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Design Guidelines



INTRODUCTION

The Design Guidelines is a guide that intends to provide supplemental and consolidated information rooted in existing local, state, and national guidance to identify potential pedestrian, bicycle, and traffic calming infrastructure for implementing improvements on the Active Transportation Network. It also seeks to expand the users' knowledge base of the opportunities and constraints for different infrastructure treatment.

The menu of infrastructure treatments addresses situations that pertain to pedestrians, bicycles, traffic calming, transit usage, and goods movement. Engineering judgment from a licensed engineer shall remain a gatekeeper for overall guidance.

DESIGN CONTEXT

NATIONAL STANDARDS AND GUIDELINES

Federal Highway Administration (FHWA)

Manual on Uniform Traffic Control Devices (MUTCD) is a nationally standardized guideline for the uniform implementation of traffic control devices (signs, signals, and pavement markings) on streets, highways, and bicycle trails that are open to the public (Title 23 of the Code of Federal Regulations, Part 655.603). Contents of the MUTCD include design, application, and placement, standards, guidance, options, and support for traffic control devices. The FHWA MUTCD forms the foundation for the California MUTCD prepared by Caltrans. Requests for experimentation for traffic control devices that are not included within the MUTCD should follow the ruling detailed in Paragraph 11 of Section 1A.10 and should originate with Caltrans, who would oversee the experimentation of new devices in California.

Standard Highway Signs and Markings is a specification manual released in 2004 and updated in 2012. It is intended to be used in tandem with the Federal Highway Administration Manual on Uniform Traffic Control Devices (MUTCD) as it provides detailed measurements and reference information for each nationally standardized signage assemblies.

American Association of State Highway and Transportation Officials (AASHTO)

The Guide for the Planning, Design, and Operation of Pedestrian Facilities (2004) offers pedestrian-centric design considerations for a breadth of facility types for a spectrum of user typologies. Pedestrian mobility is a fundamental active transportation mode but those walking, skating, and rolling are also vulnerable by their implicit exposure to motorized vehicles. As such the Guide takes an approach that starts with these users in a “design pedestrian” concept that encourages inclusive and safety for all users within the built environment.

The Guide for the Development of Bicycle Facilities, 4th Edition (2012) provides planners, engineers, and policy advocates a foundational understanding of bicycle facility planning and design considerations for safe and convenient transportation. The design considerations transcend multiple facility typologies from on-street to off-street, as well as operation and maintenance best practices. Since bicycling is expected to take place on all vehicular roadways, unless otherwise restricted, responsive guidelines herein offer a comprehensive approach to enable non-motorized users.

A Policy on Geometric Design of Highways and Streets, 7th Edition (2018) commonly referred to as the “Green Book” provides current geometric design best practices for highways and streets. Consideration of multiple variables is characteristic of active transportation facility design, balancing motorized and non-motorized user best practices to plan and design for implementable networks.

Americans with Disabilities Act (ADA)

ADA Standards for Transportation Facilities (2006) is an important part of planning for the full spectrum of users within a community. As such the 2006 document includes specific standards, exceptions, and advisory guidelines for the implementation of new transportation facilities. The focus is on public transportation facilities, including bus stops and stations, and rail stations. These standards are adopted by the U.S. Department of Transportation.

2010 ADA Standards for Accessible Design is the most current update to the ADA standards, applicable to facilities other than bus stops and stations or rail stations, including curb ramps, slope requirements, and pedestrian railings along stairs. The 2010 ADA Standards were not intended to include sidewalks, on-street parking, bike paths, or other aspects in the public right-of-way, but until such specific guidelines are adopted, the 2010 ADA Standards for Accessible Design remain the enforceable standard. These standards are adopted by the U.S. Department of Justice.

2011 Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way known colloquially as PROWAG, would address pedestrian facilities including street crossings, access routes, detectable warning surfaces, accessible signals and push buttons, on-street parking spaces, passenger loading spaces, and bike paths. PROWAG will not be an enforceable standard until adopted as a requirement by the

U.S. Department of Justice and Transportation. As of 2019, this has not yet occurred. While several states have adopted PROWAG for their own use, California is not one of them.

National Association of City Transportation Officials (NACTO)

Urban Bikeway Design Guide (2014) is built upon that understanding that unique bikeway feature applications are needed to bolster “complete streets” for all users in a variety of roadway situations and cities. The toolbox of treatments and design guidelines is rich with best practices solutions that are nationally recognized by the FHWA with inclusions in the MUTCD, as well as by Caltrans. Each feature within the guide provides a tiered level of guidance: “Required: elements for which there is a strong consensus that the treatment cannot be implemented without; Recommended: elements for which there is a strong consensus of added value; and Optional: elements that vary across cities and may add value depending on the situation.”

Urban Street Design Guide is based on an understanding that roadways are innately public spaces that should attend to the demands of pedestrians, bicyclists, vehicular traffic, and transit modes in a safe way. As such the fluidity of roadway design can attend to this initiative of multi-modal design practices by providing: case studies, recommendations, references, design alternatives. These scenarios are provided for streets, intersections, and phasing elements.

Global Street Design Guide pulls from case studies on a global scale to provide a multi-modal approach to improving, “access, safety, and mobility for all users, environmental quality, economic benefit, enhancement of place, public health, and overall quality of life.” Pedestrians, bicyclists, transit riders, motorists, freight movement, and people doing

business interact with a variety of street typologies. The design guide provides examples and references on multi-modal user facilities encouraging agencies to realize the potential of their respective streets, corridors, and networks.

Don't Give Up at the Intersection: Designing All Ages and Abilities (Bicycle Crossings) provides best practices for the design of bikeways through intersections. The guide covers protected bike intersections, dedicated bike intersections, and minor street crossings, as well as signalization strategies to reduce conflicts and increase comfort and safety.

STATE OF CALIFORNIA STANDARDS AND GUIDELINES

California Department of Transportation (Caltrans)

California Highway Design Manual, 6th Edition establishes uniform standards, procedures, policies, and requirements to carry out highway design functions for the California Department of Transportation. Active transportation facilities that seek to be implemented within this jurisdiction should reference this manual to ensure compliance. California Streets & Highways (S&H) Code 891(a) requires that all bikeways, even those not under state jurisdiction, conform to the Highway Design Manual. This is a unique statute that does not apply to motor vehicle facilities but only to bikeways. Variances from this manual may be utilized through a process defined in S&H Code 891(b) provided that they conform to NACTO or AASHTO guidelines. The manual updates regularly, sometimes multiple times per year. It is the user's responsibility to stay current.

California Manual on Uniform Traffic Control Devices, 2014 Edition Revision 4 (2018) provides uniform standards and specifications for all official traffic control devices in

California, conforming to California Vehicle Code laws and regulations. While the CAMUTCD stems from the FHWA MUTCD and has been officially adopted by the FHWA, the support, guidance, and options within are contextually sensitive towards California best practices. All bikeway traffic control devices must conform to the CAMUTCD unless a variance is sought in a process similar to that for the Caltrans Highway Design Manual.

Standard Plans and Specifications, 4th Editions (2018) are intended to complement each other for reference on the applications of striping, pavement markings, pavement, curbs/ramps, drainage, traffic control, and other design elements.

Sign Specifications Drawings (2014) are a complete set of updated and approved sign standards for use in California. Reference should be made to the CAMUTCD for comprehensive application guidance, which is adopted by the FHWA.

Main Street, California: A Guide for Improving Community and Transportation Vitality (2013) is a guide that pinpoints references to the breadth and depth of resources for project planners and engineers can use to create better main streets. As such design flexibility is encouraged to prepare congruent regional and local design applications for pedestrian and bicycle facilities, and other traffic calming features along state highways.

LOCAL STANDARDS

City of San Bernardino

The City of San Bernardino Public Works Engineering Division provides several design policy and procedure documents that include Engineering Design Drawings, and Traffic Engineering,

Storm Design, Sewer Design, Street Improvement, and Shared Parking Design Policies and Procedures. The information is intended to provide uniform design and guidance to design engineers preparing improvement plans for the City.

