

City of Sacramento
Pedestrian Crossing Guidelines



City of
SACRAMENTO

October 2014

City of Sacramento

Pedestrian Crossing Guidelines

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ABBREVIATIONS AND ACRONYMS

ADA Americans with Disabilities Act

ADT Average daily traffic

AASHTO American Association of State Highway and Transportation Officials

APS Accessible pedestrian signal

CA MUTCD California Manual on Uniform Traffic Control Devices

Caltrans California Department of Transportation

CPUC California Public Utilities Commission

CSS Context Sensitive Solutions

CTCDC California Traffic Control Devices Committee

CVC California Vehicle Code

DPM (City of Sacramento) Design and Procedures Manual

FHWA Federal Highway Administration

HAWK High Intensity Activated Crosswalk

HDM (Caltrans) Highway Design Manual

IA Interim Approval

IRWLs In-Roadway Warning Lights

ITE Institute of Transportation Engineers

LED Light emitting diode

mph or **mi/h** Miles per hour

MUTCD Manual on Uniform Traffic Control Devices

NACTO National Association of City Transportation Officials

NCHRP National Cooperative Highway Research Program

NTMP (City of Sacramento) Neighborhood Traffic Management Program

ODOT Oregon Department of Transportation

PHB Pedestrian Hybrid Beacon

PIP (City of Sacramento) Pedestrian Improvement Program

RRFB Rectangular Rapid Flashing Beacon

TCRP Transit Cooperative Research Program

TPG (City of Sacramento) Transportation Programming Guide

TRB Transportation Research Board

VPH or **vph** Vehicles per hour

EXECUTIVE SUMMARY

This document – ‘City of Sacramento Pedestrian Crossing Guidelines’ (‘guidelines’) exemplifies a step towards the City’s vision for improving pedestrian conditions to make Sacramento a model pedestrian friendly city – the “Walking Capital”.

City of Sacramento’s ‘Pedestrian Safety Guidelines’ were adopted by City Council on January 9, 2003. Since the time of adoption of that document, there has been an on-going emergence of new research related to almost every aspect of pedestrian facilities including development of innovative treatments / devices for providing safe crossings. Additionally, over the last few years, organizations like the Institute of Transportation Engineers (ITE), and National Association of City Transportation Officials (NACTO), have been promoting new principles and concepts of street designs to support a walkable urban environment.

This document is aimed at updating the City’s 2003 version of ‘Pedestrian Safety Guidelines’ by integrating the above-mentioned new research, and the modern principles and concepts of street designs as applicable to pedestrian crossing facilities.

There are several research studies and other publications covering information on different aspects of pedestrian crossing facilities. However, an engineer is unlikely to find any reference document that provides the comprehensive, step – by – step guidance on all the aspects associated with the process of providing pedestrian crossings.

This document attempts to address the above-mentioned shortcoming by integrating extensive information from a multitude of resources. A few examples of resources used include various publications by Federal Highway Administration (FHWA), Transportation Research Board (TRB), ITE, California Department of Transportation (Caltrans), NACTO, and other organizations. These enormous efforts have enabled the City to develop this comprehensive document covering

guidelines and recommendations based on synthesis of information from research publications, sound engineering principles, as well as the pertinent standards and regulations that are most current at the time of preparation of these guidelines. This guidebook is intended to serve as a one-stop source of information that can be used to make objective decisions in a consistent manner at every step of the process for providing pedestrian crossing facilities. It provides guidance on pertinent topics like basic research, regulatory provisions, step-by-step process including flow-chart for evaluating requests for marked crosswalks, and an overview of a range of pedestrian crossing treatments along with underlying concepts / criteria for their applicability, etc. An abridged version of the flow chart for evaluating requests for marked crosswalks is provided at the end of the executive summary.

One of the outstanding features of this document is that it symbolizes the City's initiative to develop guidance on existing uncontrolled marked crosswalks (refer to Chapter 6), which is probably the first of its kind. Chapter 6 begins by emphasizing the point that the adoption of this or any future update to the existing guidelines, and policies, etc. does not necessarily make all the existing pedestrian crossing facilities obsolete. In the subsequent sections, it provides guidelines on the important questions like: (a) when should the City evaluate existing uncontrolled marked crosswalks in regards to compliance with the most current guidelines; (b) how to enhance / upgrade the existing crosswalks that are non-compliant with the most current guidelines; and (c) how should existing non-compliant crosswalks be addressed when the required enhancements are not feasible?

This document strives to maintain a reasonable balance between prescriptive requirements, and flexibility based on engineering judgment, engineering study, and other necessary considerations. This approach will enable the City Traffic Engineer to consider variations and exceptions in certain circumstances. Section 1.2 provides explanation in this regard. In some instances, this document may not provide a definitive solution absent the exercise of

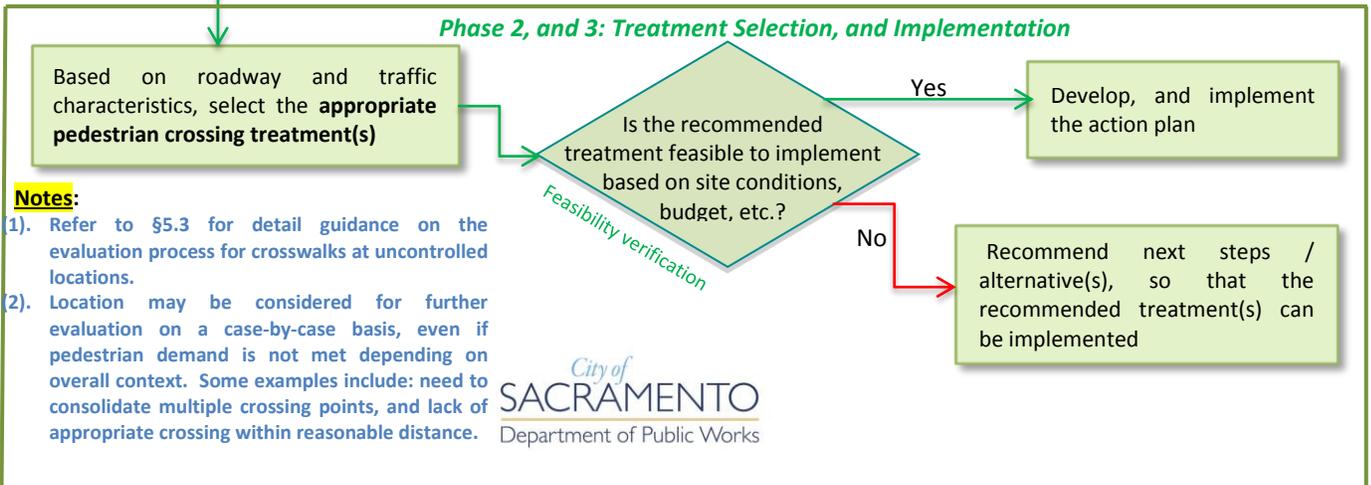
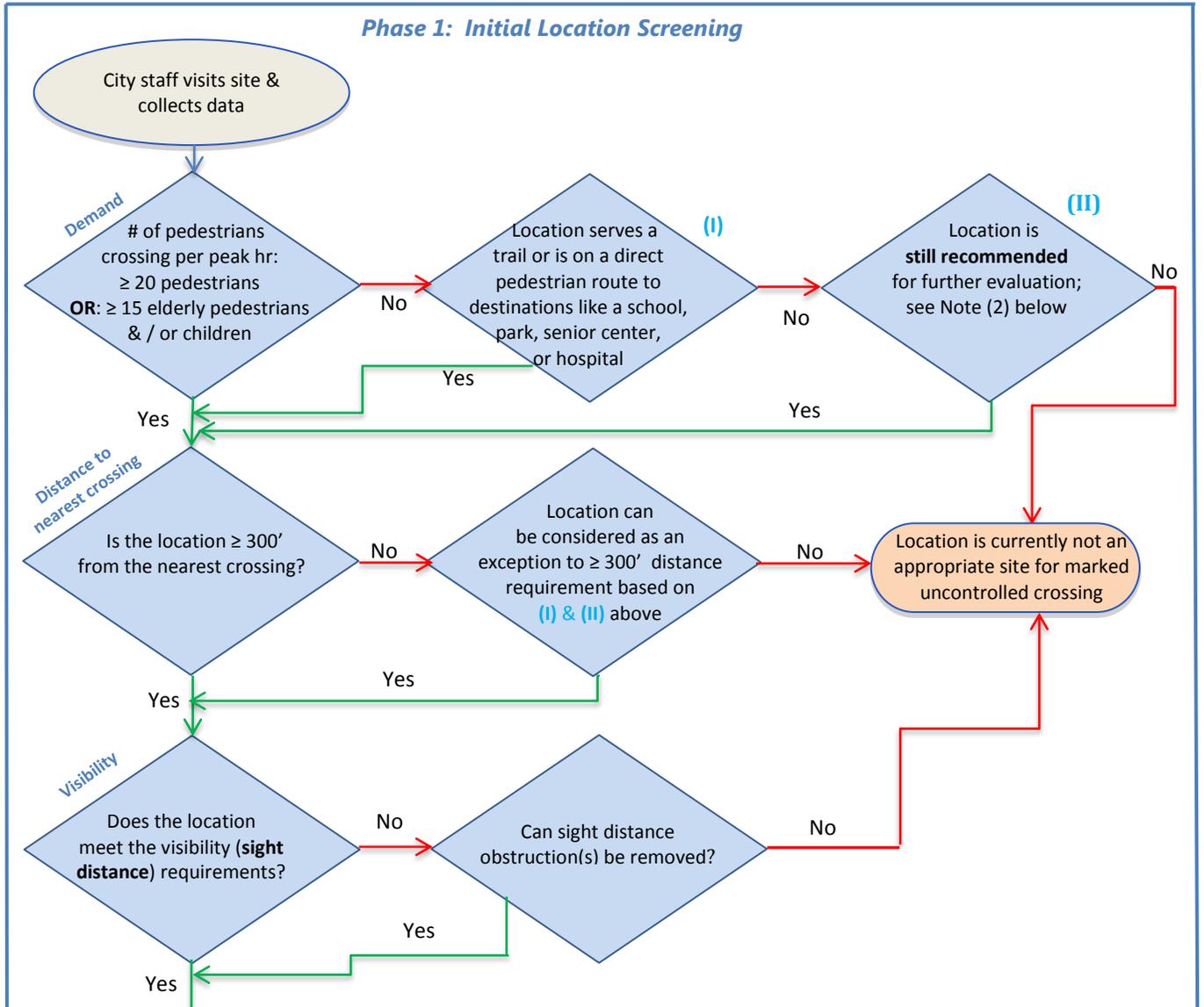
engineering judgment or engineering study. In all situations, the exercise of engineering judgment and / or engineering study are emphasized as an integral components of the decision making process.

Overall, these updated guidelines will help provide safe and frequent pedestrian crossing facilities, which in turn will help ensure consistency with the modern principles promoted by NACTO, ITE, etc. - **designing the city streets that support a walkable urban environment.**

Although this document is developed for the use of City of Sacramento staff, it is also anticipated to serve as a resource for other agencies, transportation professionals, and interest groups involved with making decisions on pedestrian crossing facilities.

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Evaluating Request to Mark Crosswalk at Uncontrolled Location: Flowchart Showing Process Overview



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1. INTRODUCTION

1.1 PURPOSE AND SCOPE

The primary purpose of this document ('guidelines') is to update the City's 'Pedestrian Safety Guidelines' that were adopted by City Council on January 9, 2003. Upon adoption by City Council, these guidelines will replace and supersede the 2003 version of 'Pedestrian Safety Guidelines'. This updated document is based on integration of new research including innovative treatments related to pedestrian crossing facilities; modern principles and concepts of street design promoted by ITE, NACTO, etc. with emphasis on designing streets that support a walkable urban environment; and the updates to the pertinent standards / regulations that are most current at the time of preparation of these guidelines. While the scope of these references is very extensive, this document focuses on pedestrian crossing facilities only.

The City regularly receives requests to install marked crosswalks from various customers including citizens, businesses, and institutions, etc. According to FHWA study⁽¹⁰⁾:

"Marked crosswalks are one tool used to direct pedestrians safely across a street. When considering marked crosswalks at uncontrolled locations, the question should not be simply, "Should I provide a marked crosswalk or not?" Instead, the question should be, "Is this an appropriate tool for directing pedestrians across the street?" Regardless of whether marked crosswalks are used, there remains the fundamental obligation to get pedestrians safely across the street".

This document addresses the above-cited fundamental aspects of pedestrian crossings. It provides guidance that can be used to determine if a marked crosswalk would be appropriate at

the requested location, and identifies a range of pedestrian crossing enhancement treatments that can be used to help accomplish the goal of getting pedestrians safely across the roadway.

1. This document describes the function of crosswalks and their legal context in the California Vehicle Code (CVC). A marked crosswalk is a traffic control device. Refer to California Manual on Uniform Traffic Control Devices (CA MUTCD) ⁽¹⁾ Section 1A.13 or Section 3.2 of this document for definition of a traffic control device. According to CVC Section 21401 (a), only those official traffic control devices that conform to the uniform standards and specifications promulgated by the Department of Transportation shall be placed upon a street or highway. The CA MUTCD published by Caltrans is issued to adopt uniform standards and specifications for all official traffic control devices, in accordance with CVC Section 21400; refer to Section 4.2.1 of this document for details. Accordingly, the guidelines and other provisions that are developed in this document are based on the current versions of pertinent documents like CA MUTCD, CVC, and Caltrans' Highway Design Manual (HDM), etc. Furthermore, by integrating available guidance from a multitude of resources as mentioned earlier, this document incorporates a comprehensive coverage of current industry practices including new concepts and treatments / devices related to pedestrian crossings.

As it relates to the treatments for pedestrian crossing enhancements, it is important to reiterate the following critical points from Section 7.1.2.5 of this document:

- (1) Consistent with the above-mentioned provisions of the CVC, the City of Sacramento's practice is to use only those traffic control devices that are approved for use in California. Accordingly, only those treatments and devices that are either included in the CA MUTCD or approved for their use by the California Traffic Control Devices Committee (CTCDC) at the time of development of these guidelines are included as the recommended treatments.

- (2) With advancement in technology, new treatments and devices may become available in the future. The City Traffic Engineer may approve the use of such treatments and devices if they meet the above-mentioned requirement.
- (3) Treatments recommended in these guidelines reflect the more common treatments being used and may not include every treatment available.
- (4) Attempts are made to recommend multiple treatment options, where feasible, in order to provide flexibility in selection of appropriate treatments depending on the site-specific conditions of the crossing locations.

The scope of this document is limited to various aspects of pedestrian crossing facilities, and is thus, essentially a technical document. It is not aimed at addressing planning / policy related aspects of pedestrian / walking mode of transportation; those aspects are addressed in the City's 'Pedestrian Master Plan'. Refer to Section 2.2 for brief information on City's 'Pedestrian Master Plan'.

The following words and phrases when used in this document are intended to apply to all types of crossings (i.e. pedestrian crossings, bike / trail / multi-use crossings, etc.): crosswalk; pedestrian crossing; pedestrian crossing facility; crossing facility; and crossing. Therefore, unless mentioned specifically, the guidelines, and all other provisions included in to this document are applicable to all types of crossing facilities.

1.2 FLEXIBILITY, AND ROLE OF ENGINEERING JUDGMENT

These guidelines strive to maintain a reasonable balance between prescriptive requirements, and flexibility based on engineering judgment, engineering study, and other necessary considerations. Guidelines based solely on regulatory provisions and scientific research are prescriptive in nature. A certain degree of flexibility based on engineering judgment,

engineering study, and other necessary considerations is appropriate when the recommendations and guidelines are not based on the aforementioned approach. Accordingly, the guidelines incorporate provisions pursuant to which the City Traffic Engineer may consider variations and exceptions in certain circumstances. For example, according to Section 5.3, the City Traffic Engineer may consider exceptions (on a case-by-case basis) to the following while making a decision on marking uncontrolled crosswalks:

- (1) Pedestrian crossing demand; and
- (2) Distance to the nearest crosswalk.

In some instances, this document may not provide a definitive solution absent the exercise of engineering judgment or engineering study by the City Traffic Engineer. In all situations, the exercise of engineering judgment and / or engineering study are emphasized as integral components of the decision making process.

The following paragraphs present provisions from CA MUTCD ⁽¹⁾, Section 1A.13, related to engineering judgment, and engineering study:

"Engineering judgment is the evaluation of available pertinent information, and the application of appropriate principles, experience, education, discretion, provisions, and practices ...for the purpose of deciding upon the applicability, design, operation, or installation of a traffic control device. Engineering judgment shall be exercised by an engineer, or by an individual working under the supervision of an engineer, through the application of procedures and criteria established by the engineer. Documentation of engineering judgment is not required." "An engineering study is the comprehensive analysis and evaluation of available pertinent information, and the application of appropriate principles, engineering judgment, experience, education, discretion, provisions, and practices as contained in this Manual and other sources, for the purpose of deciding

upon the applicability, design, operation, or installation of a traffic control device. An engineering study shall be performed by an engineer, or by an individual working under the supervision of an engineer, through the application of procedures and criteria established by the engineer. An engineering study shall be documented."

1.3 KEY CHANGES FROM THE 2003 PEDESTRIAN SAFETY GUIDELINES

These guidelines replace and supersede the Pedestrian Safety Guidelines adopted by City Council on January 9, 2003. Key changes to the 2003 version of the document are:

- Incorporating applicable provisions set forth in the most current versions (at the time of development of this document) of the pertinent governing documents like CA MUTCD, CVC, and HDM, etc.
- Incorporating only those treatments and devices that are either included in the CA MUTCD or approved for their use by the CTCDC at the time of publication of these guidelines.
- Integration of relevant research since 2003.
- Outlining a concise, and step - by - step process by incorporating updated Flowchart; Data Collection Sheets; Exhibits; and Tables to assist staff in evaluating locations for marking crosswalks and deciding appropriate crossing treatments.
- New chapter on 'Existing Uncontrolled Marked Crosswalks' to provide guidance on evaluation and enhancement of the existing uncontrolled marked crosswalks.
- Inclusion of new treatments / devices like Pedestrian Hybrid Beacons (PHBs), and Rectangular Rapid Flashing Beacons (RRFBs).

- Emphasis on application of engineering judgment and / or engineering study as integral components of the decision making process.
- Incorporation of provisions pursuant to which the City Traffic Engineer may consider variations and exceptions in certain circumstances exercising engineering judgment, based on engineering study, or based on other necessary considerations.
- Clarification in contents and overall context with an improved document format.

1.4 DOCUMENT ORGANIZATION

The remainder of this document contains the following chapters:

Chapter 2: Relationship to Other Plans and Programs

Chapter 3: Crosswalk Basics and Key Definitions

Chapter 4: Regulatory, Guidance, and Research Documents

Chapter 5: Evaluating Candidate Marked Crosswalk Locations

Chapter 6: Evaluating, and Enhancing Existing Uncontrolled Marked Crosswalk Locations

Chapter 7: Pedestrian Crossing Treatment Guide

Chapter 8 - 11 (Appendices): Guidance on pedestrian crossing treatments, and devices

Chapter 12: List of references

2. RELATIONSHIP TO OTHER PLANS AND DOCUMENTS

The City of Sacramento has an array of pedestrian-related policies and practices in place. Documents related to the guidelines include the following.

2.1 PEDESTRIAN SAFETY GUIDELINES

City's current Pedestrian Safety Guidelines were adopted by City Council on January 9, 2003⁽²⁾. At the time of publication, this document provided a compendium of City programs and practices related to pedestrian safety, and a best practices guide to pedestrian crossing treatments. However, it no longer reflects the subsequent updates to the applicable provisions set forth in the current versions of the pertinent governing documents like CA MUTCD ⁽¹⁾ etc., and the relevant research and technological advancements.

The primary purpose of this document – 'City of Sacramento Pedestrian Crossing Guidelines' ('guidelines') is to update the 2003 version of Pedestrian Safety Guidelines; Chapter 1 summarizes key changes made to this document. Upon adoption by City Council, this new document ('City of Sacramento Pedestrian Crossing Guidelines') will replace and supersede the 2003 version.

2.2 PEDESTRIAN MASTER PLAN

The Pedestrian Master Plan provides the City with a comprehensive vision for improving pedestrian conditions to make Sacramento a model pedestrian friendly city – the "Walking Capital".⁽³⁾ The document institutionalizes pedestrian considerations with policy, standard and procedural recommendations that allow the City to leverage the best pedestrian environments from new developments and incorporate pedestrian considerations into all transportation and

land use projects. It also presents a capital improvement process to systematically retrofit currently deficit sidewalk and pedestrian crossing locations. The Pedestrian Master Plan provides an assessment of walkability and demand that resulted in a Pedestrian Improvement Process to prioritize improvements based on need.

2.3 SACRAMENTO 2030 GENERAL PLAN

The adoption of the General Plan set a new direction for the future of Sacramento.⁽⁴⁾ The General Plan, which was updated in 2009, was shaped by extensive outreach to residents, businesses, developers, and decision-makers. It was developed based on the City's Smart Growth Principles; Council-adopted Vision and Guiding Principles for the General Plan; and, the Sacramento Area Council of Governments Blueprint. The Mobility section of the General Plan fully incorporates pedestrian-supportive goals and policies.

2.4 TRANSPORTATION PROGRAMMING GUIDE / PEDESTRIAN IMPROVEMENT PROGRAM

The Transportation Programming Guide (TPG) prioritizes the City's transportation projects to provide the City Council with information when making project funding decisions.⁽⁵⁾ Transportation projects are ranked according to criteria that are reflective of the City's current policies and priorities.

Beginning in 2008, the TPG was modified to include a Pedestrian Improvement Program (PIP) in response to goals and objectives set forth in both the Pedestrian Master Plan and the Sacramento 2030 General Plan. The PIP scores and ranks physical improvement projects such as new sidewalks; sidewalk planters; curb and gutter; and, crosswalks.

The City Council recently approved the 2014 TPG on August 26, 2014.

2.5 AMERICANS WITH DISABILITIES ACT TRANSITION PLAN

The City completed an Americans with Disability Act (ADA) Transition Plan in 2001 to address the maintenance and construction of curb ramps and other sloped areas. The plan included a methodology and prioritization for implementation and technical design guidance for barrier removal. In 2003, the City expanded application of the Transition Plan to all “pedestrian rights of way”, including curb ramps, sidewalks and crosswalks. Under the Transition Plan, the City spends an amount equal to at least 20-percent of its Transportation Funds (primarily eligible Gas Tax and Measure A funds) to address obstacles in pedestrian right-of-ways.

2.6 DESIGN AND PROCEDURES MANUAL

Design of pedestrian facilities and consideration of pedestrians in roadway projects are covered in the Design and Procedures Manual (DPM), Section 15: Street Design Standards.⁽⁶⁾ The Street Design Standards were last updated in 2009 and include typical street cross-sections consistent with the Pedestrian Friendly Street Standards that were approved by the City Council in 2004. As it relates to marking crosswalks, Section 15.8.3 of the DPM states that:

"Crosswalks must comply with the City's Pedestrian Safety Guidelines and be approved by the City Traffic Engineer".

2.7 TRAFFIC CALMING GUIDELINES

The Traffic Calming Guidelines were developed to complement the Neighborhood Traffic Management Program (NTMP).⁽⁷⁾ This document presents a range of traffic calming devices and

describes appropriate conditions for installation. It includes the advantages and disadvantages of each device.

