled locations with marked crosswalks. However, the City of San Diego study, which was widely used by many other cities as a rationale for removing marked crosswalks at uncontrolled locations, fails to differentiate between different types of streets and crossing locations. A separate study conducted on California State highways reached similar conclusions in 1996, but this study was also limited in its applicability to City streets that typically have fewer lanes and carry less traffic volume than State highways.

Research conducted by the Federal Highway Administration (FHWA) in 2002 found that on two-lane roads, the presence of a marked crosswalk alone at an uncontrolled location was associated with no difference in pedestrian crash rate, compared to an unmarked crosswalk. On multi-lane roads with higher traffic volumes, having a marked crosswalk alone was associated with a higher pedestrian crash rate compared to an unmarked crosswalk (see p. 8 for more information on the findings of the FHWA study). This research may be more relevant for developing a crosswalk policy for the City due to the City's varying street types.<sup>2</sup>

The 2002 FHWA study of pedestrian collisions at marked and unmarked crosswalks is widely recognized as a resource for determining appropriate locations for marked crosswalks at uncontrolled locations. This study is used because:

- It is extensive - It examined motor vehicle/pedestrian collision rates at a large number of crossing locations not limited by roadway characteristics in 30 different cities
- It is thorough- The collision rates were broken down by roadway characteristics (two-lane and multi-lane roads with various speeds and traffic volumes) in order to give the clearest picture of pedestrian safety at each type of location

The authors of the study note that:

*"When considering marked crosswalks at uncontrolled locations, the question should not simply be: 'Should I provide a marked crosswalk or not?' Instead, the question should be: 'Is this an appropriate tool for getting pedestrians across the street?' Regardless of whether marked crosswalks are used, there remains the fundamental obligation to get pedestrians safely across the street."<sup>3</sup>*

The study was subsequently followed by updated guidance from the FHWA in 2018 on best practices for installing countermeasures at uncontrolled crossing locations.

---

<sup>2</sup> Zegeer, Charles V., Stewart, J. Richard, and Huang, Herman, "Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations: Executive Summary and Recommended Guidelines," University of North Carolina Highway Safety Research Center for Federal Highway Administration, February 2002.

<sup>3</sup> Zegeer et al, opp.cit. p. 1

## FHWA Study Summary (2002)

*Study Objective:* To compare pedestrian crash occurrence at marked versus unmarked crosswalks at uncontrolled intersections throughout the U.S.

*Data:*

- 1,000 marked and 1,000 unmarked crossings
- No school crossings
- Mid-block locations were included
- Crash history (5 years), pedestrian volumes, traffic volumes, number of lanes, speed limit
- 229 pedestrian accidents in the sample

*Key findings:*

- 2-lane roads: No significant difference between marked and unmarked crosswalks
- Multi-lane road with Average Daily Traffic (ADT) below 12,000: No significant difference between marked and unmarked crosswalks
- Multi-lane road with ADT above 12,000 and no raised median: Marked crosswalks had significantly higher pedestrian crash rates than unmarked crosswalks
- Multi-lane road with ADT above 15,000 and with raised median: Marked crosswalks had significantly higher pedestrian crash rates than unmarked crosswalks
- Variables having no effect: Area type, mid-block versus intersection, speed limit, one-way versus two-way, crosswalk condition and marking pattern had no effect on the occurrence of pedestrian crashes
- Multiple threat crashes: 17.6 percent of the crashes in marked crosswalks were multiple threat crashes (i.e. one vehicle stops for the pedestrian but the driver in the adjacent lane does not see the pedestrian). None occurred in unmarked crosswalks

## FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations (2018)

In 2018, FHWA published an updated guide designed to assist agencies with selecting appropriate pedestrian crash countermeasures. The guide synthesizes previous recommendations from FHWA, and is based on published literature, best practices, and national guidance, and encourages taking a comprehensive and holistic approach to identify potential location for crosswalks. The guide has become the standard by which to identify appropriate countermeasures at uncontrolled crossing locations.

**Figure 1** illustrates the recommended guidance for countermeasures by roadway feature, including vehicle volume, lane configuration, and posted speed limits.