San Bernardino County

The Department of Public Works-Transportation Design Standards and Land Development design standards provide guidance on the design of various roadway infrastructure. The information is intended to provide uniform design and guidance to design engineers preparing improvement plans for the County.

Note: The Design Guidelines do not contain discussions of additional infrastructure that may be needed to fully install the infrastructure. Examples of such infrastructure include signage, striping, and traffic signal modifications. Guidelines for Transit treatments could be referenced in the OmniTrans Transit Design Guidelines.



Class I Off-Street Bike Path



Class II Buffered Bike Lane



Class III Bike Boulevard



Class IV On-Street Separated Bikeway

BIKEWAYS

CLASS I OFF – STREET BIKE PATH

A Class I Off-Street Bike Path is a completely separated facility for the exclusive use of bicycles and pedestrians with crossflow by motor vehicles minimized. It can be used as a recreational route or as a high-speed commute route when motor vehicle and pedestrian conflicts are minimized.

DESIGN GUIDANCE

Minimums

- Two-way: 12' (10' if between railings on structure): 8' traveled-way + 2' left shoulder + 2' right shoulder
- Vertical clearance: 8' over path, 7' over shoulders
- Cross slope: 1%
- Separation between the edges of the bikeway & roadway: 5' + standard shoulder width
- Horizon curvature radius: 90' (20MPH); 160' (25MPH); 260' (30MPH); or use warning signing/striping if smaller
- Stopping Sight Distance: 125' (20MPH); 175' (25MPH); 230' (30MPH)

Maximums

- Super elevation/Cross slope: 2%
- Grade: 5%

Other

Preferred width:

- Two-way: 16' (8' traveled way + 3' left shoulder + 3' right shoulder), 18'+ if possible (12' traveled way + 3' left shoulder + 3' right shoulder)

IMPLEMENTATION

- Bike paths immediately adjacent to streets/highways are not recommended, due to introducing major conflicts at intersections with vehicles, transit passengers at stops, and vehicle occupants crossing the path
- Can be appropriate along roads with higher traffic volumes and higher vehicle speeds as well as away from roadways at parks, greenbelts, and utility corridors.

KEY CONCERNS

- Transitions to/from/across vehicle roadways and intersections
- Sight distance and maintaining STOP/YIELD controls where the bikeway crosses other paths of travel

ADDITIONAL REFERENCES & GUIDELINES

Caltrans HDM

FHWA Bikeway Selection Guide, Feb. 2019

AASHTO Guide for the Development of Bicycle Facilities

CLASS II BIKE LANE

A Class II Bike Lane is a portion of the roadway that is designated by striping, signaling, and/or pavement markings for the exclusive use of bicyclists. They are established along streets and corridors where there is significant demand, and where there are distinct needs that can be served by them.

DESIGN GUIDANCE

Minimums

- Adjacent to curb face or on-street parking lane: 5' (includes gutter pan width) or adjacent parking lane
- Adjacent to right-turn only lane: 4' (≤ 40 MPH posted speed) or 6' (> 40 MPH), with right-hand stripe 8" wide per Caltrans Detail 38A
- Adjacent to roadside with no parking or curb: 4'

Maximums

Cross slope:

- 3% (resurfacing/widening to match the existing cross slope)

Other

Guidance at intersections:

- Terminate the solid stripe between 50' (short blocks $< 400'$) and 200' (long blocks, or speeds > 35 MPH) prior to the intersection where right turns are permitted from the outer through travel lane, and use a dashed line carried to or near the intersection

IMPLEMENTATION

- Can be appropriate on roads with moderate traffic volumes and moderate vehicle speeds
- Can be appropriate on higher speed roadways if increased width is provided for the bike lane
- At trap right-turn lanes, terminate the solid bike lane with a gap of $\geq 100'$ (or distance "d" per CAMUTCD 2C.05 for posted speeds > 40 MPH) to the beginning of a striped right-turn-only lane, and continue the solid bike lane lines to the left of the right-turn-only lane.

KEY CONCERNS

- When reducing travel lane width to add/widen bike lanes, need to consider factors such as vehicle speeds, truck volumes, alignment, bike lane width, sight distance, presence of on-street parking
- Integration with existing lane configurations, driveways, and roadside features.
- Bicycle signal controls.

ADDITIONAL REFERENCES & GUIDELINES

Caltrans Highway Design Manual (HDM) California MUTCD

CLASS II BUFFERED BIKE LANE

A Class II Buffered Bike Lane is a conventional bicycle lane (i.e., Class II Bike Lane) paired with a designated buffer space composed of painted stripes and pavement markings adjacent to the bike lane. The striped separation from vehicular traffic can decrease exposure, increase the perceived user level of comfort, provide a space for bicyclists to pass one another without encroaching into the motor vehicle travel lane, and also encourage bicyclists to ride outside of the door zone when the buffer is placed between the bike lane and adjacent on-street parked cars.

DESIGN GUIDANCE

Minimums

- 1.5' (bound by two solid lines without interior markings)
- Buffer with interior markings (chevron or diagonal): 4' or greater

Maximums

- No specified maximum geometric requirements new to Class II bikeway facilities

Other

- Requires additional maintenance when compared to a conventional bicycle lane, such as keeping the facility free of potholes, broken glass, and other debris
- Requires additional right-of-way or roadway space to accommodate buffer alongside bike lane
- Signage: Standard and special signage for bike lanes should be installed based on MUTCD guidelines. For example: Bike Lane Sign (R81(CA)), BEGIN (R81A(CA)), END (R81B(CA)), No Parking Bike Lane Signs (R7-9, R7-9a), Bicycle Regulatory Signs (R9-5, R9-6, etc.)

IMPLEMENTATION

- Can be appropriate on roads with moderate traffic volumes and moderate vehicle speeds
- Can be appropriate on higher speed roadways if increased width is provided for the bike lane or buffer

KEY CONCERNS

- Striping configuration to allow vehicles to cross buffer zone to enter/exit driveways
- Ensuring that the traveled way for motor vehicles, adjacent to the buffered bikeway area, is afforded sufficient space to maintain the agency's desired/allowable travel lane widths for each travel lane
- If raised devices are desired within the buffer area, then the bikeway classification must change to a separated bike lane and the designer shall adhere to the guidelines and requirements for Class IV Bikeways

ADDITIONAL REFERENCES & GUIDELINES

California MUTCD Figure 9C-104(CA)

CLASS III BIKE ROUTE – MARKED SHARED LANE

A marked shared roadway uses shared lane markings or “sharrows” to guide bicyclists to the most appropriate path to ride along. Sharrows can aid with having more predictable bicycle movements by informing motorists to share the roadway, showing bicyclists the direction and location of travel, and discouraging riders from traveling too close to the “door zone”.

DESIGN GUIDANCE

Minimums

(For Pavement Marking): The lateral positioning of shared lane markings should be such that the center of the marking within the lane is at least X feet from the face of the curb (or edge of pavement without curb), under the following conditions:

Streets with On-Street Parking:

- Effective lane width <14'; X = at the center of the effective lane width
- Effective lane width =14' or greater ; X = 13' or greater

• Streets without On-Street Parking:

- Outside travel lane <14' to the curb face or edge of pavement without curb; X = at the center of the travel lane
- Outside travel lane =14' or greater; X = 4' or greater from the curb face or edge of pavement without curb

Maximums

- Street width 14' or more: 13' from lateral reference point (Curb or Edgeline)

Other

- Spacing: place immediately after the intersection and space no greater than 250' thereafter
- Closer spacing can be used to navigate low sight distance environments or busy intersections

CLASS III BIKE ROUTE – MARKED SHARED LANE (CONTINUED)

IMPLEMENTATION

- Can be appropriate on roads with low traffic volumes and low vehicle speeds
- Shared lane markings should be used on roads with posted speed limits of 35 MPH or less

KEY CONCERNS

- Maintaining safety for bicyclists sharing the roadway with motorized traffic
- Travel speeds
- Unsafe vehicle overtaking where there is minimal roadway width
- Dooring hazards adjacent to on-street parked cars
- Considering the impact of bicycles opting to ride on the sidewalk

ADDITIONAL REFERENCES & GUIDELINES

California MUTCD Figure 9C-108(CA)

Note: The “effective lane width” is the width of the pavement available after subtracting the width of the parking vehicle and door zone (typically 10’) from the distance of the lane/centerline to the face of the curb/edge of the pavement. See CAMUTCD Figure 9C-108(CA) for more details.

