Appendix A: Crosswalk Policy

Introduction

This citywide Crosswalk Policy is aimed at improving pedestrian safety and enhancing pedestrian mobility by providing a framework and procedures for installation, enhancement, removal, and relocation of crosswalks throughout the City. A comprehensive pedestrian safety strategy contains a three-pronged approach of engineering, enforcement, and education programs. This document focuses on engineering elements, such as pedestrian crossing treatments and intersection design.

This document describes the function of crosswalks and their legal context in the California Vehicle Code. It discusses the advantages and disadvantages of marked crosswalks and summarizes research in the United States focused on pedestrian safety and crosswalks. It provides a summary of best practices related to numerous pedestrian treatments, including geometric, signage and striping, and signal hardware or operational measure treatments.

The purpose of this Policy is to enable the City to respond to crosswalk requests in a manner that improves pedestrian accessibility and maintains public safety. It provides information to be used when making decisions about where standard crosswalks (two, parallel white 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 policy provides an overview of crosswalk fundamental, uncontrolled crosswalk considerations, and uncontrolled

crosswalk considerations. At both uncontrolled and controlled crosswalk locations, preferred and enhanced measures are described in order to:

- Improve the visibility of pedestrians to motorists and vice-versa
- Communicate to motorists and pedestrians who has the right-of-way
- Accommodate vulnerable populations such as the disabled, children, and the elderly
- Reduce conflicts between pedestrians and vehicles
- Reduce vehicular speeds at locations with potential pedestrian conflicts

Crosswalk Fundamentals

Pedestrian crossing and right-of-way laws vary state to state, and are often a source of driver or pedestrian uncertainty and confusion for when crossing is legal. This section outlines the types of crosswalks, where crossing the street is legal in California, and the steps the City should take in identifying locations for marked crosswalks.

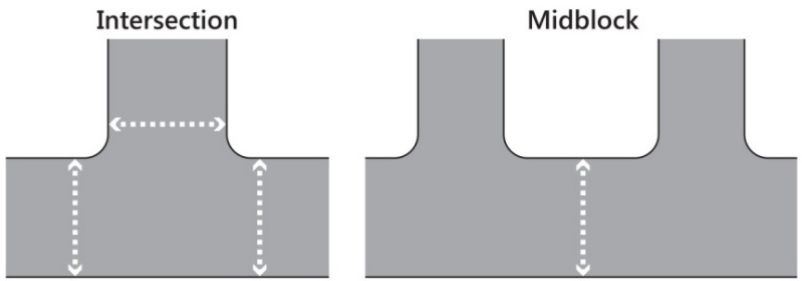
Types of Crosswalks

Crosswalks are primarily classified by three characteristics:

1. Whether they are marked (demarcated with striping on the street) or unmarked (no striping)
2. Whether they are controlled (by a traffic signal or stop-sign) or uncontrolled (with no intersection control)
3. Whether they are located at an intersection (where two streets meet) or mid-block (between intersections)

The following section outlines where crossing the street is legal in California. Based on pedestrian safety and crosswalk marking research, some types of crosswalks are safer than others (e.g., generally marked, controlled crosswalks at an intersection have lower risk of pedestrian collisions than a mid-block, uncontrolled crosswalk.

Where Is Crossing the Street Legal?



In California, a legal crosswalk exists where a sidewalk meets a street, regardless of whether the crosswalk is marked (i.e., with or without striping to denote the crosswalk). Pedestrians may legally cross any street, except at unmarked locations between immediately adjacent signalized crossings, or where crossing is expressly prohibited. Marked crosswalks reinforce the location and legitimacy of a pedestrian crossing.

These legal statues are contained in the California Vehicle Code (CVC) as follows:

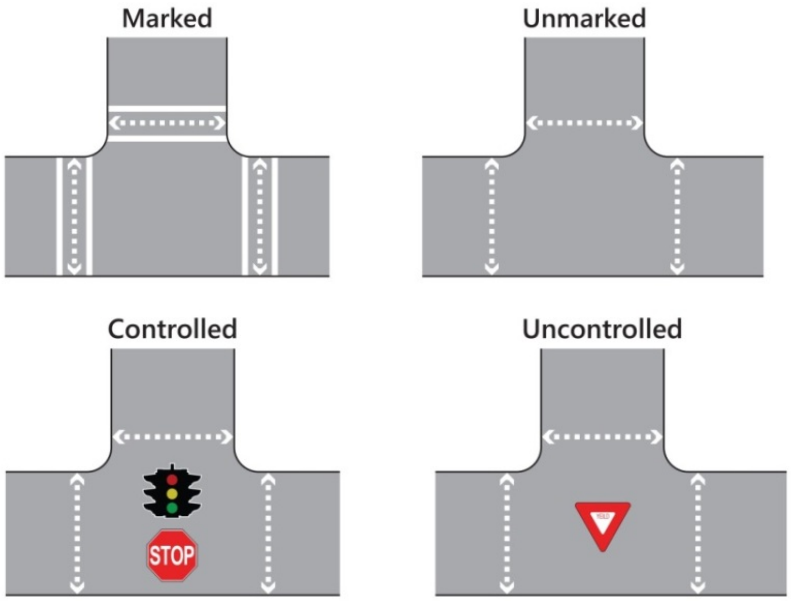
- Section 275 defines a legal crosswalk as:
    - That portion of a roadway included within the prolongation or connection of the boundary lines of sidewalks at intersections where the intersecting roadways meet at approximately right angles, except the prolongation of such lines from an alley across a street.
    - Any portion of a roadway distinctly indicated for pedestrian crossing by lines or other markings on the surface.
- Section 21950 describes right-of-way at a crosswalk:
    - The driver of a marked vehicle shall yield the right-of-way to a pedestrian crossing the roadway within any marked crosswalk or within any unmarked crosswalk at an intersection.
- Section 21955 describes where pedestrians may *not* cross a street:
    - Between adjacent intersections controlled by traffic control signal devices or by police officers, pedestrians shall not cross the roadway at any place except in a crosswalk.

Why Do Cities Mark Crosswalks?

Sidewalks and crosswalks are essential links within a pedestrian network. Whether commuting, running an errand, exercising, or wandering, pedestrians will need safe and convenient crossing opportunities to reach their destinations. A marked crosswalk has three (3) primary functions:

1) To create reasonable expectations where pedestrians may cross a roadway
2) To improve predictability of pedestrian actions and movement
3) To channel pedestrians to designated crossing locations (often selected for their optimal sight distance)

Advantages of Marked Crosswalks



Marked crosswalks offer the following advantages:

- They help pedestrians find their way across complex intersections

- They can designate the shortest path
- They can direct pedestrians to locations of best sight distance
- They assure pedestrians of their legal right to cross a roadway at an intersection or mid-block crossing

This last bullet point is important. The *California Vehicle Code* gives the right-of-way to pedestrians at any marked or unmarked crosswalk (as noted above), although the law is not always obeyed by road users, including both drivers and pedestrians. Drivers often fail to yield the right-of-way without the visual cue of a marked crosswalk. Pedestrians also do not always know the right-of-way law, and will either wait for a gap in traffic, or assert their right-of-way by stepping in to the roadway.