**Figure 1: Application of Pedestrian Crash Countermeasures by Roadway Feature**

Roadway Configuration	Posted Speed Limit and AADT								
	Vehicle AADT <9,000			Vehicle AADT 9,000–15,000			Vehicle AADT >15,000		
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph
<b>2 lanes</b> (1 lane in each direction)	① 2 4 5 6	① 5 6 7 9	① 5 6 ⑦ ⑨	① 4 5 6	① 5 6 7 9	① 5 6 ⑦ ⑨	① 4 5 6 7 9	① 5 6 7 9	① 5 6 ⑨
<b>3 lanes with raised median</b> (1 lane in each direction)	① 2 3 4 5	① ③ 5 7 9	① ③ 5 ⑦ ⑨	① 3 4 5 7 9	① ③ 5 ⑦ ⑨	① ③ 5 ⑦ ⑨	① ③ 4 5 7 9	① ③ 5 ⑦ ⑨	① ③ 5 ⑨
<b>3 lanes w/o raised median</b> (1 lane in each direction with a two-way left-turn lane)	① 2 3 4 5 6 7 9	① ③ 5 6 7 9	① ③ 5 6 ⑨	① 3 4 5 6 7 9	① ③ 5 6 ⑦ ⑨	① ③ 5 6 ⑨	① ③ 4 5 6 7 9	① ③ 5 6 ⑨	① ③ 5 6 ⑨
<b>4+ lanes with raised median</b> (2 or more lanes in each direction)	① ③ 5 7 8 9	① ③ 5 7 8 9	① ③ 5 8 ⑨	① ③ 5 7 8 9	① ③ 5 ⑦ 8 ⑨	① ③ 5 8 ⑨	① ③ 5 ⑦ 8 ⑨	① ③ 5 8 ⑨	① ③ 5 8 ⑨
<b>4+ lanes w/o raised median</b> (2 or more lanes in each direction)	① ③ 5 6 7 8 9	① ③ 5 ⑥ 7 8 9	① ③ 5 ⑥ 8 ⑨	① ③ 5 ⑥ 7 8 9	① ③ 5 ⑥ ⑦ 8 ⑨	① ③ 5 ⑥ 8 ⑨	① ③ 5 ⑥ ⑦ 8 ⑨	① ③ 5 ⑥ 8 ⑨	① ③ 5 ⑥ 8 ⑨

Given the set of conditions in a cell,

- # Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.
- Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.
- Signifies that crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures.\*

The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.

- 1 High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning signs
- 2 Raised crosswalk
- 3 Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line
- 4 In-Street Pedestrian Crossing sign
- 5 Curb extension
- 6 Pedestrian refuge island
- 7 Rectangular Rapid-Flashing Beacon (RRFB)\*\*
- 8 Road Diet
- 9 Pedestrian Hybrid Beacon (PHB)\*\*

Source: FHWA, 2018.<sup>4</sup>

<sup>4</sup> This table was developed using information from: Zegeer, C.V., J.R. Stewart, H.H. Huang, P.A. Lagerwey, J. Feaganes, and B.J. Campbell. (2005). Safety effects of marked versus unmarked crosswalks at uncontrolled locations: Final report and recommended guidelines. FHWA, No. FHWA-HRT-04-100, Washington, D.C.; FHWA. Manual on Uniform Traffic Control Devices, 2009 Edition. (revised 2012). Chapter 4F, Pedestrian Hybrid Beacons. FHWA, Washington, D.C.; FHWA. Crash Modification Factors (CMF) Clearinghouse. <http://www.cmfclearinghouse.org/>; FHWA. Pedestrian Safety Guide and Countermeasure Selection System (PEDSAFE). <http://www.pedbikesafe.org/PEDSAFE/>; Zegeer, C., R. Srinivasan, B. Lan, D. Carter, S. Smith, C. Sundstrom, N.J. Thirsk, J. Zegeer, C. Lyon, E. Ferguson, and R. Van Houten. (2017). NCHRP Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments. Transportation Research Board, Washington, D.C.; Thomas, Thirsk, and Zegeer. (2016). NCHRP Synthesis 498: Application of Pedestrian Crossing Treatments for Streets and Highways. Transportation Research Board, Washington, D.C.; and personal interviews with selected pedestrian safety practitioners.

Marked crosswalks must be installed carefully and selectively. Before installing new marked crosswalks, an engineering study is needed to determine whether a location is suitable for a marked crosswalk. For an engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, etc. may be needed at other sites. It is recommended that a minimum of 20 pedestrian crossings per peak hour (or 15 or more elderly and/or child pedestrians) exist at a location before placing a high priority on the installation of a marked crosswalk alone.

These guidelines include intersection and midblock locations with no traffic signals or stop signs on the approach to the crossing. They may not apply to school crossings. A two-way center turn lane is not considered a median. Crosswalks should not be installed at locations that could present an increased safety risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone will not make crossings safer, nor will they necessarily result in more vehicles stopping for pedestrians. Whether or not marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic-calming measures, curb extensions), as needed, to improve the safety of the crossing. These are general recommendations; good engineering judgment should be used in individual cases for deciding where to install crosswalks.

Where the posted speed limit or 85th percentile speed exceeds 35 mph, marked crosswalks should not be used at uncontrolled locations without the installation of additional countermeasures.

The raised median or refuge island must be at least 4 ft. (1.2 m) wide and 6 ft. (1.8 m) long to adequately serve as a refuge area for pedestrians.

# Crossing and Pedestrian Guidance

## Controlled Locations

### Best Practices

The following is the recommended, or best practice, for pedestrian treatments in crosswalks at signalized intersections or stop-controlled approaches (i.e., vehicles stop at approach in question).

- **Mark Crosswalks on all approaches** (i.e., legs of the intersection) using standard crosswalk markings or high-visibility markings. Where the accident data or observations of conflicts identify a crosswalk of particular concern, consider special treatments (identified below under “Solutions”)
- **Pedestrian signals should be timed for a pedestrian travel speed of up 3.5 feet per second<sup>5</sup>**. If there are special land uses such as senior centers or schools within 100 feet of the intersection, or if older or disabled pedestrians routinely use the crosswalk, a walking speed of 2.8 feet per second should be considered.