CLASS III BIKE BOULEVARD

A Class III Bike Boulevard is a special type of bike route where a street is designed to accommodate bicyclists with a wide variety of skill levels. Bike boulevards offer all of the features of a signed or marked shared lane with added considerations, such as traffic calming elements, and traffic diversion techniques that restrict thru-traffic restrictions for motor vehicle traffic while allowing bicyclists to proceed through. Bicycle boulevards promote low-speed and low-volume streets that cannot accommodate or do not need exclusive bike lanes.

DESIGN GUIDANCE

Minimums

- Shared-lane element of bike boulevards (pavement markings):
- Street width 14' or more: 13' from lateral reference point (curb or edgeline)
Street width less than 14': Center of the effective lane width

Maximums

- No specified maximum geometric requirements new to Class III bikeway facilities

Other

- Mainly applied on collector, Downtown streets, and local/ neighborhood street roadwaysIncreases comfort for bicyclists by reducing motorist speeds and volumes, if diverters or roundabouts are included
- Connects residential roads to commercial corridors/ community services.

IMPLEMENTATION

- Can be appropriate on roads with low traffic volumes and low vehicle speeds.
- If combined with other features such as traffic calming features, implementation for such items may impact where bicycle boulevards may be implemented

KEY CONCERNS

- Common issue of resident/business push back where on-street parking is removed
- Continuity of bike boulevard elements at major/busy/ built-out intersections
- Varying roadway widths, narrow shoulders.
- Driveway crossings for existing commercial uses can create conflict points.

ADDITIONAL REFERENCES & GUIDELINES

California MUTCD Figure 9C-108(CA)

CLASS IV ON-STREET SEPARATED BIKEWAY

A Class IV Separated Bikeway, also known as a cycle track or protected bike lane, is a one- or two-way bikeway for the exclusive use of bicycles that includes a physical, vertical barrier between bicyclists and motor vehicle traffic within the roadway.

DESIGN GUIDANCE

Minimums

- Clear bike lane width (one-way): 5' (4' when located at accessible parking or a bus stop)
- Clear Bikeway Width (2-way): Use Class I standards
- Separation Width or Buffer:
 - Between an on-street parking lane and the edge of the traveled way: 3' (5' if accessible parking)
 - No On-Street Parking: 2'

Maximums

- No maximum geometrics specified

Other

- Preferred geometrics:
 - Clear bike lane width (one-way): 7'
 - Clear bikeway width (2-way): Use Class I standards
 - Separation Width or Buffer: 3'

IMPLEMENTATION

- Can be appropriate on roads with higher traffic volumes and higher vehicle speeds.
- Local jurisdictions must be involved when analyzing these impacts with local residents and deciding what features are to be included in the street modification.

KEY CONCERNS

- Crossing points at intersections, alleys and driveways
- Unloading and loading zones, transit stops, and valet parking areas
- Selection of vertical element separation type.
- Maintenance
- Traffic control work zones through separated bikeways.

ADDITIONAL REFERENCES & GUIDELINES

Caltrans Class IV Bikeway Guidance Design Info Bulletin #89
Caltrans HDM Chapter 1000
Protected Bikeways Act of 2014
FHWA Separated Bike Lane Planning and Design Guide
Public Rights-of-Way Accessibility Guidelines

CLASS IV RAISED SEPARATED BIKEWAY

A Class IV Raised Separated Bikeway is a separated bikeway is typically designed to be either at the same grade as the adjacent sidewalk or set at an intermediate level mountable curb between the roadway and sidewalk.

DESIGN GUIDANCE

Minimums

- Clear bike lane width (one-way): 5' (4' when located at accessible parking or a bus stop)
- Clear Bikeway Width (2-way): Use Class I standards
- Separation Width or Buffer:
 - On-street, between an on-street parking lane and the edge of the traveled way: 3'
 - On-street, with No On-Street Parking: 2'
 - On the sidewalk, between the edge of the traveled way (no on-street parking) and the edge of the vertical element separating the bikeway and buffer: 1.5'
 - On the sidewalk, between the edge of the traveled way (with on-street parking) and the edge of the vertical element separating the bikeway and buffer: 3'

Maximums

- No maximum geometrics specified

Other

- Preferred geometrics:
 - Clear bike lane width (one-way): 7'
 - Clear bikeway width (2-way): Use Class I standards
 - Separation Width or Buffer: 3'

IMPLEMENTATION

- The separated bikeways may be raised vertically to an elevation higher than the finished grade of the roadway, but should not be raised at intersections, alleys and driveways
- For partial sidewalk conversions, the part of the sidewalk used for the separated bikeway is separated by a continuous detectable element (barrier, planters, curb, flexible post; however, these elements may be omitted) and can no longer be used by pedestrians.

KEY CONCERNS

- Ensuring adequate ADA clearance for pedestrians on walkable portions of the sidewalk
- Designing for sidewalk and above-grade treatments at driveways and intersections

ADDITIONAL REFERENCES & GUIDELINES

Caltrans Class IV Bikeway Guidance Design Info Bulletin #89

Caltrans HDM Chapter 1000

Protected Bikeways Act of 201

FHWA Separated Bike Lane Planning and Design Guide (FHWA Guide)
HDM Topical 105

Before



After



Lane Narrowing



High Visibility Crosswalk with Pedestrian Refuge Island

ROADWAY

LANE NARROWING

Lane narrowing narrows the existing travel lanes so the roadway can better accommodate multiple types of users. The treatment is intended to improve the overall safety and traffic flow of the roadway and potentially accommodate the addition of a bikeway facility.

DESIGN GUIDANCE

Minimums

Caltrans:

- 12' on State Highways (hwy) >45MPH; all State Highways connecting to a freeway interchange (2-lane hwy = all lanes; multi-lane hwy = outermost lane in each direction)
- 11' on State Highways ≤40MPH

Maximums

- Refer to Caltrans HDM for lane width minimum design values

Other

- Normal lane width = 12'
- Where unequal-width lanes are used, locate the wider lane on the outside (right) to provide more space for large vehicles and bicycles, right turns, and a larger buffer from the curb

IMPLEMENTATION

- Can be applied where lane widths exceed the needs of the types of vehicles traveling along the roadway, where a reduction of vehicular travel speeds are desired, or where improvements to bikeways and pedestrian facilities are desired

ADDITIONAL NOTES

Maintaining adequate lane width for large vehicles such as:

- Trucks and semi/trailer units
- Buses
- RVs; and fire trucks and articulated emergency vehicles

ADDITIONAL REFERENCES & GUIDELINES

Caltrans HDM Index 301.1 - Lane Width
AASHTO Greenbook
NACTO's Urban Street Design Guide.
FHWA's PEDSAFE: Lane Narrowing

ROADWAY RECONFIGURATION

Also known as a road diet, a roadway reconfiguration typically involves reducing the number of lanes to better accommodate other roadway users. The treatment reallocates roadway space for other purposes, potentially adding turn lanes, bus lanes, pedestrian refuge islands, bike lanes, sidewalks, bus shelters, or landscaping.