Steps to Identify Candidate Locations for Marked Crosswalks

Identifying candidate locations for marked crosswalks involves two steps.

The first step is to locate the places people would like to cross the street. These locations are called *pedestrian desire lines*, which represent the most desirable, and typically most direct, places that people want to cross a street. Pedestrian desire lines are influenced by elements of the roadway network, such as transit stops, and nearby land uses (homes, schools, parks, trails, commercial centers, etc.). This information provides a basis for identifying pedestrian crossing improvement areas and prioritizing such improvements, thereby creating a convenient, connected, and continuous walking environment. These locations may be identified through engineering studies, walk audits, City staff observations, or public feedback.

The second step in identifying candidate locations for marked crosswalks is to identify where people can cross safely. The primary consideration in this step is adequate stopping sight distance. Of all road users, pedestrians have the highest risk of injury in a collision because they are the least protected. The crosswalk safety treatment toolboxes in this policy provide numerous options for enhancing pedestrian safety at uncontrolled and controlled crossings, respectively, with treatment selection based on the overall context of the crosswalk – including surrounding land uses, roadway characteristics, and user characteristics.

When to Install Marked Crosswalks

Once candidate locations are identified, an engineering evaluation should be conducted to determine if a marked crosswalk should be installed at an uncontrolled or mid-block location, and if so, what visibility enhancements should be included in the design. Crossings should be marked where all of the following occur:

- Sufficient demand exists to justify the installation of a crosswalk
- Sufficient sight distance as measured by stopping sight distance calculations exists and/or sight distance will be improved prior to crosswalk marking
- Safety considerations do not preclude a crosswalk

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Figures A-1 and **A-2** describe the overall procedures from the moment City staff receives a request for a new marked crosswalk (or considers removing an existing marked crosswalk) to the installation of the treatment. As described, the first steps to determine the appropriate location and treatment for the crosswalk include a staff field visit.

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Figure A-1: Marked Crosswalk Placement Flowchart

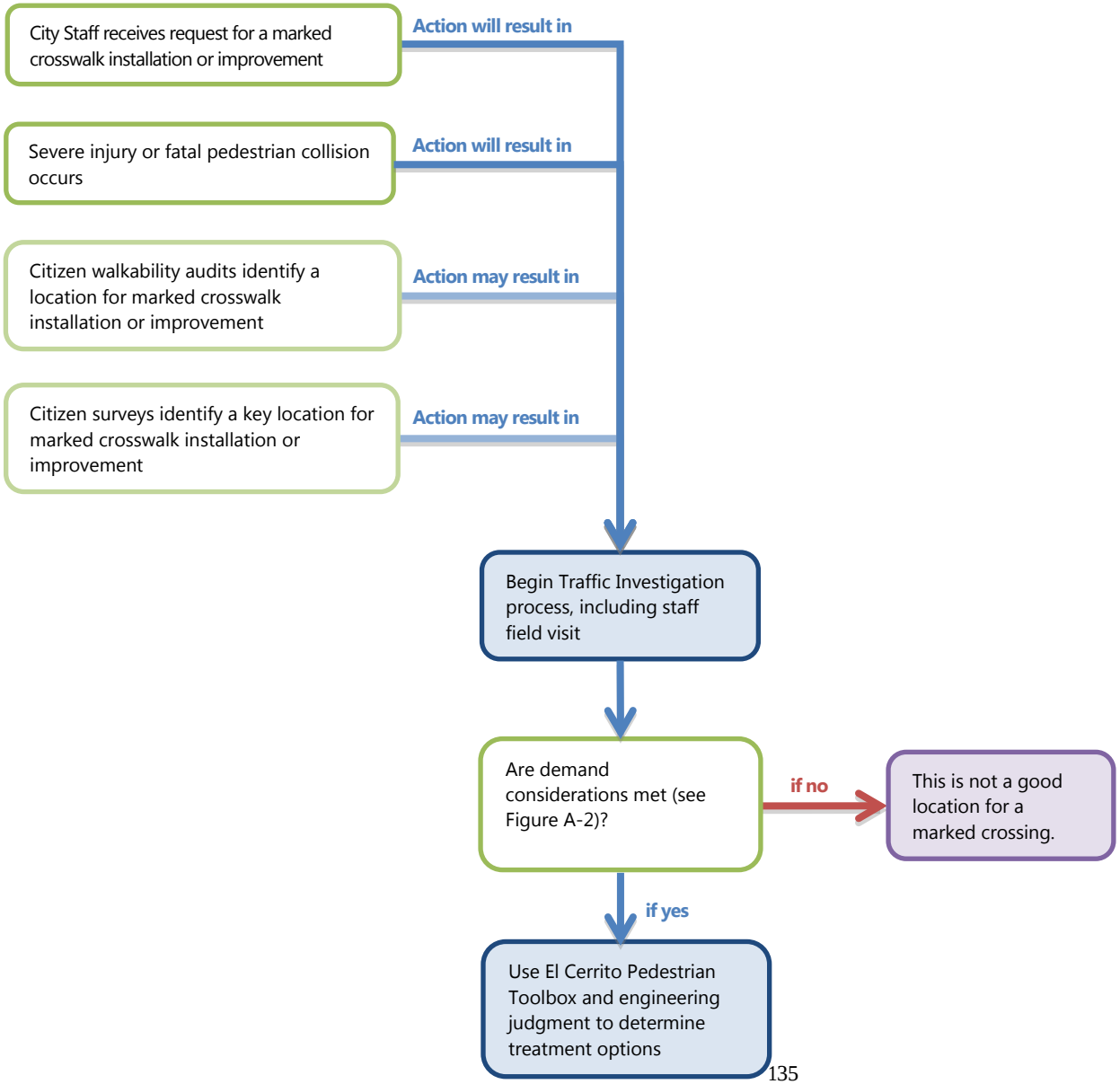
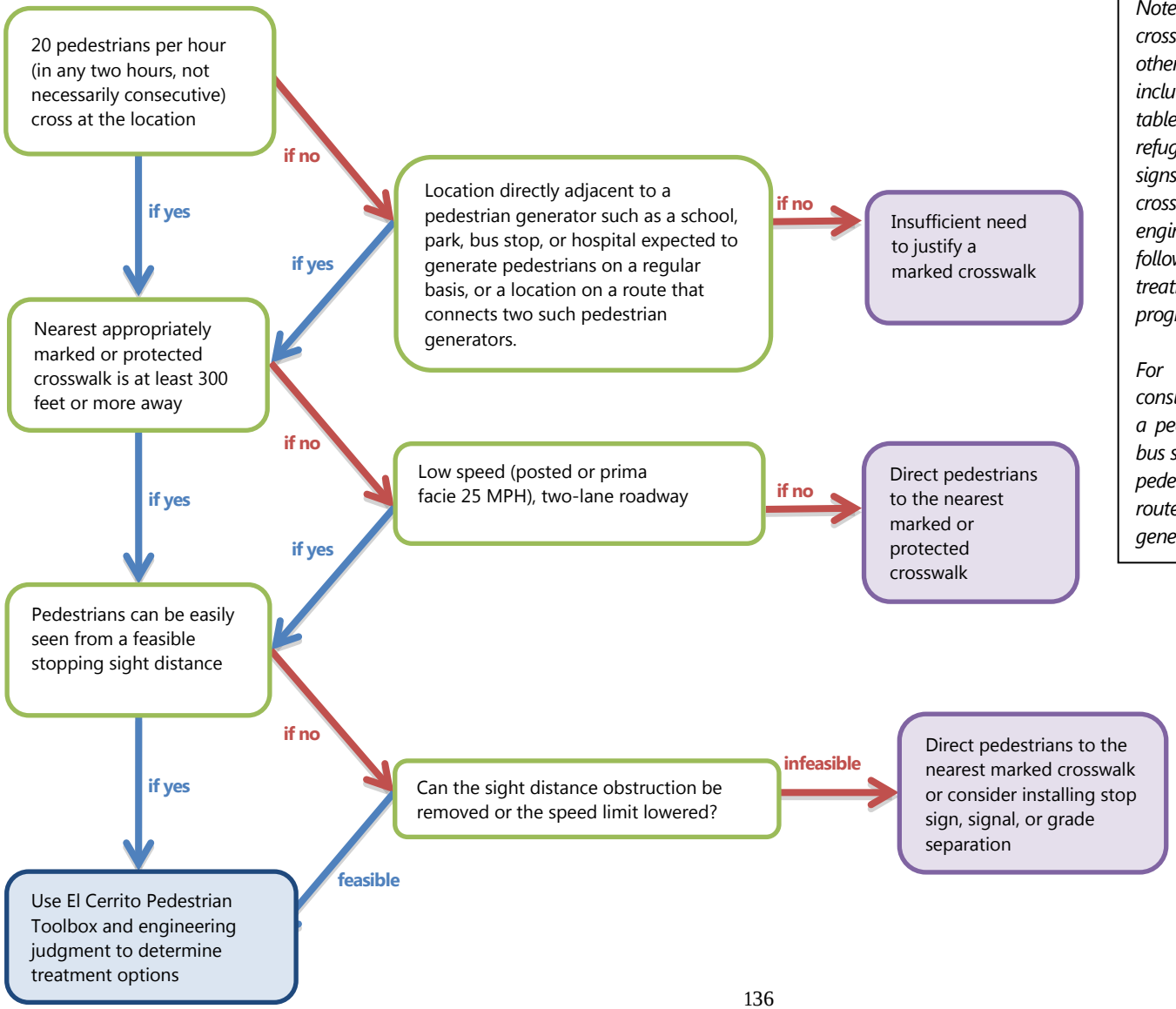