3. CROSSWALK BASICS AND KEY DEFINITIONS

3.1 FUNCTION OF CROSSWALKS

Marked crosswalks serve multiple purposes in that they provide guidance for pedestrians who are crossing roadways by defining and delineating paths to and within the controlled intersections; alert road users (in conjunction with signs and other measures) of a designated pedestrian crossing point across roadways at locations that are uncontrolled; and, legally establish the crosswalk at non-intersection locations (adapted from CA MUTCD, Section 3B.18.)

The following relevant legal statutes are contained in the CVC.⁽⁸⁾

Section 275 defines a crosswalk as:

275 "Crosswalk" is either:

(a) 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.

(b) Any portion of a roadway distinctly indicated for pedestrian crossing by lines or other markings on the surface.

Notwithstanding the foregoing provisions of this section, there shall not be a crosswalk where local authorities have placed signs indicating no crossing.

Section 21950 describes right-of-way at a crosswalk:

(a) The driver of a 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.

(b) This section does not relieve a pedestrian from the duty of using due care for his or her safety. No pedestrian may suddenly leave a curb or other place of safety and walk or run into the path of a vehicle which is so close as to constitute an immediate hazard. No pedestrian may unnecessarily stop or delay traffic while in a marked or unmarked crosswalk.

(c) The driver of a vehicle approaching a pedestrian within any marked or unmarked crosswalk shall exercise all due care and shall reduce the speed of the vehicle or take any other action relating to the operation of the vehicle as necessary to safeguard the safety of the pedestrian.

(d) Subdivision (b) does not relieve a driver of a vehicle from the duty of exercising due care for the safety of any pedestrian within any marked crosswalk or within any unmarked crosswalk at an intersection.

Section 21955 pertains to crossing between controlled intersections:

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.

3.2 KEY DEFINITIONS

The meanings of following words and phrases when used in this document are explained below:

Average Daily Traffic (ADT)	The average 24 hour volume, being the total volume during a stated period divided by the number of days in that period. Normally, this would be periodic daily traffic volumes over several days, not adjusted for days of the week or seasons of the year. (CA MUTCD, Section 1A.13) ⁽¹⁾
Critical Gap	The time in seconds below which a pedestrian will not attempt to begin crossing the street. (NCHRP 562, Appendix A, Table A-1) ⁽⁹⁾
Crosswalk Lines	White or yellow (in school areas per CVC 21368) pavement marking lines that identify a crosswalk. (CA MUTCD, Section 1A.13)
Limit Line	A solid white line not less than 12 nor more than 24 inches wide, extending across a roadway or any portion thereof to indicate the point at which traffic is required to stop in compliance with legal requirements. (CA MUTCD, Section 1A.13)
Marked Crosswalk	A pedestrian crossing delineated by crosswalk lines.
Median	The area between two roadways of a divided highway measured from edge of traveled way to edge of traveled way. The median excludes turn lanes. The median width might be different between intersections, interchanges, and at opposite approaches of the same intersection. (CA MUTCD, Section 1A.13)
Motorist Compliance	Percent of motorists yielding or stopping for pedestrians. (NCHRP 562, Chapter 6, Table 15, p 33)
Multi-Lane	More than one lane moving in the same direction. A multi-lane street, highway, or roadway has a basic cross-section comprised of two or more through lanes in one or both directions. A multi-lane approach has two or more lanes moving toward the intersection, including turning lanes. (CA MUTCD, Section 1A.13)
Multiple Threat Crashes	A multiple-threat crash involves a driver stopping in one lane of a multilane road to permit pedestrians to cross, and an oncoming vehicle (in the same direction) strikes the pedestrian who is crossing in front of the stopped vehicle. This crash type involves both the pedestrian and driver failing to see each other in time to avoid the collision. (FHWA, p. 39) ⁽¹⁰⁾

Pedestrian	A person on foot, in a wheelchair, on skates, or on a skateboard. As per CVC 467, (a) A "pedestrian" is a person who is afoot or who is using any of the following: (1) A means of conveyance propelled by human power other than a bicycle. (2) An electric personal assistive mobility device. (b) "Pedestrian" includes a person who is operating a self propelled wheelchair, motorized tricycle, or motorized quadricycle and, by reason of physical disability, is otherwise unable to move about as a pedestrian, as specified in subdivision(a). (CA MUTCD, Section 1A.13)
Stop Line	A solid white pavement marking line extending across approach lanes to indicate the point at which a stop is intended or required to be made. For all purposes, limit line(s) as defined per CVC 377 shall mean stop line(s). (CA MUTCD, Section 1A.13)
Traffic Control Device	A sign, signal, marking, or other device used to regulate, warn, or guide traffic, placed on, over, or adjacent to a street, highway, private road open to public travel, pedestrian facility, or shared-use path by authority of a public agency or official having jurisdiction, or, in the case of a private road open to public travel, by authority of the private owner or private official having jurisdiction. (CA MUTCD, Section 1A.13)
Yield Line	A row of solid white isosceles triangles pointing toward approaching vehicles extending across approach lanes to indicate the point at which the yield is intended or required to be made. (CA MUTCD, Section 1A.13)
85th Percentile Speed	The speed at or below which 85 percent of the motor vehicles travel. (CA MUTCD, Section 1A.13)

4. REGULATORY, GUIDANCE AND RESEARCH DOCUMENTS

This chapter provides a brief narrative of regulatory, guidance and research documents relevant to the decision whether or not to install a marked crosswalk and associated treatments. A list of references is provided at the end of this document.

4.1 LEGAL REQUIREMENTS

4.1.1 CALIFORNIA VEHICLE CODE

Certain sections of the CVC describe the responsibilities of pedestrians when crossing the street or walking along a street on a sidewalk.⁽⁸⁾ The CVC also addresses the roles and responsibilities of motorists in relationship to pedestrians and wheelchair users. California, like most other states, requires both pedestrians and drivers to exercise due care. The CVC Sections 275, 21950, and 21955 are applicable to pedestrian crossings; see Section 3.1 of this document for description of the subject sections of CVC.

4.1.2 SACRAMENTO CITY CODE

The Sacramento City Code⁽¹¹⁾ addresses pedestrians in Titles 10 and 12. Title 10 (Vehicles and Traffic) regulates pedestrian traffic generally while Title 12 (Streets, Sidewalks, and Public Places) applies to the walking environment. Section 10.20 (Pedestrians) designates the City Traffic Engineer as responsible for establishing marked crosswalks.

Further, the City Code establishes the following.⁽¹¹⁾

No pedestrian shall cross a through street within three hundred (300) feet of a crosswalk other than within such crosswalk, except at a location where a school bus is stopped and is displaying flashing red lights. (Chapter 10.20.020)

No pedestrian shall cross a through street at an intersection with an alley except within a marked crosswalk. (Chapter 10.20.030)

No person shall stand or otherwise be in any roadway if such action interferes with the lawful movement of traffic. This section shall not apply to any public officer or employee, or employee of a public utility, when necessarily upon a street in the line of duty. (Chapter 10.20.040)

It is unlawful for any pedestrian to enter a crosswalk where any signal device, school crossing guard, or school safety patrol officer is stationed giving warning that persons should not enter the crosswalk, and it is unlawful to proceed into such crosswalk until the signal device, school crossing guard, or school safety patrol officer indicates it is proper to proceed. (Chapter 10.20.050)

4.2 ENGINEERING GUIDANCE

4.2.1 CALIFORNIA MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES

The MUTCD is approved by the FHWA as the National Standard.⁽¹²⁾ The CA MUTCD is published by Caltrans and is issued to adopt uniform standards and specifications for all official traffic control devices, in accordance with Section 21400 of the CVC. The 2012 CA MUTCD reflects the FHWA's MUTCD 2009 as amended for use in California.⁽¹⁾

The CVC references are used throughout the CA MUTCD when the subject matter relates to State law. According to CVC Section 21401(a) only those official traffic control devices that conform to the uniform standards and specifications promulgated by the Department of Transportation shall be placed upon a street or highway. CVC 21350 and 21351 give basic authority to the Department of Transportation and local authorities, in their respective jurisdictions, to place and maintain such official traffic control devices.

Many sections of the CA MUTCD are relevant to pedestrian crossings; however, Section 3B.18 provides specific guidance regarding the decision to mark a crosswalk. The City of Sacramento follows CA MUTCD standards (as applicable) except for certain variations, which are generally more restrictive than CA MUTCD requirements.

4.2.2 INTERIM APPROVALS BY FEDERAL HIGHWAY ADMINISTRATION, AND THE STATE OF CALIFORNIA

The FHWA's 2009 MUTCD contains a provision authorizing FHWA to issue Interim Approvals (IAs).⁽¹³⁾ These approvals allow pending official rulemaking, the interim use of a new traffic control device, a revision to the application or manner of use of an existing traffic control device, or a provision not specifically described in the MUTCD. IAs are considered by FHWA based on the results of successful experimentation and typically indicate an intention to place the new or revised device into a future rulemaking process for MUTCD revisions.

Any agency in California can request and receive approval to use a device under the IA process directly from FHWA. However, until Caltrans and the CTCDC have reviewed and recommended approval of a particular IA, its use by any agency in California can constitute a violation of the CVC 21400 and 21401. If the IA is recommended for use in California, then Caltrans will request FHWA's approval for its use on a blanket basis statewide, eliminating the need for individual

agencies to seek FHWA approval. If the IA is not recommended for use in California, then Caltrans will publicize the status of the particular IA.

Relevant to uncontrolled marked crosswalks, 'IA-11: Optional Use of Rectangular Rapid Flashing Beacons' has been approved for use at uncontrolled pedestrian and school crosswalk locations on a blanket basis in California.

The CA MUTCD (Section 1A.10) describes the interpretation, experimentation and interim approval process required for California agencies. Specifically, approval from the CTCDC and FHWA, when needed, is required prior to installation of experimentation devices on public roadways in California. At this time, the City of Sacramento is not pursuing installation of experimental devices, but may pursue devices given Interim Approval by FHWA and adopted for use in CA.

4.3 RESEARCH

This section presents the summary of various research studies providing guidance on marking crosswalks at uncontrolled locations and appropriate treatments for the same.

4.3.1 SAFETY EFFECTS OF MARKED VERSUS UNMARKED CROSSWALKS AT UNCONTROLLED LOCATIONS

This FHWA study is widely recognized as one of the most relevant resources for determining appropriate locations as well as crossing treatments for marked crosswalks at uncontrolled locations.^(10, 15)

This study is commonly used for the following reasons:

- It is extensive – it involved an analysis of 5 years of pedestrian crashes at 1,000 marked crosswalks and 1,000 matched unmarked comparison sites in 30 different cities throughout the U.S.
- It is thorough – the collision rates were broken down by roadway characteristics (two-lane and multi-lane roads with various speeds and traffic volumes) to give the clear picture of pedestrian safety at each type of location.

The purpose of this study was to determine whether marked crosswalks at uncontrolled locations are safer than unmarked crosswalks under various traffic and roadway conditions. Another objective was to provide recommendations on how to provide safer crossings for pedestrians. This includes providing assistance to transportation professionals when making decisions on:

- Where marked crosswalks may be installed.
- Where an existing marked crosswalk, by itself, is acceptable.

- Where an existing marked crosswalk should be supplemented with additional improvements.
- Where one or more other engineering treatments (e.g., raised median, traffic signal with pedestrian signal) should be considered instead of having only a marked crosswalk.
- Where marked crosswalks alone are not appropriate.

The study collected detailed information related to each of the 2,000 sites. This included pedestrian crash history (average of five years per site), daily pedestrian volume estimates, ADT volume, number of lanes, speed limit, area type, type of median, type and condition of crosswalk marking patterns, location type (midblock or intersection), and other site characteristics.

The following are key findings from the study.

- 2-lane roads: no significant difference in pedestrian crashes between marked and unmarked crosswalk locations.
- Multi-lane road with ADT 12,000 or less: no differences in pedestrian crash rates between marked and unmarked crosswalks sites.
- Multi-lane roads with ADT above 12,000 and no raised median: marked crosswalks had higher pedestrian crash rates than unmarked crosswalks.
- Multi-lane roads (roads with three to eight lanes) with ADT above 15,000 and with raised median: marked crosswalks had significantly higher pedestrian crash rates than unmarked crosswalks.
- The presence of a raised median or raised crossing island was associated with a significantly lower pedestrian crash rate at multilane sites with both marked and unmarked crosswalks. Furthermore, on multilane roads, medians that were painted (but not raised) and center two-way left-turn lanes did not offer significant safety benefits to pedestrians, compared to multilane roads with no median at all.

- Variables having no significant effect on pedestrian crash rates: area type, (e.g., residential, central business district), mid-block versus intersection, speed limit, one-way versus two-way, crosswalk condition and crosswalk pattern. Of note, the study suggests that the lack of association between speed limit and pedestrian crashes may be due to lack of variation in speed limits at the test sites; 93% of the study sites had speed limits of 25 to 35 mph. In terms of speed and crash severity, the analysis showed that speed limits of 35mph and greater were associated with a higher percentage of fatal and serious or incapacitating injuries compared to sites having lower speed limits.
- Multiple threat crashes: 17.6 percent of the crashes in marked crosswalks were multiple threat crashes (where one vehicle stops for the pedestrian but the driver in the adjacent lane does not stop for the pedestrian); none occurred in unmarked crosswalks.

Exhibit 3 presented in Chapter 5, summarizes the FHWA recommendations for installing marked crosswalks at uncontrolled locations.

4.3.2 IMPROVING PEDESTRIAN SAFETY AT UNSIGNALIZED CROSSINGS

This 2006 study by Transit Cooperative Research Program (TCRP) and National Cooperative Highway Research Program (NCHRP) also known as TCRP Report 112 / NCHRP Report 562 had two main objectives: the first was to recommend selected engineering treatments to improve safety for pedestrians crossing high-volume, high-speed roadways at unsignalized intersections; and, the second was to recommend modifications to the MUTCD pedestrian traffic signal warrant.⁽⁹⁾ Appendix A (Guidelines for Pedestrian Crossing Treatments) of that report provides guidance regarding the selection of pedestrian crossing treatments for unsignalized intersections and midblock locations. Key input variables (such as pedestrian volume, street crossing width, and traffic volume) are utilized to recommend one of the following possible crossing treatment categories:

- Marked crosswalk;
- Enhanced, high-visibility, or “active when present” traffic control device;
- Red signal or beacon device; and
- Conventional traffic control signal.

4.3.3 EVALUATION OF ALTERNATIVE PEDESTRIAN CONTROL DEVICES

The subject study was sponsored by Oregon Department of Transportation (ODOT) Research Section, and FHWA ⁽²⁷⁾. A literature review, field study of RRFB installations in Oregon, and a static survey on the sequencing of the PHB were completed.

The field study conducted in this project was designed to compare side and overhead-mounted beacons and RRFBs. The field study results indicated that the environment surrounding the crossing has an impact on compliance and that the presence of a median can increase compliance.

The RRFB installation Guidelines that have been developed as part of the subject project were based on the literature review and the Oregon field study. The City of Sacramento has incorporated some of the recommendations from the subject study in regards to the selection of RRFBs in to the toolbox for selection of pedestrian crossing treatments

4.4 OTHER RELEVANT DOCUMENTS

This section provides a brief narrative of other documents that may be useful for guidance related to different aspects of pedestrian facilities. The information covered in these documents ranges from designing and / or planning of pedestrian facilities to new principles and concepts of street designs to support a walkable urban environment.

4.4.1 A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS

A 'Policy on Geometric Design of Highways and Streets' published by American Association of State Highway and Transportation Officials (AASHTO) is commonly referred to as the "Green Book". It contains current design research and practices for highway and street geometric design.⁽¹⁶⁾ The document provides guidance to highway engineers and designers. Design guidelines are included for freeways, arterials, collectors, and local roads, in both urban and rural locations.

4.4.2 HIGHWAY DESIGN MANUAL

The HDM establishes uniform policies and procedures to carry out the State highway design functions of the California Department of Transportation. Local agencies often refer to the HDM for design guidance on local streets. Topic 105: Pedestrian Facilities provides guidance regarding sidewalks, grade separations, accessibility considerations and curb ramps.⁽¹⁷⁾ Topic 201: Sight Distance defines sight distance and provides guidance on minimum stopping sight distance.

4.4.3 GUIDE FOR THE PLANNING, DESIGN, AND OPERATION OF PEDESTRIAN FACILITIES (CALLED THE PED GUIDE)

This document provides guidance on the planning, design, and operation of pedestrian facilities along streets and highways.⁽¹⁸⁾ Specifically, the guide focuses on identifying effective measures for accommodating pedestrians on public rights-of-way. Appropriate methods for accommodating pedestrians, which vary among roadway and facility types, are described in the Ped Guide.

4.4.4 PEDESTRIAN AND BICYCLE FACILITIES IN CALIFORNIA: A TECHNICAL REFERENCE AND TECHNOLOGY TRANSFER SYNTHESIS FOR CALTRANS PLANNERS AND ENGINEERS

This reference was prepared to provide Caltrans staff with a synthesis of information on non-motorized transportation.⁽¹⁹⁾ The document assists Caltrans in accommodating pedestrians and bicyclists on the state highway system throughout California, serving as a resource on policies, laws, programs, the Caltrans planning and design process, guidelines, and best practices. Crossing treatments are presented in a toolbox format.

4.4.5 URBAN STREET DESIGN GUIDE

The NACTO's Urban Street Design Guide ⁽³¹⁾ identifies principles and practices of street design for urban areas. It includes a variety of design elements for streets and intersections, many of which are relevant to crosswalks and pedestrian safety. It makes recommendations for where to mark crosswalks, the design of crosswalk markings, and enhancement devices that can improve pedestrian safety.

4.4.6 DESIGNING WALKABLE URBAN THOROUGHFARES: A CONTEXT SENSITIVE APPROACH

An ITE Recommended Practice on Designing Walkable Urban Thoroughfares ⁽²⁸⁾ applies to the concepts and principles of context sensitive solutions (CSS) to the planning and design of urban thoroughfares. It covers chapters related to Design Guidelines on Traveled Way, and Intersection which include principles, considerations, and recommended practice for midblock crossings, and pedestrian treatments at intersections. Additionally, Designing Walkable Urban Thoroughfares provides design guidance for a variety of devices that can improve pedestrian safety.

4.4.7 PEDSAFE – PEDESTRIAN SAFETY GUIDE AND COUNTERMEASURE SELECTION SYSTEM, FEDERAL HIGHWAY ADMINISTRATION

PEDSAFE ⁽²⁹⁾ presents the online tools that provide the user with a list of possible engineering, education, or enforcement treatments to improve pedestrian safety and / or mobility based on user input about a specific location.

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5. EVALUATING CANDIDATE MARKED CROSSWALK LOCATIONS

5.1 OVERVIEW

This chapter describes suggested practices for evaluating potential marked crosswalk locations. Crosswalk marking practices at signalized and stop- or yield- controlled locations differ from uncontrolled crossings.

The first step in identifying candidate marked crosswalk locations is to locate the places where people would like to cross the street (pedestrian desire lines). 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 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 to identify where people can cross safely. Of all road users, pedestrians have the highest risk of injury in a collision because they are the least protected.

5.2 CROSSWALKS AT CONTROLLED CROSSING LOCATIONS

Controlled pedestrian crossing locations are intersection approaches as well as midblock crossing sites that are controlled by a traffic signal, stop or yield control.

CA MUTCD Section 3B.18 states the following ⁽¹⁾:

At locations controlled by traffic control signals or on approaches controlled by STOP or YIELD signs, crosswalk lines should be installed where engineering judgment indicates they are needed to direct pedestrians to the proper crossing path(s).

At controlled approaches, limit lines (stop lines) help to define pedestrian paths and are therefore a factor the engineer may consider in deciding whether or not to mark the crosswalk.

Sections 7.2.1 and 7.2.2 of this document provide guidance on crosswalks at signalized, and stop or yield controlled approaches respectively.

5.3 CROSSWALKS AT UNCONTROLLED CROSSING LOCATIONS

Uncontrolled pedestrian crossing locations are intersection approaches as well as midblock crossing sites that are not controlled by a traffic signal, stop or yield control. An uncontrolled crossing site may contain one or more unmarked crosswalks. CVC Section 275⁽⁸⁾ defines a crosswalk as:

- (a) *"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."*
- (b) *"Any portion of a roadway distinctly indicated for pedestrian crossing by lines or other markings on the surface".*

Notwithstanding the foregoing provisions of this section, there shall not be a crosswalk where local authorities have placed signs indicating no crossing.

The above regulation may often result in confusion when determining the presence of an unmarked crosswalk. The guidance below is based on interpretation of the CVC.

- An unmarked crosswalk must be at an intersection.
- There cannot be an unmarked mid-block crosswalk.
- There cannot be an unmarked crosswalk at an intersection without sidewalks (at least on one side).
- Intersecting roadways must meet at approximately right angles and cannot include an alley.

As to whether or not a location should be marked, CA MUTCD Section 3B.18 provides the following guidance ⁽¹⁾:

Crosswalk lines should not be used indiscriminately. An engineering study should be performed before a marked crosswalk is installed at a location away from a traffic control signal or an approach controlled by a STOP or YIELD sign. The engineering study should consider the number of lanes, the presence of a median, the distance from adjacent signalized intersections, the pedestrian volumes and delays, the average daily traffic (ADT), the posted or statutory speed limit or 85th-percentile speed, the geometry of the location, the possible consolidation of multiple crossing points, the availability of street lighting, and other appropriate factors.

The City may use the following process to help determine if an uncontrolled location is a potential candidate for a marked crosswalk. Guidance is given to suggest whether or not the marked crosswalk by itself is sufficient or if it should be enhanced with additional crossing treatments. On page 39, Exhibit 1: Uncontrolled Crosswalk Assessment Flowchart presents three phases for the evaluation: 1) Initial Location Screening; 2) Data Collection; and, 3) Treatment Selection. Exhibit 1 is followed by Exhibit 2 and 3, which are intended to assist staff through the evaluation process.

5.3.1 PHASE 1: INITIAL LOCATION SCREENING

For use with Exhibit 1: 'Uncontrolled Crosswalk Assessment Flowchart'

Phase I is intended as an initial screening process that when coupled with engineering judgment, yields an objective evaluation as to the general appropriateness of an uncontrolled marked crosswalk (with or without additional pedestrian crossing enhancement treatments) at a specific location.

The first step involves initial data collection and an evaluation of the proposed pedestrian crossing site conditions to address the following fundamental questions:

- **Is there sufficient demand?**
- **Is there another appropriate crossing location nearby?**
- **Are the roadway and traffic conditions appropriate for providing a marked crossing?**

5.3.1.1 Demand

The pedestrian demand is an important consideration in evaluating the study location for providing marked crossings. According to the FHWA study ⁽¹⁰⁾:

While overuse of marked crossings at uncontrolled locations should be avoided, higher priority should be placed on providing crosswalk markings where pedestrian volume exceeds about 20 per peak hour (15 or more elderly pedestrians and / or children per peak hour).