DESIGN GUIDANCE

Minimums

Caltrans:

- 12' on State Highways (hwy) >45MPH; all State Highways connecting to a freeway interchange (2-lane hwy = all lanes; multi-lane hwy = outermost lane in each direction)
- 11' on State Highways ≤40MPH
- Shoulder width (includes Class II bikeway area and gutter pan) on State Highways:
 - Left: 4-lane highways = 5', 6+ lane highways = 8', 45 MPH w/ curbed median=2', ≤35MPH =none
 - Right: 8' for all multi-lane highways, and where on-street parking is provided plus the minimum required bike lane width
- Non-Caltrans Facilities
 - 12' on most high-volume highways; 11' where pedestrian crossings, right-of-way, or existing development imposes on available lane widths; 10' lanes are acceptable on low-speed facilities; 9' lanes may be appropriate on low-volume roads in rural and residential areas

Maximums

- Refer to Caltrans HDM for lane width minimum design values (see "Lane Narrowing" design guidelines)

IMPLEMENTATION

- Appropriate on all types of roads in urban and suburban settings.
- Common at 4-lane roadways
- Can be appropriate for all typical speed limits.
- Can be appropriate for any volume that can be accommodated by the revised cross-section; the commonly-referenced threshold is a peak hour volume of 1,000 vehicles per post-implementation through travel lane; a lower volume indicates a road diet is likely feasible; higher volume requires further investigation.
- Can be appropriate along a primary emergency route and on streets that provide access to emergency medical services.
- Can be appropriate along a bus transit route.
- Can be appropriate along a primary access route to a commercial or industrial site.
- Should follow recommended widths for all lanes including travel lanes, bikeways, and parking

ADDITIONAL REFERENCES & GUIDELINES

FHWA's Road Diet Information Guide

FHWA's Traffic Calming ePrimer – Module 3

A Policy on Geometric Design of Highways and Streets

LANDSCAPE MEDIANS

Landscaped medians, or raised medians, are raised barriers in the center of the roadway that are typically filled with various types of foliage. They can serve as a place of refuge for pedestrians crossing at an intersection or at the midblock.

DESIGN GUIDANCE

Minimums

- Minimum width: 6', 8' preferred
Area should be at least 50 square feet in area, preferably 75 square feet
- Curbed, elongated divisional median islands should not be less than 4' wide and 20' long

Maximums

- 12' maximum width

Other

- Cross slopes in medians greater than 65' should be treated as separate roadways

IMPLEMENTATION

- Appropriate only on two-way streets

ADDITIONAL REFERENCES & GUIDELINES

Caltrans HDM index 305.2 - Median Cross Slope

CHOKERS/ PINCHERS

Chokers or pinchers are curb extensions that narrow a segment of the roadway by widening the sidewalk or planting strip, creating a pinch point along the roadway. These pinch points can increase visibility of pedestrians looking to cross the roadway.

DESIGN GUIDANCE

Minimums

- Single Lane Chokepoint Width: 12'

Maximums

- N/A

Other

- N/A

IMPLEMENTATION

- Appropriate at mid-block locations of arterial, collector, or local roads in urban and suburban settings with one-way or two-way streets
- Can be applied on a street with, and can protect, on-street parking
- Can be appropriate for any speed limits provided adequate distance between the features
- Can be appropriate at all levels of traffic volume
- Can be appropriate along a primary emergency route and on streets that provide access to emergency medical services
- Can be appropriate at along bus transit route
- Can be appropriate along a primary access route to a commercial or industrial site

ADDITIONAL REFERENCES & GUIDELINES

Caltrans HDM Topic 303.4.

https://safety.fhwa.dot.gov/speedmgt/ePrimer_modules/module3pt3.cfm#mod320



Traffic Circle



High Visibility Crosswalk with Pedestrian Refuge Island



Protected Intersection



Pedestrian Scramble

INTERSECTIONS & CROSSINGS

HIGH VISIBILITY CROSSWALK

Predictable pedestrian actions at intersections can be aided with the installation of marked crosswalks, which indicate to motorists where pedestrian crossings take place as well as indicate to pedestrians the right-of-way they should cross within.

DESIGN GUIDANCE

Minimums

- Crosswalk line width: 12"
- Crosswalk width: 6'

Maximums

- Crosswalk line width: 24"

Other

- Typical crosswalk line width: 12"
- Typical crosswalk width: 11'
- Curb ramps (not including flared sides) shall be contained wholly within the width of the marked crosswalk

IMPLEMENTATION

- Should be prioritized in areas with high pedestrian activity or where roadway conditions may require increased awareness of possible pedestrian traffic including near schools, commercial areas, recreation areas, at mid-block marked crossings, and at marked uncontrolled crossings

KEY CONCERNS

- High visibility crosswalk should be provided at all mid-block crossings, and should be considered at uncontrolled intersections

ADDITIONAL REFERENCES & GUIDELINES

Caltrans Std. Plan A24F

California MUTCD Section 3B.18

Engineering judgment may be required to assess need

MID-BLOCK CROSSWALK

A mid-block crosswalk facilitates crossings to places that people want to go, but that are not well served by existing infrastructure.

DESIGN GUIDANCE

Minimums

- Crosswalk line width: 12"
- Crosswalk width: 6'

Maximums

- Crosswalk line width: 24"
- Crosswalk width: Not stated (some agencies have implemented crosswalks as wide as 80' for high pedestrian crossings at mid-block, ex: Green St. & Garfield Ave., Pasadena, CA)

Other

- Should follow high visibility crosswalk design
- Often includes advance stop bars (if signal controlled) or yield lines (if uncontrolled or flashing beacon installed)

ADDITIONAL REFERENCES & GUIDELINES

*NACTO Urban Street Design Guide | Caltrans Std. Plan A24F
California MUTCD Section 3B.18*

IMPLEMENTATION

- Should be implemented at locations with high pedestrian activity and where an engineering study and judgment supports the implementation
- Should be used in conjunction with other safety improvements such as bulb-outs, where feasible, and/or features that may reduce conflicts with vehicular traffic including traffic control devices (Pedestrian Hybrid Beacons, Rectangular Rapid Flashing Beacons, etc.) and traffic calming features (curb extensions, median refuge islands, etc.)

KEY CONCERNS

- Uncontrolled mid-block crosswalks should generally be discouraged for traffic safety reasons. However, if it is decided to be used, it should be justified by high pedestrian volumes, average daily traffic (ADT), approach speed, roadway configuration and designed according to FHWA's "Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations" (Jan. 2018)

CURB EXTENSION (BULB-OUT)

A curb extension, also known as a bulb-out, provides pedestrians with decreased crossing distances and time spent within the vehicle right-of-way by extending the sidewalk into the roadway. A curb extension also increases the visibility for pedestrians as they wait to cross and increases pedestrian visibility for motorists as they approach a crossing.

DESIGN GUIDANCE

Minimums

- Typical minimum width: 5'
- Minimum approaching/departure curve radii should accommodate street sweeping equipment

Maximums

- Curb extension shall allow a minimum lane width and shoulder width
- Should not extend beyond the parking lane or leave less than 10' for the travel lane, 11-12' for the transit lane, and 5' for a bicycle lane

Other

- Typical width should be 6' to 8'
- Typical offset of 2' from edge of pavement to edge of bikeway or travel lane
- Should be used at crosswalks in heavy pedestrian areas where on-street parking may limit the driver's view of pedestrians
- Should extend into the street for the width of parking lane
- Street must have on-street parking
- Should be applied only on streets with posted speed limits of 35 MPH or less

CURB EXTENSION (BULB-OUT) (CONTINUED)

IMPLEMENTATION

- Appropriate at mid-block and intersection locations of arterial, collector, or local roads in urban and suburban settings with one-way or two-way streets
- Can be applied on a street with, and can protect, on-street parking
- Can be appropriate for any speed limits provided adequate distance between the features, but most appropriate on streets with posted speed limits of 35 MPH or less
- Can be appropriate at all levels of traffic volume

KEY CONCERNS

- May be inappropriate for use on corners where frequent right turns are made by trucks or buses, which require a larger turning radius and thus preclude curb return radius reductions
- Curb extensions must not intervene with the adjacent drive lanes, bicycle lanes, or roadway shoulders

ADDITIONAL REFERENCES & GUIDELINES

HDM Topic 303.4 Figures 303.4A-4B

https://safety.fhwa.dot.gov/speedmgt/ePrimer_modules/module3pt3.cfm#mod320

RAISED CROSSWALK

Raised crosswalks are elevated crosswalks that enable pedestrians to cross an intersection at the same level as the sidewalk, which increase their visibility while crossing. They are typically installed as part of a raised intersection, which are designed to reduce speeds of approaching vehicles, enhance pedestrian connectivity, and improve safety.