Figure A-2: Feasibility Analysis for Treatments at Uncontrolled Locations



Note: Where it is determined that a marked crosswalk is not necessary based on Figure A-2, other treatment options are available. These include traffic calming measures, such as speeds tables and speed humps; curb extensions and refuges to narrow the roadway, speed feedback signs, and similar treatments to help reducing crossing distances and slow speeds. These engineering treatments are described in the following pages. In addition to engineering treatments, education and enforcement programs should also be considered.

For locations without pedestrian counts, consider whether location is directly adjacent to a pedestrian generator such as a school, park, bus stop, or hospital and is expected to generate pedestrians on a regular basis, or is located on a route that connects two such pedestrian generators.

Uncontrolled Crossing Enhancement Toolbox

This section presents best practices for the installation of marked crosswalks at uncontrolled intersections and mid-block locations. Uncontrolled crossings require additional consideration during planning and design since traffic signals and stop signs are not provided to require motorists to stop – they must recognize the pedestrian and yield accordingly. Thus, providing appropriate enhancements to improve the visibility and safety of pedestrians crossing the street at an uncontrolled location is critical.

Crosswalk Safety Research

Several studies of pedestrian safety at uncontrolled crossings have been completed, from which conflicting research had emerged in the past. Studies conducted in San Diego in the 1970s showed that pedestrian collision risk at marked, uncontrolled crosswalks was greater than at unmarked crossings. This led many cities to remove marked crosswalks, as they were suspected of providing a false sense of security that drivers would yield to pedestrians in the crosswalk. However, a more recent study[1] by the Federal Highway Administration (FHWA) comprehensively reviewed crossing safety at 1,000 marked and 1,000 matching unmarked crosswalks in 30 U.S. cities, controlling for site context factors. The study concluded that site factors related to pedestrian-involved collisions included pedestrian average daily traffic (ADT), vehicle ADT, number of lanes, median type, and the region of the U.S. At uncontrolled locations on two-lane roads and multi-lane roads with ADT below 12,000 vehicles, FHWA found that the presence of a marked crosswalk alone, compared with an unmarked crosswalk, made no statistically significant difference in the pedestrian crash rate. However, on multi-lane roads with an ADT of greater than 12,000 vehicles (without a raised median) and 15,000 vehicles (with a raised median) the presence of a marked crosswalk without other improvements was associated with a statistically significant higher rate of pedestrian collisions compared to sites with an unmarked crosswalk.

Mid-Block Crossings

Crosswalks can be marked at intersections and mid-block points. Mid-block crossings play an important role for pedestrian access; without mid-block crossing locations, pedestrians may face the undesirable choice to detour to a controlled crossing location, detour to an intersection where crossing is legal even if not controlled, or cross illegally (if the midblock crossing is between two signalized intersections). Where signals are spaced far apart (generally more than 600-800 feet), pedestrians may have to detour several minutes to a controlled crossing location. Pedestrians are more likely to wait for a gap in traffic and cross at an unmarked location, rather than travel a distance out of their way to find a marked crosswalk. Mid-block crossings also offer an important safety consideration: fewer potential conflict points between pedestrians and motorists.

[1] Zeeger, C., J. Stewart, and H. Huang. *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations*. Publication FHWA-RD-01-142, FHWA, U.S. Department of Transportation, 2001.

FHWA stressed that the results of the study should not encourage city officials to simply remove (or fail to install) marked crosswalks. Rather, he suggested adding crosswalk enhancements to the marked crosswalks to balance mobility needs with safety needs. These improvements include providing raised medians on multi-lane roads, installing traffic and pedestrian signals where warranted, adding curb extensions, providing adequate lighting, and designing intersections with tighter turn radii.

In the FHWA study, about 70 percent of the pedestrian crashes occurred at marked crosswalks on multi-lane roads. Of the pedestrian crashes at marked crosswalks, 17.6 percent were classified as multiple-threat collisions. Multiple-threat collisions occur as one car slows down to allow pedestrians to cross, but a second car approaching from behind in the adjacent lane may not see the pedestrian, as illustrated in the image to the right. The slowing vehicle blocks the sight line of both the pedestrian and the second motorist, leading to the pedestrian-vehicle collision. Multi-lane roadways are therefore not well-served by unmarked or marked crosswalks alone. At these sites, the study concluded, engineers should consider countermeasures that provide additional safety to pedestrians and alert motorists to upcoming crosswalks. These countermeasures include advanced yield lines with corresponding signs informing motorists where to yield. Other more substantial measures may also be considered, such as signalization, illumination, or raised medians. The summary table below shows when marking a crosswalk only should not be considered.