Recommended Guidelines:

As it relates to pedestrian demand for evaluating uncontrolled locations for marking the crosswalks, this document recommends the following guidelines:

- (1) In order to ensure consistency with FHWA recommendations (see above), and to implement a systemwide approach that allocates higher priority for the locations with higher demand, it is recommended to consider 20 or more pedestrians per peak hour (15 or more elderly pedestrians and / or children per peak hour) as the minimum demand for evaluating uncontrolled locations for marking the crosswalks;
- (2) The City may use equivalent units to convert the counts representing elderly pedestrians and / or children as follows:

1 elderly pedestrian and / or child = 1.33 pedestrians (20/15 = 1.33).

- (3) If the proposed marked crosswalk location is serving a trail or is on a direct pedestrian route to certain destinations like a school, park, senior center, or hospital, the City Traffic Engineer may consider an exception to the minimum demand requirements on a case-by-case basis;
- (4) In addition to evaluating pedestrian demand, staff should take into account existing / proposed pedestrian crossing(s) within a reasonable distance of the desired crossing (300 feet); refer to Section 5.3.1.2 (Distance to the Nearest Crosswalk) for discussion on this topic; and
- (5) Staff should evaluate and confirm that the proposed marked crosswalk at the location under consideration is appropriate based on the site conditions, the ability to consolidate multiple crossing locations, and to effectively channelize pedestrians.

If the study location does not meet the recommended guidelines related to pedestrian demand, staff may still evaluate the location through the remaining steps of the evaluation process (see Exhibit 1). This recommendation is aimed at introducing some degree of flexibility using engineering judgment so that the study location may be evaluated in its overall context within the transportation network. Some examples in this regard may include: (i) need to channelize the pedestrians; and (ii) the lack of appropriately marked or unmarked crossing within

reasonable distance of the crossing site under consideration. If the result of such an evaluation suggests that the location is appropriate for marking the crosswalk considering the overall context, the City Traffic Engineer may make a determination (on a case-by-case basis) as to whether or not to mark the crossing at the study location, even if the pedestrian demand requirements are not satisfied.

5.3.1.2 Distance to the Nearest Crosswalk

Once demand is understood, the distance to the nearest crosswalk should be determined. A brief summary of published research and recommended engineering guidance is presented here, which in turn is used to develop the recommended guidelines for the City of Sacramento.

Recommendations by FHWA Study⁽¹⁰⁾:

The FHWA study recommends the following regarding the spacing of marked crosswalks:

The spacing of marked crosswalks should be considered so that they are not placed too close together. Overuse of marked crosswalks may breed driver disrespect for them, and a more conservative use of crosswalks generally is preferred.

The subject study recommends further that:

Marked crosswalks should not be installed in close proximity to signalized intersections (which may or may not have marked crosswalks); instead, pedestrians should be encouraged to cross at the signal in most situations. The minimum distance from a signal for installing a marked crosswalk should be determined by local traffic engineers based on pedestrian crossing demand, type of roadway, traffic volume, and other factors. The objective of adding a marked crosswalk is to channel pedestrians to safer crossing points. It should be understood, however, that pedestrian crossing behavior may be difficult to

control merely by adding marked crosswalks. The new marked crosswalk should not unduly restrict platooned traffic.

Recommendations by NCHRP Study ⁽⁹⁾:

The NCHRP Report 562⁽⁹⁾ presents the following in regards to the MUTCD Pedestrian Volume signal warrant:

"The current warrant includes a provision that a signal shall not be considered at locations within 300 feet of another signal. This is believed to be based on the distance a pedestrian will walk in order to cross the major street. The researchers did not identify data that support this distance or other distances of how far beyond the desired path a pedestrian would be willing to walk. The U.S.DOT's 1995 Nationwide Personal Transportation Survey did find that most pedestrian trips (73 percent) are 0.5 mile (0.8 km) or less. With most trips being about 2,600 feet (792 m), pedestrians might not be willing to increase their trip length by more than 10 percent in order to walk to a different crossing location".

Recommended Guidelines:

As seen above, there is a lack of specific guidance in terms of spacing of crosswalks. However, based on the integration of available research and engineering guidance, and the current industry practice, this document recommends the following guidelines in regards to the distance between the proposed marked crosswalk and the nearest existing crosswalk:

- (1) It is recommended to consider a distance of 300 feet from the nearest pedestrian crossing as initial guidance / starting point in determining whether an uncontrolled location should be considered for a marked crosswalk. The nearest crosswalk may be controlled or appropriately treated uncontrolled crossing, and it may be marked or unmarked. For clarity, an appropriately treated uncontrolled crossing (either marked or

unmarked), is considered as one having the signage, pavement markings, and the pedestrian crossing treatments that are consistent with the applicable guidelines as provided in this document.

(2) It should be noted that, the distance of 300 feet as recommended above is a general guidance, rather than an absolute minimum requirement or a controlling design criteria. The City Traffic Engineer may consider an exception in this regard on a case – by – case basis based on engineering judgment, and based on other considerations such as:

- (i) Pedestrian crossing demand.
- (ii) Unique conditions pertaining to the proposed crossing site. Some of the examples in this regard include a proposed marked crossing location that is serving a trail or is on a direct pedestrian route to certain destinations like a school, park, senior center, or hospital.
- (iii) The need to consolidate multiple crossing points or to channel pedestrians to preferred crossing locations, such as signal / stop controlled approaches, and / or appropriately treated uncontrolled crosswalks. The FHWA study ⁽¹⁰⁾ cites some situations (low-speed, two-lane streets in downtown areas) as examples where installing a marked crosswalk may help consolidate multiple crossing points.
- (iv) Overall context pertaining to the crossing site (e.g., land uses; and roadway and traffic conditions such as number of lanes, traffic volume, and speed), that may justify marking the pedestrian crossing at the desired location.

(3) Additionally, it is recommended to give due consideration to the following objectives in evaluating the uncontrolled locations for marking the crosswalks:

- (i) Avoid over use of marked crosswalks and thereby avoid the driver disrespect for them.
- (ii) Try to maintain balance between the pedestrian crossings and traffic operations including the flow of platooned traffic approaching the signals.

5.3.1.3 Sight Distance

According to 'A Policy on Geometric Design of Highways and Streets' (AASHTO's "Green Book"), Chapter 3.2.2⁽¹⁶⁾:

"Sight distance is the length of the roadway ahead that is visible to the driver. The available sight distance on a roadway should be sufficiently long to enable a vehicle travelling at or near the design speed to stop before reaching a stationary object in its path. Although greater lengths of visible roadway are desirable, the distance at every point along a roadway should be at least that needed for a below-average driver or vehicle to stop."

Design Values:

The stopping sight distances for various speeds on level roadways are shown in the following table; AASHTO Green Book Chapter 3.2.2 presents a thorough discussion of the derivation of stopping sight distance.

Stopping Sight Distance on Level Roadways^(*)

Design Speed (mph)	Stopping Sight Distance (ft)
15	80
20	115
25	155
30	200
35	250
40	305

Design Speed (mph)	Stopping Sight Distance (ft)
45	360
50	425
55	495
60	570
65	645
70	730
75	820
80	910

Source: *'A Policy on Geometric Design of Highways and Streets'*
(AASHTO's Green Book) ⁽¹⁶⁾.

(*) Note: For information on stopping sight distance for roadways on grades, refer to AASHTO's Green Book, Chapter 3.2.2.

Criteria for Measuring Sight Distance:

Height of driver's eye: For all sight distance calculations for passenger vehicles, the height of the driver's eye is considered to be 3.50 ft above the road surface ⁽¹⁶⁾. Refer to AASHTO's Green Book, Chapter 3.2.6 for further information.

Height of object: For stopping sight distance calculations, the height of object is considered to be 2.00 ft above the road surface ⁽¹⁶⁾.

Other Considerations:

The information presented above addresses the basic aspects of stopping sight distance. There may be other aspects such as intersection sight distance; sight distance related to roadways with

curves, etc. that may need to be considered as applicable. The user may refer to AASHTO's Green Book ⁽¹⁶⁾ or other appropriate sources for the required information.

Staff should measure actual sight distance in the field to determine adequacy. If minimum sight distance is not met, consideration should be given to removing the obstruction; otherwise, the location is not appropriate for an uncontrolled marked crosswalk.

5.3.2 PHASE 2: DATA COLLECTION

For use with Exhibit 2: Crosswalk Data Collection Form, and Exhibit 3: Recommendations for Installing Marked Crosswalks and Other Needed Pedestrian Improvements at Uncontrolled Locations

Once a location is determined to be appropriate for marking a crosswalk through Phase 1, additional data should be obtained for roadway, and traffic characteristics unique to the candidate location. Exhibit 2: Crosswalk Data Collection Form presents the range of data that may be collected as part of an engineering study.

5.3.3 PHASE 3: TREATMENT SELECTION

For use with Chapter 7: Crossing Treatment Guide

The information from Phase 2 is intended to help answer the following question.

- **Is a marked crosswalk alone sufficient?**

The final section of the Crosswalk Data Collection Form requires use of Exhibit 3, which is adapted from FHWA study ⁽¹⁰⁾. Based on ADT, speed and lane configuration, Exhibit 3 suggests one of the following classifications:

- (1) **"C"** = Candidate sites for marked crosswalks.
- (2) **"P"** = Possible increase in pedestrian crash risk may occur if crosswalks are added without other pedestrian facility enhancements¹.
- (3) **"N"** = Marked crosswalks alone are insufficient, since pedestrian crash risk may be increased by providing marked crosswalks without substantial crossing improvement to improve crossing safety for pedestrians¹.

Once, this classification is determined, proceed with treatment selection by referring to Chapter 7 "Pedestrian Crossing Treatment Guide". Chapter 7 presents detail guidance on appropriate pedestrian facility enhancements / treatments for each of the Category "C", "P", and "N" locations; Sections 7.1.2.4, and 7.1.2.5 present more specific information in the subject matter.

¹ For the purpose of conciseness, the locations represented by category **P**, and **N** are also referred as '**Possible Candidate Sites for Marked Crosswalks**', and '**Marked Crosswalk alone are insufficient**', respectively in this document.

Exhibit 1: Uncontrolled Crosswalk Assessment Flowchart

(Sheet 1 of 2)

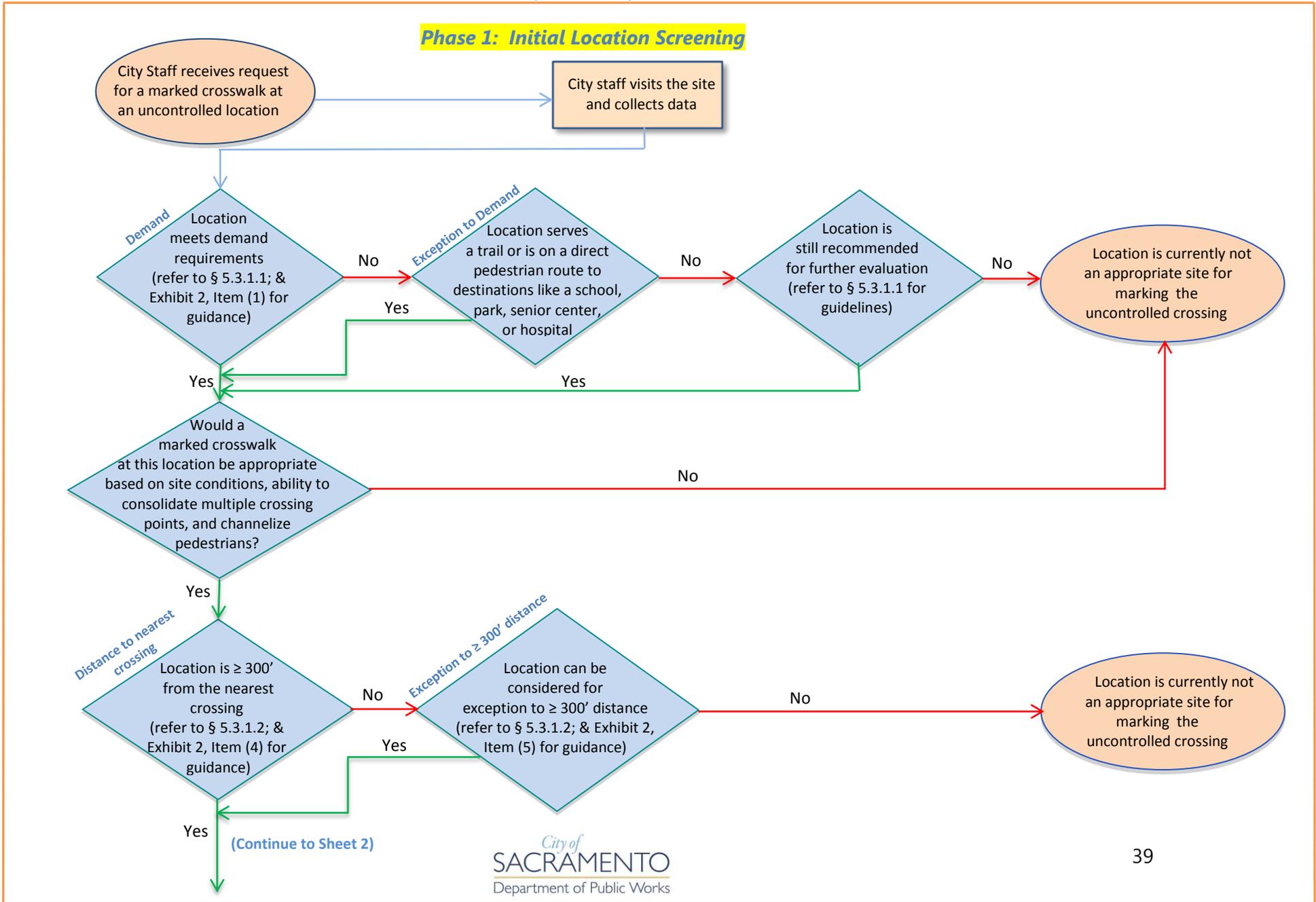


Exhibit 1: Uncontrolled Crosswalk Assessment Flowchart

(Sheet 2 of 2)

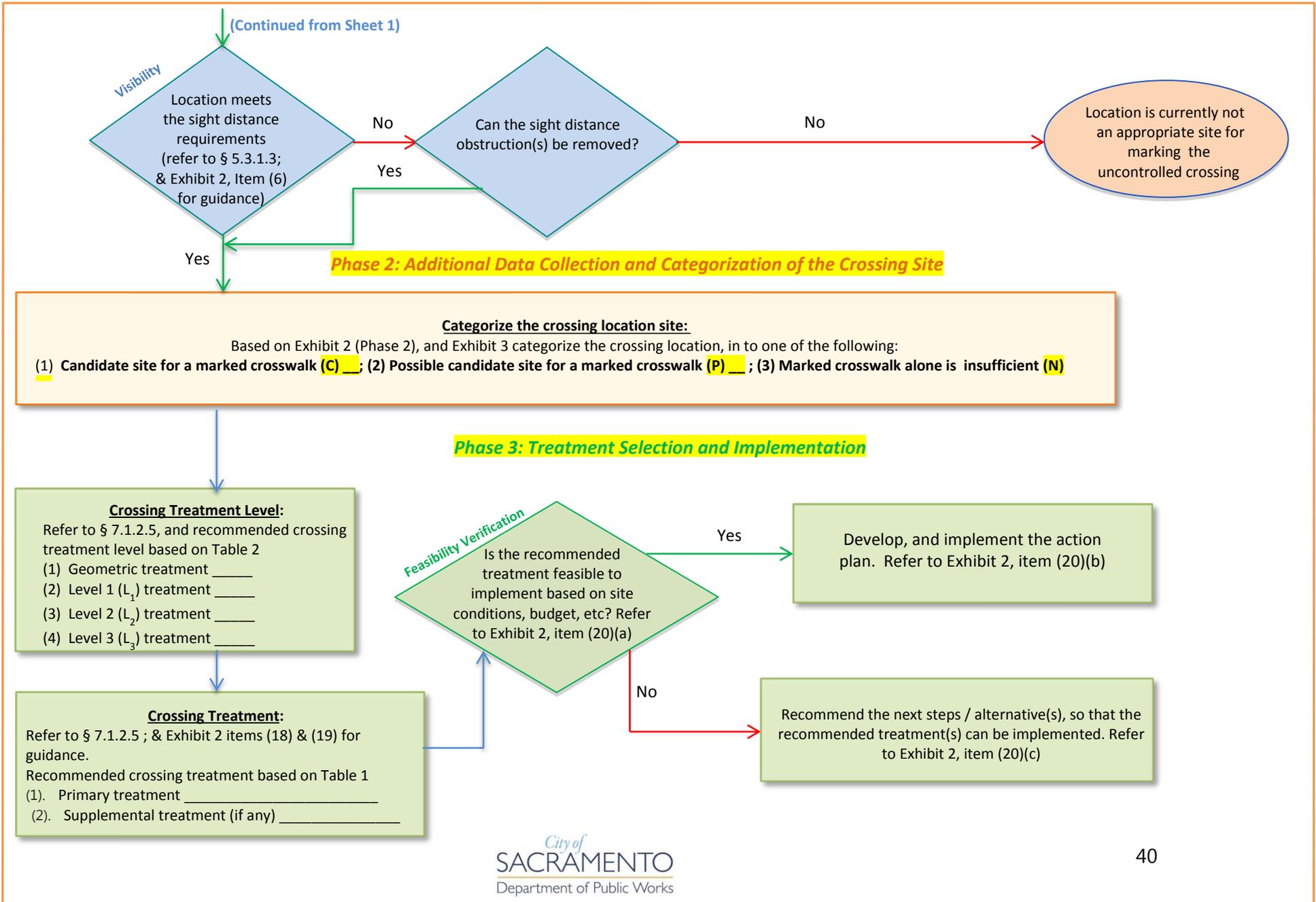


Exhibit 2: Crosswalk Data Collection Form

(Sheet 1 of 4)

(Attach additional sheet(s) if required, and provide appropriate reference)

Location (e.g., west leg of A Street / B Street intersection): _____

Date review initiated: _____ Prepared by (staff): _____

Select one: Request to mark new crosswalk: _____; Existing marked crosswalk: _____

Phase 1 (Initial Location Screening) Findings:

- (1) Pedestrian crossing volumes (peak hour):
 - (a). Pedestrian count (excluding elderly and / or children): _____
 - (b). Elderly and / or children: _____
 - (c). Equivalent pedestrian count: Elderly and / or children (from (b) above) x 1.33 = _____
 - (d). **Total number of pedestrians** ((a) +(c) above) = _____

- (2) Location is serving a trail or is on a direct pedestrian route to certain destinations like a school, park, senior center, or hospital. Provide name of each and distance to crossing location.

- (3) Location is recommended for further evaluation, even though it does not meet the demand requirements. Refer to Section 5.3.1.1 for guidance and document the justification below.

- (4) Distance to the nearest existing crossing location (Refer to Section 5.3.1.2 for guidelines):
 - (a). Name of the nearest crossing location with pedestrian crossing on an approach **controlled by traffic signal, stop or yield**: _____
 - (b). Distance to the nearest controlled crosswalk identified in (a) above: _____

OR

 - (a). Name of the nearest location with **appropriately treated uncontrolled crosswalk** (Refer to Section 5.3.1.2 for guidelines): _____
 - (b). Distance to nearest uncontrolled crosswalk identified in (a) above: _____

- (5) Location is recommended for further evaluation, even though it does not meet the requirements related to distance to the nearest crossing location. Refer to Section 5.3.1.2 for guidelines, and document the justification(s): _____

Exhibit 2: Crosswalk Data Collection Form

(Sheet 2 of 4)

(Attach additional sheet(s) if required, and provide appropriate reference)

(6) Pedestrians can be seen from required stopping sight distance (refer to Section 5.3.1.3)(Yes/No): _____

SUPPORTING DATA

(a). Required sight distance: _____

(b). Actual sight distance on both approaches (Note field review date and time):

(c). If sight distance requirements are not met, can obstruction be removed? (Yes / No): _____

(d). If answer to (c) above is YES, describe the recommended measures to ensure the required sight distance.

Phase 2: Additional Data Collection:

(7) Attach aerial or a sketch showing the following as applicable:

- Study location;
- Number of travel lanes and direction;
- Median; pedestrian refuge island;
- Pedestrian-related improvements (such as signs, markings, treatments/devices);
- Sidewalks;
- Bike lanes,
- Trail;
- On-street parking,
- Curb ramps, driveways;
- Street lights;
- Drain inlets; and
- Any other pertinent detail(s).

(8) Raised median and / or pedestrian refuge island:

(a). Raised median is present (Yes / No): _____

(b). Width of the raised median: _____

(c). Pedestrian refuge island is present (Yes / No); _____

(d). Width of the pedestrian refuge island: _____

(9) Speed limit (specify one): Posted _____ Prima facie _____

(10) 85th percentile speed (date): _____

(11) Average daily traffic (date): _____

Exhibit 2: Crosswalk Data Collection Form

(Sheet 3 of 4)

(Attach additional sheet(s) if required, and provide appropriate reference)

(12) Lane configuration:

- (a). Number of lanes in each direction (including turn pockets): _____; Total number of lanes: _____
- (b). One way or two way traffic: _____
- (c). Two Way Left Turn Lane present (Yes / No): _____

(13) Classification of the crossing location as per Exhibit 3. Refer to Section 5.3.3 for description of each of the category (“C”, “P”, or “N”):

- (a). Candidate site for a marked crosswalk (**C**) _____
- (b). Possible candidate site for a marked crosswalk (**P**) _____
- (c). Marked crosswalk alone is insufficient (**N**) _____

(14) Would a marked crosswalk at this location be appropriate based on site conditions, the ability to channelize pedestrians and consolidate multiple crossings? (Yes / No): _____

If answer to the above is **NO**:

- (a). State the reasons / contributing factors: _____

- (b). Recommend measures (if any), to make the location appropriate for marking the crosswalk:

(15) Describe any known improvements programmed or planned at the location (e.g., pavement resurfacing, traffic signal installation, or other CIP / development project(s), etc.)

(16) Five-year crash history: Select the distance for crash data considering the overall context of the crossing location using engineering judgment. Attach crash diagram or incident summary:

- (a). Pedestrian related crashes: _____
- (b). Total crashes: _____

(17) Five-year, relevant traffic investigation history.

Exhibit 2: Crosswalk Data Collection Form

(Sheet 4 of 4)

(Attach additional sheet(s) if required, and provide appropriate reference)

Phase 3 Treatment Selection:

(18) Describe selected primary pedestrian crossing treatment(s). Refer to Sections 7.1.2.4 and 7.1.2.5 for guidance (attach additional sheets as needed):

(19) Describe recommended supplemental treatments, if any. Refer to Sections 7.1.2.4 and 7.1.2.5 for guidance (attach additional sheets as needed):

(20) Feasibility verification, and **action plan / next steps:**

(a). Is it feasible to implement the recommended treatment(s) based on site conditions, budget, etc.?

(Yes / No): _____

(b). If answer to (a) above is **YES**, recommend the **action plan** to implement the recommended treatment(s):

(c). If answer to (a) above is **NO**:

i). State the reasons:

ii). Recommend the next steps / alternatives so that the recommended treatment(s) can be implemented:

Exhibit 3: Recommendations for Installing Marked Crosswalks and Other Needed Pedestrian Improvements at Uncontrolled Locations

(Adapted from FHWA⁽¹⁰⁾)

(Sheet 1 of 2)

	≤ 9,000 ADT				> 9,000 ADT to ≤ 12,000 ADT				> 12,000 to ≤ 15,000 ADT				> 15,000 ADT			
	≤ 30 mph	35 mph	40 mph	≥ 45 mph	≤ 30 mph	35 mph	40 mph	≥ 45 mph	≤ 30 mph	35 mph	40 mph	≥ 45 mph	≤ 30 mph	35 mph	40 mph	≥ 45 mph
2 Lanes	C	C	P	N	C	C	P	N	C	C	P	N	C	P	N	N
3 Lanes	C	C	P	N	C	P	P	N	P	P	P	N	P	N	N	N
4 or More Lanes with Raised Median	C	C	P	N	C	P	N	N	P	P	N	N	N	N	N	N*
4 or More Lanes No Raised Median	C	P	N	N	P	P	N	N	N	N	N	N*	N	N	N	N*

C Candidate sites for marked crosswalks.