DESIGN GUIDANCE

Minimums

- Crosswalk width: 10'
- Minimum horizontal curve radius of 300'

Maximums

- Crosswalk width: 12' long and 3" in height

Other

- Average daily traffic (ADT) should be less than 9,000
- Should be applied on 2-3 lane roads

ADDITIONAL REFERENCES & GUIDELINES

HDM Topic 303.4 Figures 303.4A-4B
https://safety.fhwa.dot.gov/speedmgt/ePrimer_modules/module3pt3.cfm#mod320

IMPLEMENTATION

- Appropriate at mid-block and intersection locations of arterial, collector, or local roads in urban and suburban settings with one-way or two-way streets
- Can be applied on a street with and can protect on-street parking
- Can be appropriate for any speed limits provided adequate distance between the features, but most appropriate on streets with posted speed limits of 35 MPH or less
- Can be appropriate at all levels of traffic volume

KEY CONCERNS

- May be inappropriate for use on corners where frequent right turns are made by trucks or buses, which require a larger turning radius and thus preclude curb return radius reductions
- Curb extensions must not intervene with the adjacent drive lanes, bicycle lanes, or roadway shoulders

ADVANCED YIELD MARKING

Advanced yield markings are pavement markings that are installed to warn motorists of possible pedestrian crossings further along the roadway.

DESIGN GUIDANCE

Minimums

- Placement: 4' minimum before a crosswalk at controlled intersections
- At unmarked crosswalks, 4' – 30' prior to the intersection edge
- At uncontrolled multi-lane approach, 20' – 50' prior to the crosswalk

Maximums

- 30' in advance of an unmarked crosswalk
- 50' in advance of a marked crosswalk

Other

- Dimensions of the triangles that comprise the yield marking include a width of 12" to 24", a height equal to 1.5 times the base, and should be spaced 3" to 12" apart

IMPLEMENTATION

- Yield lines may be used to indicate the point behind which vehicles are required to yield in compliance with a YIELD (R1-2) sign or a Yield Here To Pedestrians (R1-5 or R1-5a) sign

KEY CONCERNS

- Depending on the location, the advanced yield marking and appropriate signage should be placed adjacent to each other

ADDITIONAL REFERENCES & GUIDELINES

California MUTCD Section 3B.16 and Figure 3B-14

SCRAMBLE CROSSWALK

Scramble crosswalks grant full pedestrian right-of-way in any direction, including diagonally.

DESIGN GUIDANCE

Minimums

- Crosswalk should not be less than 6' wide

Maximums

- N/A

Other

- Should follow typical crosswalk designs

IMPLEMENTATION

- Only appropriate at signalized intersections
- Should be prioritized in areas with high pedestrian activity such as commercial areas
- They are often used in conjunction with an exclusive pedestrian phasing which restricts all vehicular movements

KEY CONCERNS

- Vehicle and pedestrian volumes should be considered prior to design

ADDITIONAL REFERENCES & GUIDELINES

California MUTCD Section 3B.16 and Figure 3B-14

CURB RAMP

A curb ramp is a ramp cutting through a curb or built up to it to provide a route to safely transition from a roadway to a curbed sidewalk.

DESIGN GUIDANCE

Minimums

- Refer to source(s) for curb ramp geometric minimum design values

Maximums

- Refer to source(s) for curb ramp geometric maximum design values

Other

- N/A

IMPLEMENTATION

- Curb ramps should be placed at the transition between sidewalks and other pedestrian facilities (i.e. sidewalks and refuge islands) and the roadway
- Existing curb ramps may be updated to meet ADA designs when sidewalks are installed or repaired

KEY CONCERNS

- Must meet specific standards for width, slope, cross slope, placement, and other features in order to be compliant with the Title II of the ADA
- Additional detectable warnings are required

ADDITIONAL REFERENCES & GUIDELINES

Caltrans HDM Section 105.5 and Section 275 of California Vehicle Code

Caltrans Standard Plan A88A

PEDESTRIAN REFUGE ISLAND

A pedestrian refuge island serves as an aid to pedestrian movement by providing a protected space while they cross streets.

DESIGN GUIDANCE

Minimums

- Minimum width: 6', 8' preferred
- Area should be at least 50 square feet in area, preferably 75 square feet
- Curbed, elongated divisional median islands should not be less than 4' wide and 20' long

Maximums

- N/A

Other

- Pedestrian crossing points must be accessible (Design Information Bulletin [DIB] 82-06)
- May also reference City of Ontario Standards 1109 and 1215

IMPLEMENTATION

- Recommended consideration in areas with mixtures of significant pedestrian and vehicle traffic (more than 12,000 average daily traffic) and moderate or high travel speeds

ADDITIONAL REFERENCES & GUIDELINES

Caltrans HDM Topic 405.4. Figure 405.4

TWO-STAGE BIKE TURN BOX

A two-stage bicycle turn box is an area designated for bicyclists waiting to proceed in a different direction that formalizes two-stage turn maneuvers in a predictable pattern.

DESIGN GUIDANCE

Minimums

- Dimensions are recommended as follows depending on anticipated queuing capacity: minimum 4' deep and 8' wide

Maximums

- Dimensions are recommended as follows depending on anticipated queuing capacity: maximum 9' deep and 10' wide

Other

- At the location where the box conflicts with turning movements, install NO TURN ON RED (R10-11) sign for prohibition of turning vehicle traffic

IMPLEMENTATION

- Only permitted at signalized intersections. Should be prioritized at intersections with high vehicular and bicycle traffic, multi-lane roadways, high vehicle speeds, a significant volume of bicyclists turning, or where there may be turning conflicts between motorists and bicyclists

KEY CONCERNS

- Should be placed in a location downstream of the cross street intersection stop line and downstream of the crosswalk across the cross street
- Multiple positions are available for queuing boxes
- Request for FHWA Interim Approval required

ADDITIONAL REFERENCES & GUIDELINES

California MUTCD Section 2B.54 and NACTO Urban Bikeway Design Guide

BIKE LANES IN RIGHT TURN ONLY LANES

Bicycle lanes leading into an intersection, depending on roadway and intersection characteristics, can be carried through the conflict zone using dotted line transition pavement markings to the left of the right turn only lane.

DESIGN GUIDANCE

Minimums

- Dotted white lines should be 6" wide and 2' long with 2' to 6' gap between dashes

Maximums

- Maintain bicycle lane width of 5' to 6' or 4' in areas impacted by roadway constraints

Other

- Minimize length of merge area as much as feasible: 60' when less than or equal to 30 MPH or 90' when greater than or equal to 30 MPH
- Dashed lines should begin a minimum of 50' before the intersection or 100' if before a high traffic roadway

IMPLEMENTATION

- Can be applied at the approach to an intersection where a turn lane can present a challenge for bicyclists
- Typically applied at auxiliary turn lanes and where parking lanes transition into vehicular turn lanes

ADDITIONAL REFERENCES & GUIDELINES

California MUTCD, Part 9

HDM Section 400 Topic 404.2

AASHTO Guide for the Development of Bicycle Facilities

NACTO Urban Bikeway Design Guide

COMBINED BIKE LANE AND TURN LANE

A combined bike lane and turn lane merges both the bike lane and right-turn lane into one lane. It is an option available in scenarios where the right-of-way at intersections is constrained.

DESIGN GUIDANCE

Minimums

- Combined lane should be 9' minimum (note a through bike lane can be accommodated if combined lane width is 14' or greater)

Maximums

- Combined lane should be 13' maximum

Other

- Minimize length of merge area as much as feasible: 60' when less than or equal to 30 MPH or 90' when greater than or equal to 30 MPH
- Dashed lines should begin a minimum of 50' before the intersection or 100' if before a high traffic roadway

IMPLEMENTATION

- Can be applied at the approach to an intersection where a turn lane can present a challenge for bicyclists
- Typically applied at auxiliary turn lanes and where parking lanes transition into vehicular turn lanes

ADDITIONAL REFERENCES & GUIDELINES

California MUTCD, Part 9

HDM Section 400 Topic 404.2

AASHTO Guide for the Development of Bicycle Facilities

NACTO Urban Bikeway Design Guide

INTERSECTION CROSSING MARKINGS

Intersection crossing markings are pavement markings that are used to indicate the intended path that bicyclists should take through an intersection.