Multiple threat conflicts on multi-lane roadways occur where a vehicle yielding to a pedestrian inhibits sight lines to another oncoming vehicle.

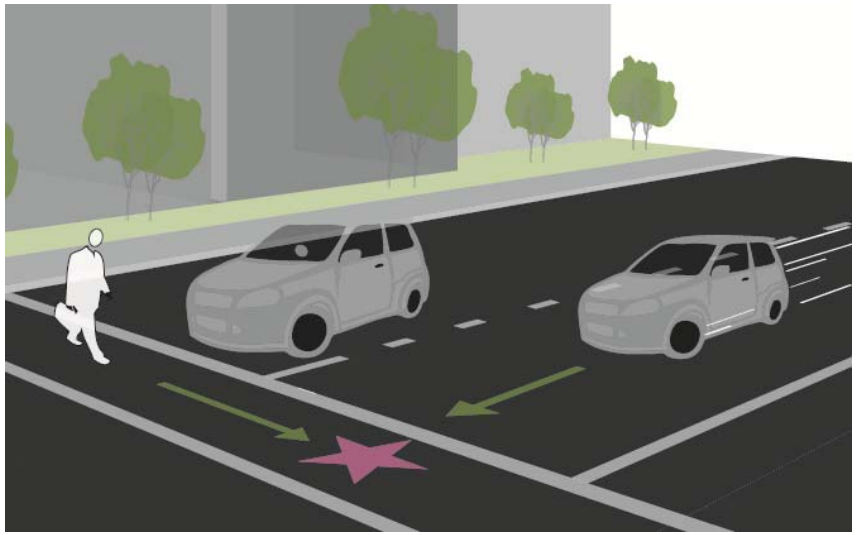


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Table 1. Recommendations for installing marked crosswalks and other needed pedestrian improvements at uncontrolled locations.*

Roadway Type (Number of Travel Lanes and Median Type)	Vehicle ADT ≤ 9,000			Vehicle ADT >9000 to 12,000			Vehicle ADT >12,000 - 15,000			Vehicle ADT > 15,000		
	Speed Limit**											
	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h
2 Lanes	C	C	P	C	C	P	C	C	N	C	P	N
3 Lanes	C	C	P	C	P	P	P	P	N	P	N	N
Multi-Lane (4 or More Lanes) With Raised Median***	C	C	P	C	P	N	P	P	N	N	N	N
Multi-Lane (4 or More Lanes) Without Raised Median	C	P	N	P	P	N	N	N	N	N	N	N

* These guidelines include intersection and midblock locations with no traffic signals or stop signs on the approach to the crossing. They do 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 speed limit exceeds 40 mi/h (64.4 km/h) marked crosswalks alone should not be used at unsignalized locations.

C = **Candidate sites for marked crosswalks**. Marked crosswalks must be installed carefully and selectively. Before installing new marked crosswalks, an engineering study is needed to determine whether the 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.

P = **Possible increase in pedestrian crash risk may occur if crosswalks are added without other pedestrian facility enhancements.** These locations should be closely monitored and enhanced with other pedestrian crossing improvements, if necessary, before adding a marked crosswalk.

N = **Marked crosswalks alone are insufficient, since pedestrian crash risk may be increased due to providing marked crosswalks alone. Consider using other treatments, such as traffic-calming treatments, traffic signals with pedestrian signals where warranted, or other substantial crossing improvement to improve crossing safety for pedestrians.**

*** The raised median or crossing 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 in accordance with MUTCD and American Association of State Highway and Transportation Officials (AASHTO) guidelines.

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With these studies as a backdrop, the remainder of this chapter outlines a decision making process to identify appropriate treatments and presents a variety of treatment options to mitigate safety, visibility, or operational concerns at specific locations.

Treatment Selection

At uncontrolled locations, a marked crosswalk with striping only may not provide adequate visibility to the pedestrian crossing, especially at high volume, high speed, or multi-lane crossings. Enhancements should be considered for installation to supplement crosswalk striping. Appropriate treatments should be identified based on:

- Site characteristics: presence of pedestrian desire lines, available sight distance and visibility, lighting
- Geometric configuration of the roadway: number of vehicle travel lanes and presence of curb extensions or median refuge islands
- Travel data: 85th percentile speeds, posted speed limits, and average daily traffic (ADT) volumes.

Marked crosswalks *alone* <u>should not</u> be installed on multi-lane streets (two or more lanes per direction; three or more lanes total) under any of the following conditions[2]:

- Speeds of greater than 40 miles per hour
- Average daily traffic volumes (ADT) greater than 12,000 without a raised median or pedestrian refuge island
- Average daily traffic volumes (ADT) greater than 15,000 with a raised median or pedestrian refuge island

Locations with speeds and ADT volumes below these thresholds may also warrant enhancements. The Uncontrolled Treatment Toolbox outlines considerations for the use of enhancements in various contexts as summarized in **Table A-1**. This Toolbox may be used to identify potential treatments at a candidate uncontrolled crosswalk location based on the results of **Figures A-1** and **A-2**.

A calculation of Pedestrian Level of Service forms the basis for the treatment identification. Pedestrian Level of Service is the average delay experienced by pedestrians as they are waiting to cross the street. Expected motorist compliance is another other key variable for treatment identification. Compliance is based on field observations and engineering judgment. It is meant to reflect typical motorist responses to pedestrians attempting to cross the street. If drivers are likely to stop for a pedestrian, the compliance is rated "high." If drivers rarely stop for pedestrians, compliance is "low." The compliance rate should be assumed to be low for all locations where the speed limit is greater than 30 MPH. **Table 5** summarizes the appropriate treatments based on level of enhancement needed (with the most significant enhancement required with the worst LOS and compliance rates).

[2] California MUTCD, Section 3B. 18.

Level 1 represents a minor intervention, appropriate for situations with lower speeds and traffic volumes and high driver yielding rates. Higher levels represent more significant interventions, as may be needed on higher speed or volume roadways, wider roadways, and roadways where motorists are less likely to yield to pedestrians. Treatments may be combined with higher level treatments added to lower level treatments (i.e., flashing beacons with curb extensions). Additional funding sources should be identified as needed for these enhancements. Failing to provide an enhanced crosswalk and/or removing a marked crosswalk should be an option of last resort.

Treatment Options

The following tables described preferred pedestrian safety treatments for uncontrolled locations with different roadway characteristics:

- **Table A-2: Geometric Treatments**
- **Table A-3: Striping and Signage**
- **Table A-4: Signal Hardware and Operational Measures**

Within each table, devices are categorized in three levels based on the level of safety concern they are meant to address: Level 1 (all cases), Level 2 (enhancements), and Level 3 (advanced enhancements). Categories of improvements are cumulative; for example, a Level 2 device should also include appropriate Level 1 devices.