P Possible candidate sites for marked crosswalks. Possible increase in pedestrian crash risk may occur if marked crosswalks are added without other pedestrian facility enhancements. These locations should be enhanced with other pedestrian crossing improvements, before adding a marked crosswalk; refer to Note (9) below for further information.

N Marked crosswalks alone are insufficient, since pedestrian crash risk may be increased due to providing marked crosswalks alone. These locations should be enhanced with substantial treatments, such as, traffic signals with pedestrian signals where warranted, or other substantial crossing improvement to improve crossing safety for pedestrians; refer to Note (9) below for further information.

* CA MUTCD 2012 suggests new marked crosswalks alone, without other measures, should not be installed.

Notes: See next page (Sheet 2 of 2)

Exhibit 3: Recommendations for Installing Marked Crosswalks and Other Needed Pedestrian Improvements at Uncontrolled Locations

(Adapted from FHWA⁽¹⁰⁾)

(Sheet 2 of 2)

Notes:

- (1). These guidelines include intersection and mid-block locations with no traffic signals or stop / yield signs on the approach to the crossing.
- (2). A two-way center turn lane is not considered a median.
- (3). 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 guidance on an engineering study, refer to Sections 1.2, 5.3.1, and 5.3.2; and Exhibits 1 and 2.
- (4). 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.
- (5). 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; refer to Note (9) below for further information.
- (6). These are general recommendations; good engineering judgment should be used in all cases for deciding where to install crosswalks, and what treatment / combination of treatments to install.
- (7). The raised median or refuge island must be at least 6 ft wide and 6 ft. long to adequately serve as a refuge area for pedestrians.
- (8). Where the speed limit exceeds 40 mph, marked crosswalks alone should not be used at uncontrolled locations.
- (9). Refer to Chapter 7.0 for detail guidance on appropriate pedestrian facility enhancements / treatments for each of the Category "C", "P", and "N" locations.

5.4 CROSSINGS AT MID-BLOCK LOCATIONS

According to the CVC Section 275⁽⁸⁾, and the interpretation of the same as presented in Section 5.3, mid-block locations cannot have an unmarked crosswalk. In order to establish a crosswalk at a mid-block location, it must be marked.

CA MUTCD Section 3B.18 Paragraph 23 and 24 state the following ⁽¹⁾:

Crosswalk markings may be established between intersections (mid-block) in accordance with CVC 21106(a).

Mid-block pedestrian crossings are generally unexpected by the motorist and should be discouraged unless, in the opinion of the engineer, there is strong justification in favor of such installation. Particular attention should be given to roadways with two or more traffic lanes in one direction as a pedestrian may be hidden from view by a vehicle yielding the right-of-way to a pedestrian.

The City Traffic Engineer may consider establishing mid-block pedestrian crossings at an uncontrolled location, if the crossing location meets the following requirements:

- (1) There is strong justification in favor of the mid-block crossing. Some examples in this regard may include one or more of the following conditions:
 - (a). There is a demonstrated need for marking the mid-block crossing based on demand and / or the need for channelizing the pedestrians; and / or
 - (b). The location is serving a trail or is on a direct pedestrian route to destinations like school, park, senior center, or hospital.
- (2) Installation of marked mid-block crossing is supported based on evaluation by staff in accordance with the guidelines outlined in Sections 5.3.1 – 5.3.3.

- (3) Installation of marked mid-block crossing is consistent with:
 - (a). The above referenced provisions of CVC, and CA MUTCD; and
 - (b). The treatment requirements as outlined in Chapter 7 in general, and Section 7.1.3 in particular.

5.5 CROSSWALKS AT TRAIL CROSSINGS

At locations where a trail or a bicycle path / bike path / shared-use path crosses a street, the appropriate guidance for controlled intersection crossings, uncontrolled intersection crossings and mid-block locations presented in this document, should be used to determine whether or not to mark a crosswalk, and to select the required crossing treatments. As mentioned earlier (Section 5.3.1.1 and 5.3.1.2), the City Traffic Engineer may consider, on a case-by-case basis, exceptions in regards to the following while making a determination on whether to mark the trail / shared-use path crossing at uncontrolled locations:

- (i) Crossing demand
- (ii) Distance to the nearest crosswalk

The approach for selection of appropriate crossing treatments presented in Chapter 7 of this document is also applicable for trail / shared-use path crossings; Section 7.1.4 provides specific guidance related to the trail / shared-use path crossings.

5.6 PROHIBITING PEDESTRIAN CROSSINGS

Legal crosswalks exist at most roadway intersections, even if they are not marked. Chapter 3 of these guidelines provides the definition of a crosswalk per CVC Section 275. Further, an unmarked crosswalk is a legal crossing unless local authorities place signs indicating otherwise. The CVC allows local authorities to prohibit pedestrian crossing with signage.

CVC Section 21106(b) states the following.⁽⁸⁾

Local authorities may install signs at or adjacent to an intersection directing that pedestrians shall not cross in a crosswalk indicated at the intersection. It is unlawful for any pedestrian to cross at the crosswalk prohibited by a sign.

The City Traffic Engineer may restrict certain pedestrian movements at any intersection. The following are example situations that may require pedestrian crossing prohibition:

- Heavy right- or left-turn volumes that occur at the same time as pedestrians cross the path of turning vehicles when protected signal phasing is infeasible.
- Multiple right / left turn lanes.
- Intersection delay or signal progression interference associated with conflicting pedestrian and vehicle traffic.
- Physical environment or geometric conditions provide inadequate sight distance.

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6. EXISTING UNCONTROLLED MARKED CROSSWALKS

This chapter addresses the following aspects of existing uncontrolled crossing locations:

- (1) When should City evaluate the existing uncontrolled marked crosswalks?
- (2) How to evaluate, and enhance / upgrade the existing crosswalk that are non-compliant with the most current guidelines?
- (3) What if the enhancement / upgrade of an existing non-compliant crosswalk is not feasible?
- (4) Removal of existing marked crosswalk(s).

Section 6.1 below presents the background information from Caltrans' HDM, and CA MUTCD in regards to evaluating, and upgrading of existing highways, and traffic control devices. This information forms a basis for developing guidelines in regards to items (1) and (2) above; refer to Sections 6.2, and 6.3 for information on the subject guidelines. Recommendations on items (3) and (4) are presented in Sections 6.4, and 6.5 respectively.

6.1 BACKGROUND INFORMATION

According to Caltrans' HDM Chapter 80 'Application of Design Standards', Topic 82: 'Application of Standards': ⁽¹⁷⁾

..... *Because design standards have evolved over many years, many existing highways do not conform fully to current standards. It is not intended that current manual standards be applied retroactively to all existing State highways; such is neither warranted nor economically feasible. However, when warranted, upgrading of existing roadway features ... should be considered, either as independent projects or as part of larger projects.*

The CA MUTCD ⁽¹⁾ (Chapter on 'Introduction', paragraph 29-30) provides following options regarding the traffic control devices on existing highways and bikeways that have become non-compliant per CA MUTCD adopted standards:

29 All traffic control devices on existing highways and bikeways that have become non-compliant per CA MUTCD adopted standards may remain in service through the end of their useful service life, unless identified specifically with a target date per Table I-101(CA)²

30 To limit the financial impact on agencies and for fiscal responsibility reasons, existing inventory of non-compliant traffic control devices, except those identified per Table I-101(CA)³, may continue to be used until these inventories are depleted.

6.2 WHEN SHOULD THE CITY EVALUATE EXISTING CROSSWALKS?

These guidelines recognize that some of the existing marked crosswalks and associated inventories of traffic control devices may not comply with these (or most current) guidelines, and / or applicable standards. Based on the above-mentioned provisions of the HDM, and CA MUTCD, unless mandated by the pertinent regulatory / governing documents, such non-compliant pedestrian crossing facilities may remain in service through the end of their useful service life and / or until the inventories are depleted. Thus, these guidelines do not suggest that the existing non-compliant pedestrian crossing facilities become obsolete upon adoption of these or any future updates / revisions to the existing guidelines, policies, procedures, and practices, etc. However, as part of the proactive safety management, it is recommended to

² Table I-101(CA) provides a list of signs that are non-compliant per the CA MUTCD ⁽¹⁾ and have been singled out for removal or replacement with specific target compliance dates.

³ Ibid

consider evaluating and enhancing (if feasible) the existing uncontrolled crosswalks and associated traffic control devices under one or more of the following conditions:

- (a) As part of a project involving change in land use (e.g., school closure, development project, etc.).
- (b) As part of a project involving change in roadway characteristics (e.g., roadway widening, lane reduction, etc.).
- (c) As part of a roadway resurfacing project.
- (d) Based on pedestrian safety related concerns identified during the course of any traffic investigation.

6.3 APPROACH TO EVALUATION, AND ENHANCEMENT OF EXISTING CROSSWALKS

The approach for evaluation of an existing uncontrolled marked crosswalk, and enhancement of the same (if determined to be non-compliant with these or the most current pedestrian crossing guidelines) is suggested below.

- (1) Using the guidance presented in Section 5.3.3, determine the applicable classification of the crossing site in to one of the following:
 - "C" = Candidate sites for marked crosswalks.
 - "P" = 'Possible candidate sites for marked crosswalks.
 - "N" = Marked crosswalks alone are insufficient.
- (2) Based on the classification of the crossing site ("C", "P", or "N"), determine the required treatment by referring to Chapter 7 (Pedestrian Crossing Treatments Guide).

- (3) Compare the existing improvements with required treatments, and make a determination whether the existing crosswalk is in compliance with these (or most current) guidelines.
- (4) If the evaluation of an existing uncontrolled marked crosswalk indicates that the subject crosswalk is non-compliant with these (or the most current) pedestrian crossing guidelines take necessary measures if feasible, to install the remaining components to bring the subject site in to compliance. Some examples in this regard are provided below to clarify the recommended approach:

Example 1: A crossing site under evaluation represents category “C” (candidate site for marked crosswalk) and the existing treatment is only the high visibility marked crosswalk and warning signs (W11-2 and W16-7p) at the crossing location. This crosswalk can be made compliant with these guidelines by installing treatments in advance of uncontrolled crossing location consistent with the recommendations in Section 7.1.1 (advance warning signs W11-2 and supplemental plaques with the legend ‘AHEAD’ or ‘XX FEET’, and ‘SLOW PED XING’ pavement markings).

Example 2: There is an existing marked crosswalk at an uncontrolled intersection approach with one lane in each direction, and a two-way left turn lane, with ADT of 14,000 and speed limit of 30 mph. Based on Exhibit 3 (Chapter 5), this location represents category “P”. With installation of a raised median and / or pedestrian refuge island, this crossing site will then be represented by category “C”. Since category “C” locations require only the City’s basic treatment (see Section 7.1.1), this example location can now be enhanced to ensure compliance with these guidelines with relatively less extensive treatment.

Similarly, a review of Exhibit 3 (Chapter 5) indicates that there are certain combinations of roadway and traffic conditions where it might be feasible to enhance the existing non-compliant

crosswalk(s) to ensure compliance with these guidelines by following an approach similar to that described in above examples.

6.4 WHAT IF THE ENHANCEMENT OF AN EXISTING CROSSWALK IS NOT FEASIBLE?

These guidelines recognize that in many cases, it may not be feasible to enhance the existing non-compliant uncontrolled marked crosswalks to bring them in to compliance with these (or most current) guidelines due to a number of reasons such as extensive treatment requirements (e.g., traffic signal, grade separated crossings, etc.), financial constraints, or other considerations.

6.4.1 General Guidance

The following information from FHWA study, CA MUTCD, and CALTRANS' directive on uncontrolled crosswalk enhancements is helpful in developing recommended approach to be followed when it may not be feasible to enhance the existing non-compliant uncontrolled marked crosswalks.

FHWA Study Recommendations⁽¹⁰⁾

As noted in Section 4.3.1, the FHWA study reports that on multi-lane roads with ADT above 12,000 and no raised median, sites with marked crosswalks had higher pedestrian crash rates than unmarked crosswalks, and on multi-lane roads with ADT above 15,000 and with raised median, marked crosswalks had significantly higher pedestrian crash rates than unmarked crosswalks.

As it relates to the general safety considerations in regards to crosswalk installation, the FHWA study states the following:

"Marked crosswalks alone (i.e., without traffic-calming treatments, traffic signals and pedestrian signals when warranted, or other substantial crossing improvement) are insufficient and should not be used under the following conditions:

- *Where the speed limit exceeds 40 mi/h.*
- *On a roadway with four or more lanes without a raised median or crossing island that has (or will soon have) an ADT of 12,000 or greater.*
- *On a roadway with four or more lanes with a raised median or crossing island that has (or soon will have) an ADT of 15,000 or greater".*

Additionally, in terms of speed and crash severity, the FHWA study reports the following results related to their study sites:

"In terms of speed and crash severity, the analysis showed that speed limits of 35 mi/h and greater were associated with a higher percentage of fatal and serious or incapacitating injuries compared to sites having lower speed limits".

The FHWA study also indicates that:

"If nothing else is done beyond marking crosswalks at an uncontrolled location, pedestrians will not experience increased safety (under any situations included in this analysis). This finding is in some ways consistent with the companion study ... that found that marking a crosswalk would not necessarily increase the number of motorists that will stop or yield to pedestrians".

CA MUTCD Provisions ⁽¹⁾

The CA MUTCD Section 3B.18 provides the following guidance in regards to new marked crosswalks at uncontrolled locations representing almost the similar characteristics as mentioned above under FHWA study recommendations:

09 New marked crosswalks alone, without other measures designed to reduce traffic speeds, shorten crossing distances, enhance driver awareness of the crossing, and/or provide active warning of pedestrian presence, should not be installed across uncontrolled roadways where the speed limit exceeds 40 mph and either:

A. The roadway has four or more lanes of travel without a raised median or pedestrian refuge island and an ADT of 12,000 vehicles per day or greater; or

B. The roadway has four or more lanes of travel with a raised median or pedestrian refuge island and an ADT of 15,000 vehicles per day or greater.

Caltrans' Directive on Crosswalk Enhancements Policy ⁽³⁰⁾

The Caltrans' Directive (Number 12-03) provides the following directions for minimum safety enhancements to existing marked crosswalks that cross uncontrolled roadways on the State Highway System with roadway characteristics that are more or less similar to those addressed above (CA MUTCD Section 3B.18):

IMPLEMENTATION:

Stage I: Minimum Enhancements:

If a marked crosswalk exists across an uncontrolled intersection or mid-block location on the State Highway System where the speed limit exceeds 40 mph and the roadway has four or more lanes of travel and an ADT of 12,000 vehicles per day or greater, advanced yield lines with associated Yield Here to Pedestrian (R 1 - 5. R 1 - 5a) signs should be placed 20 to 50 ft. in advance of the crosswalk, pedestrian crossing (W 1 1-2) warning signs with diagonal downward pointing arrow (W16-7p) plaques should be installed at the crosswalk, and a high visibility crosswalk marking pattern should be used.

Stage 2: Additional Enhancements:

Other enhancements may be considered in conjunction with the minimum enhancements, based on engineering judgment or an engineering study (taking into account roadway characteristics, collision history, and pedestrian volumes) such as curb extensions, raised medians or pedestrian refuge islands, lighting, additional signing and marking, pedestrian actuated flashing beacons, pedestrian hybrid beacons or signalized control”.

See the above referenced Policy Directive for further information.

6.4.2 Guidelines for City of Sacramento for Enhancement of Existing Uncontrolled Marked Crosswalks

The recommended approach in regards to existing non-compliant uncontrolled marked crosswalks where it may not be feasible to enhance them to bring into compliance with these (or most current) guidelines is presented below. Although, the recommendations are partially based on the integration of guidance presented in Section 6.4.1 above from FHWA study, CA MUTCD, and CALTRANS' directive, the recommended approach is more thorough in comparison to the CA MUTCD and CALTRANS' directive as it relates to the required evaluation and measures for enhancement of the crossing sites under consideration. Additionally, use of engineering judgment, as appropriate is emphasized as an integral part of the entire process.

The recommended approach is presented in two scenarios depending on roadway and traffic characteristics of the crossing sites. Additionally, the Important Considerations presented at the end of this section should be followed for both the scenarios as applicable.

SCENARIO (I)

This scenario is applicable to existing uncontrolled marked crosswalks with any of the following characteristics:

- (A). The crossing location corresponds to category "N"; refer to Section 5.3.3 for guidance.
- (B). The crossing location is across roadway where speed limit is ≥ 40 mph and the roadway has either:
 - i). ≥ 4 lanes of travel without a raised median or crossing island and an ADT of $\geq 12,000$ vehicles per day, or
 - ii). ≥ 4 lanes of travel with a raised median or crossing island and an ADT of $\geq 15,000$ vehicles per day.

The approach to be followed for these locations is outlined in the following steps:

- (1) Remove the marked crosswalk. The City Traffic Engineer may consider an exception in this regard on a case – by – case basis under certain conditions such as streets with lower speed limits (for e.g. ≤ 30 mph).
- (2) Confirm that:
 - i). There is no sight distance or other safety concerns related to the crossing location; and
 - ii). There is no reported history of crashes involving pedestrians at or near the crossing location within the last five years.
- (3) If both the conditions mentioned in (2) above are met, follow the approach outlined in (a), (b), and (c) below. If any of the condition mentioned in (2) above is not met, follow the approach outlined in step (4) below.

- (a) Consider acquiring funding by exploring potential funding sources (e.g. local, state / federal or other agencies) for installation of the required enhancement treatments at the subject location.
 - (b) Consistent with City's practice of proactive safety management, implement appropriate interim improvements to provide increased safety experience to the pedestrians until such time when all the required pedestrian crossing enhancements are in place. Refer to Chapter 7 for guidance on the treatment options.
 - (c) If it is not feasible to accomplish the goal of providing a certain level of safety experience to pedestrians at the location under consideration, it is recommended to prohibit pedestrian crossing (as a last resort) by following the same approach as presented in step (4) below.
- (4) If any of the condition mentioned in step (2) above is not met:
- (a) Prohibit pedestrian crossing by taking appropriate measures such as:
 - i). Removing traffic control devices associated with the pedestrian crossing (e.g. any signs, pavement markings, etc.).
 - ii). Implementing other measures as necessary to prevent pedestrian crossing (e.g. installing signs prohibiting pedestrian crossing, closing the ramps, installing barricades, etc.).
 - (b) Consider acquiring funding by exploring potential funding sources (e.g. local, state / federal or other agencies) for installation of the required enhancement treatments at the subject location.

SCENARIO (II)

This scenario is applicable to all other existing uncontrolled marked crosswalks across roadways with characteristics that are not covered in Scenario (I). The approach to be followed for these locations is outlined in the following steps:

(1) Confirm that:

- i). There is no sight distance or other safety concerns related to the crossing location; and
- ii). There is no reported history of crashes involving pedestrians at or near the crossing location within the last five years.

(2) If both the conditions mentioned in step (1) above are met, follow the approach outlined in Scenario (I), step (3) above. If any of the condition mentioned in step (1) above is not met, remove the marked crosswalk, and follow the same approach as outlined in Scenario (I), step (3) above.

Important Considerations (for both Scenario (I) and (II))

(1). The installation of interim improvements as recommended above should be done after exercising engineering judgment, as it is unrealistic to develop the prescriptive guidance on required interim improvements for every situation.

(2). In addition to the disclaimer in (i) above, emphasis is placed on providing increased safety experience to pedestrians until such time when all the required pedestrian crossing enhancements are in place. Thus, instead of installing only the minimum interim improvements, it is important to evaluate the site conditions, recommend appropriate interim treatment or combination of treatments that can potentially accomplish the goal of

providing as much safety experience as possible to pedestrians within the available resources.

- (3). All the evaluations and recommendations should be based on engineering judgment and / or engineering study as applicable before presenting for approval to the City Traffic Engineer.

6.5 CROSSWALK REMOVAL

Although, it may be necessary to remove an uncontrolled marked crosswalk from pedestrian safety point of view under the circumstances described in Section 6.4.2 above (Scenario (I), and (II)), it is important to note that such a removal does not prevent pedestrians from crossing the street at an intersection (see Section 5.3 for guidance), unless pedestrian crossing is specifically prohibited.

If based on the approach mentioned in the foregoing section, a determination is made to remove an existing marked crosswalk, the removal of the crosswalk shall be accomplished in a manner consistent with CVC Section 21950.5, which states the following.⁽⁸⁾

An existing marked crosswalk may not be removed unless notice and opportunity to be heard is provided to the public not less than 30 days prior to the scheduled date of removal. In addition to any other public notice requirements, the notice of proposed removal shall be posted at the crosswalk identified for removal.

Further, CA MUTCD Section 3B.18 states the following.⁽¹⁾

Where it is desirable to remove a marked crosswalk, the removal may be accomplished by repaving of surface treatment.

A marked crosswalk should not be eliminated by allowing it to fade out or be worn away.

7. PEDESTRIAN CROSSING TREATMENTS GUIDE

This chapter provides engineering guidance on designing marked pedestrian crossing facilities for both uncontrolled as well as controlled locations.

7.1 PEDESTRIAN CROSSING TREATMENTS FOR MARKED CROSSWALKS AT UNCONTROLLED LOCATIONS

The design of marked pedestrian crossing facilities at uncontrolled locations in the City of Sacramento entails two major components:

- (i) **'Basic' treatment** as outlined in Section 7.1.1 below; and
- (ii) **Pedestrian crossing facility enhancement(s) treatments** to enhance safety and / or ability of pedestrians to cross the street. Refer to Sections 7.1.2, 7.1.3, and 7.1.4 for detail information.

7.1.1 BASIC TREATMENT FOR MARKED CROSSWALKS AT UNCONTROLLED LOCATIONS

The **'basic'** treatment as outlined below, and as depicted in Figure 1 is to be provided at all marked crosswalks at the uncontrolled locations. The City Traffic Engineer may consider variations / exceptions in this regard on a case – by – case basis. Exercising engineering judgment is important in all such cases, as it is impractical to address every possible scenario of site conditions at different crossing facilities.

1) Treatment at the Uncontrolled Crossing Locations:

The marked crosswalks at uncontrolled crossing locations should be provided with:

- (a) City's standard high visibility triple four crosswalk markings; and
- (b) Warning signs W11-2 at the crossing location(s). If a W11-2 sign at the location of the crossing point is post-mounted, a diagonal downward pointing arrow (W16-7P) plaque shall be mounted below the W11-2 sign. If the W11-2 sign is mounted overhead, the (W16-7P) plaque shall not be used. Refer to CA MUTCD ⁽¹⁾ Section 2C.50 for further information.