The following two situations are **exceptions** to the policy of marking crosswalks on all approaches:

- **Crossing locations with heavy right- or left-turn volumes** that occur during the same signal phase as the conflicting pedestrian movement where protected signal phasing for the heavy movement or other solutions are infeasible<sup>6</sup>
- **Intersections with inadequate sight distance<sup>7</sup>** of pedestrians. Elimination of crosswalks in these instances should only occur after other solutions have been deemed infeasible

### Special Treatments

There are a number of innovative treatments for pedestrians at signalized intersections, mostly related to pedestrian signals. At locations with high pedestrian volumes and pedestrian-vehicle conflicts, the following measures are means to enhance the safety of pedestrian crossings:

#### *High Numbers of Turning Vehicles*

**Leading Pedestrian Intervals (LPI), or Early Release**, allows pedestrians additional time to establish themselves in the crosswalk, reducing conflicts between pedestrians and turning vehicles

**Special Pavement stencils** such as “Pedestrians Look Left” or “Watch Turning Vehicles” stencil are used in Salt Lake City, Halifax, N.S., Canada, and the UK to remind pedestrians to be watchful. These stencils, used in conjunction with special signage, significantly reduced the number of pedestrians not

---

<sup>5</sup> CA MUTCD, Section 4E.06, Pedestrian Intervals and Signal phases.

<sup>6</sup> Alternative pedestrian crossings should be identified and it may be necessary to install barrier treatments to reinforce that pedestrian should not cross at the location without a marked crosswalk.

<sup>7</sup> Unrestricted sight distance of pedestrians by motorists should be at least ten times the speed limit (for example, 250 feet for a street with a speed limit of 25 miles per hour).

looking for threats at intersections.<sup>8</sup> Additionally, high-visibility crosswalks help channelize pedestrians

Other special treatments include **“Yield to Pedestrians” signs**, and **reduced corner radii** to slow the speeds of right-turning vehicles. The curb radius should accommodate the expected amount and type of traffic for safe turning speeds. As the curb radius increases, incomplete stops become more frequent and drivers make turns at higher speeds.<sup>9</sup> Recommended ranges for curb radii are contained in the *Street Design Standards* and include: 15 feet for intersecting residential streets (local or collector), 20 feet to 30 feet for non-residential local and collector intersections. For arterial intersections, the City’s current standards require a curb radius of 30 feet, except for industrial streets in which a 50-foot radius is required to accommodate a higher volume of truck turning movements

Whenever possible, especially at locations adjacent to pedestrian generators, intersections should be designed **without “free rights”** for vehicles. When “free rights” are necessary, see the figure on p. 24 for the recommended design

### **High Numbers of Pedestrians**

**Pedestrian “scramble” phases**, so called because pedestrians have a walk signal in every direction while vehicles have a red light on all approaches. This treatment is appropriate in central business districts where pedestrian volumes are exceptionally high

**“No Right Turn on Red” restrictions** for vehicles reduce pedestrian-vehicle conflicts at locations with high numbers of pedestrians but make vehicle circulation less convenient and may cause traffic diversions. This type of treatment needs to be considered on a case-by-case basis. City policy requires that traffic signal service levels need to remain at acceptable levels

**Advance stop lines or yield lines** are stop or yield bars placed four feet in advance of the crosswalk. Advance stop lines or yield bars should be considered based on pedestrian volumes, generators and safety concerns relevant to a specific crossing

### **Wide Intersections**

**Countdown signals** are used at crosswalks where there is a pedestrian clearance interval greater than 7 seconds or a high pedestrian volume. The countdown signal effectively communicates the amount of time left to cross the street. At wide streets with medians, there should be adequate crossing time for the pedestrian to traverse the entire distance and countdown signals should be used as a default



---

<sup>8</sup> Van Houten, Ron et al, “Special Signs and Pavement Markings Improve Pedestrian Safety,” *ITE Journal*, December 1996.

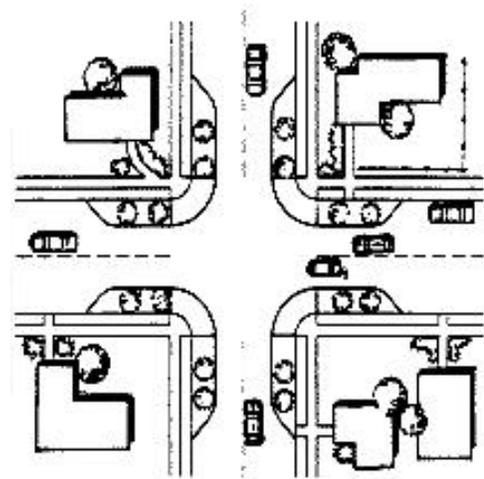
<sup>9</sup> Kulash, William M., [Residential Streets](#), Urban Land Institute, 2001.

**Pedestrian Refuge Islands** should extend through the crosswalk, with a curb cut for wheelchair accessibility. Refuge islands should be clear of obstructions and have adequate drainage. They should be at least 12 feet long or the width of the crosswalk (whichever is greater) and 60 feet square. At actuated pedestrian signals, an accessible pedestrian push button should also be located in the median. Recommended refuge island widths are as follows<sup>10</sup>:



Speed	Minimum Width
25-30 mph	5 feet
30-35 mph	6 feet
35-45 mph	8 feet

**Bulbouts** are appropriate at locations with usable space next to the curb. Consider bulbouts at intersections of three or more lanes. Bulbouts should not extend further than six feet into the street adjacent to parallel parking, or 12 feet adjacent to diagonal parking. At locations with no on-street parking, bulbouts should not impede bicycle travel.