TABLE A-1: APPLICATION OF ENHANCED TREATMENTS FOR UNCONTROLLED LOCATIONS

Pedestrian Level of Service	Expected Motorist Compliance		
	Low (or Speed >30 mph)	Moderate	High
LOS A-D (average delay up to 30 seconds)	*LEVEL 3* 2 lane road: In-pavement flashers, overhead flashing beacons Multi-lane road: RRFB *Plus LEVELS 1 and 2*	*LEVEL 2* Curb Extensions, Bus Bulb, Reduced Curb Radii, Staggered Pedestrian Refuge *Plus LEVEL 1*	*LEVEL 1* High Visibility Crosswalk Markings, Advanced Yield Lines, Advance Signage
LOS E-F (average delay greater than 30 seconds)	*LEVEL 4* Pedestrian Hybrid Beacon, RRFB, or Direct Pedestrians to Nearest Safe Crossing *Plus LEVELS 1 and 2*	*LEVEL 3* 2 lane road: In-pavement flashers, overhead flashing beacons Multi-lane road: RRFB *Plus LEVELS 1 and 2*	*LEVEL 2* Curb Extensions, Reduced Curb Radii, Staggered Pedestrian Refuge *Plus LEVEL 1*

Notes: A pedestrian refuge island (median) is recommended for consideration in all scenarios with more than 2 lanes of traffic.

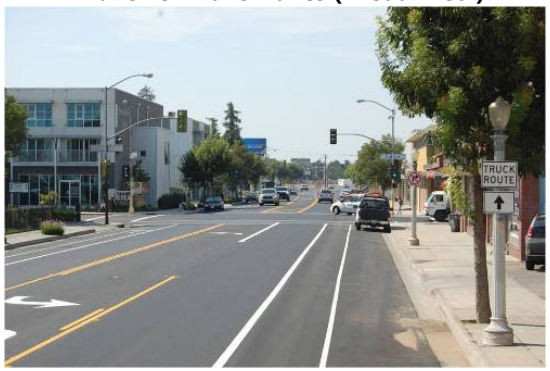
TABLE A-2: UNCONTROLLED CROSSINGS: GEOMETRIC TREATMENTS			
Treatment	**Description**	**Level**	**Estimated Cost**
2-1. Fewer Travel Lanes ("Road Diet")  *Image Source: Fehr & Peers*	Fewer travel lanes decrease roadway width and crosswalk length, reduce speeds, reduce left-turn and rear-end collisions, and often eliminate the multiple-threat collision. It takes an average pedestrian almost four seconds to cross each additional travel lane. Therefore, reducing the number of travel lanes minimizes the amount of time that pedestrians are in the crosswalk. More travel lanes than necessary can also increase vehicle travel speeds; research has shown that the severity of pedestrian collisions increases with vehicle travel speed. Where fewer travel lanes are not possible, travel lanes can be narrowed to as little as nine feet, especially left- and right-turn pockets.	**Level 1**	$20/LF (Includes removal of existing pavement markings and repainting. Assumes existing curbs remain as is)
2-2. Removal of Sight-Distance Obstructions *Image Source: Fehr & Peers*	If objects impede sight-distance, this may result in an unsafe condition where motorists and pedestrians are unable to see each other. Items such as parked cards, signage, landscaping, fencing, and street furniture should be placed in a location that will not obstruct sight distance.	**Level 1**	$150/EA (Item removed is anticipated to be no larger than a sign and post)

TABLE A-2: UNCONTROLLED CROSSINGS: GEOMETRIC TREATMENTS			
Treatment	**Description**	**Level**	**Estimated Cost**
2-3. Pedestrian Refuge Island *Image Source: Fehr & Peers*	Raised islands are placed in the center of the roadway separating opposing lanes of traffic with cutouts or ramps for accessibility along the pedestrian path. Median refuge islands are recommended where right-of-way allows and conditions warrant. Studies show medians are one of the most important safety enhancements available for crosswalks. They simplify complicated multi-lane crossings by breaking the crossings/conflicts into two stages.	**Level 1**	$130/LF (New curb and new concrete barrier. Assumes 6 foot median)
2-4. Curb Extensions *Image Source: Fehr & Peers*	Curb extensions extend the curb and sidewalks further into the roadway, shortening the length of the crosswalk. They act as a traffic calming device by narrowing the effective width of the roadway and slowing turning speeds. Because they extend into the roadway, often past parallel-parked vehicles, they improve visibility for pedestrians. They also provide space for street furniture, landscaping, bicycle parking, and signs and signal poles. Curb extensions can be constructed with reduced curb radii and to accommodate ADA improvements, such as directional curb ramps.	**Level 1**	$140/LF (Curb, sidewalk, removal of existing curb, new bollards, does not include curb ramps)

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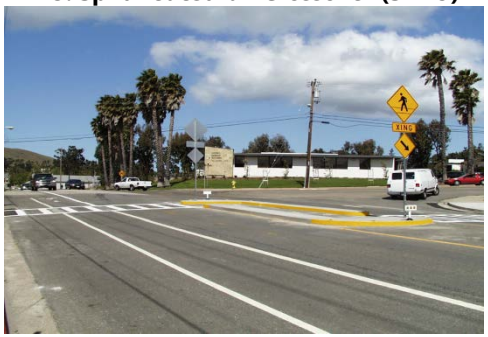
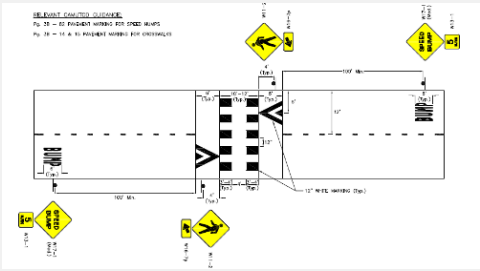
TABLE A-2: UNCONTROLLED CROSSINGS: GEOMETRIC TREATMENTS			
Treatment	**Description**	**Level**	**Estimated Cost**
2-5. Split Pedestrian Crossover (SPXO)  *Image Source: Fehr & Peers*	This measure is similar to traditional median refuge islands; the difference is that the crosswalks in the roadway are staggered such that a pedestrian crosses half of the street and then walks toward traffic to reach the second half of the crosswalk. This measure must be designed for accessibility by including rails and truncated domes to direct sight-impaired pedestrians along the path of travel.	**Level 1** Note: see Table 11 for a Pedestrian Signal	$130/LF (Same materials as 6-3)
2-6. Raised Crosswalk  *Image Source: Fehr & Peers*	Raised crosswalks are speed tables (flat-topped speed humps) outfitted with crosswalk markings and signage, providing pedestrians with a level street crossing. By raising the level of the crossing, vehicles drive more slowly through the crosswalk and pedestrians are more visible to approaching motorists.	**Level 2**	$18,000/EA

TABLE A-2: UNCONTROLLED CROSSINGS: GEOMETRIC TREATMENTS			
Treatment	**Description**	**Level**	**Estimated Cost**
2-7. Pedestrian Overpass/Underpass *Image Source: Fehr & Peers*	This measure consists of a pedestrian or pedestrian/bicycle overpass or underpass of a roadway. It provides complete separation from motor vehicle traffic, normally where no other pedestrian facility is available, and connects off-road trails and paths across major barriers. Overpasses and underpasses should be used as a measure of last resort because of their cost and barriers to their effective/efficient use, with topographical and desire line considerations influencing their design.	**Level 3**	$150/SF

Source: Fehr & Peers, 2014.