DESIGN GUIDANCE

Minimums

- Minimum striping width should be 6" adjacent to motor vehicle

Maximums

- Dotted line should be 2' long and 2' to 6' of spacing

Other

- Minimize length of merge area as much as feasible: 60' when less than or equal to 30 MPH or 90' when greater than or equal to 30 MPH
- Dashed lines should begin a minimum of 50' before the intersection or 100' if before a high traffic roadway

IMPLEMENTATION

- Can be implemented where improved awareness of bicycle crossings is desired for conflict avoidance

KEY CONCERNS

- In cases where traditional intersection striping width is not sufficient and demands higher visibility, "Elephant's Feet" (14"x20") markings can be used as alternatives to dotted lines

ADDITIONAL REFERENCES & GUIDELINES

California MUTCD Section 3B.08

AASHTO Guide for the Development of Bicycle Facilities

NACTO Urban Bikeway Design Guide

GREEN-COLORED PAVEMENT

Green colored pavement markings are used to increase the visibility of bikeways, particularly at areas with high potential for motor vehicle/bicycle conflicts.

DESIGN GUIDANCE

Minimums

- 9' minimum

Maximums

- 13' maximum

Other

- Guidance on reflective paint and surface traction
Paragraph 4 of Section 3A.04 of CA MUTCD

IMPLEMENTATION

- Can be implemented where improved awareness of bicyclists is desired
- Commonly used in conflict areas at the approach and within an intersection

KEY CONCERNS

- A through bike lane can be accommodated if combined lane width is 14' or greater

ADDITIONAL REFERENCES & GUIDELINES

FHWA Interim Approval for Optional Use of Green Colored Pavement for Bike Lanes (IA-14)

TRAFFIC DIVERTER

Traffic diverters are implemented for the purpose of volume control and managing non-local residential traffic. They are designed as islands that guide through and/or turning movements.

DESIGN GUIDANCE

Minimums

- To allow for emergency and large vehicle access, the minimum clear space between the traffic diverter features is 10'

Maximums

- It should be wide enough for emergency vehicles and single unit trucks to make turns without encroaching on opposing travel lanes

Other

- N/A

IMPLEMENTATION

- Appropriate on all types of roads in urban and suburban settings with one-way or two-way streets with a typical maximum posted speed limit of 25 MPH
- Can be appropriate at all levels of traffic volumes
- Not appropriate along a primary emergency route and on streets that provide access to emergency medical services
- Not appropriate along bus transit routes unless the route can be altered
- Not appropriate along a primary access route to a commercial or industrial site if access is blocked

ADDITIONAL REFERENCES & GUIDELINES

FHWA Interim Approval for Optional Use of Green Colored Pavement for Bike Lanes (IA-14)

TRAFFIC CIRCLE

Traffic circles feature a circular island in the center of an intersection. They are typically used at un-signalized intersections to help lower speeds, while still promoting a continuous flow of traffic.

DESIGN GUIDANCE

Minimums

- Diagonal corner clearance: 15'
- Need to follow design minimums of (1) the design vehicle using the roundabout (passenger cars, single-unit/ multi-unit trucks, emergency vehicles, etc.); and (2) the individual components of the traffic circle

Maximums

- Entry speed: 15-20 MPH
- Approach lanes: 1
- Inscribed Circle Diameter: 45' – 90'

Other

- If space is available, the planting of trees and shrubs within the traffic circle can heighten the traffic calming effect, but must be maintained to keep sight distance at a maximum

IMPLEMENTATION

- Appropriate at the intersection of two local roads in urban and suburban settings with one-way or two-way streets.
- Appropriate for relatively low-speed streets (Some jurisdictions have limits at 30 MPH).
- Can be appropriate at low - volume streets.
- Not appropriate along a primary emergency route and on streets that provide access to emergency medical services.
- Transit routes should not have a left turn at these locations.
- Typically not appropriate along a primary access route to a commercial or industrial site.

KEY CONCERNS

- Lane width and turning radius should be highly considered

ADDITIONAL REFERENCES & GUIDELINES

NACTO Urban Street Design Guide

https://safety.fhwa.dot.gov/speedmgt/ePrimer_modules/module3.cfm

ROUNDBABOUT

A roundabout directs motorists into the intersection and guides counterclockwise travel around the circular island. There are many types of roundabouts: mini roundabout (Mini-RAB), single-lane roundabout (Single-Lane RAB), and multi-lane roundabout (Multi-Lane RAB).

DESIGN GUIDANCE

Minimums

- Need to follow design minimums of (1) the design vehicle using the roundabout (passenger cars, SU/MU trucks, emergency vehicles, etc.); and (2) the individual components of the roundabout:
 - Central Island
 - Splitter island and deflection parameters
 - Entry width and entrance line
 - Circulatory width and roadway
 - Accessible pedestrian crossings
 - Landscape strips
 - Traffic control devices
 - Central island
- Must ensure adequate stopping sight distance (SSD) at every point within the roundabout, on each entering/exiting approach, and with other conflicting users (pedestrians/bikes) within the roadway. Must ensure adequate intersection sight distance (ISD) for vehicles entering the roundabout with those already circulating in it, and those entering at immediate upstream points.

Maximums

- Entry speed:
 - Single-lane RAB = 20-25 MPH
 - Multi-lane RAB = 25-30 MPH
- Approach lanes:
 - Single-lane RAB = 1
 - Multi-lane RAB = 3
- Inscribed circle diameter:
 - Single-lane RAB = 90 - 180'
 - Multi-lane RAB = 150' - 300'

Other

- Recommended posted speed limit of 30 MPH (35 MPH 85th percentile speed).

ROUNDBOUT (CONTINUE)

IMPLEMENTATION

- Appropriate at the intersection of two local roads in urban and suburban settings with one-way or two-way streets
- Generally recommended for streets with daily traffic volumes of no more than 15,000 vehicles.
- Appropriate along a primary emergency route and on streets that provide access to emergency medical services.
- Although a transit vehicle can negotiate the turn, in general, transit routes should not include a left turn at a small modern roundabout or mini-roundabout.
- Can be applied along a primary access route to a commercial or industrial site.

KEY CONCERNS

- May be inappropriate for use on corners where frequent right turns are made by trucks or buses, which require a larger turning radius and thus preclude curb return radius reductions.
- Curb extensions must not intervene with the adjacent drive lanes, bicycle lanes, or roadway shoulders.
- Roadway space requirements
- Right-of-way requirements
- Traffic operations assessment
- Geometric design

ADDITIONAL REFERENCES & GUIDELINES

NACTO Urban Street Design Guide

https://safety.fhwa.dot.gov/speedmgt/ePrimer_modules/module3.cfm

PROTECTED INTERSECTION

A protected intersection redesigns the traditional mixing zone that persists where a bicycle lane ends and the right turn lane begins. The design places bicyclists in a separated channel from motor vehicles and pedestrians at the intersection, improving yield rates amongst all users of the intersection.

DESIGN GUIDANCE

Minimums

- Corner safety island should have radius of 15' to 20'
- Pedestrian refuge island should be a minimum of 8'
- Pedestrian island width is typically 6.5' to 14'
- Crossing setback should be around 19'

Maximums

- Crossing setback are typically 19'
- Pedestrian island, if 6' or wider put detectable warning surface placed both the side

Other

Setbacks:

- Setback larger than 20' may increase turn speed
- Larger than 25' treated as separate intersection.
- Typically 14-20' setback preferred

IMPLEMENTATION

- Most commonly found on streets with parking-protected bike lanes or buffered bike lanes
- Can be implemented on most streets where improved bike comfort is desired with modifications to the typical design

ADDITIONAL REFERENCES & GUIDELINES

NACTO Urban Bikeway Design Guide and Global Street Design Guide

BIKE LANE AT CHANNELIZED TURN LANE

Channelized turn lanes or free right turn lanes can promote higher speeds through conflict zones, making navigation for through bicycle movements less comfortable.