<sup>10</sup> Where bikes are expected to use the crosswalk, medians should be at least six feet wide, the length of an average bike.

## Pedestrian actuated signals

At pre-timed signals, pedestrians get the signal to walk on every crossing, in every signal cycle. However, many signals are not pre-timed, meaning vehicles activate them. These signals have pedestrian pushbuttons, which pedestrians must push in order to get a walk signal and adequate time to cross the street.

At locations where pedestrian activation is registered for greater than 75 percent of the peak hour signal cycles, signals could be set to accommodate pedestrian crossings in every peak period cycle

At locations that are not on a direct path to a generator with low side- street volumes, signals should be partially-actuated, meaning that pedestrians crossing the side streets get a WALK signal on every cycle, but pedestrians crossing the main street must use the pedestrian push button

At locations that do not satisfy the location warrants above, where peak hour vehicle congestion and high vehicle volumes occur on all approaches, signals should be fully actuated.

When pedestrian push buttons are used, they should be well-marked, visible, and accessible to all pedestrians from a flat surface, consistent with recommendations from the U.S. Department of Transportation's *Designing Sidewalks and Trails for Access*.



## Uncontrolled Locations

This section describes best practices for considering the installation of crosswalks at uncontrolled intersections and mid-block locations, safety considerations, and special treatments in locations where special consideration is recommended.

### When to Install Crosswalks at Uncontrolled Intersections

The following is the recommended, or best practice, for pedestrian treatments at uncontrolled approaches to intersections that are not controlled by traffic signals or stop signs.<sup>11</sup>

Crossings should be marked where all of the following occur:

- Sufficient demand exists to justify the installation of a crosswalk (see Demand Considerations below)
- The location is 300 feet or more from a controlled crossing location
- The location has sufficient sight distance (sight distance in feet should be greater than 10 times the speed limit), and/or sight distance will be improved prior to crosswalk marking
- Safety considerations do not preclude a crosswalk (see p. 16, Safety Considerations at Uncontrolled Locations)

**Demand Consideration:** Uncontrolled crossings should be identified as a candidate for marking if there is a demonstrated need for a crosswalk. Need can be demonstrated by:

- 20 pedestrians per hour during the peak hour or 60 pedestrians total for the highest consecutive four- hour period
- or:
- The crossing is on a direct route to or from a pedestrian generator, such as a school, library, senior center, shopping center, park, or employment center



### When to Install Crosswalks at Mid-Block Locations

Mid-block crossings should be marked where the following occur:

- Sufficient demand exists to justify the installation of a crosswalk (see Demand Considerations below)
- The mid-block location is 300 feet or more from another crossing location (most of the downtown area has blocks that are 300 feet in length)

---

<sup>11</sup> The most common crosswalk of this type will be at intersections where a minor side street has a stop sign and a major street is uncontrolled.

- The mid-block location has sufficient sight distance (sight distance in feet should be greater than 10 times the speed limit)
- Provision of a crossing would channelize potential jaywalkers to a suitable crossing location
- Safety considerations do not preclude a crosswalk (see below, Safety Considerations at Uncontrolled Locations)
- Where mid-block crosswalks are installed, the default design should be the “triple four” or high-visibility pavement treatments. The installation of mid-block crosswalks requires approval of the City Council.

**Demand Considerations:** Candidate locations for marked pedestrian crossings at mid-block locations should meet one of the following criteria:

- 40 pedestrians during a one-hour period or 25/hour for four consecutive hours
- A pedestrian generator is less than 300 feet away at a location mid-way between signal or stop-controlled intersections, or there are significant pedestrian trip generators on both sides of the street

### Safety Considerations at Uncontrolled Locations

The flowchart in **Figure 3** should be used to determine if special treatments are needed to ensure safe crossing at uncontrolled locations (see below for examples of special treatments). Where safety concerns would continue even with special treatments, pedestrian signal warrants, established in the CA MUTCD, should be tested to determine whether the crossing warrants a signal. In the event that a signal is determined to be inappropriate, the crosswalk should not be marked.

A crosswalk should not be installed if sight distance in feet is less than ten times the speed limit. For example, if an intersection has an approach speed of 25 miles per hour, the unrestricted view of pedestrians by motorists should be at least 250 feet.

### Special Treatments for Uncontrolled Locations

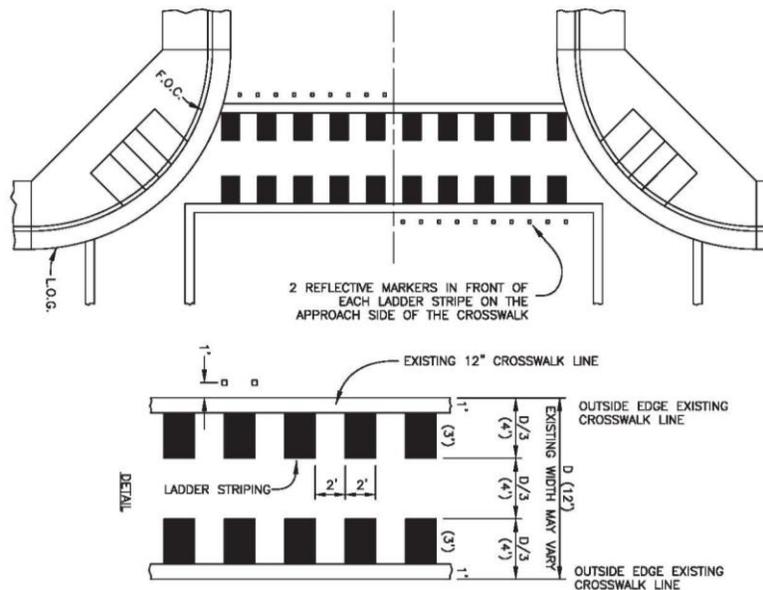
Where marking a crosswalk is deemed appropriate at an uncontrolled crossing location on either a multi-lane street (three or more lanes) or on two-lane streets with ADT greater than 12,000 or where the posted speed limit exceeds 30 miles per hour then the crossing should be a high-visibility style.