TABLE A-3: UNCONTROLLED CROSSINGS: STRIPING AND SIGNAGE			
Treatment	**Description**	**Level**	**Estimated Cost**
3-1. High Visibility Markings *Image Source: Fehr & Peers*	All uncontrolled marked crosswalks should feature high-visibility markings. Various striping patterns are available. At trail crossings, such as at the Ohlone Greenway, a triple-four crossing with bicycle stencils in the middle to denote a shared crosswalk for bicyclist s and pedestrians should be considered.	**Level 1**	$6/Foot
3-2. Advanced Yield Line *Image Source: Fehr & Peers*	Advanced yield lines, often referred to as "sharks teeth", should be striped at all marked, uncontrolled crosswalks on multi-lane roadways. They should be placed 20-30 feet in front of the crosswalk. Their intention is to identify where vehicles should stop when yielding to a pedestrian to maintain adequate sight lines. These are typically use on multi-lane roadways but could be considered on two-lane roadways were driver encroachment and yielding are a concern. They should be used with the "Yield Here to Pedestrians" sign.	**Level 1**	$100/EA

TABLE A-3: UNCONTROLLED CROSSINGS: STRIPING AND SIGNAGE			
Treatment	**Description**	**Level**	**Estimated Cost**
3-3. Advanced Warning Signs *Image Source: Fehr & Peers*	High-visibility yellow or fluorescent-yellow-green (FYG) signs are posted at crossings to increase the visibility of a pedestrian crossing.	**Level 1**	$1,000/EA

TABLE A-3: UNCONTROLLED CROSSINGS: STRIPING AND SIGNAGE			
Treatment	**Description**	**Level**	**Estimated Cost**
3-4. In-Street Pedestrian Crossing Sign *Image Source: FHWA*	This measure involves posting regulatory pedestrian signage on lane edge lines and/or road centerlines. The in-street pedestrian crossing sign may be used to remind road users of laws regarding right-of-way at an uncontrolled pedestrian crossing. They can be installed on medians and may also be temporary signs, placed by school crossing guards during school hours.	**Level 1**	$400/EA

Source: Fehr & Peers, 2014.

TABLE A-4: UNCONTROLLED CROSSINGS: BEACON, LIGHTING, AND SIGNAL TREATMENTS			
Treatment	**Description**	**Level**	**Estimated Cost**
4-1. Pedestrian-Scale Lighting *Image source: www.ci.mil.wi.us*	Pedestrian-scale lighting improves visibility along a pedestrian's path and across driveways. It also improves visibility at pedestrian/vehicle conflict points in crosswalks.	**Level 1**	$10,000 per light assuming light every 100 feet
4-2. Flashing Beacon *Image Source: Fehr & Peers*	Flashing amber lights are installed on overhead or post-mounted signs, in advance of the crosswalk or at the crosswalk's entrance. Full-time flashing beacons are not recommended; flashing beacons are most effective when they are activated by the crosswalk user (they should rest on dark). By resting on dark, they can also be solar powered.	**Level 2**	$20,000/EA

TABLE A-4: UNCONTROLLED CROSSINGS: BEACON, LIGHTING, AND SIGNAL TREATMENTS			
Treatment	**Description**	**Level**	**Estimated Cost**
4-3. Rectangular Rapid Flashing Beacon (RRFB) *Image Source: Fehr & Peers*	The RRFB is an enhancement of the flashing beacon that replaced the traditional slow flashing incandescent lamps with rapid flashing LED lamps. The RRFB may be push-button activated or activated with passive detection. This treatment was approved for use in California via Interim Approval IA-11-83 in 2011. Any installations should be reported to Caltrans for documentation, but do not require pre-approval for experimentation.	**Level 2**	$20,000/EA
4-4. Pedestrian Hybrid Beacon (PHB) *Image Source: FHWA*	The PHB is a pedestrian-activated beacon that is a combination of a beacon flasher and a traffic control signal. When actuated, the PHB displays a yellow (warning) indication followed by a solid red indication. During the pedestrian clearance interval, the driver sees a flashing red "wig-wag" pattern until the clearance interval has ended and the beacon goes dark. The device is included in the 2012 California MUTCD for use at midblock locations.	**Level 3**	$80,000/EA

TABLE A-4: UNCONTROLLED CROSSINGS: BEACON, LIGHTING, AND SIGNAL TREATMENTS			
Treatment	**Description**	**Level**	**Estimated Cost**
4-5. Pedestrian Signal *Image Source: Fehr & Peers*	A pedestrian signal is a conventional traffic control device with warrants for use based on the MUTCD. The pedestrian warrants were revised with the 2009 Federal and 2012 California MUTCD.	**Level 4**	$250,000/EA

Source: Fehr & Peers, 2013.

Controlled Crosswalk Treatment Toolbox

Controlled crosswalks are located at stop-controlled or signalized intersections. Generally, these crossings do not need enhancements beyond standard crosswalk markings (two parallel lines), as the traffic signal or stop-sign controls allocation of right-of-way. However, in some cases, such as in the Downtown, at skewed intersections, or near schools, the City may consider providing enhanced crossings to create a sense of place or improved aesthetics, or to improve visibility.

All treatments identified in this chapter are required or allowed by the standards and specifications in the *California Manual on Uniform Traffic Control Devices* (CA MUTCD).

Preferred Crossing Treatments

Preferred crossing treatments are identified as the basic pedestrian crossing improvements to be provided at all stop-controlled and signalized intersections. New controlled intersections should be designed with these treatments included; existing controlled intersections that require retrofits may be prioritized and upgraded as City funds become available. These treatments are based on recommended best practices in pedestrian safety:[3]

- Mark crosswalks on all legs of the intersection
- Provide advanced stop bars in advance of each crosswalk
- Minimize the number of vehicle traffic lanes pedestrians must cross
- Provide median refuge islands and thumbnails, as width and path of turn maneuvers allow
- Remove sight-distance obstructions
- Provide directional curb ramps for each crosswalk (e.g., two per corner)
- Eliminate free right-turn slip lanes, where feasible, and mitigate for pedestrian safety where they remain
- Locate bus stops on the far-side of the intersection (or in front of mid-block crossings)
- Minimize cycle lengths
- Reduce prevalence or eliminate permitted signal phasing where pedestrian crossings exist
- Provide pedestrian signal heads for all crossings at signalized intersections

[3] See America Walks *Signalized Intersection Enhancements that Benefit Pedestrians* http://americawalks.org/wp-content/upload/America-Walks-Signalized-Intersection-Enhancement-Report-Updated-8.16.2012.pdf (2012).

- Provide adequate pedestrian clearance intervals (crossing time) at signalized intersections

Enhanced Crossing Treatments

At high volume pedestrian crossing locations or other areas designated by the City as pedestrian zones, the City may provide additional crosswalk enhancements at controlled intersections. These treatments provide improve drivers' awareness of pedestrians by slowing traffic through geometric changes, providing signal timing or phasing modifications, or enhancing striping or signing to improve visibility.