2) Treatment in Advance of Uncontrolled Crossing Locations:

CA MUTCD Provisions:

The recommendations on treatments in advance of uncontrolled marked crosswalks are based on the following provisions of CA MUTCD ⁽¹⁾:

Section 2C.50 Non-Vehicular Warning Signs:

Non-Vehicular Warning (W11-2...,) signs (see Figure 2C.11) may be used to alert road users in advance of locations where unexpected entries into the roadway might occur or where shared use of the roadway by pedestrians, ..., might occur.

These conflicts might be relatively confined, or might occur randomly over a segment of roadway.

If used in advance of a pedestrian ..., crossing, the W11-2, ..., signs should be supplemented with plaques (see Section 2C.55) with the legend AHEAD or XX FEET to inform road users that they are approaching a point where crossing activity might occur.

Section 3B.20 Pavement Word, Symbol, and Arrow Markings:

Word, symbol, and arrow markings, ..., may be used as determined by engineering judgment to supplement signs and / or to provide additional emphasis for regulatory, warning, or guidance messages.

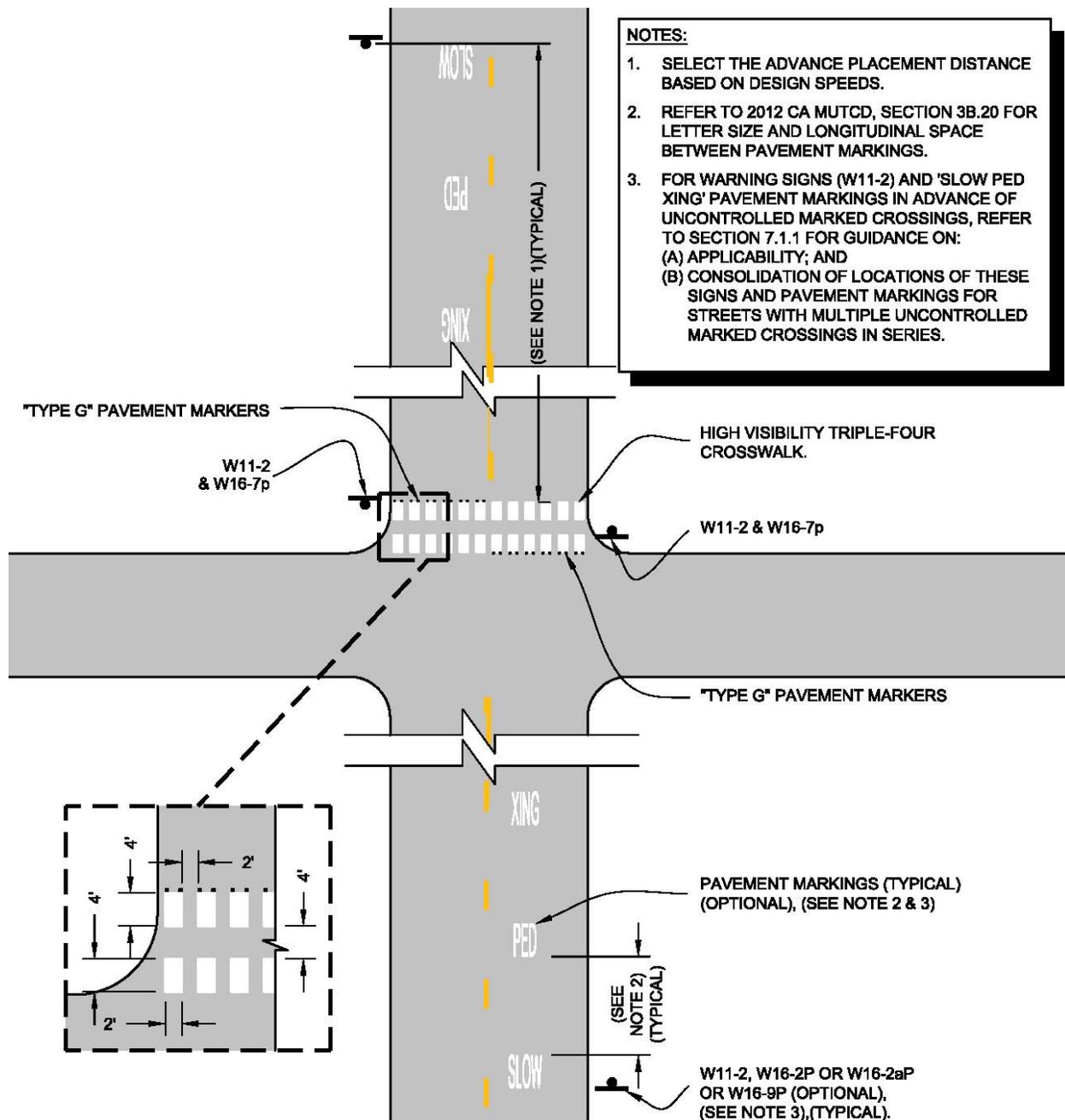
Recommended Treatments:

Based on the above-mentioned provisions in CA MUTCD, these guidelines recommend the following treatments in advance of the uncontrolled marked crosswalks:

- (a) Warning signs (W11-2) may be provided in advance of an uncontrolled marked crosswalks if an engineering judgment indicates that one or more of the following conditions are applicable:
 - i). The need for alerting road users in advance of locations where unexpected entries of pedestrians into the roadway might occur or where shared use of the roadway by pedestrians might occur.
 - ii). For crossing sites where visibility of the crossing treatments and / or pedestrians is obstructed. Some examples of obstructions to visibility may include near side transit stops, trees, visual clutter, roadway geometry that limits sight distance, a large volume of heavy vehicles, etc.
- (b) If the warning sign (W11-2) is used in advance of a pedestrian crossing (see (a) above), it should be supplemented with plaques with the legend 'AHEAD' or 'XX FEET'.
- (c) 'Slow Ped Xing' pavement word markings should be provided in conjunction with W11-2 warning signs if the W11-2 signs are provided in advance of uncontrolled marked crosswalks to supplement the signs and / or to provide additional emphasis for the warning messages. Refer to CA MUTCD Section 3B.20 for further information on pavement markings.

MULTIPLE UNCONTROLLED MARKED CROSSINGS: For streets with multiple uncontrolled marked crossings in series, excessive use of the signs and pavement markings should be avoided in order to ensure the effectiveness as well as the conservative use of these traffic control devices. Depending on site conditions, select appropriate locations to consolidate / minimize the locations of advanced warning signs (W11-2) and associated 'Slow Ped Xing' pavement word markings.

Figure 1:
City of Sacramento's 'Basic' Signing and Marking Treatment for Marked Crosswalks at Uncontrolled Locations



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7.1.2 ENHANCEMENT TREATMENTS FOR MARKED CROSSWALKS AT UNCONTROLLED LOCATIONS

7.1.2.1 Overview

As mentioned in Section 7.1, marked crosswalks at uncontrolled locations may need to be enhanced with appropriate treatments (depending on the roadway and traffic characteristics of the crossing location) to enhance safety and / or ability of pedestrians to cross the street.

Several research studies and other publications provide good information on wide range of engineering treatments available for pedestrian crossing facilities. Many studies cover extensive information on innovative designs, and state-of-the-art technologies such as RRFBs, PHBs, etc. However, these resources offer limited guidance on specific aspects such as the effectiveness and / or applicability of various treatments under different combinations of roadway and traffic conditions. For example, an engineer is unlikely to find specific recommendation as to what treatment(s) can he / she select for an uncontrolled marked crosswalk at a location having the following characteristics: four traffic lanes and a left turn lane with a raised median, speed limit of 35 mph, and ADT of 14,000. The lack of scientific research-based guidance constitutes major limitations in developing specific recommendations for selection of appropriate treatments for pedestrian crossing facilities at uncontrolled locations under different sets of roadway and traffic conditions.

Given the above-mentioned limitations, it is impractical to develop a prescriptive guidance that can provide specific recommendations on selection of a specific treatment for every condition. In view of this, the City of Sacramento has developed these guidelines based on the integration of available information from published studies, knowledge on current industry practices, and experiences with performance of various pedestrian crossing treatments.

The information from published studies in regards to general guidance on potential engineering treatments for pedestrian crossing facilities, and the range of alternative treatments available for the same is presented below in Section 7.1.2.2, and 7.1.2.3 respectively. This information forms the basis for development of recommended guidelines for the City of Sacramento as presented in the remainder of this chapter.

7.1.2.2 General Guidance on Enhancement Treatments for Marked Uncontrolled Pedestrian Crossings

The review of general guidance on type and level of treatments for enhancement of uncontrolled marked crosswalks published in FHWA, CA MUTCD, and NCHRP studies is presented in this section. As seen in Exhibit 3, the type and level of treatments is determined by the roadway and traffic characteristics of the crossing site. Based on FHWA study ⁽¹⁰⁾, the locations under category “C” are suitable for marked crosswalks alone. As it relates to Category “P”, and “N” locations, although there is a lack of adequate specific guidance, the information presented below forms the basis for developing the recommended guidelines for the City of Sacramento.

Recommendations by FHWA Study ⁽¹⁰⁾:

In regards to category “P” locations, the FHWA study mentions that a possible increase in pedestrian crash risk may occur if crosswalks are added without other pedestrian facility enhancements. In regards to category “N” locations, the FHWA study mentions that marked crosswalks alone are insufficient at these locations, since pedestrian crash risk may be increased by providing marked crosswalks alone. The subject study recommends using substantial crossing treatments such as traffic signals with pedestrian signals when warranted, or other substantial crossing improvements to improve crossing safety for pedestrians at these (category “N”) locations.

Furthermore, the FHWA study states the following:

"Marked crosswalks alone (i.e., without ..., traffic signals and pedestrian signals when warranted, or other substantial crossing improvement) are insufficient and should not be used under the following conditions:

- *Where the speed limit exceeds 40 mi/h.*
- *On a roadway with four or more lanes without a raised median or crossing island that has (or will soon have) an ADT of 12,000 or greater.*
- *On a roadway with four or more lanes with a raised median or crossing island that has (or soon will have) an ADT of 15,000 or greater".*

CA MUTCD Provisions ⁽¹⁾:

As mentioned in Section 6.4.1, the CA MUTCD Section 3B.18 provides general guidance in regards to new marked crosswalks at uncontrolled locations representing almost the similar characteristics as mentioned above under FHWA study. Refer to Section 6.4.1 of this document / CA MUTCD Section 3B.18 for further information.

Recommendations by NCHRP Study ⁽⁹⁾:

According to the NCHRP Report 562, the safest and most effective pedestrian crossings often use several traffic control devices or design elements to meet the information and control needs of both motorists and pedestrians. The NCHRP study recommends considering the following desirable characteristics for a pedestrian crossing:

- The street crossing task is made simple and convenient for pedestrians.
- The crossing location and any waiting or crossing pedestrians have excellent visibility.
- Vehicle speeds are slowed or controlled in the area of the pedestrian crossing.

- Vehicle drivers are more aware of the presence of the crosswalk.
- Vehicle drivers yield the right-of-way to legally crossing pedestrians.
- Pedestrians use designated crossing locations and obey applicable state and local traffic laws.

The NCHRP Report 562 states further that in a complex (e.g., multi-lane, high-speed, high-volume) street environment, it probably will be difficult to provide these characteristics with a single simple treatment, i.e., complex street environments may require several different treatments intended to serve different purposes. Streets with lower speeds or traffic volumes may not require multiple treatments to be safe and effective. In these less complex street environments, single treatments may be just as safe and effective as multiple treatments.

In regards to the effectiveness of engineering treatments at unsignalized roadway crossings on busy, high-speed arterial streets, NCHRP Report 562 reports that those treatments that show a red signal indication to the motorist have a statistically significant different motorist compliance rate from devices that do not show a red indication. These red signal or beacon devices had compliance rates greater than 95 percent and include midblock signals, half signals, and high-intensity activated crosswalk (HAWK) signal beacons (now being referred to as Pedestrian Hybrid Beacons - PHBs).

The above-cited information from FHWA, and NCHRP studies has been incorporated into the development of the guidance in selection of appropriate treatment levels as presented in Section 7.1.2.4, and Section 7.1.2.5.

7.1.2.3 Summary of Enhancement Treatment Options for Marked Uncontrolled Pedestrian Crossings

Based on the review of available information from NCHRP Report 562⁽⁹⁾ and other sources, various treatment options available for pedestrian crossings (uncontrolled as well as controlled) are divided in to the following treatment categories:

- **Geometric / Speed Reduction Treatments** – These physical elements are intended to provide pedestrian crossing enhancement by shortening the unprotected crossing distance, increasing visibility or slowing vehicle speeds.
- **Enhanced Treatments** – This category includes treatments as well as devices that enhance the visibility of the crossing location and pedestrians. These treatments are in effect at all times. Warning signs, markings, or beacons belong to this category and are referred to as ***present or active at all times***.
- **Active When Present Treatments** – These devices enhance the visibility of a crossing location by displaying a warning only when pedestrians are present or crossing the street.
- **Red Treatments** – These devices display circular red indication (signal or beacon) to motorists at the crossing location and offer the greatest degree of protection for pedestrians by controlling vehicle traffic.

A list of different treatment options corresponding to each of the above-mentioned categories is presented in Appendix D for information. The majority of these treatments are incorporated into the recommended guidelines for the City of Sacramento depending on their applicability and / or effectiveness under different combinations of roadway and traffic conditions.

7.1.2.4 Development of Pedestrian Crossing Enhancement Treatment Guidelines for City of Sacramento

The information presented in Sections 7.1.2.2, and 7.1.2.3 provides the basis for developing these guidelines for selection of appropriate pedestrian enhancement treatments for marked crosswalks at uncontrolled locations. The approach followed in developing these guidelines, and the recommended treatments is presented below.

Treatments for pedestrian crossing enhancements are grouped into the following two broad categories. Refer to Table 1 for the list of treatments included under each category.

(1) PRINCIPAL TREATMENTS:

The Principal treatments represent the essential components of the pedestrian crossing enhancement. These treatments can be used as stand-alone or uniquely (i.e., with or without additional treatments). Depending on their applicability and / or effectiveness under different roadway and traffic characteristics, the Principal treatments are divided further into the following sub-categories:

- (I) Geometric Treatments;
- (II) Level 1 Enhancement Treatments ('two-device' RRFBs);
- (III) Level 2 Enhancement Treatments ('four-device' RRFBs); and
- (IV) Level 3 Enhancement Treatments.

As seen above, and in Table 1, the following devices are incorporated into the pedestrian crossing treatments toolbox:

- RRFB.
- PHB.

Appendix A covers the detail information on pertinent requirements, and / or additional guidance related to the principal treatments.

(2) SUPPLEMENTAL TREATMENTS:

The supplemental treatments are the ones that may be potentially useful as supplements or add-ons to the City's basic treatment and / or the principal treatments. Appendix B covers the detail information on pertinent requirements, and / or additional guidance related to the supplemental treatments that are relatively new, and / or less commonly used.

The recommendations on selection of appropriate enhancement treatments under various combinations of roadway and traffic conditions are presented in Section 7.1.2.5 below. These recommendations are based on:

- a). The conceptual guidance presented in Section 7.1.2.2, and
- b). The applicability and / or effectiveness of various treatments specified in Table 1.

Table 2 summarizes Recommended Pedestrian Crossing Enhancement Treatments for Marked Crosswalks at Uncontrolled Locations.

7.1.2.5 Recommended Treatments for City of Sacramento for Enhancements of Pedestrian Crossings at Uncontrolled Locations

This section presents general recommendations on selection of appropriate treatments for enhancement of marked crosswalks at uncontrolled locations. It is recommended to note the following in regards to the subject recommendations:

- (1) These guidelines are aimed at ensuring a reasonable balance between engineering judgment and prescriptiveness. Although the recommendations presented in this section are intended to provide guidance in the selection of appropriate pedestrian crossing treatments; **in all situations, engineering judgment should be exercised in selecting a specific treatment for installation.**
- (2) The treatments recommended in these guidelines reflect the more common treatments being used and may not include every treatment available. Furthermore, the City of Sacramento's practice is to use only those traffic control devices that are approved for use in California. Accordingly, only those treatments and devices that are either included in to the CA MUTCD or approved for their use by the CTCDC at the time of development of these guidelines are included as the recommended Treatments. With advancement in technology, new treatments and devices may become available in the future. The City

Traffic Engineer may approve the use of such treatments and devices if they meet the above-mentioned requirement.

- (3) These recommendations build on the concepts and guidance published in FHWA, NCHRP and other important studies as summarized throughout this document in general, and in Section 7.1.2.2 in particular.
- (4) Attempts are made to recommend multiple treatments options, where feasible, in order to provide flexibility in selection of appropriate treatments depending on the site-specific conditions of the crossing locations.

The recommendations on selection of appropriate enhancement treatments for marked crosswalks at uncontrolled locations under each of the Category "C", "P", and "N" are described below, and summarized in Table 2.

Category "C" Locations:

Based on FHWA study ⁽¹⁰⁾, the locations under category "C" are suitable for marked crosswalks alone. However, these Guidelines are recommending to enhance these locations (category "C") also by incorporating the City's 'basic' treatment as outlined in Section 7.1.1.

Category "P" Locations:

Category "P" locations represent a wide range of roadway and traffic conditions, and offer an opportunity to develop a range of enhancement alternatives depending on the roadway and traffic characteristics of the crossing sites (number of lanes, speed limit, and traffic volumes), and the applicability of the treatment(s) under consideration. As mentioned above, attempts are made to recommend more than one treatment option, where feasible, depending on the site-specific conditions of the crossing locations; see Table 2 for specific details. Geometric treatments are recommended for those locations, where a geometric change (for example, a raised median / pedestrian median refuge island) can shift certain locations from Category "P" to

“C”. For crossing locations where Level 1 treatments are recommended, the possible options for using ‘two-device’ RRFBs at as many locations as possible are noted in Table 2. The objective of these recommendations is to avoid / minimize the need for ‘four-device’ RRFBs / other higher level treatments, while still ensuring the effectiveness of ‘two-device’ RRFBs. Where the use of ‘two-device’ RRFBs is not feasible, it is recommended to consider Level 2 (‘four-device’ RRFBs) or Level 3 treatments as appropriate. These locations represent one or more of the following conditions; refer to Table 2 for specific information.

- Higher speed;
- Excessive number of lanes (i.e. excessive crossing distance for the pedestrians); and
- Higher traffic volumes.

Category “N” Locations:

A review of the roadway and traffic characteristics represented by the locations under Category “N”, and the guidance presented in Section 7.1.2.2 clearly indicate the need for substantial enhancement treatments for ensuring safe pedestrian crossings at these locations. Accordingly, Level 3 enhancement treatments are recommended for most of the locations; Level 2 (a four-device RRFB) enhancement treatment being recommended for some locations depending on roadway and traffic characteristics, and the applicability of the Level 2 treatment.

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Table 1: Pedestrian Crossing Enhancement Treatments for Marked Crosswalks at Uncontrolled Locations

(Sheet 1 of 3)

CITY OF SACRAMENTO'S BASIC TREATMENT (*)

Treatment	Placement Requirements, and / or Guidance
High visibility marked triple-four crosswalk, and associated signs and pavement word markings.	(1) Required for all marked crossings at uncontrolled locations. (2) Refer to Section 7.1.1 for details.

PRINCIPAL TREATMENTS (*)

Geometric Enhancement Treatments (*)

Treatment	Placement Requirements, and / or Guidance
Raised Median / Pedestrian Median Refuge Island.	(1) Where roadway width can accommodate without negatively affecting bicycle and vehicle traffic. (2) Refer to Appendix A1 for further information.
Split Pedestrian Crossover Median Refuge Island.	(1) Where roadway width can accommodate without negatively affecting bicycle and vehicle traffic. (2) Refer to Appendix A2 for further information.

Level 1 Enhancement Treatments (L₁) (*)

Treatment	Placement Requirements, and / or Guidance
Rectangular Rapid Flashing Beacon (RRFB) – ‘two device’ treatment.	(1) A ‘two-device’ / ‘a side-mounted’ RRFB treatment refers to an installation with two RRFBs (one for each direction of an approach mounted at the right-hand side of the approach). (2) The installation of RRFBs shall comply with the FHWA’s <u>Conditions of Interim Approval</u> (FHWA IA-11); refer the subject interim approval memo at: http://mutcd.fhwa.dot.gov/resources/interim_approval/ia11/fhwamemo.htm (3) For crossings with obstructed visibility for side-mounted RRFB treatment, a median-mounted RRFB treatment (Level 2) or other appropriate treatment, such as Level 3 treatment (see below) shall be considered. (4) Refer to Appendix A3 for further information.

(*) NOTES:

- (1) These are general recommendations; good engineering judgment should be used in all situations for deciding where to install crosswalks, and what treatment / combination of treatments to install.
- (2) The treatments recommended in the guidelines reflect the more common treatments being used and may not include every treatment available.
- (3) Refer to Section 7.1.2.5 for further information on the recommended treatments.

Table 1: Pedestrian Crossing Enhancement Treatments for Marked Crosswalks at Uncontrolled Locations

(Sheet 2 of 3)

Level 2 Enhancement Treatments (L₂) (*)

Treatment	Placement Requirements, and / or Guidance
Rectangular Rapid Flashing Beacon (RRFB) – ‘four device’ treatment.	<ol style="list-style-type: none"> (1) A ‘four-device’ / a ‘median-mounted RRFB treatment’ refers to an installation of four RRFBs (two per approach with one on the roadway median / island and one on the right-hand side). (2) The installation of RRFBs shall comply with the FHWA’s Conditions of Interim Approval (FHWA IA-11); refer the subject interim approval memo at: http://mutcd.fhwa.dot.gov/resources/interim_approval/ia11/fhwamemo.htm (3) For locations where a median island RRFB treatment is not feasible, or there are more than two lanes in a direction, other appropriate treatments, such as Level 3 treatments (see below) shall be considered. Alternatively, the RRFBs may be considered for mounting overhead consistent with FHWA’s Interpretation Letter regarding RRFB Overhead mounting which is available at: http://mutcd.fhwa.dot.gov/resources/interpretations/4_376.htm (4) Refer to Appendix A4 for further information.

Level 3 Enhancement Treatments (L₃) (*)

Treatment	Placement Requirements, and / or Guidance
Pedestrian Hybrid Beacon (PHB) / High-intensity Activated Crosswalk (HAWK).	<ol style="list-style-type: none"> (1) Refer to CA MUTCD⁽¹⁾, Chapter 4F for applicable requirements, and installation guidance. (2) Refer to Appendix A5 for further information
Traffic Signal, where warranted.	<ol style="list-style-type: none"> (1) Refer to CA MUTCD⁽¹⁾, Part 4 for applicable traffic signal warrants, and other requirements. (2) It is recommended to install countdown pedestrian signal heads at all traffic signals, except where the pedestrian crossing is prohibited. Section 5.6 describes the conditions that may require pedestrian crossing prohibition. (3) Refer to Section 7.2.1 for recommended guidelines for marking crosswalks and limit lines at signalized intersections. (4) Refer to Appendix A6 for further information.
Grade Separation: Pedestrian Overcrossing or Undercrossing.	<ol style="list-style-type: none"> (1) According to FHWA study,⁽¹⁰⁾ grade-separated crossings are very expensive and should only be considered in extreme situations, such as where pedestrian crossings are essential (e.g., school children need to cross a six-lane arterial street), street – crossing at - grade is not feasible for pedestrians, and no other measures are considered to be appropriate. (2) Refer to Appendix A7 for further information.