One type of high-visibility crosswalk is the “triple-four,” which is shown at right and below. Other high visibility crosswalks include the textured pavement crosswalk, the “ladder,” and the “broken ladder.” The use of textured crosswalks should be selective due to higher maintenance costs.

*“Triple Four” Crosswalk*



**Figure 2: "Triple Four" Crosswalks**

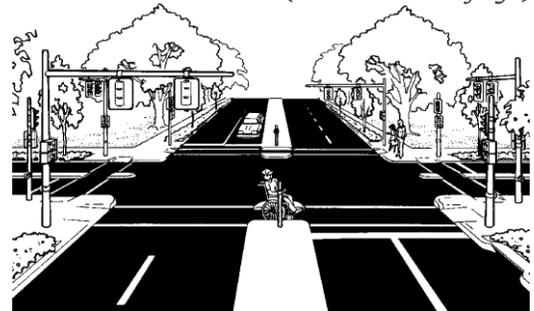


Additional special treatments can be considered at areas with heightened safety concerns. See **Table 1** for guidance on choosing crosswalk treatments for different street types, with crosswalk treatments chosen from level one, two and three devices outlined below:

**Level One**

**Median installation** - On multi-lane streets with ADT of less than 15,000 and 85th percentile speeds of less than 35 miles per hour, the FHWA research described earlier in this report concludes that provision of a median can address safety concerns.

*Raised Median (Pedestrian Refuge)*



**Split Pedestrian Crossover (SPXO)** – The SPXO is a pedestrian refuge that channels pedestrians, using railings, to cross one half of the street; enter the island at one end; walk towards the flow of traffic; and exit at the other end to cross the second half of the street. SPXOs can improve pedestrian safety on streets with ADTs below 45,000, with advance yield markings (triangles 16 inches wide by 24 inches long separated by 9 inches located 30 to 50 feet in advance of the crossing), "Yield to Pedestrians" signage, and good

*Split Cross-Over*



visibility, especially at night. This special treatment is primarily used at mid-block locations.

**Bulbouts (intersection crossing)** – Each corner of the intersection is extended into the intersection by approximately seven to eight feet to shorten the crossing distance for pedestrians and raise their visibility to motorists.

*Bulbout at Intersection*



*Bulbout at Mid-Block Crossing*

**Bulbouts (mid-block crossing)** – Curbs are extended into the street by approximately seven to eight feet to shorten the crossing distance for pedestrians and raise their visibility to motorists.



### **Level Two**

**Overhead signs and flashing beacons** – Various signs showing the universal pedestrian symbol, including both standard yellow, fluorescent yellow, and LED displays, hang from a mast arm that extends over the street.

*Overhead Pedestrian Warning and Flashing Beacon*



## **Rectangular Rapid Flashing Beacons (RRFB)**

An RRFB is a warning beacon that consists of a pedestrian crossing sign (W11-2 or S1-1), diagonal downward arrow (W16-7p) plaque, and user-activated light-emitting diodes (LEDs) using an irregular flash pattern that is similar to an emergency vehicle flasher. The LEDs remain dark until activated by a pedestrian pushbutton or by pedestrian detection. Once activated, the LEDs shall flash in an alternating 2/5 pattern.

*RRFB at McKinley Elementary School*



### Level Three

#### **Pedestrian Hybrid Beacon (formerly known as High-Intensity Activated Crosswalk or HAWK)**

A pedestrian hybrid beacon (PHB) can be used at an unsignalized intersection to assist pedestrians in crossing a street at a marked crosswalk. It is comprised of two red signal heads centered above a yellow signal head. Section 4F.01 of the MUTCD states the following: "a pedestrian hybrid beacon may be considered for installation to facilitate pedestrian crossings at a location that does not meet traffic signal warrants, or at a location that meets traffic signal warrants under Sections

*Pedestrian Hybrid Beacon at McKinley School*



4C.05 [Warrant 4, Pedestrian Volume] and/or 4C.06 [Warrant 5, School Crossing], *but a decision is made not to install a traffic control signal.*" PHBs should be installed at an intersection, or at the junction of a roadway with a driveway, or at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs.

**Pedestrian- actuated signal** at locations where pedestrian volumes warrant a signal.

*Pedestrian Signal*



## Trail Crossings

At locations where a multi-use trail crosses a street, the location of the crossing (mid-block or intersection) should determine what type of safety considerations are used to determine whether or not to mark a crosswalk.