The following tables describe the preferred and optional enhanced pedestrian safety treatments that may be used at the City's discretion for controlled locations:

- **Table A-5: Geometric Treatments**
- **Table A-6: Striping and Signage**
- **Table A-7: Signal Hardware and Operational Measures**

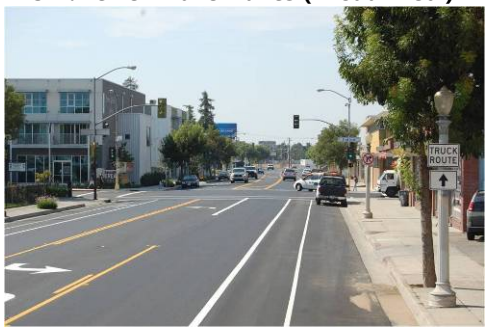
TABLE A-5: CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS		
Treatment	**Description**	**Level**
5-1. Fewer Travel Lanes ("Road Diet")  *Image Source: Fehr & Peers*	Fewer travel lanes decrease roadway width and crosswalk length, reduce speeds, reduce left-turn and rear-end collisions, and often eliminate the multiple-threat collision. An average pedestrian takes almost four seconds to cross each additional travel lane. Therefore, reducing the number of travel lanes minimizes the amount of time that pedestrians are in the crosswalk. More travel lanes than necessary can also increase vehicle travel speeds; research has shown that the severity of pedestrian collisions increases with vehicle travel speed. Where fewer travel lanes are not possible, travel lanes can be narrowed to as little as nine feet, especially left- and right-turn pockets.	Preferred
5-2. Pedestrian Refuge Island with "Thumbnail" *Image Source: Fehr & Peers*	Median pedestrian islands provide a refuge for pedestrians to stand if they do not have sufficient time to cross a street. They can be enhanced with median pedestrian push buttons at signalized crossings. Median islands can be installed throughout a corridor or only at specific crosswalks.	Preferred

TABLE A-5: CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS		
Treatment	**Description**	**Level**
5-3. Removal of Sight-Distance Obstructions *Image Source: Fehr & Peers*	If objects impede sight-distance, an unsafe condition may arise where motorists and pedestrians are unable to see each other. Items such as parked cards, signage, landscaping, fencing, and street furniture should be placed in a location that will not obstruct sight-distance.	Preferred
5-4. Directional Curb Ramps with Truncated Domes *Image Source: Fehr & Peers*	Curb ramps offer wheelchair access to/from the sidewalk and crosswalk. Truncated domes, or tactile strips, warn blind pedestrians that they are about to enter a crosswalk. The best practice for curb ramps is to install two per corner so that each ramp points directly into the crosswalk and to the curb ramp at the other side of the street. Corner bulbouts can be used to increase the amount of space available for directional curb ramps.	Preferred

TABLE A-5: CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS		
Treatment	**Description**	**Level**
5-5. Right-Turn Lane Design *Image Source: Fehr & Peers*	Free right-turns allow vehicles to turn right at high speeds. Since the vehicles are not typically controlled by the traffic signal in this circumstance, crosswalks across the turn lanes are usually uncontrolled crosswalks. Controlled right-turn movements are preferable for pedestrians because they require a vehicle to stop on red before turning right. Where "pork-chop" islands that channelize right-turns are necessary to provide acceptable turning radii, raised crosswalks are a pedestrian enhancement. Other options include signalizing the crossing (especially if it is multi-lane) and designing the "pork-chop" for slower speeds and better visibility of pedestrians.	Preferred
5-6. Far-Side Bus Stops *Image Source: Fehr & Peers*	Far-side bus stops allow pedestrians to cross behind the bus, improving pedestrian visibility. Far side bus stops also enhance transit operations by providing a guaranteed merging opportunity for buses. Exceptions for far-side bus stops include considerations for bus routing, sufficient sidewalk area, and conflicts with parking, land uses, or driveways.	Preferred

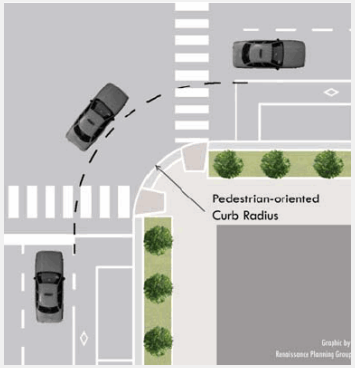
TABLE A-5: CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS		
Treatment	**Description**	**Level**
5-7. Curb Extensions *Image Source: Fehr & Peers*	Curb extensions extend the curb and sidewalks farther into the roadway, shortening the length of the crosswalk. They act as a traffic calming device by narrowing the effective width of the roadway and slowing turning speeds. Because they extend into the roadway, often past parallel-parked vehicles, they improve visibility for pedestrians. They also provide space for street furniture, landscaping, bicycle parking, and signs and signal poles. Curb extensions can be constructed to accommodate ADA improvements, such as directional curb ramps.	Enhanced
5-8. Reduced Turn Radius  *Image Source: AARP*	Vehicles travel faster through turns with a large radius. Reducing the radius of a corner is an effective way of reducing vehicle speeds. In suburban environments, turn radii generally do not need to exceed 30 feet. In urban environments turn radii can be 10 feet or less, especially where the meeting of one-way streets prohibits turning movements. Where on-street parking is permitted and/or bicycle lanes are present on one or both streets, consideration for further reductions of radii should occur acknowledging that the effective radius is increased with on-street parking. Corner curb radii on multi-lane streets should acknowledge that trucks turning right can turn into two lanes.	Enhanced

TABLE A-6: CONTROLLED INTERSECTIONS: STRIPING AND SIGNAGE		
Treatment	**Description**	**Level**
6-1. Marked Crosswalks *Image Source: Google Maps*	Marking a crosswalk across all approaches of an intersection improves pedestrian accessibility. At a four-way intersection, a closed crosswalk forces pedestrians to cross via three crosswalks instead of one. Crosswalks on all approaches can often be accommodated without a significant impact to traffic signal operations. At controlled trail crossings, high-visibility triple-four trail crossings with bicycle legends in the middle should be considered to indicate a shared crossing space for bicyclists and pedestrians.	Preferred
6-2. Advanced Stop Bar *Image Source: Fehr & Peers*	Advanced stop bars are placed five to seven feet in front of crosswalks. They keep vehicles from encroaching into the crosswalk when stopped at a red signal or stop sign.	Preferred

TABLE A-6: CONTROLLED INTERSECTIONS: STRIPING AND SIGNAGE		
Treatment	**Description**	**Level**
6-3. High Visibility Markings *Image Source: Fehr & Peers*	High-visibility crosswalks at controlled locations are appropriate in areas with high pedestrian volumes, at crosswalks with skewed geometries, or near sensitive land uses (such as schools).	Enhanced
6-4. Textured Pavement or Colored Crosswalks *Image Source: Fehr & Peers*	Textured pavement can be used in crosswalks or in intersections as an aesthetic enhancement. Because of its texture, it may also calm traffic by slowing vehicles before they cross an intersection. It can also make crosswalks more visible. Textured pavement can be made of brick or, alternatively, both concrete and asphalt can be stamped to look like brick or stone. At controlled locations, standard crosswalk striping should be provided in addition to the textured pavement. A smooth, non-slip surface is preferable.	Enhanced