(*) NOTES:

- (1) These are general recommendations; good engineering judgment should be used in all situations for deciding where to install crosswalks, and what treatment / combination of treatments to install.
- (2) The treatments recommended in the guidelines reflect the more common treatments being used and may not include every treatment available.
- (3) Refer to Section 7.1.2.5 for further information on the recommended treatments.

Table 1: Pedestrian Crossing Enhancement Treatments for Marked Crosswalks at Uncontrolled Locations

(Sheet 3 of 3)

SUPPLEMENTAL ENHANCEMENT TREATMENTS (*)

Treatment	Suggested Reference for Placement Requirements, and Guidance
In-Roadway Warning Lights (IRWLs)	Appendix B1.
Flashing Warning Beacon	Appendix B2.
“Road Diet” (Roadway Reconfiguration)	Appendix B3.
Curb Extension	Appendix B4.
Tighter Curb Return Radii	Appendix B5.
Improved Right - Turn Slip - Lane Design	Appendix B6.
Advanced Yield / Stop Lines	Appendix B7.
Advanced Stop Line / Limit Line at Traffic Signals	Appendix B8.
In-Street and Overhead Pedestrian Crossing Sign	Appendix B9.
Pedestrian-Activated Flashing (Embedded LED) Warning Sign	Appendix B10.
Traffic-calming Measures	Appendix B11.
Textured Pavement	Appendix B12.
Eliminate parking on the approach to uncontrolled crosswalks	Appendix B13.
Locate transit stops on the far side of the intersection	Appendix B14.
Hardware and Operational Treatments for Signalized Locations	Appendixes C1 – C10.

(*) NOTES:

- (1) These are general recommendations; good engineering judgment should be used in all situations for deciding where to install crosswalks, and what treatment / combination of treatments to install.
- (2) The treatments recommended in the guidelines reflect the more common treatments being used and may not include every treatment available.
- (3) Refer to Section 7.1.2.5 for further information on the recommended treatments.

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Table 2: Recommended Pedestrian Crossing Enhancement Treatments for Marked Crosswalks at Uncontrolled Locations

	≤ 9,000 ADT				> 9,000 ADT to ≤ 12,000 ADT				> 12,000 to ≤ 15,000 ADT				> 15,000 ADT			
	≤ 30 mph	35 mph	40 mph	≥ 45 mph	≤ 30 mph	35 mph	40 mph	≥ 45 mph	≤ 30 mph	35 mph	40 mph	≥ 45 mph	≤ 30 mph	35 mph	40 mph	≥ 45 mph
2 Lanes	C	C	P (L ₁ ; See Note (1)) Or L ₂ /L ₃	N L ₃	C	C	P (L ₁ ; See Note (1)) Or L ₂ /L ₃	N L ₃	C	C	P (L ₁ ; See Note (1)) Or L ₂ /L ₃	N L ₃	C	P (L ₁ ; See Note (1)) Or L ₂ /L ₃	N L ₃	N L ₃
3 Lanes	C	C	P (L ₁ ; SEE Note (2)) Or L ₂ /L ₃	N L ₃	C	P (G) OR (L ₁ ; See Note (2)) Or L ₂ /L ₃	P (L ₁ ; See Note (2)) Or L ₂ /L ₃	N L ₃	P G OR (L ₁ ; See Note (2)) Or L ₂ /L ₃	P G OR (L ₁ ; See Note (2)) Or L ₂ /L ₃	P (L ₁ ; See Note (2)) Or L ₂ /L ₃	N L ₃	P G OR (L ₁ ; See Note (2)) Or L ₂ /L ₃	N (L ₃)	N L ₃	N L ₃
4 or More Lanes with Raised Median	C	C	P L ₂ /L ₃	N L ₃	C	P L ₂ /L ₃	N L ₂ /L ₃	N L ₃	P L ₂ /L ₃	P L ₂ /L ₃	N L ₂ /L ₃	N L ₃	N L ₂ /L ₃	N L ₃	N L ₃	N L ₃
4 or More Lanes No Raised Median	C	P G Or L ₂ / L ₃	N L ₂ /L ₃	N L ₃	P G Or L ₂ / L ₃	P L ₂ / L ₃	N L ₂ /L ₃	N L ₃	N L ₂ /L ₃	N L ₂ /L ₃	N L ₂ /L ₃	N L ₃	N L ₃	N L ₃	N L ₃	N L ₃

C = Candidate sites for marked crosswalks ^(*).

P = Possible candidate sites for marked crosswalks ^(*).

N = Marked crosswalks alone are insufficient ^(*).

^(*) = Refer to Exhibit 3 for description of category "C", "P", and "N".

G = Geometric treatment.

L₁, L₂, and L₃ = Recommended level of pedestrian crossing enhancement treatment; see Table 1 for details.

Notes:

- (1) 2-lanes: Possible treatment options using RRFBs:
 - a. 1-lane each direction: 2-RRFB.
 - b. 2-lanes, one-way: 2- RRFB (one on each side of the road).
 - c. If neither (a) or (b) is feasible / applicable, consider L₂ Or L₃.
- (2) 3 – lanes: Possible treatment options using RRFBs:
 - (i). 2- lanes + TWLTL or a raised median: 2-RRFB + Ped Island - if this combination is not feasible, consider L₂ Or L₃.
 - (ii). All other scenarios (for example, 2 - through lanes + a turn pocket; 3- Lanes, one-way) : L₂ Or L₃.

Instructions:

- (1). The design of marked pedestrian crossing facilities at uncontrolled locations should incorporate the following:
 - (a) City of Sacramento's basic treatment – required for ALL marked crossings at uncontrolled locations. Refer to Section 7.1.1 for details.
 - (b) Pedestrian crossing enhancement treatment(s) – the recommended treatment levels corresponding to different site conditions as presented in the above Table; the list of different levels of treatments is presented in Table 1. Refer to Sections 7.1.2.4 and 7.1.2.5 for additional details.
- (2). The selected treatment / device shall meet the applicable requirements as mentioned in to Table 1 and the corresponding Appendix.
- (3). These are general recommendations; good engineering judgment should be used in all cases for deciding where to install crosswalks, and what treatment / combination of treatments to install.

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7.1.3 CROSSINGS AT MID-BLOCK

The following sections of CA MUTCD ⁽¹⁾ provide guidance for mid-block crossing locations:

Section 3B.18:

Because non-intersection pedestrian crossings are generally unexpected by the road user, warning signs (see Section 2C.50) should be installed for all marked crosswalks at non-intersection locations and adequate visibility should be provided by parking prohibitions.

Section 3B.16:

If yield or stop lines are used at a crosswalk that crosses an uncontrolled multi-lane approach, the yield lines or stop lines should be placed 20 to 50 feet in advance of the nearest crosswalk line, and parking should be prohibited in the area between the yield or stop line and the crosswalk (see Figure 3B-17).

If an uncontrolled mid-block location is selected for a marked crosswalk in accordance with the guidelines presented in Sections 5.3.1 - 5.3.3, and Section 5.4, the location is to be provided with the following treatments:

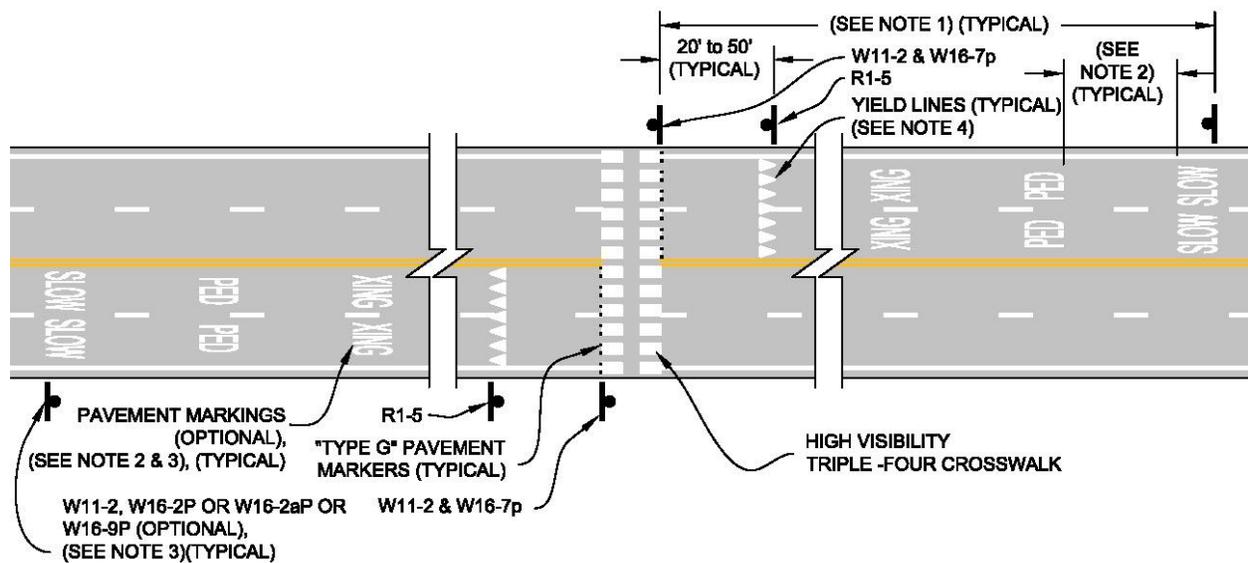
- (1) City's 'basic' treatment as outlined in Section 7.1.1 after incorporating the CA MUTCD requirements as mentioned above. See Figure 2 for details.
- (2) Pedestrian crossing facility enhancement treatments depending on whether the crossing location falls under Category "**C**", "**P**", or "**N**". Refer to Sections 7.1.2.4 and 7.1.2.5 for details.

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Figure 2:

Signing and Marking Treatments for Mid-Block Crosswalks at Uncontrolled Locations

- NOTES:**
1. SELECT THE ADVANCE PLACEMENT DISTANCE BASED ON DESIGN SPEEDS.
 2. REFER TO 2012 CA MUTCD, SECTION 3B.20 FOR LETTER SIZE AND LONGITUDINAL SPACE BETWEEN PAVEMENT MARKINGS.
 3. FOR WARNING SIGNS (W11-2) AND 'SLOW PED XING' PAVEMENT MARKINGS IN ADVANCE OF UNCONTROLLED MARKED CROSSINGS, REFER TO SECTION 7.1.1 FOR GUIDANCE ON:
(A) APPLICABILITY; AND
(B) CONSOLIDATION OF LOCATIONS OF THESE SIGNS AND PAVEMENT MARKINGS FOR STREETS WITH MULTIPLE UNCONTROLLED MARKED CROSSINGS IN SERIES.
 4. (A) PARKING SHOULD BE PROHIBITED BETWEEN YIELD LINES AND MARKED CROSSWALK.
(B) FOR STREETS WITH ONLY ONE LANE IN DIRECTION, THE USE OF ADVANCE YIELD LINE AND PROHIBITION OF PARKING BETWEEN YIELD LINE AND CROSS WALK IS NOT REQUIRED.



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7.1.4 CROSSWALKS AT TRAILS

CA MUTCD⁽¹⁾ Part 9 contains guidance regarding traffic control for bicycle facilities, including shared-use paths. Additionally, CA MUTCD Section 9B.03 provides guidance regarding placement of STOP or YIELD control at a shared-use path / roadway intersection.

Refer to the following sections of CA MUTCD, Part 9 for specific information on the warning signs related to a trail or a bike path / shared-use path crossing:

Section 9B.16 Intersection Warning Signs (W2 Series) for guidance on the use and applicability of intersection warning signs (W2-1 through W2-5) in advance of a shared-use path / roadway intersection.

Section 9B.18 Bicycle Warning and Combined Bicycle / Pedestrian Signs (W11-1 and W11-15) for guidance on the use and applicability of Bicycle Warning sign (W11-1), and combination Bicycle / Pedestrian (W11-15) signs in advance of, and at a path crossing including the use of applicable supplemental plaques.

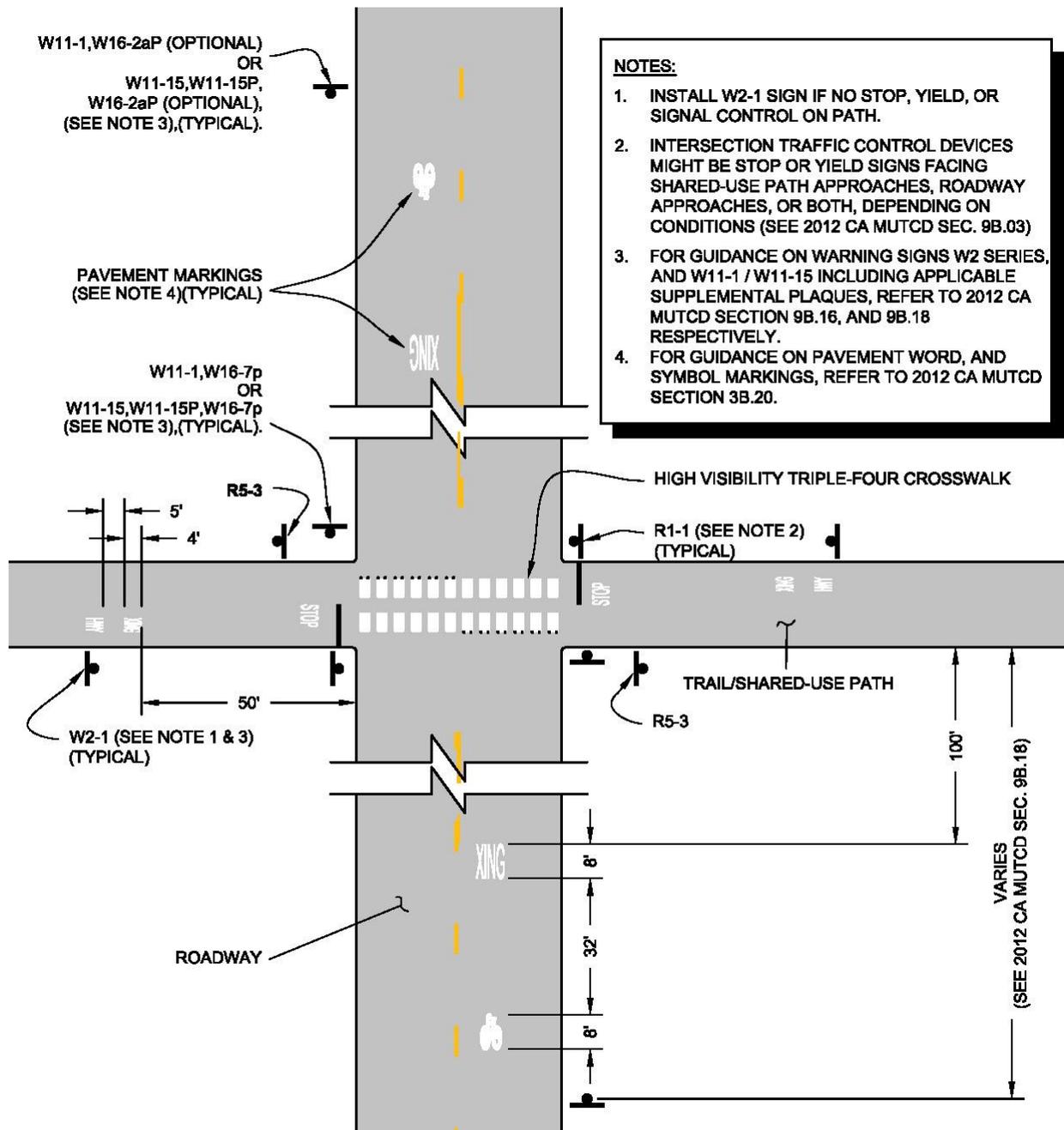
If a determination is made to provide a marked crossing for a trail or a bike path / shared-use path at an uncontrolled location, the crossing location is to be provided with the following treatments:

- (1) City's 'basic' treatment as outlined in Section 7.1.1 after incorporating the CA MUTCD requirement as mentioned above. See Figure 3 for details.
- (2) Pedestrian crossing facility enhancement treatments depending on whether the crossing location falls under Category "**C**", "**P**", or "**N**". Refer to Sections 7.1.2.4 and 7.1.2.5 for details.

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Figure 3:

Signing and Markings for a Trail / Shared-Use Path Crossing at Uncontrolled Intersections



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7.2 CROSSWALKS AT CONTROLLED LOCATIONS

The recommended guidelines for marking crosswalks at signalized, and stop or yield controlled locations are presented in Sections 7.2.1, and 7.2.2 below.

7.2.1 SIGNALIZED INTERSECTIONS

These guidelines recommend the following approach for marking crosswalks at signalized intersections:

- (1) Provide marked crosswalks on all approaches of the signalized intersections unless pedestrian crossing is prohibited. Section 5.6 presents example situations that may require pedestrian crossing prohibition.
- (2) The marked crosswalks should be 12 feet wide with a 10 feet inside clear space. The City Traffic Engineer may consider approving lesser space on a case - by - case basis, provided it is not less than 6 feet; refer to CA MUTCD Section 3B.18 for information.
- (3) Considering the advantages of advanced stop lines (see Appendix B8), it is recommended to install a 24-inch limit line (stop line) seven feet in advance of the crosswalk on each approach of the signalized intersections.

Hardware and Operational Treatments for Signalized Locations: The information on the supplemental treatments that may be used at signalized locations from the perspective of achieving optimal pedestrian service is covered in Appendix C.

7.2.2 STOP- OR YIELD-CONTROLLED LOCATIONS

These guidelines recommend the following approach for marking crosswalks at the stop or yield controlled intersections:

(1) **Stop-controlled locations:**

- a). Install marked crosswalks only if recommended by the City Traffic Engineer, otherwise, install only a 12-inch wide limit line with associated traffic control devices (e.g. signs, pavement markings, etc.) consistent with CA MUTCD. The City may consider marking the crosswalks at the stop controlled locations where engineering judgment indicates that they are needed to direct pedestrians to the proper crossing path(s); see CA MUTCD, Section 3B.18, paragraph 07.
- b). The marked crosswalks (if provided) should be 12 feet wide with a 10 feet inside clear space. The City Traffic Engineer may consider approving lesser space on a case - by - case basis, provided it is not less than 6 feet; refer to CA MUTCD Section 3B.18 for information. Additionally, the Stop controlled approach should be provided with associated traffic control devices (e.g. signs, pavement markings, etc.) consistent with CA MUTCD.
- c). Per CA MUTCD, Section 3B.16 (paragraph 21), a limit line at the stop controlled approach is not required where a marked crosswalk exists. In view of this, these guidelines recommend not to provide limit line at stop-controlled locations with marked crosswalks.

(2) **Yield-controlled locations:**

- a). Install marked crosswalks only if recommended by the City Traffic Engineer, otherwise, install only a yield line with associated traffic control devices (e.g. signs, pavement markings, etc.) consistent with CA MUTCD. Refer to CA MUTCD Section 3B.16, paragraphs 07, and 09 for pertinent details of yield lines. The City

may consider marking the crosswalks at the yield controlled locations where engineering judgment indicates that they are needed to direct pedestrians to the proper crossing path(s); see CA MUTCD, Section 3B.18, Paragraph 07.

- b). The marked crosswalk (if provided) should be 12 feet wide with a 10 feet inside clear space. The City Traffic Engineer may consider approving lesser space on a case - by - case basis, provided it is not less than 6 feet; refer to CA MUTCD Section 3B.18 for information. Additionally, the Yield controlled approach should be provided with associated traffic control devices (e.g. signs, pavement markings, etc.) consistent with CA MUTCD.
- c). These guidelines recognize that the yield-controlled pedestrian crossings may exist under a wide range of site conditions, and the City Traffic Engineer may need to consider modifications to the crossing treatments recommended above based on engineering judgment on a case-by-case basis. One of the examples in this regard include providing City's standard high visibility triple four crosswalk markings at locations where physical conditions are such that added visibility of the crosswalk is desired, or at places where a pedestrian crosswalk might not be expected.

(3) Additional Guidance for Stop - or Yield-controlled locations:

The treatments presented in (1) and (2) above cover the basic information on marking the crosswalks at the stop or yield controlled intersections. It is recommended to refer to the following sections of CA MUTCD for any additional guidance related to crossing facilities at these locations. Since extensive information on this topic is available in CA MUTCD, only the selected sections are listed below; the user may need to refer additional sections, as needed:

- a). Section 3B.16 (Stop and Yield Lines).
- b). Section 3B.18 (Crosswalk Markings).
- c). Section 3B.20 (Pavement Word, Symbol, and Arrow Markings).

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APPENDICES

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8. APPENDIX A: PRINCIPAL TREATMENTS

8.1	Appendix A1-A2: Geometric Enhancement Treatments	101
8.1.1	Appendix A1: Raised Medians / Pedestrian Median Refuge Islands	101
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8.1 APPENDIX A1-A2: GEOMETRIC ENHANCEMENT TREATMENTS

8.1.1 APPENDIX A1: RAISED MEDIANS / PEDESTRIAN MEDIAN REFUGE ISLANDS

Raised medians / pedestrian crossing islands are placed in the center of the roadway separating opposing lanes of traffic with cutouts for accessibility along the pedestrian path. Median refuge islands are recommended where right-of-way and roadway geometry allow. Islands benefit the pedestrian by facilitating crossing one direction of the street at a time. The design, and installation of the raised island should ensure that the left turn movements to or from the side street are not adversely impacted.

The AASHTO Ped Guide suggests that median islands should be at least six feet wide to accommodate more than one pedestrian and to provide two feet of detectable warning at both sides of the island.⁽¹⁸⁾; the FHWA study⁽¹⁰⁾ suggests that refuge islands should be preferably six to eight feet wide and of adequate length to allow pedestrians to stand and wait for gaps in traffic before crossing the second half of the street.

FHWA cites that providing raised medians can significantly reduce pedestrian crash rates.⁽²¹⁾ Further, FHWA suggests medians and pedestrian refuge areas in urban and suburban areas as one of the top nine safety countermeasures.

8.1.2 APPENDIX A2: SPLIT PEDESTRIAN CROSSOVER MEDIAN REFUGE ISLAND



Phoenix, Arizona

Image Source: FHWA, ADOT

This measure is similar to a traditional pedestrian median refuge island with the difference being that the crosswalks in the roadway are staggered such that a pedestrian crosses half of the street and then walks toward traffic or on an angle to reach the second half of the crosswalk. This strategy is well suited for off-set intersections and skewed crosswalk alignments where an extended median can be used to align the crosswalks perpendicular to vehicle traffic.