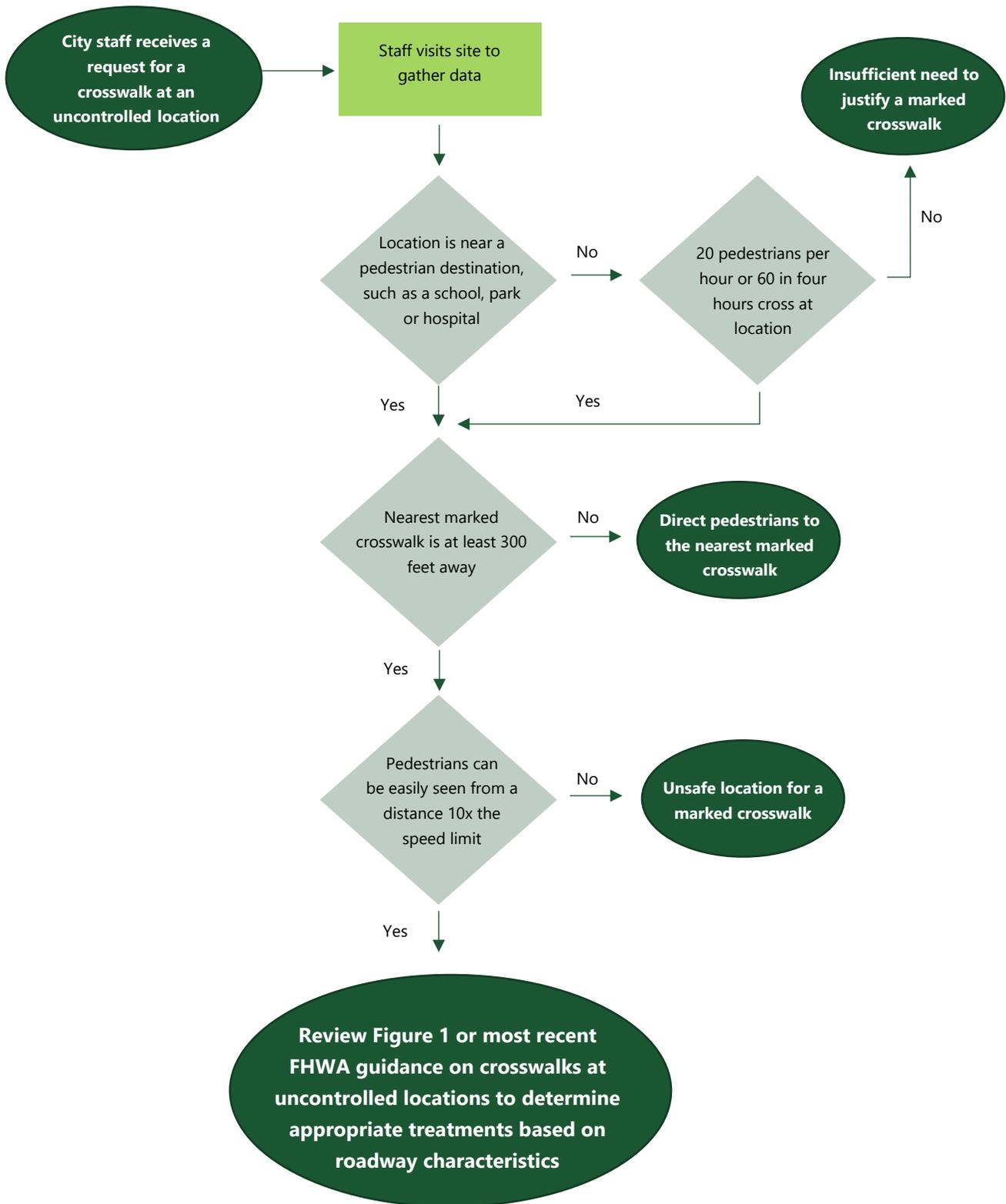
Trail crossings should be well-lit and well-signed. At all uncontrolled at-grade trail crossings, traffic calming and signage within 150 to 200 feet of the crossing should be considered. Warning signs should be installed within 30 to 50 feet of the crossing.

If the crossing does not meet the demand or safety considerations for installation of a marked crosswalk and the nearest signalized crossing location is: 300 feet or more away on an arterial street; 200 feet or more away on a collector street; or 100 feet or more away on a local street, signage and landscaping should be used to direct both cyclists and pedestrians to the adjacent signalized crossing. However, if the nearest signalized crossing is greater than 150 feet away and the location does not meet safety considerations for a marked crosswalk, and other at-grade treatments are infeasible, a grade-separated bicycle-pedestrian crossing should be considered.

## Choosing the Right Treatment for Crosswalks at Uncontrolled Locations

The following flowchart and corresponding tables provide guidelines for choosing appropriate treatment options for pedestrian crossings at uncontrolled locations, based on number of travel lanes, average daily traffic (ADT) and other factors.