TABLE A-7: CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES		
Treatment	**Description**	**Level**
7-1. Adequate Crossing Times **Image Source: Fehr & Peers**	The 2012 California MUTCD requires a walking speed of 3.5 feet per second be assumed to determine crossing times as a default minimum (4.0 feet per second was previously the guidance). A speed slower than 3.5 feet per second can be used where slower pedestrians routinely use the crosswalk, such as locations near schools, hospitals, or senior centers.	Preferred
7-2. Pedestrian Countdown Signal *Image Source: Fehr & Peers*	Pedestrian countdown signals give pedestrians "Walk" and "Don't Walk" signals with a second-by-second countdown for each phase. Research suggests that pedestrians are more likely to obey the "Don't Walk" signal when delivered using a countdown signal. The device has been shown to enhance safety for all road users. The 2012 California MUTCD requires that all new pedestrian signals be countdown signals.	Preferred

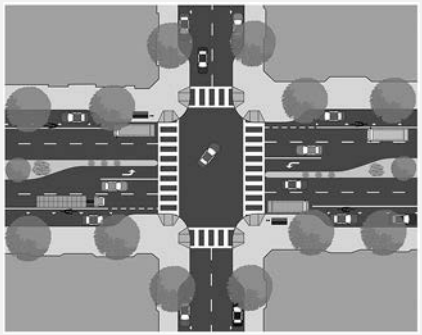
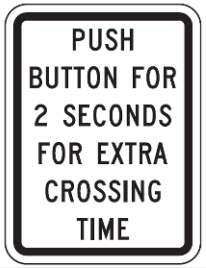
TABLE A-7: CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES		
Treatment	**Description**	**Level**
7-3. Pedestrian Signals and Push Buttons *Image Source: Fehr & Peers*	Mounting push buttons for different crosswalks on one pole can be confusing for blind pedestrians. Push buttons should be separated by ten feet and placed within five feet of each curb ramp, one per crosswalk. At long crosswalks (≥60 feet) with a median refuge island, push buttons can be placed in the median for pedestrians who may not be able to cross the entire crosswalk in one cycle length. In areas with high pedestrian volumes, eliminating pedestrian push buttons and providing a pedestrian phase in every cycle, can enhance walkability (and signal compliance).	Preferred
7-4. Short Cycle Lengths  *Image Source: Institute of Transportation Engineers*	Long cycle lengths at signalized intersections result in long pedestrian wait times to cross a street. By shortening an intersection's cycle length, pedestrians do not have to wait as long to cross after pushing the button to request a "Walk" signal.	Preferred

TABLE A-7: CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES		
Treatment	**Description**	**Level**
7-5. Protected Left-Turns *Image Source: Fehr & Peers*	Where permitted left-turns are allowed, denoted by a "Left Turn Yield on Green" sign, left-turning vehicles can conflict with pedestrians in the crosswalk. By making the left-turn protected, so that it is allowed only with a green arrow, the "Walk" signal at a crosswalk occurs at the same time that through- and right-turning vehicles in the same direction receive a green light. This reduces the risk of left-turning vehicle conflicts with the opposing crosswalk; since left-turns typically occur at a higher speed than right-turns, collisions of increased severity can be avoided by protecting left-turns.	Preferred
7-6. Accessible Pedestrian Signals *Image Source: Fehr & Peers*	Accessible pedestrian signals (APS) and detectors provide information, such as "Walk" indications and direction of crossing, in non-visual formats to improve accessibility for blind pedestrians. Audible options for accessible pedestrian signals include audible tones and speech messages. Vibrotactile push-buttons are effective options that alleviate the impacts of noise created by audible pedestrian signals. They are also accessible to deaf pedestrians. APS should always be provided when two push buttons are located on one pole and where persons with disabilities are expected frequently at a crossing. At other locations, APS is currently a best practice, but is expected to become a requirement when the proposed rulemaking of the *Public Rights of Way Accessibility Guidelines* (PROWAG) is finalized.	Enhanced

TABLE A-7: CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES		
Treatment	**Description**	**Level**
7-7. Pedestrian Recall *Image Source: Fehr & Peers*	Pedestrian recall gives pedestrians a "Walk" signal at every cycle. No push-button or detection is necessary since a "Walk" signal will always be given. Pedestrian recalls are useful in areas with high levels of pedestrian activity. They demonstrate that an intersection is meant to serve both vehicles and pedestrians. In general, pedestrian recall should be used if pedestrians actuate a "Walk" signal 75 percent of the time during three or more hours per day. Recall can be used 24-hours a day or during peak hours for pedestrians (in which case push buttons should continue to be provided).	Enhanced
7-8. No Right Turn on Red *Image Source: FHWA*	When attempting to turn right on red, motorists must look left to see if the road is clear; motorists often do not look right before turning and may not see pedestrians to their right. Restricting right turns on red can reduce conflicts between vehicles and pedestrians. "Blank out" turn restriction signs (see 11-9 below) are more effective than conventional "No Right Turn on Red" signs. "No Right Turn on Red" signs that specify time-of-day restrictions or "When Pedestrians are Present" are confusing to motorists and are often disregarded.	Enhanced

TABLE A-7: CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES		
Treatment	**Description**	**Level**
7-9. Blank-Out Turn Restriction LED Sign *Image Source: Fehr & Peers*	The ubiquity of conventional turn restriction signs, usually for no right turn on red, contributes to their disregard by motorists. Blank out turn restriction signs activate only when the specified movement is prohibited. The LED sign is also very visible.	Enhanced
7-10. Animated Eyes *Image Source: Fehr & Peers*	Animated eyes pedestrian signals feature eyes that move from side to side when a "Walk" signal is given. The signals remind pedestrians to look for turning vehicles before proceeding into the crosswalk. Research has indicated that animated eyes pedestrian signals reduce conflicts between vehicles and pedestrians.	Enhanced

TABLE A-7: CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES		
Treatment	**Description**	**Level**
7-11. Leading Pedestrian Interval (LPI) *Image Source: Fehr & Peers*	A leading pedestrian interval (LPI) advances the "Walk" signal for a few seconds while through-vehicles continue to receive a red indication. By allowing pedestrians to get a head start into the crosswalk, it can reduce conflicts between pedestrians and turning vehicles. The 2012 California MUTCD recommends that LPIs be at least three seconds in duration. Right-turn on red restrictions may be needed with LPIs are installed in locations with lower pedestrian volumes.	Enhanced
7-12. Push Button for Extended Crossing Time  *Image Source: FHWA*	Some pedestrians may need extra time to safely cross a street. Traffic signals can be retrofitted to provide pedestrians with increased crossing time by extending the duration of a pushbutton press.	Enhanced

Source: Fehr & Peers, 2014.