DESIGN GUIDANCE

Minimums

- 4' wide for bicycle lane

Maximums

- N/A

Other

- 6' wide bicycle lane when speed is >40 MPH
- R4-4 marking should be minimum of 50' at the end of the bike lane

IMPLEMENTATION

- Can be appropriate where bikeways intersect with channelized turn lanes

KEY CONCERNS

- Where speeds are high consider advanced treatments to increase advanced notice of facility and safe weave scenarios – i.e. yield or stop signs, or alter the angle of approach to be within 15 to 30 degrees

ADDITIONAL REFERENCES & GUIDELINES

NACTO Urban Bikeway Design Guide
MUTCD section 9C.04

FREEWAY INTERCHANGE DESIGN

Design for active transportation facilities at freeway interchanges can be very challenging. Freeway interchanges are typically characterized by higher speed and higher volumes of vehicular traffic. Consequently, bicycle levels of traffic stress and the potential for conflict can both increase.

DESIGN GUIDANCE

Minimums

- Solid and dashed white lines should be 6" wide

Maximums

- 8" solid white line where bicycle lane and on ramp lane intersect

Other

- N/A

IMPLEMENTATION

- Can be appropriate where bikeways intersect with freeway interchanges

KEY CONCERNS

- The design speed of entry and exit should impact through bike travel scenarios
- For low speeds – allow bikes to move through the conflict zone with priority
- For higher speeds – bikes should be encouraged to yield to motor vehicles along a dedicated lane

ADDITIONAL REFERENCES & GUIDELINES

MUTCD 3B.08

MUTCD Figure 9C-103 (CA)

RAIL CROSSING (FOR BIKES)

Rail crossings that form a skew angle to the bike facility present steering difficulties for bicyclists across rails. Designs can accommodate single direction bikeways and bi-directional bikeways to provide for preferential crossing angle and widths.

DESIGN GUIDANCE

Minimums

- 45 degree approach angle

Maximums

- Preferred 60 – 90 degree approach angle

Other

- Approach angle should be close to 90 degrees
- May widen the shoulder to help facilitate this

IMPLEMENTATION

- Generally appropriate along at-grade rail crossings with adequate space

KEY CONCERNS

- Wherever possible the bike facility crossing over a rail line should be straight and at a right angle to the rails
- The preferential angle is between 60 and 90 degrees; the minimum angle is 45 degrees

ADDITIONAL REFERENCES & GUIDELINES

HDM Section 400 – Figure 403.3.B; Topic 1003.5(3), and Figure 1003.5

RAISED INTERSECTION

Raised intersections are vertical elements that are placed at intersections. They are similar to speed humps, speed tables, and other devices. Raised intersections create a slight obstruction to vehicles approaching an intersection, which force motorists to slow down and yield to pedestrians.

DESIGN GUIDANCE

Minimums

- Refer to source(s) for design guidance

Maximums

- Maximum grade of 8% recommended in ITE Guidelines for the Design and Application of Speed Humps
- Refer to source(s) for design guidance

Other

- N/A

IMPLEMENTATION

- Appropriate at intersections with marked crosswalks at all four intersection legs and where crosswalks are warranted
- Appropriate along collector and local roads in residential and commercial business district settings with one-way or two-way street
- Can be appropriate along bus transit routes. Typically not appropriate along a primary access route to a commercial or industrial site
- Can include on-street parking at the approach legs
- Maximum speed limit of 30 MPH based on ITE Guidelines for the Design and Application of Speed Humps
- Appropriate if the daily traffic volume on each intersection approach is relatively low (some agencies use 10,000 vehicles total and other use 4,000 vehicles at each leg)

ADDITIONAL REFERENCES & GUIDELINES

NACTO Urban Street Design Guide

BIKE BOX

A bicycle box is an exclusive bicycle space at the head of a traffic lane at a signalized intersection. They allow for increased visibility, priority bicycle movement, and potential conflict reduction between vehicles and bicyclists.

DESIGN GUIDANCE

Minimums

- Minimum box depth of 10' typical depths as deep as 16'
- At least 50' of bicycle ingress lane should be provided on the approach to the bike box

Maximums

- Refer to Caltrans/FHWA bike box design info bulletin

Other

- Where bike box crosses more than one lane, a pedestrian signal with countdown display is required
- Stop line standards from California MUTCD Section 3B.16

IMPLEMENTATION

- Only permitted at signalized intersections. Should be prioritized at intersections with high vehicular and bicycle traffic and where there may be turning conflicts between motorists and bicyclists

KEY CONCERNS

- Limited to signalized intersections
- Applied at intersections where vehicle traffic flows right and bicycle traffic continues through

ADDITIONAL REFERENCES & GUIDELINES

NACTO Urban Street Design Guide.



Pedestrian Hybrid Beacon



Leading Pedestrian Interval



Rectangular Rapid Flashing Beacon (RRFB)

TRAFFIC CONTROL, SIGNAGE, & MARKINGS

PEDESTRIAN HYBRID BEACON

A pedestrian hybrid beacon (PHB) is a traffic control device used to increase motorists' awareness of pedestrian crossings at an uncontrolled marked crosswalk location. A PHB is distinct from pre-timed traffic signals and constant flash warning beacons because it is only activated by pedestrians when needed.

DESIGN GUIDANCE

Minimums

- Install 2 pedestrian hybrid beacons facing major street
- Pedestrian Hybrid Beacons should be installed at least 100' from side streets

Maximums

- Design maximums should follow those for signalized traffic control devices in the CAMUTCD and the Caltrans HDM

Other

- Adequate site distance should be provided at least 100' in advance of the crossing and 20' after the crossing.

IMPLEMENTATION

- APS should be installed at new traffic signals and where signal poles with existing pedestrian push buttons will be modified
- Since many old pushbutton units are 2-wire configurations, may need to review the existing pole wiring to determine whether or not 3-CSCs are currently in use/available since Caltrans approved APS units are 3-wire
- Should be placed at least 100' from side streets or driveways that are controlled by STOP or YIELD signs
- May be appropriate on roadways with high and low speed following figure 4F-1 and figure 4F-2 of the CA MUTCD.

KEY CONCERNS

- On each approach of the crosswalk, a stop line is required
- Advance stop lines should be used on multi-lane crossings to reduce the potential for second threat collisions

ADDITIONAL REFERENCES & GUIDELINES

CA MUTCD section 4F

RECTANGULAR RAPID FLASHING BEACON

Rectangular Rapid Flashing Beacons (RRFBs) are a type of active warning beacon that combines a pedestrian warning sign with user-activated light emitting diodes (LEDs). The device flashes amber when activated through a pedestrian push button or by pedestrian detection.

DESIGN GUIDANCE

Minimums

- The illuminated period of each flash shall be minimum 1/2 of total cycle

Maximums

- The illuminated period of each flash shall a maximum 2/3 of total cycle

Other

- Beacons shall be flashed at a rate of not less than 50 or more than 60 times per minute

IMPLEMENTATION

- Appropriate at uncontrolled marked crosswalks with the exception of roundabout crossings controlled by YIELD signs

KEY CONCERNS

- Use in combination with a crosswalk, wheelchair ramps, advance warning signs or pavement markings, and overheard lighting
- Usually implemented at high volume pedestrian crossings

ADDITIONAL REFERENCES & GUIDELINES

FHWA Interim Approval 21 (IA-21)

SPEED FEEDBACK SIGN

Speed feedback signs are dynamic traffic calming devices that alert approaching motorists of their travel speeds. If motorists are speeding, the feedback sign will flash an LED display of the motorists' speed which is in excess of the posted speed limit, underneath the static portion of the sign which reads, 'YOUR SPEED'.