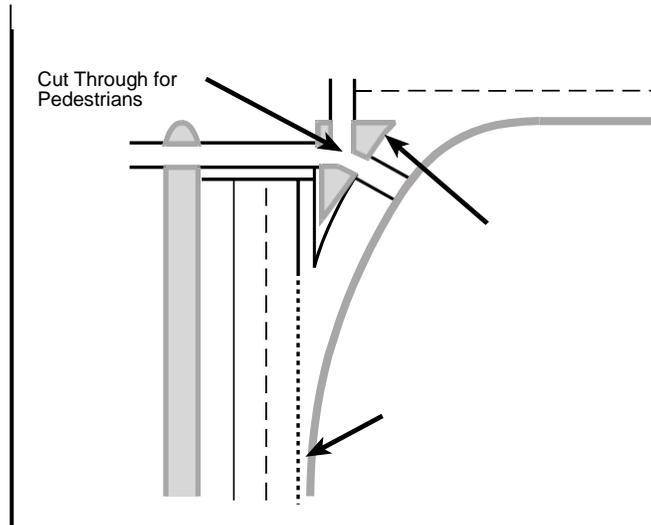
**Figure 3: Cross Walk Placement Flow Chart for Uncontrolled Locations**



## Compact Intersection Design

“Never design more than you need” is the maxim underlying pedestrian-friendly intersections. Compact intersections, where pedestrian crossing distances are minimized and pedestrian visibility is enhanced, are the most accessible, safe, and effective for pedestrians. There are several elements to consider when evaluating an intersection for pedestrian friendliness:

**Turning Radius:** Whenever possible, especially at locations adjacent to pedestrian generators, intersections should be designed with tight corner radii and without “free rights” for vehicles. When “free rights” are necessary, the turning radius should follow the figure at right. Bulbouts can help retrofit existing inter-sections – reducing corner radii and crossing distances and raising pedestrian visibility. The San Joaquin Regional Transit District (SJRTD) should be consulted to determine the minimum turning radius to allow buses to make the turn.



**Refuge Islands:** Where refuge islands are included, the tip of the island should extend through the crosswalk, with a curb cut for accessibility. Refuge islands should be clear of obstructions and have adequate drainage. They should be at least 12 feet long or the width of the crosswalk (whichever is greater) and 60 feet square. Recommended refuge island widths are as follows:

Speed	Minimum Width
25-30 mph	5 feet
30-35 mph	6 feet
35-45 mph	8 feet

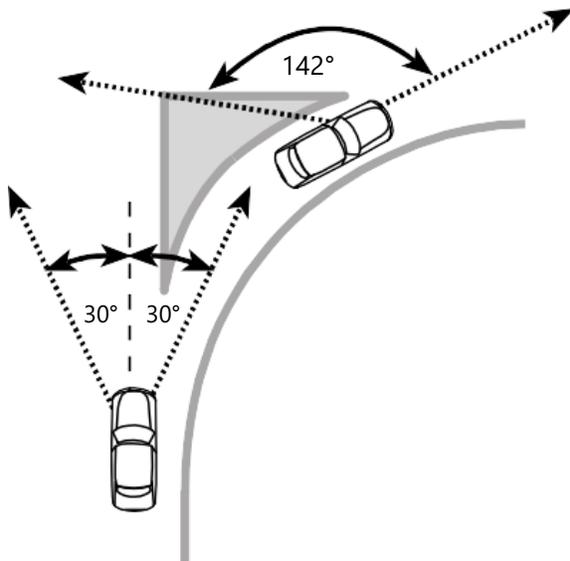
**Signal Visibility:** Pedestrian signal heads should be located for maximum visibility

**Miscellaneous:**

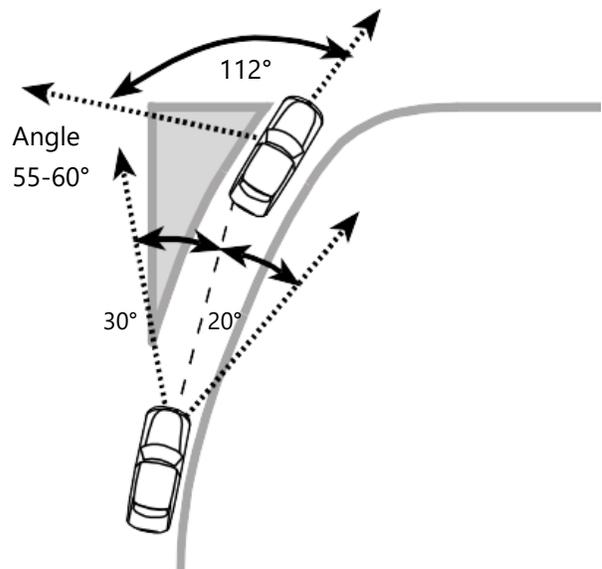
Signalized intersections should be well-lit, with pedestrian signals at each crosswalk.

At intersections where free right turns are permitted, right-turn slip lane design should benefit pedestrian circulation by shortening crossing distances and increasing driver sight lines as shown below.

**High Speed, Low Visibility, Head Turner**



**14 to 18 mph Good Visibility (Recommended)**



# Sidewalks and Curb Ramps

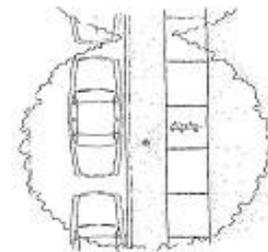
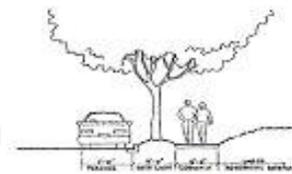
## Sidewalks

Sidewalks are the primary circulation routes for pedestrians. Pedestrian-friendly neighborhood street design improves the safety of the walking environment, fosters trips made on foot, and facilitates better access to transit service provided in the community. The City's street standards contain guidance on the placement of sidewalks. Key recommendations are summarized below.