8.2 APPENDIX A3-A4: LEVEL 1 (L₁) AND LEVEL 2 (L₂) ENHANCEMENT TREATMENTS

8.2.1 APPENDIX A3-A4: RECTANGULAR RAPID FLASHING BEACON (RRFB) LEVEL 1 (L₁), AND LEVEL 2 (L₂) TREATMENTS

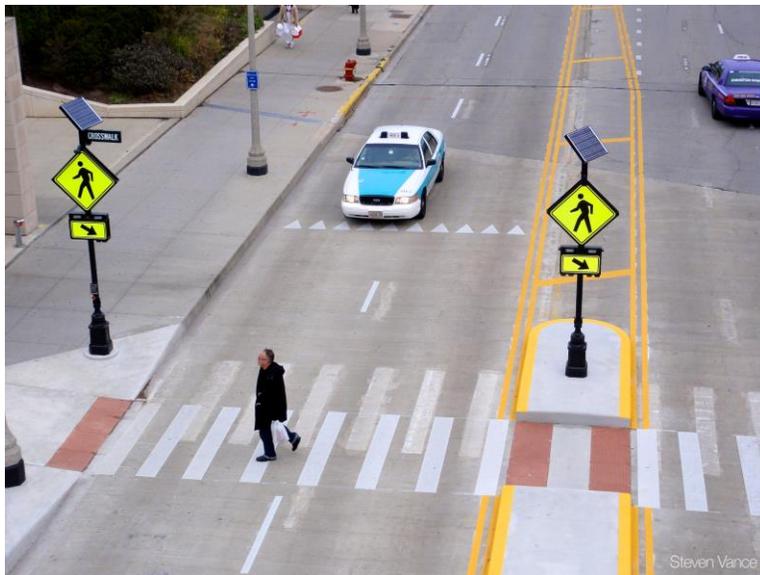


Image Source: PEDSAFE 2013⁽²⁹⁾

The RRFB is another alternative pedestrian device that has shown impressive results in improving driver-yielding rates. It is also known as Light Emitting Diode (LED) Rapid-Flash System, Stutter Flash or LED Beacons. These LED RRFBs are similar in operation to emergency flashers on police vehicles. The RRFB may be push-button activated or activated with passive detection.

FHWA states the following regarding the potential benefits of RRFBs.⁽²²⁾

RRFBs are a lower cost alternative to traffic signals and hybrid signals that are shown to increase driver yielding behavior at crosswalks significantly when supplementing standard pedestrian crossing warning signs and markings.

The following motorist (yield) compliance findings are from FHWA-HRT-11-039.⁽²³⁾

Yielding during the baseline period before the introduction of the RRFB ranged between zero and 26 percent. The introduction of the RRFB was associated with yielding that ranged between 72 and 96 percent at the 2-year follow-up.

CA MUTCD⁽¹⁾ Provisions:

This treatment is approved for use in California, but is not yet included in the CA MUTCD. The CTCDC has adopted (in 2011) the optional use of RRFB based on the FHWA Interim Approval IA-11 (FHWA IA-11) on a blanket basis for all locations in CA:

<http://www.dot.ca.gov/hq/traffops/engineering/mutcd/interim.htm>.⁽¹³⁾

The IA-11 allows for usage of RRFB as a warning beacon to supplement standard pedestrian crossing warning signs and markings at either a pedestrian or school crossing; where the crosswalk approach is not controlled by a yield sign, stop sign, or traffic-control signal; or at a crosswalk at a roundabout.

Guidelines for use of RRFBs in City of Sacramento:

The guidelines recommended for selection of RRFBs in the tool box for pedestrian crossing treatments are based on the integration of information from research report titled Evaluation of Alternative Pedestrian Control Devices⁽²⁷⁾, published by ODOT, and FHWA, and the overall approach presented in Section 7.1.2.

The type of RRFB treatments recommended could be either two-device or four-device system depending on roadway and traffic conditions at the pedestrian crossing location.

A 'two-device' system in this document refers to an installation with two RRFBs (one for each direction of an approach mounted at the right-hand side of the approach). A 'four-device' system refers to an installation of four RRFBs (two per approach with one on the raised median / island and one on the right-hand side). The two-device system is also referred to as '2-RRFB treatment', 'a treatment without median-mounted RRFB' or 'a side-mounted RRFB treatment', whereas the four-device system is referred to as '4-RRFB treatment' or a 'median-mounted RRFB treatment'.

For crossing treatments to be effective, they need to be placed in a location where drivers are able to see them. Similarly, visibility of the pedestrian is also important; the pedestrian waiting to cross must be clearly conspicuous to all approaching drivers. Several items can obstruct the visibility of a crossing or a treatment. Obstructions may include near side transit stops, trees, visual clutter, roadway geometry that limits sight distance, a large volume of heavy vehicles, etc. Crossings with obstructed visibility for side-mounted devices need to be designed to ensure adequate visibility for motorists by installation of a '4-RRFB treatment' (a 'median-mounted RRFB treatment'). RRFBs installed on a median increase visibility by maintaining the devices at a height closer to the driver's eye level. Median islands have been shown to have many other benefits including simplifying the crossing for pedestrians in situations such as higher crossing distance and / or higher traffic volumes, attaining higher crossing compliance rates, improving efficiency at the crossing, and providing a refuge for trapped pedestrians.

For locations where a median island RRFB treatment is not feasible or not likely to ensure the visibility (of both the crossing treatment as well as pedestrians) from all approaching lanes of traffic, other appropriate treatments, such as Level 3 treatments (see Table 1, Section 7.1.2.4) shall be considered. Alternatively, the RRFBs may be considered for mounting overhead

consistent with FHWA's Interpretation Letter regarding RRFB Overhead Mounting which is available at:

http://mutcd.fhwa.dot.gov/resources/interpretations/4_376.htm

RRFB Installation Requirements:

(1) The installation of RRFBs shall comply with the FHWA's Conditions of Interim Approval (FHWA IA - 11); refer the subject interim approval memo at:

http://mutcd.fhwa.dot.gov/resources/interim_approval/ia11/fhwamemo.htm

(2) For locations with obstructed visibility for side-mounted RRFB treatment, a median-mounted RRFB treatment (4-RRFB treatment) shall be considered. For locations where a median island RRFB treatment is not feasible, or there are more than two lanes in a direction, other appropriate treatments, such as Level 3 treatments (see Table 1, Section 7.1.2.4) shall be considered. Alternatively, the RRFBs may be considered for mounting overhead consistent with FHWA's Interpretation Letter regarding RRFB Overhead Mounting which is available at:

http://mutcd.fhwa.dot.gov/resources/interpretations/4_376.htm

(3) See the discussion above for additional information.

8.3 APPENDIX A5-A7: LEVEL 3 (L₃) ENHANCEMENT TREATMENTS

8.3.1 APPENDIX A5: PEDESTRIAN HYBRID BEACON



Image Source: City of Sacramento

The PHB is a special type of hybrid beacon used to warn and control traffic at an unsignalized location to assist pedestrians in crossing a street or highway at a marked crosswalk. 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 4C.05 (Warrant 4, Pedestrian Volume) and / or 4C.06 (Warrant 5, School Crossing) but a decision is made to not install a traffic control signal ⁽¹⁾.

According to FHWA's PEDSAFE 2013⁽²⁹⁾:

Pedestrian hybrid beacons are best suited for uncontrolled crossings of multi-lane, higher speed or volume roadways where there is a need to provide occasional pedestrian crossings without inordinate delay to motor vehicles (i.e. school crossings, intermittent neighborhood street crossings of high volume, multi-lane arterials). A 2010 FHWA study indicates that a Pedestrian Hybrid Beacon reduces total crashes by 29 percent and pedestrian crashes by 69 percent.

The PHB treatment is now approved for use in California. It was adopted in the 2012 CA MUTCD. Refer to Chapter 4 F of CA MUTCD for guidance on the pedestrian volume warrants, design features, and restrictions associated with the pedestrian hybrid beacon.

8.3.2 APPENDIX A6: TRAFFIC SIGNAL WHERE WARRANTED

According to FHWA'S PEDSAFE 2013⁽²⁹⁾:

Traffic signals create gaps in the traffic flow and allow pedestrians to cross the street at locations where pedestrians would otherwise experience excessive delay, difficulties crossing the street, or safety issues. Warrants in the MUTCD govern the installation of traffic signals, which are based on the number of pedestrians and vehicles crossing the intersection, among other factors. However, judgment must also be used on a case-by-case basis. For example, pedestrian volume must exceed MUTCD thresholds as a requirement to install a traffic signal to address pedestrian activity. If a new facility is being built—a park or recreational path, for example—there will be a new demand, and the signal could be installed in conjunction with the new facility based on projected crossing demand. There may also be latent demand if a destination is not currently accessible, but could become so with new facilities or redesign.

Based on the above, these guidelines recommend that when determining the applicable signal warrant(s), consideration may also be given on a case-by-case basis, to projected demand in terms of pedestrian and / or vehicle volumes, as well as the anticipated latent demand as described above.

As it relates to pedestrian signal, it is recommended to install countdown pedestrian signal heads at all traffic signals, except where the pedestrian crossing is prohibited. Section 5.6 describes the conditions that may require pedestrian crossing prohibition.

Refer to CA MUTCD ⁽¹⁾, Part 4E for the provisions related to traffic signal pedestrian control features. The CA MUTCD extensively covers the provisions and requirements related to almost all the aspects of traffic control signals. These provisions / requirements shall be followed as applicable if a traffic signal is being considered for installation.

8.3.3 APPENDIX A7: PEDESTRIAN OVERCROSSING / UNDERCROSSING (GRADE SEPARATION)

Pedestrian overcrossings and undercrossings allow for the uninterrupted flow of pedestrian movement separate from the vehicle traffic. They may be the best or only option to connect pedestrians with their desired destinations. Generally, pedestrian/bicycle overcrossings work best when they overcome major barriers hindering direct travel between origins (e.g., residential neighborhoods) and destinations (e.g., schools, commercial areas, and transit stops).⁽¹⁸⁾

This measure must be designed to accommodate all pedestrians as required by the ADA. The use of ramps to achieve the required grade can result in long crossing distances and additional time that may discourage use.

Actual pedestrian use of an overcrossing or undercrossing depends on a range of physical attributes. Listed below are some considerations.

- Pedestrians may not use a grade separation if a nearby street-level crossing is available that will save time.
- The use of extensive ramping may discourage use. Grade separations are best suited where site topography lends itself to a more level pedestrian crossing.
- Pedestrians may have perceived or actual personal security concerns regarding grade-separated structures. Care should be taken to design facilities that have an open feel with adequate lighting.

Grade separated facilities are extremely high-cost, and overcrossings can be visually intrusive.

9. APPENDIX B: SUPPLEMENTAL TREATMENTS

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9.1 APPENDIX B1: IN-ROADWAY WARNING LIGHTS (IRWLS)

According to CA MUTCD ⁽¹⁾, Section 4N.01:

In-Roadway Lights are special types of highway traffic signals installed in the roadway surface to warn road users that they are approaching a condition on or adjacent to the roadway that might not be readily apparent and might require the road users to slow down and / or come to a stop. This includes situations warning of marked school crosswalks, marked midblock crosswalks, marked crosswalks on uncontrolled approaches,, and other roadway situations involving pedestrian crossings.

These Guidelines recommend the use of IRWLS as supplemental treatment at category 'C' locations where there is a need for enhancement due to one or more of the following:

- a). Where there are many other features of the surrounding environment besides the crosswalk competing for driver's attention.
- b). Where there are high pedestrian crossing volumes during evening or under poor weather conditions.

Refer to CA MUTCD ⁽¹⁾, Chapter 4N for requirements related to IRWLS.

9.2 APPENDIX B2: FLASHING WARNING BEACON

According to CA MUTCD ⁽¹⁾, typical uses of flashing beacons include obstructions in or immediately adjacent to the roadway, supplemental to advance warning signs, at mid-block crosswalks, and at intersections where a warning is appropriate. The use of flashing warning beacons (also referred to as standard beacons) for pedestrian crossings is prevalent in the United States. However, there are concerns that the overuse of flashing beacons or the

continuous flashing at specific locations has diluted their effectiveness in warning motorists of conditions.⁽⁹⁾ The evaluations performed in several Florida cities show the compliance rates for the standard beacons in the range of only 15 to 20 percent compared to over 80 percent for RRFBs.⁽²⁷⁾ Based on this, these guidelines recommend the use of standard beacons only as supplemental treatments.

Flashing warning beacons can be installed overhead or post-mounted on the roadside either in advance of the crosswalk or at the crosswalk to increase visibility of a pedestrian crossing.

Several studies have shown that intermittent (typically activated using a manual pushbutton or automated sensor) flashing beacons provide a more effective response from motorists than continuously flashing beacons.⁽⁹⁾

The design and installation of flashing warning beacons shall comply with the requirements of CA MUTCD Chapter 4L.

9.3 APPENDIX B3: "ROAD DIET" (ROADWAY RECONFIGURATION)

According to FHWA,⁽²⁰⁾ the classic roadway reconfiguration, commonly referred to as a "road diet," involves converting an undivided four lane roadway into three lanes made up of two through lanes and a center two-way left turn lane. The reduction of lanes allows the roadway to be reallocated for other uses such as bike lanes, pedestrian crossing islands, and / or parking.

FHWA cites the following benefits from road diets:

- Decreasing vehicle travel lanes for pedestrians to cross, therefore reducing the "multiple threat" conditions for pedestrians,
- Providing room for a pedestrian crossing island,

- Improving safety for bicyclists when bike lanes are added (such lanes also create buffer space between pedestrians and vehicles),
- Providing the opportunity for on-street parking (also a buffer between pedestrians and vehicles),
- Reducing rear-end and sideswipe crashes, and
- Improving speed limit compliance and decreasing crash severity when crashes do occur.

FHWA suggests that roadways with ADT of 20,000 or less may be good candidates for a road diet and should be evaluated for feasibility. It has been shown that roads with 15,000 ADT or less had very good results in the areas of safety, operations, and livability. Driveway density, transit routes, the number and design of intersections along the corridor, as well as operational characteristics are some considerations to be evaluated before deciding to implement a road diet.⁽²⁰⁾

Where fewer travel lanes are not possible, narrower lanes may be considered, especially left- and right-turn pockets. For example, where travel lanes are wider than necessary, travel lane width may be reduced to the minimum required and the excess pavement could be striped for on-street bicycle lanes and / or parking. Narrower travel lanes decrease the unprotected crosswalk length.

9.4 APPENDIX B4: CURB EXTENSION



Image Source: Fehr & Peers

Curb extensions can be installed at intersections or mid-block to extend the curb and pedestrian space further into the roadway, shortening the exposure crossing distance for pedestrians. They act as a traffic calming device by narrowing the effective width of the roadway. They extend into the roadway to improve visibility for both pedestrians and roadway users. Curb extensions prevent parked cars from encroaching into the crosswalk area. Curb extensions should be constructed to accommodate ADA requirements. It is important to ensure that the bicycle and vehicle movements are not negatively affected.

9.5 APPENDIX B5: TIGHTER CURB-RETURN RADII

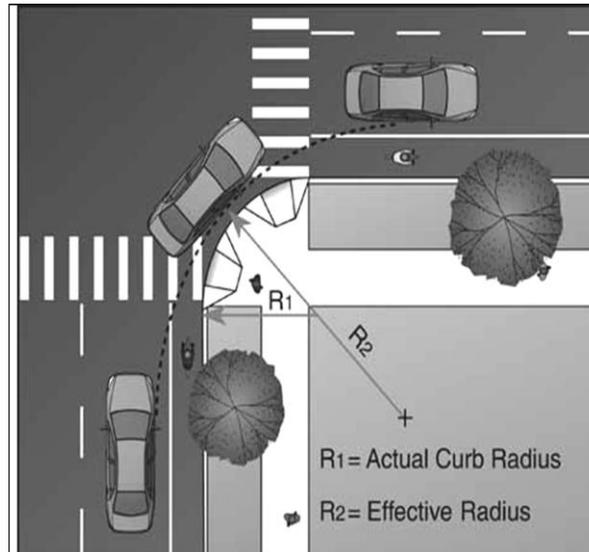


Image Source: ITE ⁽²⁸⁾

According to ITE, ⁽²⁸⁾ the primary benefits of smaller curb-return radii to pedestrians in urban areas include:

- Increasing motorist visibility of pedestrians waiting to cross the street;
- Reducing pedestrian crossing distance (which also benefits vehicles with a shorter cycle length at signalized intersections) and exposure to traffic;
- Providing the shortest accessible route for disabled persons; and
- Reducing speed of turning vehicles and severity of the crashes if they occur

Corner curb radii should accommodate design vehicle turning movements appropriate for the roadway type. Curb-return radii should be designed to reflect the “effective” turning radius of the corner. The effective turning radius takes into account the wheel tracking of the design vehicle utilizing the width of parking and bicycle lanes. Use of the effective turning radii allows a

smaller curb-return radius while retaining the ability to accommodate larger design vehicles. Refer to the above referenced publication, ⁽²⁸⁾ (Chapter 10, Intersection Design Guidelines) for detail information including recommended practice on selection of curb return radii under different conditions.

9.6 APPENDIX B6: IMPROVED RIGHT-TURN SLIP - LANE DESIGN

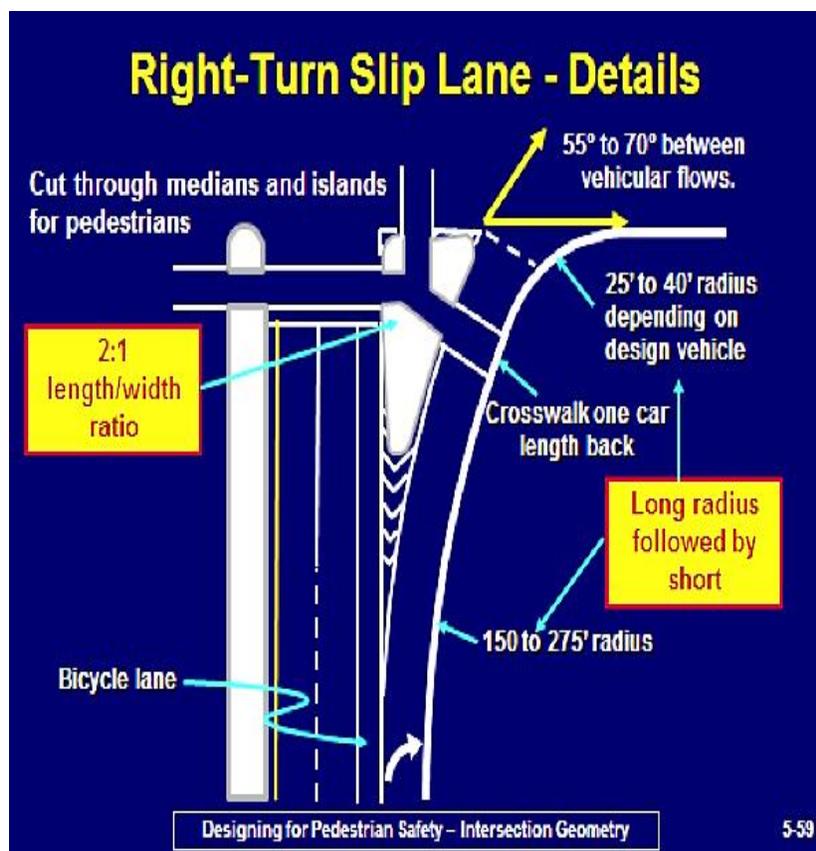


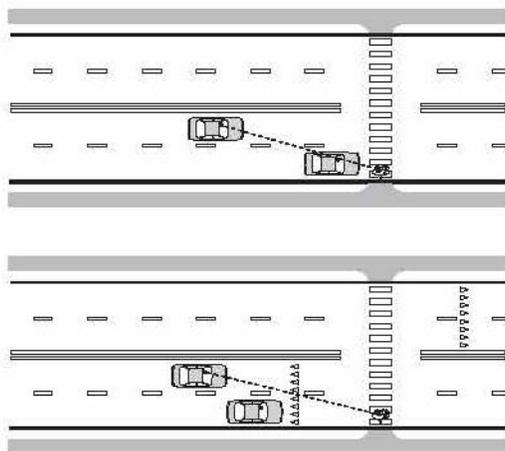
Image Source: PEDSAFE 2013⁽²⁹⁾

Free right-turn lanes / right-turn slip - lanes allow vehicles to turn right at higher speeds. Where right turning vehicles are not controlled by a traffic signal / other type of control, pedestrians cross a free right-turn lane as an uncontrolled crosswalk. According to ITE's *Recommended*

Practice - Designing Walkable Urban Thoroughfares: A Context Sensitive Approach,⁽²⁸⁾ even at the signalized intersections with free right-turn lanes, drivers are usually looking to their left to merge into cross-street traffic and are not always attentive to the presence of pedestrians.

According to the FHWA publication PEDSAFE 2013⁽²⁹⁾, well-designed right-turn slip lanes slow turning vehicles, allow drivers and pedestrians to easily see each other, reduce pedestrian exposure in the roadway, reduce the complexity of an intersection by breaking it into manageable parts, and allow drivers to see oncoming traffic as they merge into the receiving roadway. The illustration provided above is one of the several options recommended by PEDSAFE 2013⁽²⁹⁾; refer to this publication for further details. The ITE publication referenced above⁽²⁸⁾ also provides detail guidance on this topic (Chapter 10, Intersection Design Guidelines).

9.7 APPENDIX B7: ADVANCED YIELD / STOP LINES



Advance stop lines and yield markings improve the visibility of pedestrians to motorists and prevent multiple-threat crashes.

Image Source: TCRP Report 112/NCHRP Report 562⁽⁹⁾

An advance stop or yield line placed 20 to 50 feet ahead of the crosswalk can greatly reduce the likelihood of a multiple-threat crash at uncontrolled midblock crossings, as the line encourages

drivers to stop back far enough so a pedestrian can see if a second motor vehicle is not stopping and be able to take evasive action⁽²⁹⁾.

As mentioned in Section 7.1.3: 'Crossings at Mid-Block' (Figure 2), these guidelines provide for installation of advanced yield lines for mid-block crosswalks that cross an uncontrolled multilane-lane approach.

9.8 APPENDIX B8: ADVANCED STOP LINES AT TRAFFIC SIGNALS

Motorists sometimes crowd pedestrian crossings by stopping too close to a crosswalk. Advanced stop lines at traffic signals are helpful in improving the visibility of pedestrians to motorists and also allow pedestrians to advance in a crosswalk before motor vehicle has the opportunity to turn⁽²⁹⁾.

The CA MUTCD⁽¹⁾ does not require to install an advance stop line. However, considering the advantages as mentioned above, these guidelines recommend to install a 24-inch limit line (stop line) seven feet in advance of marked crosswalks on signalized approaches.

9.9 APPENDIX B9: IN-STREET AND OVERHEAD PEDESTRIAN CROSSING SIGNS



* The legend STATE LAW is optional. A fluorescent yellow-green background color may be used instead of yellow for this sign.

Image Source: CA MUTCD ⁽¹⁾

This measure involves posting these signs in the street (on lane lines, road centerlines or medians).

CA MUTCD Section 2B.12 states the following.⁽¹⁾

The In-Street Pedestrian Crossing (R1-6) sign or the Overhead Pedestrian Crossing (R1-9) sign may be used to remind road users of laws regarding right-of way at an unsignalized pedestrian crosswalk.

If used, the In-Street Pedestrian Crossing sign shall be placed in the roadway at the crosswalk location on the center line, on a lane line, or on a median island. The In-Street Pedestrian Crossing sign shall not be post-mounted on the left-hand or right-hand side of the roadway.

If used, the Overhead Pedestrian Crossing sign shall be placed over the roadway at the crosswalk location.

Refer to CA MUTCD Section 2B.12 for further information.

These guidelines recommend that these signs may be considered for local streets with low volumes, and low speeds.

9.10 APPENDIX B10: PEDESTRIAN-ACTIVATED FLASHING (EMBEDDED LED) WARNING SIGN

Similar to a typical warning sign, this treatment is intended to increase motorist awareness of a pedestrian in a crosswalk. The sign includes embedded Light Emitting Diodes (LED) within the sign border that illuminate when activated. The sign may be push-button activated or activated with passive detection. Embedded LED units enhance visibility and recognition of warning signs to drivers, especially under low-light or low-visibility conditions.