DESIGN GUIDANCE

Minimums

Min. Static Letter Height

- 4" for posted speeds 20-25MPH
- 6" for posted speeds 30MPH and above

Min. LED Letter Height

- 12" for posted speeds 20-40MPH
- 18" for posted speeds 45MPH and above

Maximums

- Sight distance is dependent on design speed and type of road

Other

Different static sign colors are to be applied at specific locations:

- White – Not FHWA standard
- Yellow – Applied to any location
- Fluorescent Yellow/Green – School zones
- Orange – Work zones

IMPLEMENTATION

- Can be installed in conjunction with a Speed Limit (R2-1) sign or an Assembly C (CA) (SR4-1) school sign where vehicular speeding or changes in posted speed limits are a concern
- Signs may be placed on the same support as an R2-1 sign or Assembly C (CA) sign or on a separate support
- The signs should not be located in areas where drivers frequently perform lane-changing maneuvers, merging or weaving conditions

KEY CONCERNS

- Effective placement of speed feedback signs is important
- The engineer should coordinate with local law enforcement officials on placement
- The CAMUTCD advises that changeable message signs such as the speed feedback sign, should not be positioned at locations where the information load on drivers is already high because of guide signs and other types of information

ADDITIONAL REFERENCES & GUIDELINES

FHWA Interim Approval 21 (IA-21)

BICYCLE DETECTION & PUSH BUTTONS/ ACTUATION

Bicycle detection and push buttons are designed to alert the signal controller of a bicyclist on approach of and at the intersection. Actuation can be installed as push buttons or by automated means that include in-pavement loops, video detection, and microwave.

DESIGN GUIDANCE

Minimums

- Detection zone can be narrower than 6'

Maximums

- Consider maximum mounting height in accordance with ADA requirements and push button standards

Other

- In conjunction with the push button, install optional R62 (CA) faceplate sign that faces the bicyclist's approach to increase visibility

IMPLEMENTATION

- Should be applied at all newly-installed traffic signals
- May be implemented with other detection or actuation devices such as bicycle push buttons or bike detection devices

ADDITIONAL REFERENCES & GUIDELINES

CA MUTCD Section 9

BICYCLE SIGNAL

Bicycle signals facilitate safe bicyclist intersection crossings by restricting conflicting vehicle movements. Bicycle signal heads are standard three lens signal heads with green-yellow and red lenses that can be applied to signalized intersections and hybrid signal crossings.

DESIGN GUIDANCE

Minimums

- Where limit line detection zones that detect the Reference Bicycle-Rider are provided, minimum bicycle timing should be provided (i.e., minimum green interval, Yellow clearance interval and red clearance interval) as a function of the crossing speed (14.7 ft/sec) distance from the limit line to the far side of the last conflicting lane

Maximums

- N/A

Other

- The Bicycle Signal Actuation (R10-22) sign may be installed at signalized intersections where markings are used to indicate the location where a bicyclist is to be positioned to actuate the signal

IMPLEMENTATION

- Separates bicycle movements from conflicting movements with other modes
- Gives priority to bicycle movements at the intersection
- Improves bicycle operation

KEY CONCERNS

- To prohibit right turn on red while the bicycle signal is active, the installation of a traffic signal with red, yellow, and green arrow displays is necessary

ADDITIONAL REFERENCES & GUIDELINES

CA MUTCD section 4D.104(CA), 4D-105(CA)
Table 1A-101(CA) on FHWA's Interim Approval for Optional Use of a Bicycle Signal Face (1A-16)

PEDESTRIAN SAFETY & WARNING SIGNS

Pedestrian signage serves to warn and advise vehicular, bicycle, and other traffic of oncoming pedestrian movement. Signage implementation is often used in conjunction with pavement markings and pedestrian features that enhance awareness of pedestrian crossings or areas.

DESIGN GUIDANCE

Minimums

- N/A

Maximums

- N/A

Other

- N/A

IMPLEMENTATION

- Non-vehicular warning signs (W11-2 Pedestrian or W11-15 or W11-15P) are used to alert road users in advance of locations where unexpected entries in the roadway might occur

KEY CONCERNS

- Specific signage types and locations of signage are governed by the California MUTCD and shall be adhered to when designing for minimum requirements for establishing pedestrian friendly areas or crossings

ADDITIONAL REFERENCES & GUIDELINES

CA MUTCD Part 2

EMBEDDED LED'S IN TRAFFIC SIGNS

Embedded Light Emitting Diodes (LEDs) enhanced traffic signs are similar to typical advisory and warning signs, but are intended to increase motorist awareness of signage. Low-light or low-visibility settings can benefit from added signage visibility per the LED enhancements along the fringe of the sign. Sign illumination can operate 24-hours a day, by time of day, or by pedestrian activation.

DESIGN GUIDANCE

Minimums

- LED installation shall flash at the rate of 50 times per minute

Maximums

- LED installation shall flash at the rate of 60 times per minute

Other

- Sign illumination can operate 24-hours a day, by time of day, or by pedestrian activation

IMPLEMENTATION

- Can be appropriate where increased motorist awareness is desired

KEY CONCERNS

- LED enhanced signs require a low amount of power, which can be sourced from a stand-alone solar panel

ADDITIONAL REFERENCES & GUIDELINES

CA MUTCD Section 2A.07

BICYCLE SAFETY & WARNING SIGNS

Bicycle signage serves to regulate and warn vehicular traffic of the presence or movement of bicyclists within the roadway or traveling across the roadway.

DESIGN GUIDANCE

Minimums

- Where unexpected bicycle conflicts may occur across the traveled way, install bicycle crossing/advance warning signage in advance of the point of crossing

Maximums

- N/A

Other

- Confirmation signs should be implemented every 1/4- to 1/2-mile along off-street facilities, and every 2 to 3 blocks along on-street facilities

IMPLEMENTATION

- Signage should be implemented in conjunction with pavement markings

KEY CONCERNS

- Ensuring minimization of sign clutter, sufficient advance warning with respect to travel speeds and bicycle crossing conflicts, and ensuring adequate sight and compliance of signs

ADDITIONAL REFERENCES & GUIDELINES

CA MUTCD Part 9

LEADING PEDESTRIAN (BICYCLE) INTERVAL

A leading pedestrian interval (LPI), also known as a "pedestrian head start" and "delayed vehicle green", gives pedestrians the opportunity to enter an intersection before motorists are given a green indication.

DESIGN GUIDANCE

Minimums

- 3 to 7 seconds minimum

Maximums

- 10 seconds at longer crossings

Other

- In addition to the LPI, if a bikeway exists at the intersection, and the through movement conflicts with vehicle traffic, install a leading bicycle interval along with the LPI

IMPLEMENTATION

- Should be implemented at intersections with high pedestrian volumes or high conflicting turning vehicle volumes

KEY CONCERNS

- The use of accessible pedestrian signals should be considered
- Requires signal timing adjustments

ADDITIONAL NOTES

- LPI allows for pedestrians to better establish their presence within the intersection, lessening the chances of a vehicle to pedestrian conflict

ADDITIONAL REFERENCES & GUIDELINES

CA MUTCD Section 4E.06(19)

ACCESSIBLE PEDESTRIAN SIGNAL

An Accessible Pedestrian Signal (APS) unlike a conventional pedestrian push button, is more than a detection device, but also serves as a signal for visually-impaired pedestrians who rely on tactile or audio indications to determine when it is safe to enter a crosswalk.

DESIGN GUIDANCE

Minimums

- Two APS on a corner should be at least 10' apart in order for pedestrians to accurately identify the correct direction of the sound source, and which crosswalk is activated by the APS signals

Maximums

- 10 seconds at longer crossings

Other

- For crosswalks where the pedestrian enters the crosswalk more than 100 feet from the pedestrian signal head indications, the symbols should be at least 9 inches high

IMPLEMENTATION

- APS should be installed at new traffic signals and where signal poles with existing pedestrian push buttons will be modified
- Since many old pushbutton units are 2-wire configurations, may need to review the existing pole wiring to determine whether or not 3-CSCs are currently in use/available since Caltrans approved APS units are 3-wire

KEY CONCERNS

- In retrofit situations, need to ensure that:
- There is sufficient vertical space on the pole for the APS housing unit, given the existing pole-mounted equipment, signs and mountings

ADDITIONAL REFERENCES & GUIDELINES

CA MUTCD section 4E