- Install **continuous sidewalks, separated from the roadway by a planter or park strip with a vertical curb** along all new streets next to commercial or residential land uses. Recent research from the FHWA indicates that basic elements such as continuous, separated sidewalk may reduce "walking along roadway" pedestrian/vehicle crashes.<sup>12</sup>
- Follow **block-length recommendations** included in the City's *Traffic Calming Guidelines*:

"Some street networks leave excessively long blocks without interrupting intersections. Drivers that travel a long distance (600 feet or greater) without being required to slow or stop by traffic control devices can tend to travel at excessive speeds. To minimize this effect, the street network can be designed such that street blocks are interrupted by streets of sufficient traffic volumes to warrant a traffic control device (e.g. a traffic circle or stop sign) on the street of concern."

Continuous sidewalks, separated by a planter or park strip with a vertical curb, create a pedestrian-friendly environment.

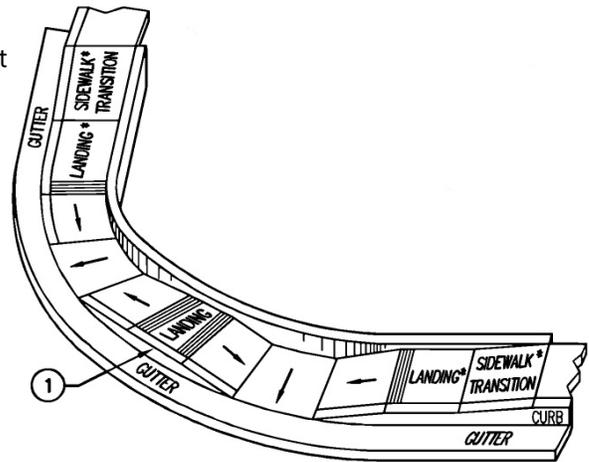


<sup>12</sup> McMahon, Patrick et al, "An Analysis of Factors Contributing to 'Walking Along Roadway' Crashes: Research Study and Guidelines for Sidewalks and Walkways," Report No. FHWA-RD-01-101.

## Curb Ramps

## Dual Curb Ramps

The City maintains definitions and standards for curb ramp installation on City streets. Curb ramps provide street and sidewalk access to pedestrians using wheelchairs. The current standards require a single curb ramp at each corner. Dual ramps, as shown below, may be provided as right-of-way and crosswalks allow. Dual ramps are desirable to direct pedestrians to the correct alignment of the crosswalk, and where feasible, opposing curb ramps should align.



## Development Review

Traffic Impact Studies and plan checks conducted by cities to review private development proposals have not traditionally incorporated measures of pedestrian safety or convenience. This report recommends that pedestrian safety impacts be evaluated during the development review process. The following are basic guidelines that could be included in Transportation Impact Studies:

### Impact on the existing pedestrian system

Will the project change the width, routing, or conditions of an existing pedestrian facility?

### Pedestrian travel patterns and access

Will the project alter existing pedestrian travel patterns and/or otherwise affect a pedestrian's ability to travel as directly as possible from origin to destination with no circuitous travel, due to any change to the sidewalk or pathway network?

### Pedestrian circulation and access

Will the project reduce or restrict a pedestrian's access to any roadway or site, by decreasing safety, increasing the stress, or increasing the delay experienced by the pedestrian? This includes but is not limited to increasing the width of the road or reducing the width of the shoulder, bridge, overpass or underpass.<sup>13</sup>

<sup>13</sup> Pedestrians' stress levels can be quantitatively measured using Pedestrian Level of Service methodology. The PLOS is a spreadsheet with inputs for roadway width, traffic levels, posted speed, sidewalk width, and the presence and measurements of pedestrian buffers (including street trees).

## **Safety of Operations**

Does the project meet or exceed accepted design standards and guidelines, as promulgated by responsible agencies such as the State of California or AASHTO? How will the project enhance and/or improve safety and connectivity for pedestrians?

## **Internal Pedestrian Circulation**

Applicants should submit an internal pedestrian circulation plan (for all non-residential proposals) in order to facilitate the safest, smoothest transition from sidewalk or parking lot to building entrance. The circulation plan should include clearly marked walkways for pedestrians, delineated by textured or colored pavement or pavement stencils. In large parking lots, a continuous sidewalk should be provided in parking lot medians from the parking lot to a marked crossing to the building entrance. All new public buildings, meaning buildings that the public may use, such as shopping centers, should have at least one main entrance immediately adjacent to the sidewalk.

## **Access to Transit**

The Regional Transit district should be consulted during the development review process with regard to the location of transit stops and the installation of pedestrian paths and crossings to facilitate access to existing or new transit stops. Will the project restrict or enhance access to transit service currently provided or to future transit service planned?

## **Developer Education Program**

In order to raise developer awareness about the benefits of pedestrian safety measures, both to pedestrians and to homeowners, this report recommends the development of a brief brochure detailing the guidelines in this report. Staff could distribute the brochures during the application process to educate builders about the City's recommendations pertaining to pedestrian safety measures.