CA MUTCD Section 2A.07 states the following.⁽¹⁾

Light Emitting Diode (LED) units may be used in the border of a STOP or warning signs, except for Changeable Message Signs, to improve the conspicuity of signs.

If flashed, all LED units shall flash simultaneously at a rate of more than 50 and less than 60 times per minute.

The uniformity of the sign design shall be maintained without any decrease in visibility, legibility, or driver comprehension during either daytime or nighttime conditions.

9.11 APPENDIX B11: TRAFFIC CALMING MEASURES

Installing traffic-calming measures may be appropriate on certain streets to slow vehicle speeds and / or reduce cut-through traffic. Traffic-calming measures include raised crossings (raised crosswalks, raised intersections), street narrowing measures (chicanes, slow points, “skinny street” designs), and intersection designs (traffic mini circles, diagonal diverters). Note that some of these traffic-calming measures are better suited to local or neighborhood streets than to collector or arterial streets.⁽¹⁰⁾

Refer to City of Sacramento Traffic Calming Guidelines ⁽⁷⁾ for further information.

9.12 APPENDIX B12: TEXTURED PAVEMENT



Image Source: Fehr & Peers

Paving treatments may send a visual cue to motorists about the function of a street. They can also create an aesthetic enhancement of a street and be used to delineate separate space for pedestrians or bicyclists⁽²⁹⁾.

CA MUTCD Section 3E.01 states the following.⁽¹⁾

When used for guidance or regulation of traffic, colored pavements are traffic control devices. Colored pavements also are sometimes used to supplement other traffic control devices.

Colored pavement located between crosswalk lines to emphasize the presence of the crosswalk is not considered to be a traffic control device.

The City may allow the use of textured pavement in the crosswalk and / or intersection as long as: (a) the crosswalk markings are consistent with these guidelines, and (b) there is a provision / agreement in place for funding for maintenance and / or replacement of the textured pavement.

9.13 APPENDIX B13: PARKING RESTRICTIONS (AT CROSSING LOCATIONS)

The FHWA study ⁽¹⁰⁾ recommends that parking be eliminated on the approach to uncontrolled crosswalks to improve vision between pedestrians and motorists. According to the FHWA publication PEDSAFE 2013 ⁽²⁹⁾, when vehicles are parked too close to pedestrian crossings, they limit the sightlines of pedestrians and motorists, which can increase pedestrian risk. The subject publication recommends that generally, vehicles should not be parked within at least 20 feet of an intersection and parking restrictions should consider adequate sightlines for motorists and pedestrians to be able to see and react to each other.

According to the CA MUTCD ⁽¹⁾, Section 3B.19:

At all intersections, one stall length on each side measured from the crosswalk or end of curb return should have parking prohibited. A clearance of 6 feet measured from the curb return should be provided at alleys and driveways.

The following sections of CA MUTCD provide guidance for non-intersection (mid-block) crossing locations:

Section 3B.16:

If yield or stop lines are used at a crosswalk that crosses an uncontrolled multi-lane approach, the yield lines or stop lines should be placed 20 to 50 feet in advance of the nearest crosswalk line, and parking should be prohibited in the area between the yield or stop line and the crosswalk (see Figure 3B-17).

Section 3B.18:

Because non-intersection pedestrian crossings are generally unexpected by the road user, warning signs (see Section 2C.50) should be installed for all marked crosswalks at non-intersection locations and adequate visibility should be provided by parking prohibitions.

Recommended Guidelines:

The recommendations presented below are aimed at parking restrictions related to pedestrian crossings only. There are other aspects such as intersection sight distance, stopping sight distance, etc. that may need to be considered as applicable. The user may refer to AASHTO Green Book ⁽¹⁶⁾ or other appropriate sources for further information on sight distance.

The City Traffic Engineer may consider variations to the guidelines recommended below (on a case-by-case basis) depending on overall context of the crossing location such as roadway and traffic conditions (number of lanes, traffic volume, and speed); area type (downtown / central business districts, suburban areas, etc.); required and available sight distance; reported crash history involving pedestrian related crashes; etc. Exercising engineering judgment / engineering study before making the recommendations to City Traffic Engineer for variations in the subject matter is emphasized.

(1) Pedestrian Crossings at Uncontrolled Intersection Approaches:

For pedestrian crossings at uncontrolled intersection approaches, minimum one stall length on each side measured from the crosswalk or end of curb return should have parking prohibited.

(2) Pedestrian Crossings at Non - intersection (Midblock) Approaches:

For a crosswalk that crosses an uncontrolled multi-lane approach, the yield lines (or stop lines) should be placed 20 to 50 feet in advance of the nearest crosswalk line, and parking should be prohibited in the area between the yield (or stop) line and the crosswalk (see Figure 2 of these guidelines). For a crosswalk that crosses an uncontrolled single-lane approach in each direction, the above-mentioned provisions regarding placing yield lines (or stop lines), and restricting parking is not required.

(3) Additional Requirement for all Cases (Intersection as well as Midblock Approaches):

In addition to the minimum requirements as mentioned above, adequate visibility should be ensured within the clear sight triangle based on required stopping sight distance. This requirement applies to all cases, i.e. uncontrolled as well as controlled intersection and midblock approaches.

9.14 APPENDIX B14: LOCATE TRANSIT STOPS ON THE FAR SIDE OF THE INTERSECTION

The FHWA study ⁽¹⁰⁾ recommends locating bus stops on the far side of uncontrolled marked crosswalks as one of the alternative pedestrian improvements.

Additionally, the FHWA publication PEDSAFE 2013⁽²⁹⁾ states the following on the topic of 'Access to Transit':

"..... Bus stops should be located at intersections wherever possible because intersections are generally more convenient for passengers intercepting other transit connections, accessing crosswalks, and connecting to pedestrian routes. At intersections, far-side placement is generally preferred; however, location selection should be done on a site-by-site basis. Placing bus stops on the near side of intersections or crosswalks may block the pedestrians' view of approaching traffic, and approaching motorists may be unable to stop in time when a pedestrian steps from in front of a stopped bus to cross vehicle travel lanes. Advantages of locating stops on the far side of an intersection include encouraging pedestrians to cross the street behind the bus where they are more visible to approaching traffic, reduced delay for buses, and minimizing conflicts between buses and right turning motor vehicles".

According to ODOT / FHWA study ⁽²⁷⁾:

Buses at near side transit stops and heavy vehicles obstruct the visibility of side-mounted treatments (such as RRFBs) making overhead placement of the devices an option to be considered. When possible, the transit stop should be located to the far side of the intersection.

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10. APPENDIX C: HARDWARE AND OPERATIONAL TREATMENTS FOR SIGNALIZED LOCATIONS

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NOTE:

1. This Appendix presents the toolbox of supplemental treatments specific to signalized locations. The discussion presented is aimed at providing:
 - a. Guidance on pertinent provisions of CA MUTCD; and / or
 - b. Information on the relatively new and / or less commonly practiced treatments / concepts.
2. The treatments described in this toolbox are from the perspective of achieving optimal pedestrian service. City's practice(s) may vary in regards to one or more of these treatments considering the complexities of factors affecting the signal design; a partial list of such factors include:
 - a. The effectiveness of treatment(s) under consideration may or may not be proven or known, or there may be lack of adequate information about the same;

- b. Lack of established criteria / guidance in regards to applicability and / or design of the treatment (s) under consideration;
- c. Level of pedestrian activity / demand;
- d. Location of the signalized intersections (central business district, suburban areas, etc);
- e. Need for optimizing signal phasing, cycle timings, etc;
- f. Vehicle demand (including turning movements);
- g. The overall intersection operation (level of service); and
- h. Other considerations such as cost, feasibility, site constraints, etc.

10.1 APPENDIX C1: SHORT CYCLE LENGTHS

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.

According to PEDSAFE 2013⁽²⁹⁾:

In general, shorter cycle lengths (Ideally less than 90 second) and longer walk intervals provide better service to pedestrians and encourage better signal compliance.

10.2 APPENDIX C2: LONGER CROSSING TIMES

Longer crossing times at crosswalks improve the likelihood that pedestrians are able to cross the street within the allotted time. The CA MUTCD ⁽¹⁾ provides guidance on using different walking speeds. This information may be useful in designing for longer crossing times consistent with provisions of CA MUTCD depending on conditions at the location. The pertinent provisions of CA MUTCD, Section 4E.06 are presented below for information:

07 The pedestrian clearance time should be sufficient to accommodate the walking speed of the 15th percentile pedestrian, meaning that 85% walk faster. However, where no specific engineering study has been conducted and except as provided in Paragraph 8, the pedestrian clearance time should be sufficient to allow a pedestrian crossing in the crosswalk who left the curb or shoulder at the end of the WALKING PERSON (symbolizing WALK) signal indication to travel at a walking speed of 3.5 feet per second to at least the far side of the traveled way or to a median of sufficient width for pedestrians to wait.

07a A walking speed between 3.5 and 4 feet per second may be used for pedestrian clearance time if an engineering study at a representative location documents that it is sufficient to accommodate the walking speed of the 15th percentile pedestrian.

08 A walking speed of up to 4 feet per second may be used to evaluate the sufficiency of the pedestrian clearance time at locations where an extended pushbutton press function has been installed to provide slower pedestrians an opportunity to request and receive a longer pedestrian clearance time. Passive pedestrian detection may also be used to automatically adjust the pedestrian clearance time based on the pedestrian's actual walking speed or actual clearance of the crosswalk.

10 Where pedestrians who walk slower than 3.5 feet per second, or pedestrians who use wheelchairs, routinely use the crosswalk, a walking speed of less than 3.5 feet per second should be considered in determining the pedestrian clearance time.

10a Where older or disabled pedestrians routinely use the crosswalk, a walking speed of 2.8 feet per second may be used in determining the pedestrian clearance time.

Refer to CA MUTCD Section 4E for further information.

10.3 APPENDIX C3: PUSH BUTTONS OR PASSIVE PEDESTRIAN DETECTORS

Pedestrian detectors may be pushbuttons or passive detection devices ⁽¹⁾.

According to PEDSAFE ⁽²⁹⁾:

Pedestrian pushbuttons are detectors intended to provide pedestrians with the ability to activate a pedestrian signal and reassure pedestrians that they will receive a crossing

indication. However, only approximately 50 percent of pedestrians at intersections activate pushbuttons to cross at the intersection. To improve potential use of the pushbuttons and compliance with pedestrian signals, pushbuttons should be designed and installed to maximize convenience, conspicuity, and communication for pedestrians.

Refer to Section 4E.08 of the CA MUTCD ⁽¹⁾ for specific guidance on the location and other requirements related to pushbuttons at traffic signals.

Pushbuttons are not required at locations where pedestrian signal intervals are automatically activated for every signal cycle. Automatic pedestrian signal intervals are preferred at locations with significant pedestrian activity ⁽²⁹⁾.

As mentioned above, the pedestrian signals may be equipped with passive detectors instead of pushbuttons. Passive detection devices register the presence of a pedestrian in a position indicative of a desire to cross, without requiring the pedestrian to push a button. Some passive detection devices are capable of tracking the progress of a pedestrian as the pedestrian crosses the roadway for the purpose of extending or shortening the duration of certain pedestrian timing intervals. ^{(1), (29)}

10.4 APPENDIX C4: PEDESTRIAN COUNTDOWN SIGNAL

Pedestrian countdown signals give pedestrians "Walk" and "Don't Walk" signals and inform them how long they have to cross the street.

CA MUTCD Section 4E.07 states the following. ⁽¹⁾

All pedestrian signal heads used at crosswalks where the pedestrian change interval is more than 7 seconds shall include a pedestrian change interval countdown display in order to inform pedestrians of the number of seconds remaining in the pedestrian change interval.

Pedestrian signal heads used at crosswalks where the pedestrian change interval is 7 seconds or less may include a pedestrian change interval countdown display in order to inform pedestrians of the number of seconds remaining in the pedestrian change interval.

As mentioned earlier, these guidelines recommend installing countdown pedestrian signal heads at all traffic signals, except where the pedestrian crossing is prohibited. Section 5.6 describes the conditions that may require pedestrian crossing prohibition.

10.5 APPENDIX C5: PEDESTRIAN RECALL

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 may be useful in areas with high levels of pedestrian activity.

10.6 APPENDIX C6: NO TURN ON RED RESTRICTIONS



R10-11



R13A (CA)



R13B (CA)

Image Source: CA MUTCD ⁽¹⁾

Right-Turn-On-Red (RTOR) Restriction

According to PEDSAFE ⁽²⁹⁾:

Prohibiting RTOR should be considered where exclusive pedestrian phases or high pedestrian volumes are present. While the law requires motorists to come to a full stop and yield to cross-street traffic and pedestrians prior to turning right on red, many motorists do not fully comply with the regulations, especially at intersections with wide turning radii. Motorists are so intent on looking for traffic approaching on their left that they may not be alert to pedestrians approaching on their right. In addition, motorists usually pull up into the crosswalk to wait for a gap in traffic, blocking pedestrian crossing movements. In some instances, motorists simply do not come to a full stop.

One concern that comes up when RTOR is prohibited is that this may lead to higher right-turn-on-green conflicts when there are concurrent signals. The use of the leading pedestrian interval (LPI) can usually best address this issue.

According to the guidance provided in CA MUTCD ⁽¹⁾, Section 2B.54:

A No Turn on Red (R10-11, R13A(CA) or R13B(CA)) sign should be considered when an engineering study finds that one or more of the following conditions exists:

- A. Inadequate sight distance to vehicles approaching from the left (or right, if applicable);*
- B. Geometrics or operational characteristics of the intersection that might result in unexpected conflicts;*
- C. An exclusive pedestrian phase;*
- D. An unacceptable number of pedestrian conflicts with right-turn-on-red maneuvers, especially involving children, older pedestrians, or persons with disabilities; or*

E. The skew angle of the intersecting roadways creates difficulty for drivers to see traffic approaching from their left.

Left-Turn-On-Red Restriction

Based on the above referenced guidance provided in CA MUTCD, the no turn on red restriction can also be considered for left turning movements, i.e. No Left-Turn-on-Red (from a one-way street to one-way street).

Blank-Out Turn Restriction LED Signs:

“Blank out” turn restriction signs are more effective than the conventional “No Right Turn on Red” signs. Furthermore, the “No Right Turn on Red” signs that specify time-of-day restrictions may be confusing to motorists. The CA MUTCD Section 2B.54 provides the following option:

Alternatively, a blank-out sign may be used instead of a static NO TURN ON RED (symbolic circular red) (R10-11) sign, to display either the NO TURN ON RED legend or the No Right Turn symbol or word message, as appropriate, only at certain times during the day or during one or more portion(s) of a particular cycle of the traffic signal.

Refer to CA MUTCD Section 2B.54 for further information on No Turn on Red signs.

10.7 APPENDIX C7: PROTECTED LEFT TURNS

One of the most common conflicts at signalized intersections is the competition between vehicles permissively turning left and pedestrians crossing during the concurrent pedestrian signal phase. Drivers typically focus on on-coming traffic to identify gaps for left turns and may not pay due attention to pedestrians approaching or in the parallel crosswalk. Furthermore, permissive left turns at congested intersections contribute to drivers accepting smaller gaps,

turning at higher speeds, and “sneaking” through the intersection during the yellow or all-red signal intervals. Implementing protected left turn phasing can reduce conflicts with pedestrians crossing parallel to vehicle traffic ⁽²⁹⁾.

Implementing protected left turn phasing may reduce intersection vehicle capacity, impact signal system coordination, or require longer cycle lengths to manage combined vehicle and pedestrian traffic volumes ⁽²⁹⁾.

According to CA MUTCD ⁽¹⁾, Section 4D.19:

Since separate signal phases for protected left turns will reduce the green time available for other phases, alternate means of handling left turn conflicts should be considered first.

Refer to CA MUTCD for information regarding: (a) alternatives to protected left turns, and (b) conditions under which protected left turns may be considered when the other alternatives suggested couldn't be utilized.

10.8 APPENDIX C8: LEADING PEDESTRIAN INTERVAL (LPI)

A leading pedestrian interval (LPI) advances the “Walk” signal for a few seconds while vehicles continue to receive a red light. By allowing pedestrians to get a head start into the crosswalk, a LPI may improve pedestrian intersection safety.

CA MUTCD Section 4E.06 states the following ⁽¹⁾:

At intersections with high pedestrian volumes and high conflicting turning vehicle volumes, a brief leading pedestrian interval, during which an advance WALKING PERSON (symbolizing WALK) indication is displayed for the crosswalk while red indications continue to be displayed to

parallel through and/or turning traffic, may be used to reduce conflicts between pedestrians and turning vehicles.

Refer to CA MUTCD for further information.

10.9 APPENDIX C9: ACCESSIBLE PEDESTRIAN SIGNALS



Accessible pedestrian signals (APS) and detectors provide information, in non-visual formats (such as audible tones, speech messages, and/or vibrating surfaces) to improve accessibility for pedestrians who have visual disabilities. The primary technique that pedestrians who have visual disabilities use to cross streets at signalized locations is to initiate their crossing when they hear the traffic in front of them stop and the traffic alongside them begin to move, which often corresponds to the onset of the green interval. The existing environment is often not sufficient

to provide the information that pedestrians who have visual disabilities need to cross a roadway at a signalized location ⁽¹⁾.

CA MUTCD Section 4E.09 ⁽¹⁾ provides the following guidance:

If a particular signalized location presents difficulties for pedestrians who have visual disabilities to cross the roadway, an engineering study should be conducted that considers the needs of pedestrians in general, as well as the information needs of pedestrians with visual disabilities. The engineering study should consider the following factors:

A. Potential demand for accessible pedestrian signals;

B. A request for accessible pedestrian signals;

C. Traffic volumes during times when pedestrians might be present, including periods of low traffic volumes or high turn-on-red volumes;

D. The complexity of traffic signal phasing (such as split phases, protected turn phases, leading pedestrian intervals, and exclusive pedestrian phases); and

E. The complexity of intersection geometry.

CA MUTCD Section 4E.09 through 4E.13 provides detail information on various aspects of APS. Section 4E.09 (Paragraph 16) lists the intersection characteristics that may be considered for APS when the need and visibility are confirmed by engineering study.

Further CA MUTCD Section 4E.09 (Paragraph 17) provides the list of minimum conditions when installation of Accessible Pedestrian Signals is considered. One of these conditions states that *"there must be a demonstrated need for the audible signals in the form of a request from an individual or group that would use the audible signal. The individual or group requesting the device should agree to train the visually impaired users of the audible signals."*

City of Sacramento's Current Practice

The City's current practice is that the new signalized intersections should be provided with the necessary hardware for installation of APS based on the future requests. For existing signalized intersections, the City's current practice is to retrofit the signal with APS if there is a request for the same from an individual or the groups.

10.10 APPENDIX C10: ANIMATED EYES PEDESTRIAN SIGNAL



Animated eyes pedestrian signals feature eyes that look from side to side when a "Walk" signal is given. The signals remind pedestrians to look for turning vehicles before proceeding into the crosswalk.

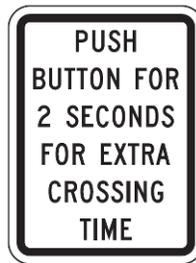
CA MUTCD Section 4E.04 states the following.⁽¹⁾

An animated eyes symbol may be added to a pedestrian signal head in order to prompt pedestrians to look for vehicles in the intersection during the time that the WALKING PERSON (symbolizing WALK) signal indication is displayed.

If used, the animated eyes symbol shall consist of an outline of a pair of white steadily-illuminated eyes with white eyeballs that scan from side to side The

animated eyes symbol shall be illuminated at the start of the walk interval and shall terminate at the end of the walk interval.

10.11 APPENDIX C11: EXTENDED PUSHBUTTON



R10-32P Sign

Image Source: CA MUTCD ⁽¹⁾

Some pedestrians may need extra time to safely cross a street. Traffic signals can be programmed to increase crossing time by pressing the push button longer.

CA MUTCD Section 4E.06 states the following. ⁽¹⁾

A walking speed of up to 4 feet per second may be used to evaluate the sufficiency of the pedestrian clearance time at locations where an extended pushbutton press function has been installed to provide slower pedestrians an opportunity to request and receive a longer pedestrian clearance time.

Passive pedestrian detection may also be used to automatically adjust the pedestrian clearance time based on the pedestrian's actual walking speed or actual clearance of the crosswalk.

The additional time provided by an extended pushbutton press to satisfy pedestrian clearance time needs may be added to either the walk interval or the pedestrian change interval.

CA MUTCD Section 4E.08 states the following.⁽¹⁾

If additional crossing time is provided by means of an extended pushbutton press, a PUSH BUTTON FOR 2 SECONDS FOR EXTRA CROSSING TIME (R10-32P) plaque (see Figure 2B-26) shall be mounted adjacent to or integral with the pedestrian pushbutton.

11. APPENDIX D: LIST OF DIFFERENT TYPES OF PEDESTRIAN CROSSING TREATMENTS

(1) Geometric / Speed Reduction Treatments

- A) "Road Diet" (Roadway Reconfiguration)
- B) Curb Extension
- C) Tighter Curb Return Radii
- D) Raised Medians / Pedestrian Median Refuge Islands
- E) Split Pedestrian Crossover Median Refuge Island
- F) Traffic Calming Measures
- G) Pedestrian Overcrossing/Undercrossing (Grade Separation)
- H) Improved Right-Turn Slip - Lane Design

(2) Enhanced Treatments: Treatments and Devices that display warning at all times

- a) High Visibility Marking
- B) Advanced Yield Line
- C) Advanced Stop Line (Limit Line) at Traffic Signals
- D) Warning Signs
- E) In-Street and Overhead Pedestrian Crossing Sign
- F) Textured Pavement
- G) Flashing Warning Beacon

(3) Active When Present Treatments: Treatments and Devices that display warning only when pedestrians are present

- A) Flashing Warning Beacon (pedestrian-activated)
- B) Pedestrian-Activated Flashing (Embedded LED) Warning Sign
- C) Rectangular Rapid Flashing Beacon
- D) In-Roadway Warning Lights

Notes:

This Appendix presents only a general list of the common treatment options, and is not intended to be an all-inclusive list. The majority of these treatments are incorporated into the recommended guidelines for the City depending on their applicability and / or effectiveness under different combinations of roadway and traffic conditions. Refer to Sections 7.1.2.4, and 7.1.2.5 for further information.

(4) Red Treatments – Devices that display circular red indication

- A) Pedestrian Hybrid Beacon
- B) Traffic Signal where warranted

(5) Signal Hardware and Operational Treatments

- A) Short Cycle Lengths
- B) Longer Crossing Times
- C) Push Buttons – Separated and in Median
- d) Pedestrian Countdown Signal
- E) Pedestrian Recall
- F) Right Turn on Red Restrictions
- G) Blank-Out Turn Restriction LED Sign
- H) Protected Left Turn Phasing
- I) Leading Pedestrian Interval (LPI)
- J) Accessible Pedestrian Signals
- K) Animated Eyes
- L) Extended Pushbutton

Notes:

This Appendix presents only a general list of the common treatment options, and is not intended to be an all-inclusive list. The majority of these treatments are incorporated into the recommended guidelines for the City depending on their applicability and / or effectiveness under different combinations of roadway and traffic conditions. Refer to Sections 7.1.2.4, and 7.1.2.5 for further information.

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